Proceedings of the Gene Flow Symposium of the North Central Weed Science Society Annual Meeting

(www.ncwss.org)

Dates: December 12 & 13, 2007

Location: The Hyatt Regency, St. Louis, Missouri, USA

Purpose: The purpose of the meeting is to bring together academic, industry, government, and other interested scientists to discuss recent and ongoing research on topics related to gene flow from transgenic plants. The meeting will focus on: 1) within-species gene flow; 2) hybridization and gene introgression between transgenic plants and their sexually compatible relatives; 3) consequences of gene flow from transgenic and non-transgenic plants; 4) approaches to managing gene flow; and 5) modeling gene flow.

Organizing Committee:

Michael Horak, Chair. Monsanto Company (michael.j.horak@monsanto.com)
David Gealy, USDA, (dgealy@spa.ars.usda.gov)
Hector Quemada, Crop Technology, Inc.(hdquemada@croptechnology.com)
Allison Snow, Ohio State Univ. (snow.1@osu.edu)
Neal Stewart, Univ. of Tennessee (nealstewart@utk.edu)
Mark Westgate, Iowa State Univ., (westgate@iastate.edu)

Gene Flow Symposium – Wednesday

Room: *Grand Ballroom B*
Moderators: Allison Snow, Hector Quemada

10:00 **Welcome and Introduction.** Michael Horak, Monsanto Company, St. Louis, MO.

10:15 **Seed Mediated Gene Flow in Canola**. Linda M. Hall* and Robert Gulden, University of Alberta, Edmonton, AB. (128)

11:15 **Pollen Mediated Gene Flow in Canola.** Hugh Beckie* and Linda Hall, Agriculture and Agri-Food Canada, Saskatoon, SK and University of Alberta, Edmonton, AB. (129)

12:15 **Lunch Break**

1:45 **Interspecific Gene Flow in Canola.** Suzanne I. Warwick*, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON, Canada. (130)

2:45 **Impact of Distinct Insect Pollinators on Gene Flow.** Johanne Brunet* and Karsten G. Holmquist, USDA-ARS, University of Wisconsin, Madison. (131)

3:00 **Ecological Effects of Virus-Resistant Transgenic Squash on Wild Squash Population Dynamics.** Holly R. Prendeville* and Diana Pilson, University of Nebraska, Lincoln, NE. (132)

3:15 **Long-term Field Studies of the Evolution of Crop-Weed Hybrids in Radish: Implications for Invasiveness.** Allison A. Snow*, Lesley G. Campbell, Theresa M. Culley, and Caroline E. Ridley, The Ohio State University, Columbus, OH; University of Maryland, College Park, MD; University of Cincinnati, OH; and University of California, Riverside, CA. (133)

3:30 **Discussion**

3:45 **Break**

4:00 **Weed-to-Weed Gene Flow – What is the Potential for Glyphosate Resistance Movement via Interspecific Hybridization?** Micheal D. K. Owen* and Ian A. Zelaya, Iowa State University, Ames, IA and Syngenta Ltd. Jealott's Hill International Research Centre, UK. (134)

4:15 **Gene Flow and Risk Assessment: Case by Case Considerations.** Michael J. Horak* and Thomas E. Nickson, Monsanto Company, St. Louis, MO. (135)

4:30 **Gene Flow Dynamics and Confinement: A Regulatory Perspective.** Subray Hegde*, Biotechnology Regulatory Services/APHIS/USDA, Riverdale, MD. (136)

4:45 **Introduction of a New Issue Paper from CAST, 'Implications of Gene Flow in the Scale-up and Commercial Use of Biotechnology-Derived Crops: Economic and Policy Considerations'.** David R. Gealy*, USDA-ARS, DBNRRC, Stuttgart, AR. (137)

5:15 **Discussion**

5:30 **Adjourn**

6:45 **Banquet**

Gene Flow Symposium - Thursday

Room: *Grand Ballroom B* Moderators: Mark Westgate, David Gealy

8:15 **Modeling the Biology of Out-Crossing by Adventitious Pollen.** Mark Westgate*, Juan Astini, Agustin Fonseca, Jon Lizaso, Craig Clark, and Ray Arritt, Iowa State University, Ames, IA. (199)

8:30 **Application of a 3D Windbreak Model to Compare Field Plot Designs for Limiting Pollen Dispersal.** Craig Clark, Juan Astini, Ray Arritt*, Mark Westgate and Susana Goggi, Iowa State University, Ames, IA. (200)

8:45 **Application of Large Eddy Simulation to Quantify Dispersal of Viable Maize Pollen.** Brian Viner*, Ray Arritt, Mark Westgate and Susana Goggi, Iowa State University, Ames, IA. (201)

9:00 **Pollen Flow in the Environment - Development of a Research Program.** John A. Glaser*, USEPA, Office of Research & Development, National Risk Management Research Laboratory, Cincinnati, OH. (202)

9:15 **Seed-to-Seed and Hay-to-Seed Pollen Mediated Gene Flow in Alfalfa.** Larry R. Teuber*, Shannon Mueller, Allen Van Deynze, Sharie Fitzpatrick, James R. Hagler and Jose Arias, University of California, Davis, Forage Genetics, Inc, West Salem, WI and ARS-USDA, Arid-Land Agricultural Research Center, Maricopa, AZ. (203)

9:30 **Alfalfa Gene Flow Research and Information: Applicability to Seed Production Systems.** Sharie Fitzpatrick*, Jose Arias, Mark McCaslin and Peter Reison, Forage Genetics, Inc., West Salem, WI. (204)

9:45 **Discussion**
10:00 **Break**

10:15 **Red Rice Diversity and Planting Date Effects on Risk of Gene Flow.** Nilda R. Burgos*, Vinod K. Shivrain, David R. Gealy, Kenneth L. Smith, and Robert C. Scott, University of Arkansas, Fayetteville, AK and USDA-ARS, DBNRRC, Stuttgart, AK. (205)

10:30 **Gene Flow between Sugar Beet and Weed Beet: From Facts to Models.** Henri Darmency*, Nathalie Colbach, Mathilde Sester, Yann Tricault, Etienne Klein and Marc Richard-Molard, INRA, Dijon, France. (206)

10:45 **Discussion**

11:00 **Commercial-Scale Pollen-Mediated Gene Flow in Winter Wheat in the Central Western Great Plains.** Todd A. Gaines, Patrick F. Byrne*, Philip Westra, Scott J. Nissen and Phillip L. Chapman, Colorado State University, Fort Collins, CO; W. Brien Henry, USDA-ARS, Akron, CO; and Dale L. Shaner, USDA-ARS, Fort Collins, CO. (207)

11:30 **Hybridization between Jointed Goatgrass and Imidazolinone-Resistant Winter Wheat.** Todd A. Gaines,* W. Brien Henry, Patrick F. Byrne, Philip Westra, Scott J. Nissen and Dale L. Shaner, Colorado State University, Fort Collins, CO; USDA-ARS, Akron, CO; and USDA-ARS, Fort Collins, CO. (208)

11:45 **Tier 1 Evaluation of Pollen-Mediated Gene Flow between Triticale (X Triticosecale, Wittmack) and Common Wheat, Durum Wheat and Rye.** Melissa J. Hills*, Linda M. Hall and François Eudes, Agriculture and AgriFood Canada, Lethbridge, Alberta; Alberta Agriculture and Food/University of Alberta, Edmonton; Grant MacEwan College, Edmonton, Alberta. (209)

12:00 Discussion and Wrap-up

Poster Titles –

Identifying Maize Diversity Areas and Implications Regarding Biosafety Measures. Francisca Acevedo*, José Sarukhán, Jorge Larson, Elleli Huerta, Patricia Koleff, Claudia Aguilar, Alejandra Barrios and Oswaldo Oliveros, National Commission for the Knowledge and Use of Biodiversity, CONABIO, Mexico City, Mexico and Ministry of the Environment and Natural Resources, Mexico City, Mexico (66)

Seed-Mediated Gene Flow in Certified and Farm-Saved Seed Lots. Todd A. Gaines*, Christopher Preston, Patrick F. Byrne, W. Brien Henry, and Philip Westra, Colorado State University, Fort Collins; University of Adelaide, Australia; and USDA-ARS, Akron, CO. (67)

Interloper's Legacy: Invasive, Hybrid-Derived California Wild Radish (Raphanus sativus) Evolves to Outperform its Immigrant Parents. Caroline E. Ridley*, Rosamond F. Tsao and Norman C. Ellstrand, University of California, Riverside, CA. (68)

Sympatry and Hybridization of Canola and Bird Rape (Brassica rapa) in Quebec. Marie-Josée Simard, Anne Légère, and Suzanne I. Warwick*, Agriculture and Agri-Food Canada (AAFC) Québec, QC; Saskatoon, SK; and Ottawa, ON, Canada. (69)

Do Escaped Transgenes Persist in Nature? The Case of an Herbicide Resistance Transgene in Weedy Population of Brassica rapa. Suzanne I. Warwick*, Anne Légère, Marie-Josée Simard, and Tracey James, Agriculture and Agri-Food Canada (AAFC) Ottawa, ON; Saskatoon, SK; Québec, QC; and Ottawa, ON, Canada. (70)

Measuring the Effects of Crop Genetic Load on Productivity and Fitness in Weedy Brassica rapa (wild turnip) × Brassica napus (oilseed rape) Hybrid Populations. Reginald J. Millwood*, Christy W. Rose*, and C. Neal Stewart, Jr., University of Tennessee, Knoxville, TN. (71)

Strategies to Reduce Transgene Movement and Persistence. Hong S. Moon*, Jason N. Burris*, Reginald J. Millwood, Christy W. Rose, and C. Neal Stewart, Jr., University of Tennessee, Knoxville, TN. (72)

Estimating Pollen-Mediated Gene Flow in Colorado Corn Fields with the Blue Kernel Trait. Patrick F. Byrne*, Todd A. Gaines, Ron F. Meyer, and Rob Alexander, Colorado State University, Fort Collins, CO; Colorado State University, Burlington, CO; Boulder County Parks and Open Space Department, Longmont, CO. (73)

Assessment of Potential Impact of Hybridization between Teosinte (Zea ssp.) and Maize (Zea mays ssp. mays) on Dormancy Characteristics of Teosinte. Baltazar M. Baltazar*, William J. Duncan, Daniel L. Kendrick and Michael J. Horak, Monsanto Company, St. Louis, MO. (74)

Regulation of Diurnal Pollen Release. Brian Viner*, Ray Arritt and Mark Westgate, Iowa State University, Ames, IA. (75)

Variation in ALS Herbicide Resistance of Diverse Crop-Wild Sunflower Hybrids. Kristin L. Mercer*, Kevin Betts, Ruth G. Shaw, and Donald L. Wyse, The Ohio State University, Columbus, OH and University of Minnesota, St. Paul, MN. (76)

Lifetime Fecundity of F1 Crop-Wild Sorghum Hybrids: Implications for Gene Flow from Transgenic Sorghum in Africa. Allison A. Snow, Patricia M. Sweeney*, Cécile Grenier, Tesfaye Tesso, Issoufrou Kapran, Gurling Bothma, Gebisa Ejeta, and Jeffrey F. Pedersen, The Ohio State University, Columbus, OH; Purdue University, West Lafayette, IN; Ethiopian Institute of Agricultural Research, Nazareth, Ethiopia; Institut National de la Recherche Agronomique du Niger, Niamey, République du Niger; ARC-Roodeplaat, Pretoria, South Africa; and USDA, ARS, University of Nebraska, Lincoln, NE. (77)

Crop-Wild Hybridization and the Rate of Evolution in Weeds. Lesley. G. Campbell*, Allison A. Snow, and Patricia M. Sweeney, University of Maryland, College Park, MD and The Ohio State University, Columbus, OH. (78)

Modeling Pollen Dispersal between Fields of White Clover – Co-existence with GM-White Clover? Christina L. Løjtnant*, Christian. F. Damgaard and Rikke B. Jørgensen, Risø National Laboratory; Technical University of Denmark, DK-4000 Roskilde, DMU; and University of Århus, DK-8600 Silkeborg, Denmark. (79) CANCELLED

Biosafety Assessment and Benefits for Co-existence of Biological Contained Plants – Regulatory Assessment in the EU-project "TransContainer". Christiane Koziolek* and Detlef Bartsch, Federal Office of Food Safety and Consumer Protection, Berlin, Germany. (80)

Addressing Gene Flow Issues in Cowpea for West Africa. Remy Pasquet, ICIPE, IRD Nairobi, Kenya; Barry Pittendrigh, Purdue University, West Lafayette, IN; Mohammad Ishiyaku, Ahmadu Bello University, Zaria, Nigeria; Ibrahim Baoua, INRAN, Maradi, Niger; Clementine Dabiré, INERA Ouagadougou, Burkina Faso; Malik Ba, INERA, Ouagadougou, Burkina Faso; Manuele Tamò, IITA Cotonou, Benin; Larry Murdock, Purdue University, West Lafayette, IN; and Joseph Huesing*, Monsanto Company, St. Louis, MO. (81)

ABSTRACTS OF PRESENTATIONS AND POSTERS

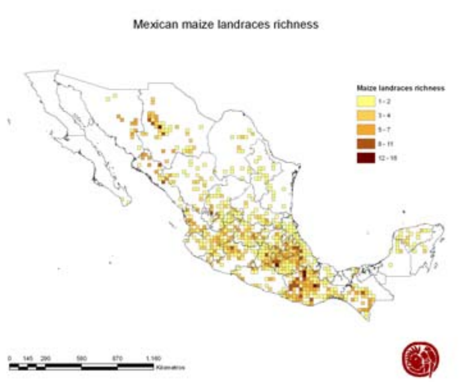
Listed alphabetically by first author; also listed at www.ncwssa.org by scheduling number.

IDENTIFYING MAIZE DIVERSITY AREAS AND IMPLICATIONS REGARDING BIOSAFETY MEASURES. Francisca **Acevedo**, José Sarukhán, Jorge Larson, Elleli Huerta, Patricia Koleff, Claudia Aguilar, Alejandra Barrios and Oswaldo Oliveros*, National Commission for the Knowledge and Use of Biodiversity, CONABIO, Mexico City, Mexico and Ministry of the Environment and Natural Resources, Mexico City, Mexico.

In March 2005, Mexico approved the "Biosafety Law on Living Modified Organisms"(visit http://bch.cbd.int/database/record.shtml?id=8474) which among other things calls for a special regime to protect maize (article 2 fraction XI) and specifies the need to identify areas that are center of origin and current centers of genetic diversity for those species for which Mexico is center of origin and/or center of genetic diversity (articles 86 and 87), so as not to release GM related species in these areas.

Article 86 calls for the Ministries of Agriculture and Environment to arrange for "legal agreements" regarding these areas based on existing information coming from several governmental institutions, among those, the National Commission for the Knowledge and Use of Biodiversity (CONABIO, visit at www.conabio.gob.mx). In 2006 the Ministry of Agriculture asked CONABIO to provide the existing information on maize and its related wild relatives present in its biological databases. CONABIO generated a document called "General elements to determine the maize origin and genetic diversity centers, and the specific case of the experimental release into the environmental of transgenic maize in Mexico" (visit http://www.conabio.gob.mx/conocimiento/bioseguridad/doctos/Doc_CdeOCdeDG.pdf) which was sent to the two Ministers as information for the decision making process related to this particular issue.

This document includes distribution analysis both for maize landraces and teocintle species in a quadrant system of 0.5° x 0.5° (approximately 25 km per side) were landrace and species numbers present are enumerated. See maps that include all maize and teocintle information available to CONABIO through its biological databases.



It also includes four possible decision making scenarios related to spatial distribution, going from less to more conservative, the most conservative being a 32 km buffer around the quadrant according to *Luna et al.* 2001 as a safety area related to the maximum hypothetical linear distance of pollen flow. Article 86 calls for current genetic diversity areas, what this means is not clear. CONABIO decided that information coming from 1990 and onward would be considered current under its analysis, whilst only 20% of the data deposited in its biological databases fitted the criteria.

The document makes recommendations, one of them being to "integrate all the existing information in the country as well as to update it to reduce uncertainty in delimitating the areas the law calls for". Taking this recommendation into account, the two ministries plus CIBIOGEM, a interministerial commission on biosafety (visit http://www.cibiogem.gob.mx) donated funds so as to accomplish the task asked for in this recommendation.

The key question is if delimitating these areas will be enough so as to make sure that maize landraces and/or teocintle species present in these areas will be "protected" from GMO related species if grown in Mexican territory. Probably not. Even though buffers were chosen to be the most "conservative" possible, no biosafety measures will be enough at a commercial scale as to counteract traditional seed exchange between the rural farmers which happens to be the single most important factor to ensure genetic diversity existing in the first place. The law in question on the other hand does not describe the components of the regime. Delimitating areas will certainly be a component but seed management and other cultural practices should be considered. This is why an exercise to map land use to reflect the distribution of agroindustrial production (indicated by the presence of irrigation agriculture) and traditional rainfed agriculture would be useful as well in such an analysis.

Although the analysis here presented focuses on maize, the fact is that GMO have been developed and trials are underway for other crops for which Mexico is a center of origin and/or center of genetic diversity. If other genera are added to the analysis what would emerge are centers of diversity of genetic resources for food and agriculture. These areas, viewed as regions which contribute to *in situ* conservation of genetic resources could then be subject to specific policies that promote and protect this diversity.

Luna S., Figueroa J., Baltazar B., Gómez R., Townsend R., J.B. Schoper. Maize pollen longevity and distance isolation requirements for effective pollen control. Crop Science 2001 Vol. 41, pp 1551-1557.
Turrent A. and J.A. Serratos. Context and Background on Maize and its Wild Relatives in Mexico. Chapter 1. In: Maize and Biodiversity: The Effects of Transgenic Maize in Mexico. CEC, 2004.
Biosafety Law on Living Modified Organisms (visit http://bch.cbd.int/database/record.shtml?id=8474)
"General elements to determine the maize origin and genetic diversity centers, and the specific case of the experimental release into the environmental of transgenic maize in Mexico" (visit http://www.conabio.gob.mx/conocimiento/bioseguridad/doctos/Doc_CdeOCdeDG.pdf)

ASSESSMENT OF POTENTIAL IMPACT OF HYBRIDIZATION BETWEEN TEOSINTE (*Zea* spp.) AND MAIZE (*Zea mays* spp. *mays*) ON DORMANCY CHARACTERISTICS OF TEOSINTE. Baltazar M. **Baltazar***, William J. Duncan, Daniel L. Kendrick and Michael J. Horak, Monsanto Company, St. Louis, MO 63167, USA.

Teosinte (*Zea* spp.) is an annual and perennial grass endemic to Mexico and Central America. Teosinte resembles maize (*Zea mays* spp. *mays*), but differs in various phenotypic characteristics including: pollen size and pollen viability, number of tassels per plant, and in the morphology of the pistillate inflorescence. In contrast to maize, teosinte populations survive as wild plants. This may be in part due to seed dispersal and dormancy mechanisms found in teosinte but absent in maize.

Research has demonstrated that gene flow and hybridization between teosinte and maize is possible. Furthermore, with the advent of genetically modified (GM) maize, questions have been raised regarding the potential ecological risks associated with the introduction of GM maize into areas where teosinte is present. However, there has been limited research on the biological effects of maize genes transferred to teosinte. One area of interest is on the effect of hybridization and introgression on seed dormancy (e.g., hard seed). One possible effect of hybridization between teosinte and maize would be decreased dormancy of hybrid seed.

Experiments to evaluate seed dormancy of *Zea* spp. were conducted during 2007. Four replicates of 25 seeds each of 8 *Zea* spp. were placed in rolled germination towels, arranged in a completely randomized block design and then placed in a germination chamber set at 25°C for 8 days. Seed/seedlings were evaluated as germinated (normal and abnormal, dead, or hard following AOSA guidelines 5 and 8 days after planting. The percentages of each category were statistically compared for each species.

Results of the experiments revealed four significantly different groups for the *Zea* species evaluated according to their percentage of dormant seed; Group 1, *Zea nicaraguensis* with 55%; Group 2, *Zea luxurians* (34%), *Zea mays* spp. *mexicana* (30%) *and Zea mays* spp. *parviglumis* (25%); Group 3, *Zea huehuetenangensis* (20%) *and Zea perennis* (16%) and Group 4, *Zea diploperenis* (8%) *and Zea mays* spp. *mays* (0%).

Additionally, experiments are underway to evaluate seed dormancy characteristics of hybrid seed from crosses between teosinte and maize.

POLLEN-MEDIATED GENE FLOW IN CANOLA. Hugh J. **Beckie** and Linda M. Hall, Plant Scientist, Agriculture and Agri-Food Canada, Saskatoon, SK S7N 0X2 and Research Scientist/Adjunct Professor, Alberta Agriculture and Food, University of Alberta, Edmonton, AB T6G 2P5.

Outcrossing in canola or oilseed rape (*Brassica napus* L.) is highly variable, averaging 30%. The crop is partially pollinated by insects, particularly honey bees and bumble bees, but is also known to release large amounts of air-borne pollen. There is consensus that insects can be important contributors to short-distance pollination; in addition, bees and other insects such as pollen beetles can also contribute to long-distance pollen movement. However, the relative importance of wind vs. insects in long-distance gene flow in canola is uncertain. Coexistence among transgenic and non-transgenic cropping systems and identity preservation at the field level are increasingly important issues in many countries. Different types of pollen-mediated transgene flow models for canola have been released during the past decade primarily as a decision-support tool to achieve the European Union (EU) 0.9% transgenic labeling threshold for adventitious presence (AP) of authorized transgenes in food and feed. Many empirical models simulate gene flow well, although their utility is usually restricted by datasets with limited environmental variability or spatial scale. Development of predictive mechanistic models and simulation of transgene flow via insects and wind across agroecosystem landscapes are still in their infancy, although recent progress is promising. Experimental and modeling outcrossing studies reveal that no isolation distance is required between transgenic pollen donor and non-transgenic (conventional) receptor fields of realistic size to meet the EU threshold if AP from other sources (e.g., volunteers, admixture) is minimal. Because seed loss and volunteerism are common in canola, however, transgene flow via seed, not pollen, may be a greater source of AP.

IMPACT OF DISTINCT INSECT POLLINATORS ON GENE FLOW. Johanne **Brunet** and Karsten G. Holmquist, research ecologist and postdoctoral associate, United States Department of Agriculture, Agricultural Research System, Vegetable Crops Research Unit, University of Wisconsin, Madison, WI 53706.

The vast majority of fruits and vegetables, together with some hay crops (alfalfa) and some oil-producing crops (canola) are pollinated by insects. However we have little information on how insect pollinators affect the movement of genes via pollen and even less on how distinct insect pollinators may differentially affect pollen flow. In this study we examined whether two types of insect pollinators, bumble bees and hawkmoths, differentially affected gene flow via pollen in the rocky mountain columbine, our model system. In one experiment, we used paternity analyses to contrast the movement of genes via pollen by bumble bees and hawkmoths within and between patches within a population. In a second experiment, we genotyped seeds from many target females located within a 40 km^2 area, and used the Kindist module of Poldisp v.1.0 to fit the exponential power model to the haplotype data in order to calculate the average distance, axial variance and kurtosis of pollen dispersal for each pollination treatment. Both pollinator types were as efficient at moving pollen around (male function). In addition both pollinator types visited the same number of females and each female received similar progeny diversity whether pollen was carried by hawkmoths or by bumble bees. Moreover bumble bees did not limit their movement to nearest neighbor plants but frequently moved pollen among patches. On a larger geographical scale, dusk and night flying pollinators (hawkmoths) moved pollen 2-5 X as far as day flying pollinators (bumble bees). Pollen dispersal was fat tailed with relatively high kurtosis indicating the importance of long distance gene dispersal.

RED RICE DIVERSITY AND PLANTING DATE EFFECTS ON RISK OF GENE FLOW. Nilda R. **Burgos**, Vinod K. Shivrain, David R. Gealy, Kenneth L. Smith, and Robert C. Scott, Associate Professor, Graduate Assistant, Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR 72704, Plant Physiologist, Dale Bumpers National Rice Research Center, Stuttgart, AR 72160, Professor, University of Arkansas Cooperative Extension Service, Monticello, AR 71656, and Associate Professor, University of Arkansas Cooperative Extension Service, Lonoke, AR 72086.

Red rice (*Oryza sativa* L.) is a problematic weed in rice production worldwide. Red rice control is difficult with conventional herbicides due to its similar biology and physiology as cultivated rice. Herbicide-resistant (HR) rice provides a valuable tool for red rice management, but with a risk of transferring HR gene to red rice populations. Diversity in red rice populations mainly in flowering time, plant height, and sexual compatibility with cultivated rice and the wide window of planting time can affect the rate of HR gene transfer from rice to red rice. Thus, experiments were conducted to understand the effect of: a) red rice biotype, b) rice cultivar, and c) sexual compatibility of rice and red rice on outcrossing rate.

Small plot experiments were conducted at the Rice Research Extension Center, Stuttgart; and Southeast Research and Extension Center, Rowher, AR from 2005 to 2007. Experimental design was a split-split plot with 3-4 replications, with planting date as main plot, Clearfield (CL) rice cultivar as subplot, and red rice biotype as sub-subplot. Rice and red rice were planted from early April to late May at 2-week intervals. CL161, CL hybrid and 12 red rice accessions were used. Red rice was planted in the middle row of each plot, flanked by four CL161 or CL hybrid rice on each side. Emergence, flowering, and plant height of red rice and CL rice were recorded. Red rice seed was harvested and a sub-sample of 100 g was planted in the field in subsequent years. Red rice seedlings were sprayed twice with imazethapyr at 0.14 kg ai/ha. Red rice plants which survived imazethapyr applications were counted and confirmed as outcrosses by DNA analysis. Manual crosses also were performed between the 12 red rice accessions and CL161 to determine their sexual compatibility.

The red rice accessions were 100 to 160 cm tall, with a flowering period ranging from 88 to 128, 87 to 117, 79 to 118, and 71 to 116 days after planting in the first, second, third, and fourth planting, respectively. Outcrossing rate differed between locations, but trends of outcrossing rate affected by red rice biotypes, CL rice, and planting dates were similar at both locations. At any given planting date, outcrossing rates differed between red rice accessions due to differences in flowering time. Planting date by CL cultivar and planting date by red rice accession interactions were significant ($p< 0.05$) for outcrossing rate. The outcrossing rate in different red rice accessions ranged from 0 to 0.3% across planting dates. Brownhull red rice had the highest outcrossing rate regardless of the CL rice cultivar pollen donor, and strawhull had the lowest outcrossing rate in general. Averaged over planting dates, the outcrossing rate between CL hybrid rice and red rice accessions was 0.3% compared with 0.06% in CL161. In experiments related to compatibility, brownhull, blackhull, and strawhull had 91, 78, and 71% seed set, respectively, which corroborate the results of field experiments. The data suggest that the interaction of planting date, red rice biotype, and rice cultivar can result in no gene transfer in some cases to significantly high risk of gene transfer in others. Hence, these factors need to be considered in planning HR gene transfer mitigation strategies for rice.

ESTIMATING POLLEN-MEDIATED GENE FLOW IN COLORADO CORN FIELDS WITH THE BLUE KERNEL TRAIT. Patrick F. **Byrne**, Todd A. Gaines, Ron F. Meyer, and Robert Alexander. Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Extension Agronomist, Colorado State University Cooperate Extension, Burlington, CO 80807-1674, and Agricultural Resource Specialist, Boulder County Parks and Open Space, Longmont, CO 80503.

Pollen-mediated gene flow (PMGF) from genetically engineered (GE) corn (*Zea mays* L.) has become a topic of intense interest. Organic growers and others seeking to avoid the presence of transgenic material in their corn harvests want to know how far to isolate their crops from GE hybrids. Although similar studies on corn gene flow have been conducted in other parts of the U.S., to our knowledge none had been carried out under conditions similar to Colorado's corn growing areas. Our objective was to determine the percent cross-pollination that occurred across a range of distances in multiple locations and years in Colorado's Front Range and eastern plains. We used the dominant blue kernel trait to track cross-pollination. Plots of blue corn were planted as central islands surrounded by large fields of yellow corn. Dates of pollen shed and silk emergence were recorded to verify a sufficient overlap in flowering time between pollen source and recipient plants. At harvest, samples of 10 ears each were collected in several directions from the blue corn plot at distances that generally ranged from 0.75 to 300 m. For each sample, the number of blue and yellow kernels were counted and the percentage of blue kernels was calculated as an indication of the frequency of cross-pollination. Data from a total of 13 locations over six years were used in the analysis. As expected, the amount of cross-pollination was high at the closest sampling sites (mean of 29.3% at 0.75 m). Cross-pollination decreased rapidly with distance, dropping to a mean of 0.20% at 46 m and 0.05% at 92 m. The farthest distance at which any blue kernels were observed was 320 m. The information collected in this study helped a Boulder County technical advisory committee determine an isolation distance of 46 m between GE corn crops and organic corn crops on county-owned Open Space lands. This study will also be relevant elsewhere in Colorado and similar environments where there are concerns about cross-pollination from GE corn.

CROP-WILD HYBRIDIZATION AND THE RATE OF EVOLUTION IN WEEDS. Lesley. G. **Campbell**, Allison A. Snow, and Patricia M. Sweeney, Postdoctoral fellow, Department of Plant Sciences and Landscape Architecture, University of Maryland, College Park, MD, 20742, Professor, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210, and Senior Research Associate, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210.

When species hybridize their offspring routinely suffer from reduced fertility and poorly adapted phenotypes. Consequently, it seems unlikely that these plants could be successful weeds. Reflecting this belief, risk assessments of crop-wild hybrids often dismiss the potential for crop gene flow to produce 'superweeds'. However, in the absence of empirical evidence, the evolutionary potential of early-generation hybrids remains hypothetical. Here, we explore the potential for *rapid* evolution in crop-weed hybrids and its consequences for crop allele introgression. Using hybrids of a cosmopolitan weed (*Raphanus raphanistrum*) and its cultivated relative (*R. sativus*), we compared the ability of hybrid and wild lineages to respond to artificial selection for early flowering and large size at reproduction, two life-history strategies which characterize weedy species. *Raphanus raphanistrum* grows a rosette with a thin, fibrous taproot, bolts within a few weeks after germination and produces yellow flowers soon after. On the other hand, crop breeding has emphasized delayed bolting with white flowers in *R. sativus* in order to produce the edible, enlarged roots (Snow and Campbell, 2005). Early flowering may be adaptive for weedy radishes because growing seasons for weeds are often curtailed by tilling schedules, herbivores, frost, and other causes of mortality or severe stress. The evolutionary potential to evolve earlier flowering may be more important for hybrid radishes given that hybrid fecundity, relative to wilds, may be limited by delayed flowering, a trait inherited from their cultivated parent and by low pollen fertility due to a reciprocal translocation that affects chromosome pairing (Snow et al. 2001; Campbell and Snow, in prep.). When hybridization occurs between species with such diverse life histories, the individual offspring will be phenotypically variable. Populations created with this initial diversity should have the opportunity to evolve along diverse trajectories with respect to life history. If crop-wild hybrids can evolve quickly from maladaptive intermediates to adaptive phenotypes, they may be more difficult to control. Large size in annual weeds is often correlated with rapid growth rates. In weedy radish, leaf length is correlated with high flower and seed production, suggesting that plants with rapid growth rates would also be highly fecund. If large size is adaptive, this may facilitate the introgression of additional adaptive quantitative traits into weed populations.

In wild and hybrid lineages, four generations of selection were performed to determine whether these traits exhibited a response to selection (i.e., were heritable) and the relative magnitude of their response across wild and hybrid lineages. Hybrid lineages exhibited a greater response to selection for early flowering suggesting its heritability is greater in hybrid lineages versus wild lineages. Early-generation hybrids had longer leaves than wild plants and they maintained this length difference after selection for longer leaves. This suggests that polygenic traits, such as size, inherited from domestic relatives may easily introgress into weed populations. Four generations of selection also resulted in the correlated evolution of hybrid flower petal color and hybrid pollen fertility. Large hybrid lineages exhibited higher than expected frequencies of plants with white petals, a crop-specific, simply inherited trait. Therefore, selection for a polygenic crop-specific trait accelerated the introgression of an additional crop-specific trait. Further, pollen fertility of early-flowering hybrid lineages was similar to that of wild lineages, and at least 12% higher than hybrid control lineages. Therefore, selection for earlier flowering in hybrid lineages led to rapid evolution of fertility, a key component limiting hybrid fitness. Despite selection for the early-flowering, wild phenotype, hybrid lineages maintained high frequencies of the crop-derived trait, white flower color, confirming persistent introgression. The persistence of white flower color and increase in pollen fertility after experimental manipulation of the selection environment may explain some results from our long-term studies in crop allele introgression (Snow et al., in prep; Campbell et al., 2006)

Both wild and hybrid lineages apparently possess substantial additive genetic variation for size at reproduction. Nevertheless, hybrid lineages evolved more rapidly under selection for age at reproduction and exhibited more extreme phenotypes under selection for large size at reproduction than their weedy parents. We suggest that hybrids have the potential to rapidly respond to newly invaded environments and may become more invasive weeds than their wild progenitors.

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APPLICATION OF A 3D WINDBREAK MODEL TO COMPARE FIELD PLOT DESIGNS FOR LIMITING POLLEN DISPERSAL. Craig A. **Clark**, Juan Astini, Raymond W. Arritt, Mark E. Westgate and A. Susana Goggi, Graduate Students and Professors, Department of Agronomy, Iowa State University, Ames, IA 50011.

Placing windbreaks or shelter around a field may help reduce the escape of transgenes into the environment. An optimal configuration of such designs is desirable, but the cost and labor involved in field studies imposes practical limitations on the number of candidate designs that can be tested. We propose that a combined shelter flow model and a Lagrangian dispersion model can be used as a screening tool to test the effect of border design, field geometry, wind climatology, and other factors on pollen transport. This allows field studies to focus more efficiently on designs that are likely to be successful. We tested a the model by simulating results from field projects in the 2005 and 2006 growing seasons in which a tall annual grass (sorghum sudangrass) was planted as a border around a small maize plot. Field measurements for both 2005 and 2006 showed that a sorghum sudangrass border reduced the maximum distance of pollen dispersal from 300 m to 160 m. Model results show a decrease in downwind transport of pollen but predicted patterns of pollen deposition are much smoother than observed. We propose that this limitation derives partly from incomplete knowledge of the diurnal timing of pollen shed and partly from limitations in sampling observed pollen deposition.

GENE FLOW BETWEEN SUGAR BEET AND WEED BEET: FROM FACTS TO MODELS. Henri **Darmency**, Nathalie Colbach, Yann Tricault, Mathilde Sester, Etienne Klein and Marc Richard-Molard, Seniors and graduate scientists, Weed Biology and Management, Institut National de la Recherche Agronomique, BP 86510, 21065, Dijon, Senior scientist, Biostatistics, Institut National de la Recherche Agronomique, 84914 Avignon cedex 9 and Director, Institut Technique de la Betterave, 45 rue de Naples, 75008 Paris, France.

Farm-scale monitoring was conducted at two locations in root production fields during six-years to study the occurrence and the mechanisms of gene flow between transgenic herbicide-resistant sugar beet and weed beet. We investigated the impacts of cultivar properties and control of bolting plants on the frequency of the transgene presence in weed beet populations. Specific experiments were carried out to quantify biological parameters affecting competition response, flowering, pollen flow, seed set and survival in the soil. These quantifications were incorporated as sub-models in the GENESYS model to simulate the effects of various farming systems (crop succession, cultivation techniques) on the dynamics and genetic composition of weed beet populations in a small region, and to propose the best agricultural practices to control weed beet and to prevent the advent of herbicide resistance in weed beet.

ALFALFA GENE FLOW RESEARCH AND INFORMATION: APPLICABILITY TO SEED PRODUCTION SYSTEMS. S. **Fitzpatrick***, J. Arias, M. McCaslin and P. Reisen, Forage Genetics International, West Salem, WI 54669

With the advent of the first biotech-improved varieties in alfalfa, there have been renewed efforts to manage and model pollinator-mediated gene flow between alfalfa seed production fields. Separate research-scale models have been developed for honey bee (Teuber et al. 2005) and alfalfa leafcutting bee pollination systems (Fitzpatrick et al., 2003) which used plots ≤1 acre in most cases. Due to factors of scale and bee foraging behavior, etc, it is recognized that small alfalfa seed fields have greater proportional gene influx than larger fields. For example, certified foundation seed fields larger than 5 ac are required to have 600 ft isolation, whereas, smaller fields must have 900 ft (1.5X). Therefore, it was hypothesized that these research models were likely to overestimate the amount of pollen flow into commercial-scale fields. Nonetheless, FGI in consultation with alfalfa industry stakeholders used these small-field models and existing foundation standards to develop the FGI Best Practices for Roundup Ready Trait Stewardship during Commercial Seed Production ("Best Practices"). The Best Practices require isolation distances that are intentionally rigorous, science-based, and pollinator species-specific; the isolation distances are five to 95 times greater than certified standards. Specifically minimum distances are: 900 ft, 1 mi or 3 mi for leafcutter, alkali or honeybees, respectively. The practices were designed to help conventional seed growers mitigate adventitious presence (AP) to a very low amount (e.g., <0.5%). For a range of isolation distances, FGI used the RRA trait as a pollen-marker to compare pollen-flow predicted vs. observed values for 116 large fields grown 2006/2007. The new data were also used to determine the efficacy of the Best Practices seed stewardship program.

The amount of pollen-flow between large fields, in all cases, was less than was predicted using the models and well within the company's tolerance, <0.5%. In the 104 conventional seed lots grown with Best Practices minimum isolation, AP occurred infrequently and when detected, was at a very low level (0.004-0.180%). For the 12 closer fields, AP was ≤0.47%; the nearest field being only 120 ft isolated under leafcutter bee pollination. This nearest field (150 acres, 0.47% overall) was sampled on a grid and the borders were harvested separately to evaluate field border effects. As expected based on previous research and certification standards, the nearest border (the area <165 ft isolation) had the highest incidence of pollen-flow (>1%). For AP sensitive seed lots, segregated harvest of the nearest field edge can therefore be used to help mitigate gene flow to the main field bulked seed lot. Nearest-edge harvest segregation is consistent with seed certification standards for fields with a portion of the field at less than the minimum requirement, 165 ft isolation. Other FGI conventional seed lots were evaluated for seed admixture consequent to seed conditioning on equipment previously used for RRA seed handling; the equipment was thoroughly cleaned between lots. No AP was detected in these conventional seed lots.

While the research models are accurate for seed production in small fields (<5 ac) they significantly overestimate pollen-flow in the commercial setting where very large fields are common. The models have been extremely useful as a first step in the initial development of pollinator-specific commercial trait mitigation systems for alfalfa seed producers. These commercial-scale data help put in perspective the minimum incremental risk associated with potential "real world" concerns about pollination from wild pollinators, extraordinary pollen flow via wind-driven pollinator movement, and, contamination through physical mixtures of seed in harvesting and/or seed processing. It supports science-based isolation standards, the efficacy of the FGI Best Practices quality control program, and demonstrates that reasonable tools are available to allow successful coexistence within and between diverse alfalfa seed market sectors.

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Teuber, L.R., et al. 2005. Proc. of the NCWSS 2005 Meeting (http://www.ncwss.org/)

HYBRIDIZATION BETWEEN JOINTED GOATGRASS AND IMIDAZOLINONE-RESISTANT WINTER WHEAT. Todd A. **Gaines**, W. Brien Henry, Patrick F. Byrne, Philip Westra, Scott J. Nissen, and Dale L. Shaner, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Research Geneticist, USDA/ARS Corn Host Plant Resistance Research, Mississippi State, MS 39762, Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, and Plant Physiologist, USDA/ARS Water Management Research, Fort Collins, CO 80526.

Gene flow between jointed goatgrass and winter wheat is a concern because transfer of herbicide resistance genes from imidazolinone-resistant (IR) winter wheat cultivars to jointed goatgrass could restrict weed management options for this serious weed of winter wheat cropping systems. The objective of this study was to investigate the frequency of interspecific hybridization between IR wheat and jointed goatgrass in eastern Colorado. Jointed goatgrass was sampled side-by-side with IR wheat and at distances up to 53 m away in both experimental plots and at commercial field study sites in 2003, 2004, and 2005. A total of 141 samples were collected from 16 different sites. A greenhouse screening method was used to identify IR hybrids in collected jointed goatgrass seed, and over 60,000 plants were screened. The average percent hybridization across sites and years when IR wheat and jointed goatgrass were grown side-by-side was 0.1% and the maximum was 1.6%. The greatest distance over which hybridization was documented was 16 m. The hybridization rate between wheat and jointed goatgrass will influence trait introgression into jointed goatgrass. Studies have subsequently been initiated to measure the frequency of hybrid plant backcrossing to jointed goatgrass under eastern Colorado field conditions.

SEED-MEDIATED GENE FLOW IN CERTIFIED AND FARM-SAVED SEED LOTS. Todd A. **Gaines**, Christopher Preston, Patrick F. Byrne, W. Brien Henry, and Philip Westra, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Lecturer, School of Agriculture, Food, and Wine, University of Adelaide, South Australia, 5005, Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Research Geneticist, USDA/ARS Corn Host Plant Resistance Research, Mississippi State, MS 39762, and Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177.

Varietal purity in wheat seed production is necessary for agronomic uniformity and to enable potential market segregation. We conducted a survey of certified and farm-saved seed samples using a non-transgenic imidazolinone resistant (IR) winter wheat variety in 2004 and 2005 in eastern Colorado. The objective was to compare varietal purity based on type of seed producer and IR wheat history. Ninety-two samples of non-IR varieties were taken from certified and farm-saved seed growers, who either produced or had never produced IR wheat. Adventitious IR seeds were detected using a seed soaking technique in samples from each producer type and each IR production history. The total emerged plants evaluated for each sample ranged from 4,000 to 7,000. Levels of IR seed detected ranged from 0% to 11.28%. One certified sample and three farm-saved samples exceeded the 0.1% threshold for off-types in certified wheat seed. Using a two-factor analysis, farm-saved production class and positive IR history increased the estimated proportion of adventitious seed. Based on grower interviews, higher levels of adventitious seed presence were associated with volunteer plants from previous crops of the resistant variety and mechanical mixture during harvesting. Production practices for certified seed address these factors and may need to be strengthened if more stringent purity criteria are adopted. This information is important for risk assessment and policy development for potential commercial release of transgenic wheat varieties.

COMMERCIAL-SCALE POLLEN–MEDIATED GENE FLOW IN WINTER WHEAT IN THE CENTRAL WESTERN GREAT PLAINS. Todd A. **Gaines**, Patrick F. Byrne, Philip Westra, Scott J. Nissen, W. Brien Henry, Dale L. Shaner, and Phillip L. Chapman, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Research Geneticist, USDA/ARS Corn Host Plant Resistance Research, Mississippi State, MS 39762, Plant Physiologist, USDA/ARS Water Management Research, Fort Collins, CO 80526, and Professor, Department of Statistics, Colorado State University, Fort Collins, CO 80523-1877.

Pollen-mediated gene flow (PMGF) in wheat (*Triticum aestivum* L.) has been investigated in several studies, but most have been conducted on relatively small experimental plots. The introduction and widespread planting of a Clearfield (imidazolinone herbicide resistant) wheat cultivar in Colorado provided the opportunity to examine PMGF in commercial-scale production fields. We sampled a total of 56 large wheat fields in eastern Colorado in 2003, 2004, and 2005, and tracked the movement of the resistance gene from resistant cultivars to adjacent susceptible cultivars at distances up to 61 m. The highest level of PMGF we observed was 5.3% at 0.23 m, and the farthest sample at which we detected PMGF was 61 m. All 18 sampled cultivars showed some level of PMGF, with earlier heading cultivars having higher levels of cross-pollination than those that were late heading. At least in some cases, higher PMGF in early cultivars appeared to be due to late frosts that rendered recipient plants male sterile and therefore more susceptible to fertilization by foreign pollen. We used these data to develop a generalized linear mixed model with a random location effect. Based on the model results for cultivars heading earlier than the pollen source, the required separation distance between fields to ensure 95% confidence that 95% of locations have PMGF less than 0.9% is 41.1 m. For cultivars heading later than the pollen source, the equivalent required distance is 0.7 m. These are conservative confidence limits that should represent the highest levels of PMGF occurring in winter wheat in the central western Great Plains.

INTRODUCTION OF A NEW ISSUE PAPER FROM CAST--IMPLICATIONS OF GENE FLOW IN THE SCALE-UP AND COMMERCIAL USE OF BIOTECHNOLOGY-DERIVED CROPS: ECONOMIC AND POLICY CONSIDERATIONS. David R. **Gealy**, Kent J. Bradford, Linda Hall, Richard Hellmich, Alan Raybould, Jeffrey Wolt, and David Zilberman, United States Department of Agriculture–Agricultural Research Service, Dale Bumpers National Rice Research Center, Stuttgart, AR, Seed Biotechnology Center, Department of Plant Sciences, University of California, Davis, CA, Alberta Agriculture, Food and Rural Development/University of Alberta, Edmonton, Canada, United States Department of Agriculture–Agricultural Research Service, Corn Insects and Crop Genetics Research Unit, and Department of Entomology, Iowa State University, Ames, IA, Product Safety, Syngenta, Berkshire, United Kingdom, Biosafety Institute for Genetically Modified Agricultural Products, Iowa State University, Ames, IA, and Department of Agricultural and Resource Economics, University of California, Berkeley, CA.

This paper reviews the concept of gene flow—the successful transfer of genetic information between different individuals, populations, and generations (to progeny) and across spatial dimensions. The paper also discusses the relatively limited situations in which gene flow is likely to cause economic problems in the production of commercial biotech crops. Gene flow is presented in the context of an associated phenomenon, adventitious presence, in which unwanted substances unavoidably make their way into the production, channeling, and marketing system of grain and crop products.

Because reproductive biology differs markedly among crop species, so does the potential for outcrossing and subsequent gene flow. Economically or environmentally significant gene flow into weedy relatives of these crops often is limited because of restricted geographical overlap of the crop and weed regions or because the weedy relatives are not exceptionally competitive or invasive.

Numerous useful traits are being imparted into biotech (transgenic) and nonbiotech crops. Most of these traits are likely to have little impact on the dynamics of gene flow, especially outside of agricultural fields. Precommercialization procedures that take into account the specific trait being introduced will help to insure that impacts of gene flow remain low. Where trait characteristics warrant, a variety of production practices can be used to mitigate gene flow, and novel genetic/molecular containment technologies are being developed to accomplish similar goals.

The economic consequences of gene flow from biotech crops may differ in crops produced for seed (to be planted) vs. crops produced for commodity uses (to be consumed or woven into textiles), or in traditional vs. niche marketplaces. Approaches to minimize potential negative impacts are discussed.

Potential risks and benefits of maintaining or altering the existing safety and regulatory mechanisms are addressed in the context of public policy considerations. These considerations include the potential benefits of establishing thresholds for unapproved biotech substances in any commodity and for approved biotech substances in a commodity labeled as nonbiotech. Existing regulations are costly and can discourage development of beneficial products. Regulatory approaches that consider benefits and costs more holistically may facilitate improved development of these technologies.

To date, there have been no major health or environmental setbacks due to gene flow from biotech crops; in fact, these crops have led to significant, documentable improvements and, in some instances, decreased environmental risks. Education addressing the realistic advantages and challenges of continued development and commercialization of biotech crops, as well as nonbiotech crops, will be a key to public understanding and discourse related to future policy toward biotech crops.

POLLEN FLOW IN THE ENVIRONMENT - DEVELOPMENT OF A RESEARCH PROGRAM.
John A. **Glaser**, Biotechnology Research Program Leader, USEPA, Office of Research & Development, National Risk Management Research Laboratory, Cincinnati, OH 45268.

The USEPA Office of Research and Development seeks to provide to the agency and society the best information relating to the status of the environment and any related technology maintaining environmental quality. In this effort, a recent research workshop (Pollen Mediated Gene Flow in the Environment) was conducted to assess the level of knowledge and possible future research directions related to pollen flow of transgenic crops. In the development of future research directions, several questions are needed to focus the inquiry. What are the important technical issues? How should the selection or prioritization of research goals be developed? What are the best research questions for field scale experimentation? Thinking of potential uses of this research, can we assemble decision making aids for transgenic crop pollen effect evaluation?

SEED-MEDIATED GENE FLOW IN CANOLA. Linda M. **Hall**, Robert H. Gulden and Hugh J. Beckie, Research Scientist/Adjunct Professor, Alberta Agriculture and Food, University of Alberta, Edmonton, AB, T6G 2P5; Assistant Professor, Department of Plant Science, University of Manitoba, Winnipeg, MB, R3T 2N2; and Research Scientist, Agriculture and Agri-Food Canada, Saskatoon, SK, S7N 0X2.

Canola or oilseed rape (*Brassica napus* L.) is a relatively newly domesticated oilseed crop grown in Canada and in temperate regions around the world. Canola resistant to glyphosate, glufosinate or imidazolinone (IM) herbicides was introduced in Canada in 1996 and has been widely adopted, occupying 45, 42 and 10% of canola acres, respectively. Herbicide-resistant canola is planted on 97% of acres but seed sources are not necessarily pure. In a study of admixture in certified canola seed, the permitted threshold of 0.25% was frequently exceeded. Harvest loss in canola due to pod shatter prior to and during harvest averaged 5.9% of the seed yield, or approximately 3,000 viable seeds m^{-2}, however, harvest losses ranged from 9 to 56 times the normal seeding rate of canola. Canola can develop secondary seed dormancy that varies with genotype, and is induced most effectively by low water potential in combination with warm temperatures. Fall tillage promotes the persistence of high dormancy genotypes. While the majority of canola volunteers are recruited in the year following dispersal, seed banks can persist for 3 to 4 years. Seed bank deletion occurs by predation, pathogenesis and desiccation, in addition to germination in spring and fall. High densities of seed can germinate pre-seeding and within a crop. Canola can be a competitive weed within cropping systems, and weed surveys have ranked it as the 14th most abundant weed in the 2000's, occurring in 11% of fields surveyed. Volunteer control options exist for all herbicide-resistant biotypes. However, with naive herbicide rotations, resistant canola can be difficult to control - for example if glyphosate is used alone pre-seeding on glyphosate-resistant canola, or if ALS inhibitors are used alone in-crop to control IM resistant canola. Seed losses along transport corridors have led to feral herbicide-resistant populations along roadsides and rail lines in Canada and Japan. These populations may persist and spread, and contribute to gene flow. Seed-mediated gene flow is a significant temporal and spatial factor in the spread of herbicide-resistant genes locally and internationally.

TIER 1 EVALUATION OF CROSSABILITY BETWEEN TRITICALE (X *TRITICOSECALE* WITTMACK) AND COMMON WHEAT, DURUM WHEAT AND RYE. Linda M. **Hall**, Melissa J. Hills, Francois Eudes, Research Scientist and Adjunct Professor, Alberta Agriculture and Food/University of Alberta, 410Ag/ForBuilding, Edmonton, AB, T6G 2P5, Instructor, Grant MacEwan, 10700-104 Avenue, Edmonton, AB T5J 4S2, Research Scientist, Alberta Agriculture and Food, Lethbridge, AB.

Development of transgenic triticale as a platform for novel bio-industrial products is predicated on an environmental biosafety assessment that quantifies the potential risks associated with its release. Pollen-mediated gene flow to related species and conventional triticale varieties is one pathway for transgene movement. A tier 1 quantification of triticale hybridization was conducted by emasculating and hand pollinating flowers under greenhouse conditions. Approximately 2000 manual pollinations were conducted for each cross and its reciprocal between two triticale genotypes: a modern triticale cultivar (AC Alta) and primary triticale (89TT108), and common wheat, durum wheat and rye. The frequency of outcrossing, hybrid seed appearance and weight, and F_1 emergence and fertility were recorded. Outcrossing, F_1 emergence and fertility rates were high from crosses between triticale genotypes. Outcrossing in inter-specific crosses was influenced by the species, and the genotype and gender of the triticale parent. In crosses to common and durum wheat where triticale was the male parent, outcrossing was $\geq$73.0% and $\geq$69.5%, respectively, but $\leq$23.9% and $\leq$3.0% when triticale was the female parent. Overall, outcrossing with rye was lower than with common and durum wheat. F_1 hybrid emergence was greater when triticale was the female parent. With the exception of a single seed, all wheat-triticale F_1 hybrid seeds were non-viable when triticale was the male parent in the cross. Only 7 durum wheat-triticale F_1 hybrids emerged from 163 seeds sown and all were produced with triticale 89TT108 as female parent. With rye, 8 F_1 hybrids emerged from 38 seeds sown and all were produced from crosses to AC Alta; 5 with AC Alta as the female parent and 3 as the male. Interspecific F_1 hybrids were self-sterile, with the exception of those produced in crosses between common wheat and triticale where triticale was the female parent. Tier 2 hybridization quantification will be conducted under field conditions.

GENE FLOW DYNAMICS AND CONFINEMENT: A REGULATORY PERSPECTIVE. Subray **Hegde***, Biotechnology Regulatory Services/Animal and Plant Health Inspection Service, United States Department of Agriculture, Riverdale, MD.

Gene flow is a natural biological process with potential evolutionary consequences. For a few human activities, however, gene flow from certain source populations into the environment is undesirable, which prompted the development of confinement protocols to contain gene flow to a defined physical space. A variety of confinement protocols are currently in use to prevent unintended gene flow from genetically engineered (GE) crops beginning from their creations to their intended use. Because gene escape from focal populations can occur in time and space, and is affected by a variety of genetic and ecological factors, the existing confinement protocols have gradually been evolving to address new issues and concerns raised by stakeholders. A few issues that could significantly alter the confinement principle in the future are: (i) an acceptable level of gene flow from GE plant populations into the environment, (ii) the cost and benefit of doing business with alternate gene flow containment strategies, and (iii) the public perception about genetically modified plants and plant products.

GENE FLOW AND RISK ASSESSMENT: CASE BY CASE CONSIDERATIONS. Michael J. **Horak** and Thomas E. Nickson, Monsanto Company, St. Louis, MO.

A fundamental tenant of risk assessment is that risk is a function of *hazard* and *exposure*. For biotechnology-derived crops, a risk assessor considers potential *hazards* associated with the crop that could include altered pest potential and potential adverse environmental impacts including adverse effects on non-target organisms. A risk assessor also considers e*xposure* by examining reasonable pathways for release into the environment, the environmental fate of the plant and trait, and potential routes of exposure to non-target organisms. The assessor would also evaluate information on potential gene flow via pollen, seed and tissue, and information on potential consequences of gene flow. The hazard and exposure information is then incorporated into the overall risk assessment.

During the risk assessment planning phase, the nature of the crop, the nature of the trait, the likely receiving, and the interactions among these factors are considered to identify potential hazards. Then comparative plant characterization data are generated on the biotechnology-derived crop. The comparative data are assessed for unintended and/or potentially adverse differences in the plant, and trait advantages to the crop that potentially affect the weediness of the crop. This information is used in an assessment of potential hazards of the crop. Concurrently, data are generated for an assessment of the potential effects to non-target organisms. The data from the hazard characterization are then considered in the context of a gene flow assessment (a portion of the exposure assessment). The gene flow assessment considers gene flow within the crop species and the likelihood of trait introgression into a sexually compatible species. Together the information from the hazard assessment and the exposure assessment, including gene flow information, are used in an overall assessment of risk.

BIOSAFETY ASSESSMENT AND BENEFITS FOR CO-EXISTENCE OF BIOLOGICAL CONTAINED PLANTS – REGULATORY ASSESSMENT IN THE EU-PROJECT "TRANSCONTAINER". Christiane **Koziolek** and Detlef Bartsch, Professor, Federal Office of Food Safety and Consumer Protection, Mauerstrasse 39-42, D-Berlin 10117.

The EU-project TransContainer[1] deals with the evaluation of environmental impact and benefits for coexistence between GM- and non-GM plants. Different containment strategies are applied to a broad spectrum of crops (*e.g.* oilseed rape, sugar beet, tomato) as well as to perennial plants like trees and grasses. The containment methods focus on three strategies: Chloroplast Transformation, Controllable Flowering and Controllable Fertility. Key issues are (a) safety assessment focussing on three points: molecular characteristics, ecology of the GM species and consequences of a potential break-down of the containment system. (b) Benefit assessment of the containment system for the co-existence of GM and non-GM plants. The environmental impact assessment is performed based on the criteria provided by the EFSA Guidance document (2006)[2] for the placing on the market of GM plants in the EU. Additionally to impact assessment, an economic evaluation is performed. The development of contained GM crop plants is still in an early stage and thus our evaluation is focussed on the safety assessment of the general methodical characteristics.

<u>Benefits of Chloroplast Transformed plants:</u> Chloroplast transformation is a promising containment system for plant species with strict maternal plastid inheritance by avoiding the out-crossing of recombinant genes via the pollen. The targeted insertion of a GM sequence in the chloroplast genome by homologous recombination has three advantages: (1) insertional inactivation of unknown functional genes is avoided, (2) endogenic *in-situ* promoters can be used, and (3) even though plastids harbour relatively small replicons, large insertions are tolerated. However, it has to be verified that the transgene is not inserted unintentionally in the nuclear genome since the transformation (*e.g.* particle bombardment technique) could be unspecific.

Benefits of plants with Controlled Flowering: The suppression of flowering is useful for plants that are cultivated for their vegetative parts, *e.g.* sugar beet, grasses or trees. For bi-annual sugar beet, the inhibition of undesired bolting and flowering will either prevent out-crossing and introgression into endogenous beet populations as well as facilitate the cultivation of beets for the farmer. In grasses, flower suppression will improve the fodder quality as the shoots have higher lignin content thus hampering the digestibility of the feed. In trees that are intended to be cultivated in plantations for biomass production, the suppression of flower development would offer certain advantages: GM trees with *e.g.* changed wood properties would neither develop pollen nor seeds containing the inserted DNA, avoiding any unintended hybridisation or spread of the GM seeds by wind. In contrast to trees that can be propagated vegetative, grasses as well as sugar beet need to flower for breeding purposes. Therefore, a molecular switch will be introduced, which will initiate flowering upon an external chemical stimulus. In case of flower induction for breeding, other (physical) measures are requested to avoid unintended out-crossing and spread of hybrids.

Benefits for Co-existence: Regarding the legislation on GM plants in the EU, the minimisation of GM escape via pollen into adjacent non-GM fields or wild relatives is an important point in the improvement of co-existence measures. In chloroplast transformed plants, the spread of inserted DNA is limited only at the pollen level, whereas the (transgene) seeds produced by the mother plant could still be lost or spilled unintended during harvest and transport. Upon complete flower suppression, neither pollen nor seeds will be released, thus gaining a very high level of restriction. The containment measures will allow (i) minimising the isolation distances between GM and non-GM fields, (ii) protecting the GM cultivating farmers for liability claims from neighbours, (iii) reduce conflicts with bee keepers, and (iv) avoid unintended mixtures with food products.

VARIATION IN ALS HERBICIDE RESISTANCE OF DIVERSE CROP-WILD SUNFLOWER HYBRIDS. Kristin L. **Mercer**, Kevin J. Betts, Ruth G. Shaw, and Donald L. Wyse, Postdoctoral Researcher, Department of Evolution, Ecology, and Organismal Biology, The Ohio State University, Columbus, OH 43210, Senior Scientist, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108, Professor, Department of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, MN 55108, and Professor, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108.

Across the range of sunflower production, there is considerable gene flow from crop fields into to wild sunflower (*Helianthus annuus* L.) populations. With the development of herbicide resistant crops, concerns have surfaced about the transfer of herbicide resistance to wild relatives. Even with stewardship guidelines associated with herbicide resistant varieties, which require farmers to control wild sunflower populations in and around their fields, we expect to see gene flow into wild populations. We performed greenhouse and field experiments to understand the role of genetic variation, both within and among wild sunflower populations, in determining the herbicide tolerance of the crop-wild hybrids they produce. We created crop-wild hybrids by crossing diverse wild populations with pollen from either ALS resistant crop or conventional crop sunflower. We tested the resistance of these crop-wild hybrids and their wild counterparts to Pursuit, an imidazolinone herbicide, and Express, a sulfonylurea herbicide. Field grown crop-wild hybrids with putative ALS resistance were more tolerant of the herbicide applications than their susceptible wild and hybrid counterparts, evidenced by taller seedlings with more leaves, and less injury to their primary meristem. However, that advantage did not last through the season. Compensatory growth resulted in greater seed production by surviving non-herbicide resistant hybrids and wilds. Follow-up experiments in the greenhouse indicated that both the origin of the wild population and the family within a population affected herbicide resistance expressed in crop-wild hybrids. Therefore, the adaptive advantage conferred by the herbicide resistance will vary depending on the wild genetic background and may not last throughout the season unless other stressors are applied.

MEASURING THE EFFECTS OF CROP GENETIC LOAD ON PRODUCTIVITY AND FITNESS IN WEEDY *BRASSICA RAPA* (WILD TURNIP) × *BRASSICA NAPUS* (OILSEED RAPE) HYBRID POPULATIONS. Reginald J. **Millwood***, Christy W. Rose*, and C. Neal Stewart, Jr. University of Tennessee, Knoxville 37966.

With the implementation of transgenic crops in agriculture, transgene flow to wild relatives is sure to occur. In the event transgenic hybrids are produced, the inherited transgene could supply a fitness advantage. This is a real agronomic and ecological concern, but only if transgene introgression occurs. In many cases, hybrids such as these exhibit lower fitness when compared to their wild parents. This may be due to the inheritance of disadvantageous crop/domestication genes present in the new host genome. These genes would certainly negatively impact transgene introgression and possible reduce the risk associated with many transgenes. In order to gain a better understanding of transgene introgression, we plan to assess how productivity and fitness of backcrossed hybrids are affected by the presence of a transgene in the company of crop/domestication alleles. Here, we use transgenic *Brassica napus* cv. westar as a model crop plant. *B. napus* has been transformed with the *Bacillus thuringiensis* endotoxin (*BtCry1Ac*) and the green fluorescent protein. Subsequently, we made hybrids between the transgenic *B. napus* and its wild weedy relative *Brassica rapa* ac. 2974. We produced mixed BC_1/F_2 populations in the field as well as advanced backcross generations (F_1, BC_1F_1, BC_2F_1 BC_2F_2, BC_3F_1 and BC_4F_2) by hand-crossing in controlled environment chambers. First, we plan to grow the BC_1/F_2 populations in competition with *Triticum aestivum* as well as with each other. Productivity and fitness data will be gathered for both the hybrids and wheat. Secondly, we will grow the advanced backcross populations under agronomic conditions. Productivity data such as seed yield and dry above ground biomass will be recorded. In addition, to gain an understanding of hybrid fitness, we will also grow these plants in competition with *B. rapa* and the number of transgenic progeny will be recorded. All of the above data will then be correlated to the amount of crop specific AFLP markers present in each population. These data together will determine if there is any relationship between inherited crop/domestication alleles and productivity or fitness of transgenic hybrids of *B. rapa* × *B. napus*.

STRATEGIES TO REDUCE TRANSGENE MOVEMENT Hong S. **Moon**, Jason N. Burris, Reginald J. Millwood and C. Neal Stewart, Jr., Department of Plant Sciences, The University of Tennessee, Knoxville, TN 37996

Transgene escape is of a major ecological concern when growing transgenic plants in the field. To address these concerns, suitable strategies for transgene containment must be created. Currently, two strategies that can be utilized as transgene containment and control are male sterility and site-specific recombination. First, male sterility can be obtained by making interspecific hybrids of *Nicotiana tabacum* X *Nicotiana glaca*. By using the genetic "distance" and a large difference in chromosome number, we can produce non-functional gametes, and thus, create functional sterility. We will transform male sterile hybrids with fluorescent-protein markers to track the potential of pollen formed in the field. Secondly, a transgene excision system using a site-specific recombinase or a zinc finger nuclease will be created in order to remove transgenes from the pollen. A model plant, canola or tobacco, will be transformed via *Agrobacterium*-mediated methods with constructs containing site-specific recombinases or zinc finger nucleases. This system will employ a visual marker green fluorescence protein driven by pollen-specific promoter to ensure transgene excision. Pollen-specific promoters, *LAT52* and *LAT59*, will be used to activate the recombinase or zinc finger nuclease in pollen to induce the excision of transgenes.

WEED-TO-WEED GENE FLOW – WHAT IS THE POTENTIAL FOR GLYHPOSATE RESISTANCE MOVEMENT VIA INTERSPECIFIC HBRIDIZATION?

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When evaluating herbicide resistance and the potential for herbicide resistance dissemination within agroecosystems, most studies focus on weed seed production, viability and dispersal, the species mating system, and the genetics associated with the resistance trait. However, far less attention has been centered on the potential for herbicide resistance spread though interspecific hybridization (introgression). For that matter, the ability of weeds to hybridize with near relatives has not been well-studied or documented in agro-ecosystems, however some data exists for Amaranthaceae. While some studies describe gene flow and successful transmission of herbicide resistance alleles from cultivated crop species to their weedy relatives, little data exists regarding the between weed species gene flow. Part of the problem describing weed hybridization is recognition of the hybrids in the field; this is particularly challenging since hybrids in most cases resemble (phenotypically) the parents.

Herbicide resistance potentially represents an effective marker to document hybridization between weed species. This study assessed the introgression of herbicide resistant alleles in the important genii *Ambrosia*, *Conyza* and *Helianthus*, considering the importance of Asteraceae weeds in current agroecosystems. The study used the cross resistant triazolopyrimidine, sulfonanilide and sulfonylurea (SU) giant ragweed (*A. trifida* L.; $2n = 24$) and imidazolinone and SU common sunflower (*H. annuus* L.; $2n = 34$) populations from Iowa, in addition to a glyphosate resistant horseweed (*C. canadensis* L. Cronq.; $2n = 18$) population from Delaware. The herbicide susceptible common ragweed (*A. artemisiifolia* L.; $2n = 36$), Jerusalem artichoke (*H. tuberous* L.; $2n =102$), and dwarf fleabane (*C. ramosissima* Cronq.; $2n = 18$) populations originated from Iowa. In all three genii evaluated, herbicide resistance was expressed as a nuclear allele, partially dominant (*Ambrosia* and *Helianthus*) or over dominant (*Conyza*) trait in first filial interspecific hybrid generation (F_1^H). Herbicide resistance transfer frequency in the F_1^H ranged from 40 to 60%, 0 to 9%, and 30 to 50% in *Ambrosia*, *Conyza*, and *Helianthus*, respectively.

Inheritance of herbicide resistance in the selfed F_1^H generation (F_2^H) followed the mono-factorial model in all evaluated genii; F_1^H backcrosses confirmed successful introgression of the herbicide resistance allele to parents. Thus, interspecific hybridization is possible and may be a potentially important avenue for the dissemination of herbicide resistance, specifically glyphosate resistance, and the promotion of genetic diversity within compatible weed species.

The occurrence of glyphosate resistant hybrid weeds may complicate the containment of glyphosate resistance in current crop production systems. However, it has yet to be determined if interspecific hybridization of weed species is frequent and pervasive within the agro-ecosystems. If the occurrence of weed hybridization is relatively frequent, important ecological studies should be conducted to determine if the weedy hybrids are well-adapted to current crop production systems and thus may evolve into economically important weed problems. The movement of glyphosate resistance via gene flow as a companion to the hybridization process could improve the adaptation of weedy hybrid progeny to the agro-ecosystem. Despite the likely negative implications of evolved glyphosate resistance and weed hybridization , the occurrence of glyphosate resistance could be a useful marker to assess weed hybridization.

ADDRESSING GENE FLOW ISSUES IN COWPEA FOR WEST AFRICA. Remy **Pasquet**, Barry Pittendrigh, Mohammad Ishiyaku, Ibrahim Baoua, Clementine DaBrie, Malik Ba, Joseph Huesing, and Larry Murdock, ICIPE, IRD, Nairobi, Kenya; Purdue University, West Lafayette, IN 47907; Ahmadu Bello University, Zaria, Nigeria; INRAN, Maradi, Niger; INERA Ouagadougou, Burkina Faso; INERA, Ouagadougou, Burkina Faso; IITA Cotonou, Benin; Purdue University, West Lafayette, IN 47907; and Monsanto Company, St. Louis, MO 63167.

Cowpea (*Vigna unguiculata*), known in the U.S. as "black-eyed pea," is a legume crop grown and consumed across West Africa. Native to East Africa, cowpeas are relatively drought resistant and the grain serves as an important source of quality protein. Like the grain, the leaves are rich in protein and are consumed in salads and used as animal fodder. Insects, particularly pod boring insects, can reduce yields as much as 90% or more. One of the primary limiting pests is the legume pod borer (*Maruca vitrata*), a lepidopteran insect closely related to the European corn borer, which has been successfully controlled by several different *Bacillus thuringiensis* (*Bt*) genes. An international group of scientists organized as the Network for the Genetic Improvement of Cowpea for Africa (NGICA) in cooperation with the African Agricultural Technology Foundation (AATF) is developing a transgenic cowpea variety engineered to express an insecticidal *Bacillus thuringiensis* (*Bt*) Cry1Ab protein to control this pest. Key issues to be addressed are gene flow potential and weediness particularly within areas of cultivation. To that end, assessments are under way to determine 1) outcrossing rates, 2) outcrossing distances, 3) the potential for insects to vector pollen, and 4) the consequences of gene flow as it relates to the fitness potential (insect resistance) of wild or weedy species. These data will be used in conjunction with cultivated cowpea production data to assess potential environmental effects of *Bt*-cowpea in West Africa.

ECOLOGICAL EFFECTS OF VIRUS-RESISTANT TRANSGENIC SQUASH ON WILD SQUASH POPULATION DYNAMICS. Holly R. **Prendeville***, Graduate student, and Diana Pilson, Associate Professor, University of Nebraska, 348 Manter Hall Lincoln, NE 68588-0118.

Several genetic and environmental factors can influence the degree of assortative mating in natural plant populations. In many, perhaps most, natural plant populations assortative mating occurs because plants do not have identical flowering schedules. When only one phenotype is in bloom, mating is necessarily assortative, leading to increased genetic variance for flowering phenology. This is important because increased genetic variance allows a trait to be more responsive to natural selection. Thus, fixation of a trait favored by selection will be faster when a population mates assortatively. For example, if the presence of a transgene in a wild population leads to assortative mating, then the transgene will introgress into that population more rapidly than expected. In a common garden experiment healthy and virus-infected squash had different flowering phenologies. These differences in flowering phenology will lead to assortative mating among virus susceptible and virus resistant plants. In another set of common garden experiments we found that bumbles bees spent more time in flowers on virus infected plants, while squash bees spent more time in flowers on healthy plants. These data suggest that if a transgene for virus resistance were present in a wild population it could lead to assortative mating, and thus increase in frequency more rapidly than anticipated. In contrast to differences in flowering phenology and pollinator preference, which cause assortative mating, temporal variation in sex ratios results in disassortative mating. Thus, different flowering phenologies and pollinator preferences will lead to assortative mating and increased genetic variance, while temporal variation in sex ratios will lead to disassortative mating and reduced genetic variance. Interactions between these processes and their effect on character evolution (e.g. transgenic virus- resistance) are under investigation.

INTERLOPER'S LEGACY: INVASIVE, HYBRID-DERIVED CALIFORNIA WILD RADISH (*RAPHANUS SATIVUS*) EVOLVES TO OUTPERFORM ITS IMMIGRANT PARENTS. Caroline E. **Ridley**, Rosamond F. Tsao and Norman C. Ellstrand, Graduate Student, Undergraduate Student and Professor of Genetics, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Hybridization between species and subspecies may lead to the evolution of invasive weeds by enhancing survival and reproduction in hybrid-derived lineages. California wild radish (*Raphanus sativus* × *Raphanus raphanistrum*) is a hybrid-derived species that has spread prolifically within the last 150 years, replacing all pure parental populations throughout California. Though highly plausible, a link between hybridization and invasiveness in California wild radish has never been empirically tested. In field experiments, we compared the survival and reproduction of several populations of California wild radish with that of populations of its pure parents in multiple years and varied environments. California wild radish has high survivorship and generally produces more fruits per plant, more seeds per fruit and more seeds per plant than either of its progenitors. In year one in Riverside, CA, it produced 3-times more seeds per plant than *R. raphanistrum* and *R. sativus*. In Irvine, CA, reproduction was higher overall and California wild radish produced 2-times and 20-times more seeds per plant than *R. raphanistrum* and *R. sativus*, respectively. Individual populations of California wild radish also display a strong genotype-by-environment interaction, indicating genetic diversity may be partly responsible for the weed's ability to invade California's vast and varied landscape. Our results demonstrate that by limiting the introduction and subsequent hybridization of congeners, we may be able to prevent the evolution of new invasive lineages.

SYMPATRY AND HYBRIDIZATION OF CANOLA AND BIRD RAPE (*BRASSICA RAPA* L.) IN QUÉBEC. Marie-Josée **Simard**, Anne Légère, and Suzanne I. Warwick, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Québec, QC G1V 2J3; Research Scientist, AAFC, Saskatoon, SK S7N 0X2, Research Scientist, AAFC, Ottawa, ON K1A 0C6.

Hybridization between herbicide resistant (HR) transgenic canola (*Brassica napus* L.) and weedy bird rape (*B. rapa* L., also birdsrape mustard) has been documented in Québec. We evaluated the actual hybridization potential based on range overlap and *in situ* rates. We mapped the distribution of canola fields and bird rape herbarium specimens in Québec; collated information on the presence of bird rape in certified canola seed production fields; and surveyed for bird rape in, or close to canola field margins. Progeny from these populations was screened for herbicide resistance (HR) and for the presence of the HR transgene. Significant sympatry was observed in several areas and hybridization occurred in all eight populations (1.1-17.5% hybrid seed) located in field margins and in one (1.1%) out of three populations located less than 10 m from a canola field. Hybridization rates decreased exponentially as bird rape density increased, but rates across plants at any given density were highly variable (0 to 68%). At present, there are no compelling data suggesting that the presence of an HR transgene in a wild/weedy relative is inherently risky. However, our current knowledge might not fully describe the risks posed by other transgenes, particularly those that convey fitness-enhancing traits.

LONG-TERM FIELD STUDIES OF THE EVOLUTION OF CROP-WEED HYBRIDS IN RADISH: IMPLICATIONS FOR INVASIVENESS. Allison A. **Snow**, Lesley G. Campbell, Theresa M. Culley, and Caroline E. Ridley, Professor, Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, OH 43210, Postdoctoral Associate, Departments of Plant Science, Landscape Architecture, and Entomology, University of Maryland, College Park, MD 20742, Assistant Professor, Department of Biological Sciences, University of Cincinnati, Cincinnati, OH 45221, and Graduate Student, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Many cultivated plants hybridize naturally with wild and weedy relatives, but little is known about the evolutionary effects of this process on recipient populations. To examine the dynamics of introgression in a natural setting, we monitored crop-specific genetic markers in replicated field populations of weedy *Raphanus raphanistrum* in Michigan, USA, for ten years. Four isolated hybrid populations were established in 1996 using a 1:1 ratio of *R. raphanistrum* and F_1 crop-wild hybrids (*R. raphanistrum* x *R. sativus*). The sites were tilled and fertilized annually to mimic agricultural fields, and plants were exposed to local biotic and abiotic selective pressures. Initially, F_1 hybrids had reduced fitness relative to wild genotypes, but the populations quickly regained wild-type pollen fertility, presumably by losing a crop-specific reciprocal translocation. Recombination and natural selection allowed the populations to absorb two crop-specific allozyme markers at relatively high frequencies in all populations, even exceeding their initial frequency of 0.25 in a few cases. Frequencies of a crop-specific white petal color allele were much lower, but this allele also persisted in all populations. Overall, frequencies of the three crop-specific alleles varied considerably among locations, years, and loci. In the tenth year, plants from each hybrid population were grown in a common garden experiment along with wild genotypes. The lifetime fecundity of these advanced-generation hybrids was similar to that of the wild genotypes. This long-term study provides a unique example of how easily certain crop alleles can become established in weed populations while others remain rare or disappear.

In a second study, we tested the hypothesis that crop-wild hybridization can allow weeds to become more successful. A third study was carried out simultaneously to determine whether cultivated radish could generate feral populations. We established replicated populations of wild, hybrid, and "volunteer" cultivated radishes in Michigan and let them evolve for three growing seasons, starting in 2002. Three of the five volunteer populations died out. The two remaining populations became contaminated with wild genes and evolved traits that were similar to crop-wild hybrids (Campbell and Snow, in prep.). Although we did not find evidence for ferality in the absence of hybridization with *R. raphanistrum*, further studies involving more populations and locations might detect ferality.

Results from the wild and hybrid populations were reported in Campbell et al. (2006) and are summarized briefly here. The initial frequency of crop alleles in these hybrid populations was 0.50 (twice the level in our introgression study above) because all plants were F_1 hybrids. Frequencies of white-flowered plants declined slightly, unlike our previous study, and then remained relatively constant. We suspect that the sharp drop in white-flowered plants in our previous study was due to the fact that many hybrid plants flowered very late or not at all, and the white petal allele is linked to delayed reproduction (Campbell, 2007). In 2005, advanced-generation hybrid and wild seedlings were grown in common garden experiments in Michigan and California. Hybrid-derived plants had slightly lower fecundity than wild plants in Michigan, but exhibited ~270% greater lifetime fecundity and ~22% greater survival than wild plants in California. These results support that hypothesis that crop-wild hybridization may create genotypes with the potential to displace parental taxa in new environments, which is consistent with other studies of hybrid-derived wild radish populations in California (C. E. Ridley et al., in prep.). In summary, our combined field studies of evolving crop-wild hybrids show that conventional crop alleles can persist in wild populations and may increase the fitness of wild relatives in some cases. Further research is needed to confirm the common assumption that enhanced fitness results in more abundant weed populations.

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LIFETIME FECUNDITY OF F1 CROP-WILD SORGHUM HYBRIDS: IMPLICATIONS FOR GENE FLOW FROM TRANSGENIC SORGHUM IN AFRICA. Allison A. **Snow**, Patricia M. Sweeney*, Cécile Grenier, Gebisa Ejeta, Tesfaye Tesso, Issoufrou Kapran, Gurling Bothma, and Jeffrey F. Pedersen, Professor and Research Associate, respectively, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210; Research Geneticist and Professor, respectively, Department of Agronomy, Purdue University, West Lafayette, IN, 47907; Researcher and Leader, National Sorghum Research Project, Ethiopian Institute of Agricultural Research, Melkassa Research Center, Nazareth, Ethiopia; Principle Sorghum Breeder, Institut National de la Recherche Agronomique du Niger, Niamey, République du Niger; Researcher, Agricultural Research Council-Roodeplaat, Pretoria, South Africa; and Research Geneticist, United States Department of Agriculture-Agriculture Research Service, University of Nebraska, Lincoln, NE, 68583.

Researchers are developing transgenic crops with enhanced nutrition and higher yields for Africa, but few studies have assessed environmental risks of growing these crops. Since wild relatives of sorghum (*Sorghum bicolor*) are often weedy and represent valuable germplasm, plans to release transgenic sorghum should consider consequences of gene flow. Our previous studies in Ethiopia and Niger showed that wild and cultivated sorghum often co-occur and flower simultaneously. Here, we tested for spontaneous hybridization between accessions of wild *S. bicolor* and local cultivars from eastern Africa at times when their flowering overlapped. Plants were grown in field plots in Ohio, with a ratio of more than 20 crop plants per wild individual. Microsatellite DNA markers showed that some seeds on wild plants were fertilized by crop pollen. We also studied the fecundity of F_1 hybrids between a male-sterile cultivar and three wild accessions. Wild and hybrid progeny were grown in Niger, Ohio, and Indiana. The relative fecundity of hybrids was fairly consistent across locations but differed somewhat among accessions. For two accessions, crop-wild hybrids produced more seeds per plant than their wild parent. For a third accession, hybrids produced similar numbers of seeds per plant in Niger, but fewer seeds per plant in the USA. However, this decrease in seed per plant in the USA was not significant. Although one hybrid had poor seedling survival, once established, all crop-wild F_1 hybrids were vigorous, and fertile, and could easily contribute pollen and seeds to subsequent generations. This study shows that selectively neutral or advantageous crop alleles are likely to persist in wild sorghum populations following hybridization. Before transgenic sorghum varieties are grown near wild relatives in Africa, ecological effects and other consequences of crop-to-wild gene flow should be examined for each transgenic trait.

SEED-TO-SEED AND HAY-TO-SEED POLLEN MEDIATED GENE FLOW IN ALFALFA. Larry R. **Teuber***, Shannon Mueller, Allen Van Deynze, Sharie Fitzpatrick, James R. Hagler, and Jose Arias, University of California, Davis 95616, Forage Genetics, Inc, West Salem, WI 54669, and ARS-USDA, Arid-Land Agricultural Research Center, Maricopa, AZ 85239.

Honey bees (*Apis mellifera* L.) are predominantly used in California as pollinators for alfalfa (*Medicago sativa* L.) seed production. In some areas there is an increasing use of leafcutter bees (*Megachile rotundata* Fabricius.) in combination with honey bees. It is well known that honey bees will forage up to several miles from their hive. A study conducted in 2003 by our group conducted a gene flow study with a 6 acre Roundup Ready® source plot and eleven 0.54A trap plots at regular intervals extending East and West of the source. That study demonstrated adventitious presence (AP) in excess of 1.5% 900 ft from the marker gene source plot. Furthermore, the marker gene was detectable at very low frequency out to 2.5 miles – the outer limit of the study. The objectives of the current studies were to 1) evaluate the effectiveness of commercially available test kits in detecting the presence of the CP4 EPSPS (Roundup Ready) protein in seed samples from the 2003 study and known to have low levels of the trait

based on extensive seedling growouts, 2) to determine the degree to which genes present in alfalfa fields being produced for hay are transferred to adjacent seed fields located the minimal legal distance of 165 ft from the hay field, and 3) to study gene flow between commercial scale production fields to further determine the extent of potential gene flow between alfalfa cultivars within the foraging range of honey bees.

To assess the effectiveness of the Roundup Ready test strips for seed we used seed produced on each of the 0.54 A trap plots during the 2003 study. All evaluations we conduced in accordance with the manufacturer's instructions. A total of 125 test strips were used to determine if the CP4 EPSPS protein was present in each of the traps. Strip test results from traps with a percentage AP less than 1% as determined by seedling growouts of seventy- to ninety-thousand seedlings provided virtually identical AP percentages based on determinations using "Seed Calc". AP percentages approaching and in excess of 1% could not be quantified because the frequency of AP seeds caused all the test strips to give positive results. For research purposes, we reduced the number of seeds tested when we started getting all positive strips, but kept all the other procedures the same. Results with this modification have also been in agreement with AP percentages found in large scale seedling growouts.

Conventional seed production fields were planted radiating out from a Roundup Ready hay production field. On all sides of the hay field the seed field was planted to within 165 ft and pollinated using honey bees. During the pollination period of approximately 8 weeks, the hay field was allowed to develop approximately 20% bloom (at least one open flower on 20% of the stems in the field) prior to being cut for hay. This is an amount of bloom the will occur with some commercial hay production and results in an opportunity for bees to visit the flowers and tripping does occur. Under this protocol, however, no seed is produced in the hay field. This degree of bloom was allowed to occurred in two consecutive cutting cycles during pollination. Seed was harvested at maturity from the seed fields at 50 foot intervals between 165 ft from the hay field (0 to 3 ft into the seed field) out to 615 ft from the hay field. Based only on test strip assessment, AP percentage was 0.29 % at 165 ft and dropped to less than 0.1% within 200 feet (365 ft of the hay field). This percentage of AP is well within current standards for varietal purity in the Federal Seed Law.

Seed to seed gene flow was studied in commercial seed production fields in the San Joaquin Valley of California. The source field was a 240A planted to cultivar bred to express the CP4 EPSPS protein. This field was isolated from all other seed production, except fields within the study area, by three miles in all directions. Within in the study area, a conventional cultivars was being produced for seed at 1 mile (240A), 3 miles (40A), and 5 miles (100A). All commercial seed production was pollinated by a combination of honey bees and leafcutter bees. 1.8A bridged trap plots were located on one edge of the study at 900 ft intervals between the source field and the conventional cultivar located 1 mile away. The first of these traps was located 165 ft from the source field. Current results are preliminary and are based on test strips. Equal size (1.8A) study areas were intensely sampled within each of the commercial. Among the small bridged traps, AP averaged 2.3% at 165 ft and rapidly decreased to 0.9% at 900 feet and 0.6% at approximately 4000 ft. At one mile AP percentage was less than 0.2%. At three miles the AP percentage was less than 0.03%. AP was not detected 5 miles from the source plot. Growouts of seedlings from form these test areas are still in progress. However, current data from this study using strip tests is in very close agreement with seedling growout data from our previous study.

APPLICATION OF LARGE EDDY SIMULATION TO QUANTIFY DISPERSAL OF VIABLE MAIZE POLLEN. Brian **Viner**, Ray Arritt, Mark Westgate and Susana Goggi. Graduate Research Assistant, Professor, and Professor, Department of Agronomy, Assistant Professor, Department of Seed Science, Iowa State University, Ames, IA 50011.

The creation of genetically modified (GM) crops has raised concerns regarding the transfer of genes from GM crops to wild relatives. To assess the risk of outcross, the development of numerical models that can accurately predict the movement depositional viability of pollen is needed. In maize, the primary mode of pollination is the transport of pollen by wind. Large Eddy Simulation (LES) is a tool to model turbulent motions that have the potential to lift pollen high into the atmospheric boundary layer and transport it over distances of at least five kilometers.

A LES model has been combined with a Lagrangian Dispersion Model to predict the transport and viability of pollen in the atmosphere. Predictions have been made for the deposition of maize pollen and of pollen viability upon deposition, as well as for vertical profiles of concentration and viability through the boundary layer. Viable pollen is modeled to be distributed throughout the boundary layer and transported over five kilometers before reaching the ground.

REGULATION OF DIURNAL POLLEN RELEASE IN MAIZE. Brian **Viner**, Raymond Arritt and Mark Westgate. Graduate Research Assistant, Professor and Professor, Department of Agronomy, Iowa State University, Ames, IA 50011.

The ability to accurately model pollen dispersion is reliant on reasonably predicting the magnitude of pollen shed over the day. To develop a predictive equation, pollen was collected at two field sites from 29 July to 3 Aug 2003. Based on measurements of collected pollen, a rate of pollen shed was calculated over each day and normalized to the total amount of pollen collected. Our model predicts the rate of shed as a function of two processes. The first equation is a Gaussian curve that predicts the percentage of pollen that is available for shed as a function of vapor pressure deficit. The second process predicts the amount of available pollen that will be shed. The output from this model would provide the rate of pollen shed in terms of the percent of a day's total shed. Results from this model show R^2 values ranging between 0.54 and 0.99 when compared to our field observations.

DO ESCAPED TRANSGENES PERSIST IN NATURE? THE CASE OF AN HERBICIDE RESISTANCE TRANSGENE IN WEEDY POPULATIONS OF *BRASSICA RAPA*. Suzanne I. **Warwick**, Anne Légère, Marie-Josée Simard and Tracey James, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON K1A OC6; Research Scientist, AAFC, Saskatoon, SK S7N 0X2; Research Scientist, AAFC, Québec, QC G1V 2J3; Technician, AAFC, Ottawa, ON K1A OC6.

This is the first report of the persistence and apparent introgression of an herbicide resistance transgene from canola (*Brassica napus)* into the gene pool of its weedy relative, bird rape (*B. rapa* L., also birdsrape mustard), monitored under natural commercial field conditions. Hybridization between glyphosate-resistant (HR) *B. napus* and *B. rapa* was first observed at two Québec sites, Ste-Agathe and St-Henri, in 2001. *Brassica rapa* populations at these two locations were monitored in 2002, 2003 and 2005 for the presence of hybrids and transgene persistence. All plants were scored for the HR trait (HR+/HR-), presence of species-specific AFLP molecular markers from both parental species, pollen viability, and ploidy level. Hybrid numbers decreased over the 3-year period, from 85 out of ca. 200 plants surveyed in 2002 to only 5 out of 200 plants in 2005 (St-Henri site). Most hybrids had the HR trait, reduced male fertility, intermediate genome structure, and presence of both species-specific AFLP markers. Both F1 and backcross hybrid generations were detected. One introgressed individual, i.e. with the HR trait and diploid ploidy level of *B. rapa*, was observed in 2005. The latter had reduced fertility but produced ca. 480 seeds. Forty-eight of the 50 progeny grown from this plant were diploid with high pollen viability and 22 had the transgene (1:1 segregation). These observations confirm the persistence of the HR trait over time. Persistence occurred over a six year period, in the absence of herbicide selection pressure (with the exception of possible exposure to glyphosate in 2002), and in spite of the fitness cost associated with hybridization.

INTER-SPECIFIC GENE FLOW IN CANOLA. Suzanne I. **Warwick**, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON K1A OC6.

Canola (*Brassica napus*) is capable of genetic exchange with related *Brassica* crop species as well as with several wild relatives. The large-scale use of herbicide-resistant (HR) canola has allowed us to examine inter-specific gene flow on realistic field scales. The HR trait is easy to monitor, provides accurate assessments, and is highly suited for extensive screening programs. Recent studies documenting gene flow distances of up to 200m between HR canola fields and Polish canola (*Brassica rapa*) and oriental mustard *(Brassica juncea*) fields will be presented. *Brassica napus* can potentially hybridize with four related weedy species in Canada and the United States (bird rape, *Brassica rapa*; wild radish, *Raphanus raphanistrum*; dog mustard, *Erucastrum gallicum*, and wild mustard *Sinapis arvensis*). Interspecific gene flow results with these four species will be reviewed, and will include the first report of the persistence and apparent introgression of an HR transgene from canola into the gene pool of *B. rapa*, monitored under natural commercial field conditions. Subsequent studies in eastern Canada confirm that hybridization is frequent throughout the sympatric ranges of these two species. Additional canola-quality *Brassica* crops (*B. juncea*, *B. carinata*) are under development, and interspecific gene flow concerns for these species will be reviewed and recent data from *Sinapis arvensis* x *B. juncea* hybridization studies presented. Consequences of hybridization and introgression are dependent on the traits that are introduced and their effect on hybrid fitness. The results from recent fitness trials for herbicide resistant (HR) and insect resistant Bt weed-crop hybrids (*B. rapa* x *B. napus*), suggest a cost to hybridization, independent of the transgenic trait. Future research needs will be outlined including a need for empirical data on: ecological effects of fitness-enhancing traits such as stress-tolerances, the consequences of transgene spread to non-agricultural habitats (now largely undocumented), and what specific environmental risks transgenic hybrid weed populations pose under field conditions.

MODELING THE BIOLOGY OF OUT-CROSSING BY ADVENTITIOUS POLLEN. Mark **Westgate**, Juan Astini, Agustin Fonseca, Jon Lizaso, Craig Clark, and Ray Arritt, Professor, and Graduate Student, Agronomy Department, Iowa State University, Ames, IA 50011, Research Scientist, Monsanto Company, Williamsburg, IA 52361, Crop Modeler, McNair Bostick Simulation Laboratory, University of Florida, Gainesville, FL 32611-0570, Assistant Professor, Department of Geography and Meteorology, Valparaiso University, Valparaiso, IN 46383-6493, and Professor, Agronomy Department, Iowa State University, Ames, IA 50011.

Risk of out-crossing from adventitious maize pollen results from complex interactions between the biology of flowering and pollination processes as well as the physical nature of pollen transport in the atmosphere. To quantify this risk, we have developed biological models of maize pollen production and viability, physical atmospheric models for pollen dispersal, and a biological model of pollen-silk interaction leading to kernel formation. We will show how these biological and physical models are linked to predict out-crossing events associated with adventitious pollen production and transport. Examples include results from field trials designed for production of non-transgenic grain, hybrid seed, and pharmaceuticals.

WEED CONTROL AND CROP RESPONSE IN TRIBENURON-TOLERANT SUNFLOWER. Amar S. Godar*, Phillip W. Stahlman, and Anita J. Dille, Graduate Research Assistant, Department of Agronomy, Kansas State University, Manhattan, KS 66506, Research Weed Scientist, Kansas State University Agricultural Research Center, Hays, KS 67601, and Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Two experiments were conducted at KSU Agricultural Research Center, Hays, KS, in 2007 with moderate to low infestations of broad-leaf weeds to assess the weed control and crop response in tribenuron-tolerant sunflower. Evaluation of weed control level by species, and crop response in terms of stunting, chlorosis, and malformation were made on percent visual basis.

In the first experiment, 10 treatments were combinations of tribenuron in terms of time (3 and 4 weeks after planting (WAP), frequency (single and double), and rate (8.75 and 17.5 g ai/ha) of application with quizalofop (61 g ai/ha), plus two imazamox treatments (35 and 17.5 g ai/ha at 3 and 4 WAP, respectively), a weed-free check, and an untreated check. All the tribenuron treatments provided significantly superior (90-100%) control of Russian thistle compared to both imazamox treatments. The results showed a similar pattern for the control of Puncturevine except for tribenuron at 17.5 g ai/ha applied 4 WAP. Imazamox at 35 g ai/ha applied at 3 WAP appeared to be as good as all the double applications of tribenuron in controlling Pigweeds. However, both imazamox applications and the tribenuron applications of 17.5 g ai/ha at 3 WAP provided the same level of Kochia control as all the double applications of tribenuron. None of the tribenuron treatments caused significant crop injury. At 1 week after application (WAA), imazamox applied at 35 g ai/ha at 3 WAP demonstrated noticeably higher level of stunting (31.25 $\pm$ 2.4%), chlorosis (23.75 $\pm$ 1.25%) and malformation (43.75 $\pm$ 3.75%) as compared to imazamox applied at 17.5 g ai/ha at 4 WAP (stunting 7.5 $\pm$ 1.45%, chlorosis 10 $\pm$ 2%, and malformation 0%). At 2 WAA, stunting, chlorosis, and malformation decreased to 20 $\pm$ 4.6%, 0%, and 16.25 $\pm$ 2.4%, respectively for imazamox applied at 35 g ai/ha at 3 WAP and no significant injury symptoms were observed for imazamox applied at 17.5 g ai/ha at 4 WAP. The plant height measured at 8 WAP and the seed yield did not differ significantly among the treatments; however, a weak relationship (r^2 = 3.96) was observed between the plant height and the seed yield.

In the second experiment, the treatments consisted of two rates of tribenuron (8.75 and 17.5 g ai/ha) without and in combination with label rates of pendimethalin, sulfentrazone or S-metolachlor. Quizalofop (61 g ai/ha) and COC (1% v/v) were applied tank-mixed with respective post-emergence treatments at 24 days after planting (DAP). Evaluation of pre-emergence applications at 24 DAP showed sulfentrazone as the best treatment for controlling all the weed species evaluated. However, pendimethalin and S-metolachlor were found to be as good as sulfentrazone in controlling Kochia, and Kochia and Pigweeds, respectively. Tribenuron alone provided the same level of control of all the weed species except Pigweeds as tribenuron in combination with pre-emergence herbicides. However, Pigweed control was significantly improved when the rate of tribenuron increased from 8.75 to 17.5 g ai/ha. None of the treatments caused significant stunting and malformation of the sunflower plants at 6 days after application (DAA) of post-emergence treatments. However, 17.5 g ai/ha of tribenuron alone and the same rate in combination with pendimethalin caused 11.25 $\pm$ 1.25 % and 8.75 $\pm$ 2.4 % chlorosis, respectively; and no chlorosis was observed at 12 and 17 DAA, respectively. Height of the sunflower plants measured 8 WAP showed no significant differences among the treatments, and the result was the same for seed yield. However, the seed yield was appeared to be correlated (r = 0.73) to the height of the plant. In conclusion, in a condition of a moderate to low infestation of broad-leaf weeds, a single application of tribenuron alone at the higher rate can provide a satisfactory level of weed control without any significant injury to sunflower.

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DUPONT EXPRESSSUN TRAIT WITH PIONEER ‘63N81’ NUSUN SUNFLOWER HYBRID AND DUPONT HERBICIDE SYSTEMS. James D. Harbour, Michael T. Edwards, Robert N. Rupp, Jeff H. Meredith, and Eric Hoeft, Field Development Representatives and Product Development Manager, DuPont Crop Protection, Wilmington, DE 19802, and Research Scientist, Pioneer Hybrid International, Inc., Johnston, IA, 50131.

In 2007, fourteen tests were conducted to determine DuPont ExpressSun trait system and Pioneer ‘63N81’ NuSun hybrid tolerance and weed efficacy to tribenuron-methyl herbicide. The objectives were two-fold; 1) determine crop response of Pioneer ‘63N81’ sunflower hybrid, which contains the ExpressSun trait, to single and sequential tribenuron-methyl herbicide applications; and 2) determine crop response of Pioneer ‘63N81’ sunflower hybrid and weed efficacy to pre-emergence herbicides followed by a single post-emergence application of tribenuron-methyl herbicide. Herbicides were applied pre-emergence and / or as a single or sequential applications to V4 to V8 growth stage Pioneer ‘63N81’ sunflower hybrids using small-plot sprayers. Crop response and weed efficacy was recorded

Crop response was minimal, for the first objective, and transient. Kochia control was 83% with the single application of tribenuron-methyl at 0.125 oz ai/a. However, kochia control increased to 95-98% with the single application of tribenuron at 0.25 oz ai/a or with the sequential applications of tribenuron (0.125 oz ai/a followed by (fb) 0.125 oz ai/a, and 0.25 oz ai/a fb 0.25 oz ai/a). Tumble pigweed control was 80% with the single application of tribenuron-methyl at 0.125 oz ai/a, but tumble pigweed control increased to >96% from the single application of tribenuron at 0.25 oz ia/a or the sequential tribenuron applications.

For the second objective, herbicide program trials containing a pre-emergence herbicides (pendimethalin or sulfentrazone) followed by a single post-emergence application of tribenuron (0.125 and 0.25 oz ai/a) exhibited crop response (23%) at a TX location, but injury symptoms were determined to be from the pre-emergence application of sulfentrazone. Pre-emergence herbicides followed by post-emergence tribenuron at either rate provided control of tumble pigweed (99%), redroot pigweed (>93%) and velvetleaf (>95%). Without pre-emergence herbicides, velvetleaf control was 57% with tribenuron-methyl applied post-emergence at 0.125 oz ai/a, but controlled improved to 100% with tribenuron-methyl at 0.25 oz ai/a. Tribenuron-methyl at either 0.125 or 0.25 oz ai/a controlled jimsonweed and puncture vine.

DUPONT AFFINITY PRODUCTS TANKMIXED WITH STARANE NXT, CLEANWAVE OR FLORASULAM. MICHAEL T. EDWARDS, ERIC P. CASTNER, JAMES D. HARBOUR, C. WILLIAM KRAL, JEFF H. MEREDITH, DuPont Crop Protection, Wilmington, DE 19802

In 2007 twenty-five tests were conducted to determine the efficacy when Affinity Tankmix and Affinity BroadSpec (Thifensulfuron-methyl and Tribenuron-methyl premixes) were tankmixed with Florasulam (6 tests) or Starane NXT (10 tests - Fluroxypyr + Bromoxynil) or Cleanwave (9 tests - Fluroxypyr + Aminopyralid).

Cleanwave was tested at 7 and 14 floz/ac (7 floz = 0.074 ozai Aminopyralid+1.05 ozai fluroxypyr). Control with Cleanwave alone at 7 fl oz/ac was poor on mayweed chamomile, blue mustard, flixweed, and prickly lettuce. Only lambsquarter, sunflower and wild buckwheat were controlled with 7 fl oz/ac of Cleanwave. Doubling the rate to 14 fl oz/ac improved flixweed and prickly lettuce to near control levels >80%, but control of mayweed chamomile and blue mustard remained poor. The addition of Affinity BroadSpec to the 14 fl oz/ac rate controlled mayweed chamomile. All other species were controlled with the addition of Affinity BroadSpec to the 7 fl oz/ac rate. The addition of Affinity Tankmix to the 14 fl oz/ac rate and Affinity Tankmix at 1.0 oz/ac to the 7 fl oz/ac rate controlled mayweed chamomile. All other species were controlled with the addition of Affinity Tankmix to the 7 fl oz/ac rate.

Starane NXT was tested at 3 rates (1/2 pt/ac, 3/4 pt/ac, 1 pt/ac = 1.2 ozai fluroxypyr + 4.66 ozai bromoxynil) and at 2 timings of application – 2” and 4” weeds. No crop response was seen with any treatment at the early application timing. Control with Starane NXT alone at 8, 12 or 16 fl oz/ac controlled redroot pigweed, lambsquarter, sunflower, wild buckwheat and cocklebur. The addition of Affinity BroadSpec to the 8 fl oz/ac rate improved control 5-8% on pigweed and sunflower.
No crop response was seen with any treatment at the late application timing. Control with Starane NXT alone at 8, 12 or 16 fl oz/ac controlled sunflower, wild buckwheat and cocklebur, but was about 10% less in control of redroot pigweed and lambsquarter. The addition of Affinity BroadSpec to the 8 fl oz/ac rate improved control 5-6% on pigweed and lambsquarter.

Florasulam at 1X or 2X rates did not control lambsquarter and was marginal on prickly lettuce. Florasulam at 1X suppressed blue mustard and flixweed, and at 2X did provide control. Frontline did not control prickly lettuce, but did control flixweed, and blue mustard. Florasulam + Axial only controlled blue mustard and flixweed, and crop response increased to 6%. Frontline + Affinity BroadSpec and Florasulam + Axial + Affinity Tankmix controlled all species. Addition of 2,4-D ester to Florasulam + Affinity BroadSpec controlled all species, but did increase crop response to 13%.

ROW SPACING EFFECTS ON WEED MANAGEMENT IN GLYPHOSATE-RESISTANT SUGAR BEET. Jon-Joseph Q. Armstrong and Christy L. Sprague, Graduate Assistant and Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

The introduction of glyphosate-resistant sugar beet (*Beta vulgaris*) will improve weed control and crop safety in sugar beet. With less need for in-row cultivation, this technology may also allow producers to plant sugar beet in narrower rows. Field trials were established in 2006 and 2007 to evaluate the effect of row width on canopy development and weed growth in glyphosate-resistant sugar beet. Row widths of 38-, 51-, 76-cm were investigated in this study. Canopy cover measurements in 2006 showed significantly greater cover in 38-cm rows compared to 76-cm rows at all sampling times. However, in 2007 canopy cover during the growing season was similar among the three row widths. In both years, plant population did not have an effect on canopy cover. Weed biomass was similar among all row widths in untreated plots both years. However, a trend of reduced weed biomass in narrower rows was present. Moisture limitations in 2007 may have contributed to the lack of differences in canopy cover among the row widths in 2007 as compared with 2006.

BROADLEAF WEED CONTROL IN OAT. Krishona Martinson, Lisa Behnken, Fritz Breitenbach, Jochum Wiersma, and Beverly Durgan. Assistant Extension Professor, Extension Professor, IPM Specialist, Assistant Extension Professor, and Professor. University of Minnesota Extension, St. Paul, MN 55108.

Although considered a minor crop in Minnesota (300,000 acres), oat still has multiple uses. Recently, there has been an increased interest in weed free oat straw as mulch for right-of-way seedings. The objective of this research was to evaluate broadleaf weed control and crop injury using postemergence herbicides in oat. Research plots were established in 2007 at three locations in Minnesota; Rosemount, Rochester, and Crookston. 'Kame' oat was seeded at a rate of 5 bu/ha and fertilized according to soil test. The experiments were organized in a randomized complete block design with three replications. Dicamba, bromoxynil + MCPA, bromoxynil, clopyralid + MCPA ester, thifensulfuron, pyrasulfotole, MCPA amine, MPCA + dicamba, fluroxypyr + 2,4-D, and clopyralid + fluroxypyr were applied to three to five leaf weeds at label rates. Weed control, crop injury, and grain yields were taken. Visual weed control and crop injury ratings were taken at seven, 14 and 21 DAT, and prior to oat harvest. Oat injury was minimal in all treatments. Weed control varied among treatments and weed species, but was acceptable in all treatments.

RESPONSES OF WINTER WHEAT TO PREPLANT AND PREEMERGENCE HERBICIDE TANKMIXES. Peter H. Sikkema, Christy Shropshire, and Nader Soltani*. University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada. N0P 2C0.

Field experiments were established at the Huron Research Station and at University of Guelph Ridgetown Campus in the fall of 2004 and 2005 to evaluate the tolerance of winter wheat to tankmixes of glyphosate plus either amitrole, dicamba, dicamba/diflufenzopyr, 2,4-D amine, 2,4-D ester, chlorimuron-ethyl or thifensulfuron- methyl/tribenuron-methyl applied preplant (PP) and preemergence (PRE). Contrasts comparing PP vs PRE treatments showed no difference in visible injury, plant height and yield between application timings. The tankmix of glyphosate (1800 g/ha) plus either amitrole (1155 g/ha), dicamba (300 g/ha), 2,4-D amine (700 g/ha), 2,4-D ester (700 g/ha) or thifensulfuron-methyl/tribenuron-methyl (15 g/ha) caused minimal (less than 5%) and transient visible injury in winter wheat (Table 1). In addition, these tankmixes had no effect on plant height and yield. The tankmix of glyphosate (1800 g/ha) with dicamba/diflufenzopyr (200 g/ha) or chlorimuron-ethyl (9 g/ha) caused as much as 8 and 18% visible injury in winter wheat, respectively (Table 1). Glyphosate (1800 g/ha) plus dicamba/diflufenzopyr (200 g/ha) did not affect plant height but glyphosate plus chlorimuron-ethyl reduced plant height 11%. Yield was reduced 15% when glyphosate was tankmixed with dicamba/diflufenzopyr and 26% when glyphosate was tankmixed with chlorimuron-ethyl. Based on these results, the PP and PRE application of glyphosate tankmixes with dicamba/diflufenzopyr or chlorimuron-ethyl resulted in unacceptable injury in winter wheat at the rates evaluated. The PP and PRE application of glyphosate tankmixes with amitrole, dicamba, 2,4-D amine, 2,4-D ester and thifensulfuron- methyl/tribenuron-methyl at the rates evaluated had an adequate margin of crop safety for weed management in winter wheat under Ontario growing conditions.

WEED MANAGEMENT SYSTEMS IN DRY BEAN. Nader Soltani*, Richard Vyn, Christy Shropshire, and Peter H. Sikkema. University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada. N0P 2C0.

Three field experiments were conducted over a three-year period (2004, 2005 and 2006) to evaluate various weed management programs in white bean in Ontario, Canada. Herbicide treatments evaluated caused no visible injury in white beans. Trifluralin provided 12% grater control of common lamb's-quarters compared to s-metolachlor. There was no benefit of tankmixing s-metolachlor + trifluralin in respect to yield and profitability compared to either trifluralin or s-metolachlor alone. The postemergence application of bentazon + fomesafen following a soil applied herbicide resulted in improved control of common lamb's-quarters 15%. Two inter-row cultivations following a soil applied herbicide resulted in improved control of redroot pigweed, common lamb's-quarters, and green foxtail. The addition of imazethapyr (60% label dose; 45 g a.i. ha^{-1}) to the soil applied grass herbicide resulted in improved control of redroot pigweed, common lamb's-quarters 16%, and green foxtail 6%. There was an increase in profitability with the use of s-metolachlor or trifluralin. There was a further increase in profitability by adding imazethapyr (60% label dose) to the grass herbicide. Profitability was increased by following the grass herbicide with a postemergence (POST) application of bentazon plus fomesafen or two interrow cultivations. There was a decrease in profitability by applying a tankmix of s-metolachlor + trifluralin. There was a decrease in profitability if a POST application of bentazon plus fomesafen or two inter-row cultivations followed a soil applied herbicide that included imazethapyr (60% label dose).

WATERHEMP CONTROL IN CORN AND SOYBEAN WITH SEQUENTIAL HERBICIDES.
Nader Soltani*, Joshua D. Vyn, and Peter H. Sikkema. University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada. N0P 2C0.

Common waterhemp (*Amaranthus tuberculatus*) is an aggressive annual broadleaf weed that is a dominant species in cropping systems in the mid-western United States. Waterhemp was first identified in Ontario, Canada in 2002 and is expected to rapidly infest agricultural land in eastern Canada similar to its development in the United States. In 2005 and 2006, four separate field experiments (2 in corn & 2 in soybean) were established on two Ontario farms (near Petrolia and Comber, Ontario) with heavy infestations of waterhemp to evaluate the efficacy of various PRE- and POST-emergence herbicides applied alone or in sequence for the control of waterhemp in corn and soybean. There was no injury to corn and soybean from any of the herbicide treatments evaluated. In corn, sequential herbicide programs of isoxaflutole + atrazine PRE fb either dicamba POST, dicamba/diflufenzopyr POST, dicamba/atrazine POST or mesotrione + atrazine POST provide consistent full-season control of waterhemp. Corn yield was reduced 48% when waterhemp was not controlled. Corn yield was equivalent to the weed-free check with the herbicide treatments evaluated. In soybean, PRE or POST herbicides alone provided 52 to 94% control of waterhemp however, waterhemp control was 92 to 99% with the sequential herbicide programs. Dimethenamid (PRE; 1250 g/ha) followed by glyphosate (POST1; 900 g/ha) followed by glyphosate (POST2; 900 g/ha) controlled waterhemp 99%. Results with waterhemp density were similar to visible control. Soybean yield was reduced 41% when waterhemp was not controlled. Soybean yield was equivalent to the weed-free check with all the herbicide treatment except dimethenamid PRE, acifluorfen POST1 and fomesafen POST1 where the yield was lower 30, 19 and 19%, respectively.

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WEED TOLERANCE TO FLAMING. Stevan Z. Knezevic and Santiago Ulloa*. Associate Professor and Graduate Student Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Organic producers rank weeds as the most important pests that limit their crop production. In order to optimize propane use as a weed control tool, the objective of this study was to collect a baseline data on weed tolerance to broadcast flaming. Field studies were conducted in 2007 utilizing six rates of propane and ten major weed species in northeast Nebraska, including: Venice mallow (*Hibiscus trionum*), waterhemp (*Amaranthus rudis*), field bindweed (*Convolvulus arvensis*), kochia (*Kochia scoparia*), Ivyleaf morning-glory (*Ipomoea hederacea*), velvetleaf (*Abutilon theophrasti*), redroot pigweed (*Amaranthus retroflexus*), barnyardgrass (*Echinocloa crus-galli*), green foxtail (*Setaria viridis*) and yellow foxtail (*S. glauca*). The propane rates included: 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha (0, 2.5, 6.5, 10.5, 14.4 and 18.4 gal/a). Flaming treatments were applied utilizing an ATV mounted flamer moving at a constant speed of 6.5 km/hour (4 MPH). Species response to propane rates were described by log-logistic models based on relative dry matter for each weed species. Overall response to flame varied among the species, growth stages and propane rate. Broadleaf weeds were more susceptible to flames than grasses. Propane rate of 50-70 kg/ha provided 90% control of most broadleaf species. Although, 70-90 kg/ha provided 80% control of grasses, none of the propane rates provided 90% control. Flaming has a potential to be used effectively in organic agriculture (sknezevic2@unl.edu).

POPCORN TOLERANCE TO MESOTRIONE, TEMBOTRIONE AND TOPRAMEZONE. Thomas T. Bauman and Michael D. White, Professor and Research Associate, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

A field trial was conducted in 2007 to test the tolerance of four popcorn hybrids to X and 2X rates of three HPPD herbicides: mesotrione, tembotrione and topramezone. These herbicides were sprayed 31 days after planting to V-3 stage popcorn that was 25 cm tall. Mesotrione was applied at rates of 105 and 210 g/ha. Crop oil concentrate (Herbimax) (1% v/v) was added to the mesotrione treatments. Tembotrione was applied at rates of 92 and 184 g/ha. Methylated seed oil (MSO Concentrate) (1.0% v/v) and 28% UAN (3.5 l/ha) were added to both tembotrione treatments. Topramezone was applied at three rates; 12, 18 and 39 g/ha. Methylated seed oil (MSO Concentrate) (1.0% v/v) and 28% UAN (2.5 % v/v) were added to both rates of topramezone. Spray volume for the post-emergence treatments was 187 l/ha. Plots were maintained weed free for the entire growing season with a pre-emergence application of s-metolachlor+atrazine (3.2 kg/ha) and mechanical cultivation.

The four hybrids differed greatly in their response to the different herbicides. While all four popcorn hybrids exhibited some bleaching of treated leaves, each hybrid varied in their sensitivity to the HPPD herbicides. One hybrid was very sensitive. Two hybrids were intermediary in sensitivity. One hybrid was fairly resistant. No injury was visible from any treatment 21 days after treatment however. More injury was observed from treatment with mesotrione than from tembotrione or topramezone. The 2X rates caused more injury than the X rates. No difference in grain yield was observed for three of the hybrids in spite of injury observed earlier in the season.

While HPPD herbicides can cause significant visual injury, this injury may not result in a reduction in popcorn yield.

GRAIN SORGHUM RESPONSE TO POSTEMERGENCE MESOTRIONE APPLIED AT DIFFERENT GROWTH STAGES. Mary Joy M. Abit, Kassim Al-Khatib, David L. Regehr, Mark M.Claassen, Phillip W. Stahlman, Barney W. Gordon, Randall S. Currie, and Patrick W. Geier, Graduate Research Assistant, Professor, Professor, Professor, Professor, Professor, Professor, and Assistant Scientist, respectively, Kansas State University, Manhattan, KS 66506.

Field experiments were conducted at Belleville, Hays, Hesston, Garden City, and Manhattan, KS to determine sorghum response to postemergence application of mesotrione at three growth stages. Mesotrione was applied at 52, 105, 157 and 210 g/ha in combination with 280 g/ha atrazine when sorghum was at 5 to 8, 15 to 20 and 30 cm tall. All rates of mesotrione caused visual injury at all growth stages. Sorghum was more injured when mesotrione was applied at 5 to 8 cm than 15 to 20 and 30 cm growth stages. Sorghum at Belleville, Garden City (irrigated) and Manhattan sites showed least injury at 15 to 20 cm while at Hays, Hesston and Garden City (dryland) sites the least injury was at 30 cm growth stage. Overall sorghum injury from mesotrione was greatest at 1 week after treatment with 25 to 64% injury. However, sorghum yield was reduced by only 13 and 14% at 30 and 5 to 8 cm growth stages, respectively. No yield reduction was observed when sorghum was treated with mesotrione at 15 to 20 cm growth stage. This study showed that postemergence applications of mesotrione can injure grain sorghum and reduce yields. The degree of injury can be lessened when mesotrione was applied at later stages. In addition, this study suggests that sorghum plant can sustain some level of plant injury without large reductions in yield.

JOHNSONGRASS CONTROL WITH POSTEMERGENCE CORN HERBICIDES APPLIED ALONE OR IN TANK MIX COMBINATIONS. James R. Martin and Charles R. Tutt, Extension Professor and Research Specialist, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445.

Postemergence herbicides used to manage johnsongrass are sometimes tank mixed with other herbicides to broaden the spectrum of weeds controlled in corn. There is concern this practice may cause antagonism in the form of reduced control of johnsongrass.

Five field studies were conducted during 2002 through 2005 at University of Kentucky Research and Education Center in Princeton to evaluate johnsongrass control with five postemergence corn herbicides applied alone or in combination with other herbicides. The herbicides and rates used to control johnsongrass were foramsulfuron at 0.53 oz ai/A, glyphosate at 0.75 lb ae/A, nicosulfuron at 0.5 oz ai/A, the sulfonylurea premix of nicosulfuron at 0.38 oz ai/A plus rimsulfuron at 0.19 oz ai/A, and the imidazolinone premix of imazethapyr at 0.67 oz ai/A plus imazapyr at 0.22 oz ai/A. These were applied alone or in combination with atrazine at 1 lb ai/A, carfentrazone at 0.13 oz ai/A, mesotrione at 1.5 oz ai/A, 2,4-D at 5.7 oz ae/A, or the premix dicamba at 2 oz ae/A plus diflufenzopyr at 0.8 oz ae/A. Adjuvants were included according to label directions of the herbicides used for johnsongrass control.

The first three studies designated as 2002A, 2002B, and 2003 were conducted in fallow areas where johnsongrass was mowed and allowed to regrow. Treatments were applied in mid June to late July when johnsongrass was at a height of 24 inches in 2002A study, 21 inches in 2002B study, and 14 inches in 2003 study. Studies conducted in 2004 and 2005 were planted to corn on May 7 and 5, respectively, using conventional tillage practices and treated with S-metolachlor and atrazine at planting. Postemergence treatments were applied June 3 in 2004 and 2005 when johnsongrass was approximately 12 inches in height. Based on field histories, the majority of johnsongrass plants originated from rhizomes or produced rhizomes and therefore was more prone to regrowth than seedling plants.

Visual ratings at four weeks after application indicated the overall average control of johnsongrass in the fallow studies was less than where corn was grown. The average control across all treatments was 62% for 2002A, 47% for 2002B, 69% for 2003, 85% for 2004 and 92% for 2005. The greater control observed where corn was present is likely due to shading from the crop plants and smaller johnsongrass plants that were more actively growing at the time of application. The extreme dry conditions in the 2002B study caused poor johnsongrass control for all treatments, except for glyphosate.

Control in the two studies with corn (i.e. 2004 and 2005 studies) was at least 93% for all johnsongrass herbicides that were applied alone, except for 80% control with the premix of imazethapyr plus imazapyr in the 2005 study. Glyphosate was superior to the other johnsongrass herbicides, except for the premix of nicosulfuron plus rimsulfuron in the 2002A study, in controlling johnsongrass in fallow areas.

Tank mixing reduced rhizome johnsongrass control in only a few cases. There were six treatments in the 2002 B study where control with tank mix combinations was less relative to the johnsongrass herbicide alone. Johnsongrass control with the premix of nicosulfuron plus rimsulfuron was reduced by 20% with atrazine, 17% with mesotrione, 17% with the premix of dicamba plus diflufenzopyr, and 14% with 2,4-D ester. The control with the premix of imazethapyr plus imazapyr, when combined with 2,4-D ester, was reduced by 10% in the 2002 B study and by 7% in the 2005 study.

In summary, antagonism in the form of reduced rhizome johnsongrass control from using tank mix combinations was an issue in only a few instances. Control with all five johnsongrass herbicides applied alone was generally equal when corn was present and johnsongrass was 12 inches in height at the time of application. However, glyphosate was usually the best among the herbicides tested for controlling rhizome johnsongrass in fallow areas when plants were large and stressed at the time of application.

COMPETITIVE ABILITY OF VOLUNTEER CORN IN CORN AND SOYBEAN. Jill Alms, Mike Moechnig, Darrell Deneke, and Dave Vos, South Dakota State University, Brookings, SD.

Volunteer corn can be a problematic weed in corn-soybean and corn-corn cropping systems. However, there is little information available quantifying the effects of volunteer corn on soybean or corn yield, particularly in drier regions of the Midwest where competition for soil moisture may influence weed-crop growth interactions. Concerns regarding the effects of volunteer corn on corn have increased due to greater continuous corn acres resulting from expansion of the ethanol industry. One option for controlling volunteer corn in corn may be to rotate glyphosate- and glufosinate-tolerant corn varieties. However, glufosinate may only partially control volunteer corn which could result in corn yield loss. Similarly, glufosinate used to control volunteer corn in glufosinate-tolerant soybeans may also result in partial volunteer corn control and soybean yield loss. Studies were conducted in Brookings, SD to 1) quantify the effect of volunteer corn on corn yield, 2) quantify the effect of partially controlled volunteer corn on corn yield, 3) quantify the effect of volunteer corn on soybean yield, and 4) quantify the effect of partially controlled volunteer corn on soybean yield.

The effect of volunteer corn on corn yield was determined by establishing volunteer corn densities of 0, 0.2, 0.8, 1.2, 1.9, 2.5, 2.7, or 3.5 plants m^{-2} in Dekalb DKC 46-60 VT3 corn. Volunteer corn density treatments were established in a RCB design with four replications. Volunteer corn seed was collected from DKC 58-73 harvested in 2006, scattered on the soil surface on May 14, 2007 and incorporated approximately 4 cm below the soil surface using a field cultivator. On November 7, 2007, volunteer corn ears were hand-harvested from the center five feet of each ten foot wide plot and the remaining corn in the center five feet was harvested with a plot combine on November 10. The results indicated that corn yield loss ranged from 0-13% among the volunteer corn densities or 0-9% when accounting for corn grain produced by volunteer corn. In another study, volunteer glyphosate-tolerant corn was established at 3.5 plants m^{-2} in corn and glufosinate (470 g a.e. ha^{-1}) was applied when volunteer corn was 13, 18, 28, or 46 cm tall. These treatments were established in a RCB design with four replications. Visual estimates of volunteer corn control were greatest when glufosinate was applied to 18-28 cm tall volunteer corn. Partially controlled or uncontrolled volunteer corn did not reduce corn yield. These results indicated that volunteer corn had a relatively minor affect on corn yield and incomplete control of volunteer corn with glufosinate did not reduce corn yield.

The effect of volunteer corn on soybean yield was determined by establishing volunteer corn densities of 0, 0.2, 0.6, 1.5, or 3.5 plants m^{-2} in soybeans. Volunteer corn treatments were established in a similar manner as the volunteer corn in corn density experiment. Soybean yield loss ranged from 0-54% among the volunteer corn densities. In another study, volunteer corn was established at 1.5 plants m^{-2} in soybean and clethodim was applied at 13.2, 26.3, or 52.6 g a.i. ha^{-1} when volunteer corn was approximately 51 cm tall. At the low, medium, and high clethodim rates, volunteer corn biomass was reduced by 0, 30, and 76%, respectively, and soybean yield loss was 5, 14, and 21%, respectively. These results indicated that volunteer corn greatly affected soybean yield and even partially controlled volunteer corn resulted in soybean yield loss.

BROADLEAF WEED CONTROL WITH KIH-485. Peter J. Porpiglia* and Yoshihiro Yamaji, K-I Chemical U.S.A., Inc. and Osamu Watanabe, Kumiai Chemical Industry Company, Ltd., Shizuoka, Japan. (15)

KIH-485 in new herbicide under development by Kumiai Chemical Industry Co., Ltd and Ihara Chemical Industry Co., Ltd. as a pre emergence herbicide for corn and soybean. While the initial weed targets primarily included annual grasses, it was soon discovered that many broadleaf weeds were also well controlled. For several years, researchers have been quantifying broadleaf weed control activity of KIH-485 compared to other standard pre emergence herbicides such as s-metolachlor and acetochlor. In medium textured soils, such as loams and silty clay loams, KIH-485 was tested at rates of 166 and 209 grams of active ingredient per hectare. KIH-485 was compared to s-metolachlor at a 1:8.5 ratio and to acetohlor at a 1:9.4-10.4 ratio taking into account different soil textures. At these fixed rate comparisons, KIH-485 was 2-35% more effective than s-metolachlor on *Amaranthus, Chenopodium, Sida, Solanum, Abutilon, Ipomoea*, and *Pologonium* species. KIH-485 was 4-20% more effective than acetochlor on *Amaranthus, Sida, Abutilon, Ipomoea* and *Pologonium* species. On several broadleaf species there was no significant difference between KIH-485 and acetochlor. Results presented are averaged across all soil moisture conditions. Since soil moisture can affect the performance of these products, studies are currently underway to clarify the effect of soil moisture on weed control.

DOSE RESPONSE CURVES OF KIH-485 FOR WEED CONTROL IN CORN. Stevan Z. Knezevic, Jon E. Scott* and Peter Porpiglia, Associate Professor and Research Technologist, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828, and Researcher, Kumia America, White Plains, New York.

KIH-485 is a new herbicide under development. Field studies were conducted in 2006 and 2007 at Brunswick and Concord to describe and compare dose response curves for KIH-485 at three soil types (eg. 1%OM, 2%, and 3% OM) for control of green foxtail, field sandbur, large crabgrass, velvetleaf and tall waterhemp. Dose response curves were fit, and ED90 values (effective dose that provides 90% weed control) were determined utilizing the **R** and *drc* software package. Corn showed excellent tolerance to KIH-485, as there was no crop injury at any of the rates tested at medium and heavy soils. There was crop injury at sandy soil (<1%OM) at 2X and 3X rates due to cold-wet spring in 2007 only. Generally, an increase in OM resulted in higher ED90 values for all weed species. Based on the 2006 data, the ED90 (90% control) for green foxtail was 115 g ai/ha for soils with 1% OM, while 300 g ai/ha was calculated for soils with 3% OM. Similar response was observed for other weed species. The proposed label rate for KIH might be between 200-250 g ai /ha, which would provide excellent control of most weed species for at least first four weeks of the growing season on soils up to 3% OM. Based on the 2006 data, at 28 DAT field sandbur was controlled with 228 g ai/ha on soils with 1% OM, green foxtail with 115g and 121g ai/ha on soils with 1% and 2% OM, as well as velvetleaf and tall waterhemp on soils with 3% OM with 189 g ai/ha and 240 g ai/ha. Most soils in Nebraska contain no more than 3% OM, thus the KIH has a good potential for PRE use in corn as it provided excellent early season control of our major weed species (sknezevic2@unl.edu).

FIELD SURVEY OF PPO-RESISTANCE IN ILLINOIS WATERHEMP POPULATIONS. Daniel D. Schnitker, Bryan G. Young, Julie M. Young, and Joseph L. Matthews, Graduate Research Assistant, Professor, and Researchers, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Prior to the introduction of glyphosate-resistant soybeans, PPO-inhibiting herbicides were frequently used for postemergence control of common waterhemp. Reports from growers experiencing inadequate control of common waterhemp with this chemistry led to the confirmation of PPO-resistant biotypes in Illinois in 2002. Along with crop safety concerns, challenges with managing common waterhemp contributed to the widespread adoption of glyphosate-resistant soybeans. The objective of this study was to quantify the incidence of PPO-resistance in common waterhemp populations sampled throughout Illinois. In fall 2006, seed was collected from mature common waterhemp plants found in 77 random Illinois fields in 43 counties, as well as 26 fields in 12 counties that were suspected to contain PPO-resistant biotypes. Plants grown from these seed sources and known PPO-susceptible sources were screened for resistance to lactofen at two rates, 220 and 660 g ai/ha. At 21 DAT, plant responses were categorized as resistant or susceptible based on visible injury ratings as described in previous literature. Typical injury symptoms of rapid necrosis from lactofen were observed as well as various levels of regrowth on plants that survived the herbicide application. Approximately 25% (19 of 77) of the random collections were confirmed to contain PPO-resistant biotypes. All but one of the suspected seed collections was confirmed to exhibit some level of resistance. From this screen, PPO-resistant biotypes were found in 21 counties in Illinois, mostly in the south-central and western areas of the state. The geography encompassed by PPO-resistant common waterhemp in Illinois is much greater than previously documented or suspected since the shift to glyphosate-based weed management in soybean. Therefore, growers should not assume that the postemergence PPO-inhibiting herbicides they once utilized in the 1990s will still be effective to manage common waterhemp populations in the future if glyphosate performance declines.

SANDBUR CONTROL IN SOYBEAN WITH IMAZETHAPYR. Peter H. Sikkema, Joshua D. Vyn, Chris Kramer, and Nader Soltani*. University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada. N0P 2C0.

Five field trials were conducted at various locations in Ontario over a two year period (2005 and 2006) to study the efficacy of imazethapyr applied at various timing for the control of sandbur in soybean. Treatments consisted of a weedy check, a weed-free check, early and delayed preemergence (PRE) imazethapyr (100 g ai/ha) and postemergence (POST) applied imazethapyr (100 g ai/ha) at spike to five-leaf stage of sandbur. There was no visible injury to soybean 7, 14 and 28 days after treatment (DAT). Imazethapyr PRE treatments provided 46 to 66% control of sandbur. Imazethapyr POST provided up to 72, 66, 78, 91, 78 and 71% control of sandbur when applied at spike, one-, two-, three-, four-, and five-leaf stage, respectively. Sandbur density (#/m^{-2}) and biomass (g/m^{-2}) corresponded with the level of sandbur control. Generally, there was an improvement of sandbur control as the imazethapyr application timing was delayed until the three-leaf stage and then the control decreased when the application timing was delayed past this stage. Yield was reduced as much as 30% when sandbur was not controlled. Imazethapyr PRE treatments did not affect yield but imazethapyr POST when applied at spike, one-, two-, three-, four-, and five-leaf stage increased yield 44, 28, 39, 24, 38, and 20%, respectively. Based on these results, imazethapyr PRE does not provide adequate control of sandbur in soybean however, imazethapyr applied POST at three-leaf stage has potential for the control of sandbur in soybean.

EFFECTIVENESS OF PREPLANT SOYBEAN HERBICIDES ON GLYPHOSATE-RESISTANT GIANT RAGWEED. Mark M. Loux, Jeff M. Stachler, and Anthony F. Dobbels, Professor, Extension Program Specialist, and Research Associate, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

Field research was conducted in Ohio in 2007 to determine the effectiveness of PRE herbicides for control of glyphosate-resistant giant ragweed in no-tillage soybeans. Herbicides were applied on May 4 and 8 in Licking and Butler Co., respectively, when giant ragweed plants were 2 to 8 and 5 to 30 cm tall. PRE herbicide treatments were followed with two POST applications of glyphosate, at rates of 1.7 and 0.8 kg ae/ha. The response of individual plants and overall control were measured 21 DAT and in early October. PRE treatments that controlled at least 95% of emerged plants 21 DAT at both locations included: glyphosate (1.7 kg/ha) plus 2,4-D ester; paraquat plus 2,4-D ester or metribuzin; and glufosinate plus 2,4-D ester or metribuzin. PRE application of glyphosate at rates up to 3.4 kg/ha killed no more than 82 and 53% of individual plants at Licking and Butler Co., respectively. Combinations of glyphosate (8.4 or 1.7 kg/ha) with chlorimuron- or cloransulam-containing products did not provide acceptable control of emerged plants at either location, which indicated that plants within each population were resistant to both glyphosate and ALS inhibiting herbicides.

Regrowth of herbicide-injured plants and emergence of additional plants resulted in a reduction in control between 21 DAT and the time of POST glyphosate application, which occurred approximately 45 DAT. Giant ragweed control 45 DAT at Butler Co. exceeded 80% only for combinations of glyphosate (0.8 or 1.7 kg/ha) with 2,4-D ester. At Licking Co., control exceeded 80% for the following combinations: glyphosate (3.4 kg/ha), cloransulam, and flumioxazin; paraquat, chlorimuron, and metribuzin; and glufosinate, chlorimuron, and metribuzin. POST glyphosate applications had little activity on giant ragweed at Butler Co., and control at the time of soybean harvest did not exceed 78% for any treatment. POST glyphosate applications had more activity on giant ragweed at Licking Co, compared with Butler Co., due to a lower level of resistance in the former. Late-season control at Licking Co. ranged from 91 to 94% for PRE treatments consisting of a combination of either glyphosate (1.7 kg/ha), paraquat, or glufosinate, plus chlorimuron and metribuzin.

FALL APPLICATIONS OF CHLORIMURON-ETHYL BASED OFFERINGS IN COMPARISION TO KEY COMPETITIVE STANDARDS IN SOYBEAN. Marsha J. Martin, Gregory R. Armel, Helen A. Flanigan, Susan K. Rick. DuPont Crop Protection. Newark, DE, 19711.

Twelve university and four DuPont field trials were conducted in 2006/2007 to compare fall applications of chlorimuron-ethyl plus tribenuron-methyl (Canopy™ EX) to iodosulfuron-methyl sodium (Autumn) and determine differences in burndown spectrum and length of residual control. Four treatments were tested in the university protocol, Canopy™ EX at 1.1 and 2.2 oz/ac, Autumn at 0.3 oz/ac and a glyphosate standard. In addition to these treatments, the DuPont trials also included Autumn at 0.6 oz/ac and both Autumn treatments tank mixed with Sencor at 10 oz/ac. All treatments included crop oil concentrate at 1% v/v and 1 pt/ac 2,4-D LV4.

In university trials, both rates of Canopy™ EX showed good to excellent control of the following weeds evaluated at multiple locations: common ragweed, common lambsquarters, marestail, henbit, annual bluegrass, chickweed, and dandelion. Canopy™ EX at both rates gave suppression of giant ragweed and giant foxtail. Autumn gave good control of henbit, fair control of chickweed and dandelion, poor control of common ragweed, common lambsquarters, giant foxtail, annual bluegrass, and suppression of giant ragweed.

In the 4 DuPont trials, both rates of Canopy™ EX gave excellent control (93% or greater) of the following weeds rated at multiple locations: annual mustards, deadnettle, chickweed, dandelion, and speedwell sp., while single observations showed good to excellent control (90-100%) of red root pigweed and common lambsquarters. All Autumn treatments showed poor control of common lambsquarters and red root pigweed, whereas the addition of Sencor improved speedwell control to fair. Annual mustard and chickweed control in all Autumn treatments was fair to good regardless of Sencor presence or absence. Dandelion control was poor to fair with Sendor and fair to good without Sencor.

For this data set of 16 fall trials, 1.1 - 2.2 oz/ac Canopy™ EX showed a better burndown spectrum and significantly better residual activity than 0.3 - 0.6 oz/ac Autumn or 0.3 - 0.6 oz/ac Autumn + 10 oz/ac Sencor.

INFLUENCE OF PREPLANT GROWTH REGULATOR HERBICIDES ON SOYBEAN DEVELOPMENT AND YIELD. Joseph L. Matthews, Bryan G. Young, Dean E. Riechers, and Gordon K. Roskamp, Researcher and Professor, Department of Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901, Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801, and Professor, Department of Agriculture, Western Illinois University, Macomb, IL 61455.

Field research was conducted at Belleville, Champaign, and Macomb, IL in 2006 and 2007 to evaluate the effect of various rates of 2,4-D and dicamba applied preplant to soybean with and without soil residual herbicides. Additionally, some herbicide treatments were repeated on more than one soybean variety to determine if the response to herbicide treatment changed with soybean variety. Evaluations on soybean included days to 90% emergence, population, developmental growth stage, visual injury at 14, 21, 28, 42, 56, and 84 days after planting (DAP), and grain yield. Data were subjected to stepwise multiple regression to determine which in-season evaluation was most predictive of yield reduction. Data were also subjected to factorial ANOVA to determine if soil residual herbicide treatments and soybean variety influenced yield reduction.

The extent of delayed soybean emergence, population reduction, delayed development, visual injury symptoms and the associated yield reduction varied by location and year, but overall there was a strong correlation of yield reduction with reduced population, delayed development and visual injury evaluated at 28 DAP. The best overall predictor of yield reduction was a natural log transformation of population. The prediction model was further improved equally by adding either the linear, quadratic and cubic transformations of visual injury at 28 DAP or by adding soybean developmental stage at 28 DAP. When soybean population was removed from the model, visual injury was a better predictor of yield reduction than developmental stage when both evaluations were made at 28 DAP. Duration of soybean injury, as expressed by developmental delays at 56 and 84 DAP, was also a good predictor of yield reduction. Failure to reach 90% emergence by 14 DAP was indicative of substantial yield reduction.

Although soil residual herbicides in addition to the plant growth regulator (PGR) herbicides 2,4-D or dicamba reduced soybean population and yield in three of six site-years, combining soil applied herbicides with a PGR herbicide did not reduce yield to a greater extent than either herbicide applied alone. Differences between soil residual herbicides were most evident when no PGR herbicides were applied or when the PGR herbicide rate was low. Differences between soil residual herbicides were minimal when injury was high and population was severely reduced by a PGR herbicide.

Soybean variety influenced population and yield in three of six site-years when no PGR herbicide was applied. Interactions between soybean variety and PGR herbicide rate were not evident. Interactions between soybean variety and PGR herbicide type were evident in one of six site-years with a difference in varietal response to dicamba.

PREFIX™ FOR RESIDUAL WEED CONTROL IN SOYBEAN. Dain E. Bruns*, Don J. Porter, Scott E. Cully, and Eric W. Palmer, Syngenta Crop Protection, Inc., Greensboro, NC 27419.

Prefix™ is a formulated premix of *s*-metolachlor and fomesafen designed for preemergence weed control in conventional and glyphosate-tolerant soybean. Prefix, containing two modes of action, has demonstrated excellent safety to soybean while controlling annual grass and dicot weeds (including glyphosate and ALS resistant amaranthus species and common ragweed) in conventional and no-till soybean weed control research trials. As a residual foundation treatment applied in the spring, Prefix provides early season weed control and extends the application window for in-crop glyphosate applications, thus giving greater glyphosate timing flexibility for full-season weed control.

BURNDOWN AND RESIDUAL CONTROL WITH TWO NEW CHLORIMURON-ETHYL, THIFENSULFURON-METHYL PLUS FLUMIOXAZIN BLENDS IN SOYBEANS. Susan K. Rick, Marsha J. Martin, Gregory R. Armel and Helen A. Flanigan. Field Development Representatives and Product Development Specialist, DuPont Crop Protection. Wilmington, DE 19880.

Field studies were conducted in 2007 to evaluate the postemergence control of emerged winter annual weeds and the residual control of summer annual weeds in soybeans with two new chlorimuron-ethyl, thifensulfuron-methyl and flumioxazin blends. University and in-house small plot trials were conducted throughout the soybean growing areas comparing these new blends to key commercial standards. The new blends gave excellent control of emerged weeds including marestail, henbit, dandelion, cressleaf groundsel, chickweed and cutleaf evening primrose. Control of winter annuals was similar to or better than most standards depending on the target weed. Evaluations taken seven to nine weeks after application showed residual control of summer annual weeds such as waterhemp, Palmer amaranth, common lambsquarters, ragweeds, prickly sida and morningglories comparable to or better than most commercial standards.

These blended products will be marketed under the trade names of Envive™ and Enlite™ herbicides. Envive™ herbicide will contain 29.2% flumioxazin , 9.2% chlorimuron-ethyl and 2.9% thifensulfuron-methyl. The active ingredients in Enlite™ herbicide will be 2.85% chlorimuron-ethyl, 36.21% flumioxazin and 8.8% thifensulfuron-methyl. The lower rate of chlorimuron-ethyl in Enlite™ herbicide will allow the use on higher pH soils. Envive™ and Enlite™ used in planned preemergence followed by post herbicide program will provide postemergence burndown and season long weed residual control of key weeds in soybeans.

Volunteer glyphosate-resistant corn control in Roundup Ready soybeans. Kevin R. Westerfeld, Vince M. Davis, Melissa M. Kruger, and William G. Johnson, Research Associate, Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Volunteer corn is an emerging weed control issue in soybeans with the continued adoption of glyphosate-resistant corn hybrids. The objective of this research was to evaluate various herbicides for control of volunteer glyphosate-resistant corn in glyphosate-resistant soybeans. Two field studies were conducted in Indiana. One location was in northwestern Indiana and the other was in southeastern Indiana. Both trials were treated the same. Glyphosate resistant seed corn was spread on the trial and lightly tilled in with a field cultivator. Glyphosate-resistant soybeans were planted in 76 cm rows. Various post application herbicides were applied when corn was at the 25- to 38- cm timing or the 56- to 66- cm tall. One rating at the 28 day after treatment was analyzed. Both trials concluded that the early post timing controlled the volunteer corn the best. Most chemicals faired well with clethodim alone controlling volunteer corn the best. Both trials concluded that imazethapyr alone did not control volunteer corn sufficient enough.

RESPONSE OF SOYBEAN CYST NEMATODE AND PLANT GROWTH TO COMBINATIONS OF PURPLE DEADNETTLE, ANNUAL RYEGRASS, AND SOYBEANS. Valerie A. Mock, J. Earl Creech, and William G. Johnson. Graduate Research Assistant, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Assistant Professor, University of Nevada Cooperative Extension, University of Nevada, Fallon, NV, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

In soybean producing regions of the United States, soybean cyst nematode (*Heterodera glycines;* SCN) has become one of the most economically important pathogens. At least six winter annual weeds can serve as alternate hosts to SCN. The winter annual weed purple deadnettle (*Lamium purpureum*) and SCN-susceptible soybean (*Glycine max*) are known hosts of SCN. Annual ryegrass (*Lolium multiflorum*) and SCN-resistant soybeans and are non-host species to SCN and have also been reported to reduce the SCN population density. The objective of this greenhouse experiment was to evaluate the influence of combinations of these plant species on SCN population density and plant growth. This experiment had three plant species, annual ryegrass, purple deadnettle, SCN-resistant soybean, and SCN-susceptible soybean, grown at one or zero plants per pot. Seeds were planted into one liter pots and allowed two weeks of growth to establish roots. Each pot was then inoculated with 10,000 SCN eggs, fertilized weekly, and watered when needed. Eight weeks after the experiment was initiated, plant biomass was harvested. Roots were harvested and SCN cysts and eggs were counted, and dry weights were collected. Results from this experiment suggested that purple deadnettle dry weight is reduced when in competition with the SCN-susceptible soybean and/or annual ryegrass. The SCN-resistant soybean dry weight was reduced when grown in competition with purple deadnettle and/or annual ryegrass. The number of cysts per gram of root suggests that the SCN-susceptible soybean is a less compatible host than purple deadnettle. The number of cyst per pot showed similar results as the number of eggs per pot. When the two SCN-susceptible plants were grown together the number of cysts and eggs were highest. It also showed that if there were one or two susceptible plants in a pot with one resistant plant SCN numbers were reduced compared to pots with susceptible host(s).

A NEW EXTENSION PUBLICATION CONCERNING AND WINTER ANNUAL WEEDS AND SOYBEAN CYST NEMATODE. Valerie A. Mock, William G. Johnson, Kevin L. Smith, and Kevin Bradley. Graduate Research Assistant and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Editor, Department of Agricultural Communication, Purdue University, West Lafayette, IN 47907, and Assistant Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211.

In soybean producing regions of the United States, soybean cyst nematode (*Heterodera glycines* Ichinohe; SCN) is one of the most yield limiting pathogens in soybean production. Winter annual weeds are becoming more problematic due to the adoption of conservation tillage and the reduction in use of residual herbicides. Currently, six winter annual weeds have been identified as being alternate hosts to SCN. These winter annual weeds are identified as weak, moderate, and strong hosts to SCN. In this publication, the SCN and winter annual weed life cycles described in relation to the overlap of their lifecycles and that of soybean. It also describes some of our research on the interaction between winter annual weeds and SCN and how SCN population density can increase on winter annual weed hosts after crops are harvested in the fall. Possible management tactics of controlling SCN and winter annual weeds are included, as well as, a weed identification guide with pictures to aid in diagnosing fields with winter annual weeds that are alternate hosts to SCN.

TRANSITIONING WEEDSOFT TO INTERNET-BASED GENERAL ACCESS APPLICATIONS.
Richard C. Eubanks, Mark L. Bernards, Lowell D. Sandell, Chris M. Boerboom, Christy L. Sprague, William G. Johnson, Kevin W. Bradley and Dallas E. Peterson, Software Developer, Assistant Professor, Extension Educator, University of Nebraska, Lincoln, NE, 68583, Professor, University of Wisconsin, Madison, WI, 53706, Associate Professor, Michigan State University, East Lansing, MI, 48824, Associate Professor, Purdue University, West Lafayette, IN, 47907, Assistant Professor, University of Missouri, Columbia, MO, 65211, Professor, Kansas State University, Manhattan, KS, 66506.

WeedSOFT has been a widely used computer program since its inception. It has been evaluated or cited in at lest 23 referred journal articles since 2000. Approximately 2345 copies of the 2002-2006 versions (average of 469/year) were distributed to individuals in at least nine states. It has been primarily used by crop consultants and extension personnel. Computer technology has progressed to the point where migration of this program to an internet-based format is desirable. In September 2006, the decision was made by the WeedSOFT working group to discontinue the annual updates and transition portions of WeedSOFT to an internet-based platform.

Utilizing an internet-based format will provide the following advantages and functionalities:

- There is potential to reach a greatly expanded audience. The program will be available without subscription costs to any individual with internet access in the world, although the data in the model will apply primarily to users in the North Central United States. It will be easy to reference and demonstrate in weed management presentations. The web-based format will enable the development of online lessons that use WeedSOFT to teach principles of integrated weed management (IWM).
- The ability to more easily expand program features and content. Components of WeedSOFT Advisor will be developed into more focused tools, such as WebAdvisor, Yield Loss Calculator, Tank-mix calculator, Range and Pasture Advisor. This will simplify the amount of user-input and will allow the user and educators to highlight key principles of integrated weed management without having to enter large amounts data unrelated to the specific principle. It will also simplify the process of adding new tools.
- More emphasis on will be placed on the principles of IWM. The initial tools to be available at www.weedsoft.org will be less focused on herbicide selection and more focused on the effect management decisions have on weed control and yield loss, especially timely herbicide applications and the value of residual herbicides.
- Improved timeliness of updates and data content. WeedSOFT online can be updated at any time and all users will have the most current information possible.
- Login capabilities will be added. For individuals who register and save a profile it will simplify the amount of input required to run various scenarios.
- Creating a more intuitive and attractive user interface will enhance usability.

The site utilizes active server pages (.asp) platform. The data has will be streamlined and converted to Microsoft SQL Sever database. www.weedsoft.org is the new internet address for WeedSOFT. This transition is a necessary improvement to maintain the viability of this program into the future.

NORTH CENTRAL WEED SCIENCE SOCIETY WEED CONTEST 2007. Jess J. Spotanski, Midwest Research Inc., York, NE 68467. Tate Castillo, Bennett Agricultural Research Corp., Richland, IA.

The 2007 NCWSS summer annual Weed Contest was hosted by Bennett Ag Research Corp in Richland, IA on July 18th and 19th. There were a total of 48 students from nine schools. The schools were Purdue University, Ohio State University, University of Missouri, Kansas State University, Parkland College, Iowa State University, University of Illinois, University of Nebraska, and Michigan State University. Of the students who participated, there were 20 graduate students and 28 undergraduates. Volunteer support was excellent as 30 people from both industry and academia braved the high heat and humidity to make the contest a success. The contest was made up of the traditional four events which were farmer problem solving, sprayer calibration, weed identification and unknown herbicide identification. A total of 22 awards were handed out to the highest scoring teams and individuals in both graduate and undergraduate divisions. The overall graduate team award winners were: 1st-Purdue, 2nd-Missouri, 3rd-Kansas State. The overall undergraduate team award winners were: 1st-Ohio State-Green, 2nd-Ohio State-Blue, 3rd-University of Illinois. The overall graduate individuals were: 1st-Jason Parrish, Ohio State, 2nd-Carl Woodard, Missouri, 3rd-Jason Haegele, Iowa State. The overall undergraduate award winners were: 1st-Nathan Miller, Ohio State, 2nd-Janelle Donahue, Purdue, 3rd-Melinda Hoffman, Ohio State. The individual events and winners were: Team field calibration: Kansas State-graduate and Ohio State-Blue-undergraduate; Written calibration individual: Joe Armstrong, Michigan State-graduate and Mike Butler, Illinois-undergraduate; Unknown herbicide individual: Jason Parrish, Ohio State-graduate and Janelle Donahue, Purdue-undergraduate; Weed identification individual: Jason Parrish, Ohio State-graduate and Nathan Miller, Ohio State-undergraduate; Farmer problem solving individual: Kellan Kershner, Kansas State-graduate and Mike Butler, Illinois-undergraduate. Thanks to all the volunteers who helped with the contest and congratulations to all the winners.

DEPOSITION ADJUVANTS FOR ENHANCING DOWNY BROME AND WILD OAT CONTROL. Michael H. Ostlie and Kirk A. Howatt, Graduate Student and Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Deposition aids primarily are used to control spray particle size and to reduce the amount of spray drift. Studies were conducted with wild oat and downy brome to determine if using a deposition aid will enable increased activity under adverse conditions. To account for this, studies were established to compare the three-fourths rate of an herbicide with and without a deposition aid with the full rate of the herbicide with and without a deposition aid. Herbicides evaluated in field studies were propoxycarbazone, propoxycarbazone + mesosulfuron, and fenoxaprop for wild oat control; propoxycarbazone + mesosulfuron, and flucarbazone were used for downy brome control. Adding a deposition aid to fenoxaprop at the three-fourths rate increased wild oat control to 85% compared with 76% without the deposition aid. For downy brome control, adding a deposition aid tended to increase activity with the full rate of flucarbazone. In the greenhouse, propoxycarbazone, flucarbazone, sulfosulfuron, propoxycarbazone + mesosulfuron, imazamox, fenoxaprop (for wild oat only), and clethodim (for downy brome only) were applied to seedling grasses. Sulfosulfuron activity generally was increased by the use of a deposition aid in both wild oat and downy brome, with wild oat control improved by up to 24 percentage points. There was little difference in herbicide activity when applying at a three-fourths rate plus deposition aid versus a standard rate without deposition aid, while the three-fourths rate of herbicides with deposition aid also tended to increase activity in wild oat over three-fourths rate without deposition aid.

HERBICIDE SOLUTION PH EFFECT ON CONTROL OF DOWNY BROME AND WILD OAT. Angela J. Kazmierczak and Kirk A. Howatt, Graduate Research Assistant and Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Herbicide solution pH potentially can have a dramatic effect on the efficacy of a herbicide. Greenhouse experiments were conducted to evaluate whether solution pH influenced the activity of weak acid herbicides for control of downy brome and wild oat. Herbicide treatments were applied to two-tiller downy brome and three- to four-leaf wild oat. Treatments included either the herbicide, methlylated seed oil, and ammonium sulfate alone, with Climb™ (raises pH solution), or with Climb™ and Trifol™ (acidifier and buffering agent). Species were visually evaluated 21 and 35 d and biomass was harvested 35 d after treatments were applied. Results from the downy brome 21 d after treatment indicated that within a herbicide, regardless of additive, provided a narrow margin of separation. Thirty-five days after treatment, flucarbazone or propoxycarbazone with mesosulfuron provided less than 43% control of downy brome, but fresh weights were reduced by 70% when compared to the control. Propoxycarbazone with Climb™ and Trifol™ provided 85% control at 21 d which increased to 92% at 35 d with fresh weights 96% less than the control. Results from the wild oat experiment were less variable than the downy brome experiments. Sulfosulfuron at 25 g/ha, alone, provided greater than 94% control of wild oat 21 and 35 d after application and dry weight was 88% less than control plants. All treatments that included propoxycarbazone at 30 g/ha provided greater than 90% control at both evaluation timings. Mesosulfuron at 2.5 g/ha, alone and with the addition of Climb™ and Trifol™, provided 91 to 94% control while mesosulfuron with Climb™ only provided 80% control. In conclusion, downy brome control was affected more with solution pH in comparison to wild oat.

ADJUVANT CLASS SCREENING WITH PROPOXYCARBAZONE FOR CONTROL OF DOWNY BROME. Angela J. Kazmierczak and Kirk A. Howatt, Graduate Research Assistant and Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Adjuvants can enhance activity of herbicides to achieve better weed control. Achieving this improved weed control can depend on the adjuvant class, herbicide, or target weed species. Greenhouse experiments were established to evaluate which adjuvant class provides the greatest enhancement of activity with propoxcarbazone when applied to downy brome. Herbicide treatments were applied to downy brome with two-tillers. Treatments included propoxycarbazone at 30 g/ha with one of nine different adjuvants representing different classes. Downy brome was evaluated 21 and 35 d after treatment. Plants were harvested 35 d after treatment and fresh and dry weights were recorded. All treatments provided better than 70% control 21 d after treatment and greater than 68% control 35 d after treatment. Methylated seed oil (MSO), methylated seed oil basic pH blend, and methylated seed oil with nitrogen source provided greater than 82% control at 21 d and 85% control 35 d after treatment. Fresh weights for the above mentioned treatments were reduced by 96% when compared to the control. Petroleum oil concentrate and surfactant with nitrogen provided only 70 to 72% control at both evaluation timings although fresh weights where reduced by as much as 92%. Overall, the addition of an adjuvant system that included a MSO component provided greater control when compared to the other treatments.

BUILDING A RESEARCH FLAMER. Stevan Z. Knezevic, Logan Dana*, Jon E. Scott and Santiago Ulloa. Associate Professor, Research Technician, Research Technologist, and Graduate Research Assistant, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Weed flaming can be an additional tool for weed control options in organic cropping systems. There are several commercial flamers available for use in agronomic crops with the cost ranging from $6,000 to $15,000 depending on the number of rows the flamer covers. However, most of the commercial flamers are physically too large to be effectively utilized in small research plots. Therefore, as part of a larger study, the objective of this project was to build a relatively inexpensive and smaller research-type flamer for flaming weed and crop species at various growth stages. As a result, the three types of flamers were built, including two types for broadcast flaming (1.2 m and 3 m wide) and one for intra-row flaming that can cover three to five crop rows planted 76cm apart. Custom designed main frame was built to be interchangeably used with each flamer type, while a three-point-hitch allowed mounting on a tractor or ATV. Square steel tubing of different sizes (2.5-5.6cm) was utilized for building the main frame, which allowed to easily adjust burner height, burner angle, distance between burners to fit the crop row width, and the flame direction (inter or intra-row). There are also two pressure gauges (low and high) to control propane pressures ranging from 70 to 620 kPa (10-90 PSI). Propane application rate (kg ha^{-1}) was regulated by a combination of propane pressure and application speed. For example, using a driving speed of about 6 km/hour (4MPH), the propane rates can vary from 12 to 93 kg ha^{-1}(3-20 GPA). Burners were purchased at the cost of about $100 per burner, while the overall cost of material (eg. steel tubing, propane tank, valves, electronic safety solenoids, two pressure regulators, hose) ranged from $2,000-$3,000 depending on the flamer (sknezevic2@unl.edu).

FLAMING WEEDS IN INTEGRATED CROPPING SYSTEMS. Erin C. Taylor-Hill, Karen A. Renner, Christy L. Sprague, and Dale R. Mutch, Research Assistant, Professor, Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325 and Extension Specialist, Kellogg Biological Station, Hickory Corners, MI 49060.

Three experiments in propane flaming for weed control were conducted in Michigan. We evaluated the influence of tractor speed, the effect of time of day of flaming, and compared flaming versus rotary hoeing for weed control in organic corn and soybeans. Treatments in the flaming versus rotary hoeing study included flaming + cultivation (F), rotary hoeing + cultivation (RH), and flaming + rotary hoeing + cultivation (FRH). The FRH treatment provided the most stable level of weed control and lowest cost in soybean (i.e. average of \$45 A^{-1}, including fuel and hand weeding labor) in both years. In the tractor speed study, there was no significant difference in weed density across tractor speeds ranging from 3.5 to 5.5 mph. The 4 mph treatment had the lowest average weed density of 4.25 weeds m^{-2}. For the time of day study, we flamed corn at four different times during the day at two sites. Relative humidity levels were higher and air temperatures were lower at 8 a.m. and 8 p.m. compared with noon and 4 p.m. At site 1, there was no difference in weed control due to the time of flaming. Weed densities were reduced by 46% in the noon treatment. At site 2, the noon and 4 p.m. treatments reduced weed densities by 49%, while flaming at 8 p.m. reduced weed densities by only 32%. These studies support the use of a propane flamer for weed control in organic systems.

TARGET-SITE RESISTANCE TO ALS INHIBITORS IN HORSEWEED. Danman Zheng, Patrick J. Tranel, Vince M. Davis, Greg R. Kruger, and William G. Johnson, Graduate Research Assistant and Associate Professor, University of Illinois, Urbana, IL 61801, and Graduate Research Assistants and Associate Professor, Purdue University, West Lafayette, IN 47907.

The mechanisms of resistance to ALS-inhibiting herbicides were investigated in four horseweed populations designated 13R, 40R, 525R and 116R. Results from acetolactate synthase (ALS) activity assays indicated that altered target sites caused herbicide resistance in 13R, 40R and 525R. In addition, cross-resistance patterns were compared between protein extracts derived from 40R and 525R in response to cloransulam and chlorimuron. The R/S ratios calculated based on estimated I_{50} values were 400 and 222-fold for cloransulam and 789 and 947-fold for chlorimuron in 40R and 525R respectively. Southern blot analysis showed that there was only one *ALS* gene locus in the diploid horseweed genome. Three overlapping *ALS* gene regions were amplified in three selected plants from each biotype. Amino acid sequences were inferred and compared with each other to identify the resistance-conferring mutations. Amino acid substitutions conferring ALS inhibitor resistance in horseweed plants were population specific. Substitution of Ser for Pro at position 197 was identified in both 13R and 40R. However, substitution of Ala for Pro at position 197 and Glu for Asp at position 376 were identified in 525R and 116R, respectively. Based on mechanisms identified from the above studies, PCR/*BsaJ*I and PCR/*Mae*II molecular markers were developed to differentiate between wild type and resistant codons at position 197 and 376 of horseweed *ALS*, respectively.

INVESTIGATING LINKAGE OF DIFFERENT HERBICIDE RESISTANCES AND SEED DORMANCY IN WATERHEMP BY SEGREGATION ANALYSIS. Gurpreet S. Smagh, Patrick J. Tranel and William L. Patzoldt. Graduate Research Assistant and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61802, and Agricultural Biologist, BASF Corporation, Research Triangle Park, NC 27709.

Waterhemp populations are quickly evolving resistance to different herbicides in Illinois. Many populations have been found resistant to ALS-inhibiting, PPO-inhibiting and/or triazine herbicides. Different waterhemp populations have shown different levels of seed dormancy. In this study, we investigate genetic linkage of seed dormancy with the above three herbicide resistance traits. To develop a segregating population, two parental lines were utilized. One line, ACR from Adams County, IL, was resistant to atrazine, ALS-inhibiting, and PPO-inhibiting herbicides, and had limited seed dormancy. The second line, WCS from Wayne County, IL, was susceptible to atrazine, ALS-inhibiting, and PPO-inhibiting herbicides, and had high seed dormancy. F_1 lines were created by crossing ACR with WCS plants. After maturity, seeds were harvested from each female individually as full-sib lines. F_1 male plants were crossed with female plants from the WCS biotype, ACR biotype or F_1 full sibs to create BCS, BCR or F_2 lines, respectively. F_1, F_2 and BCS were tested for dormancy levels and resistances to atrazine, ALS-inhibiting, and PPO-inhibiting herbicides. Herbicide resistance segregation ratios for BCS lines were analyzed. Segregation for triazine resistance in plants from BCS lines were evaluated two weeks after spraying with atrazine at 500 g a.i./hactare on greenhouse-grown plants. Segregation for PPO and ALS resistance genes was determined by using *PPX2* and *ALS* CAPS molecular markers. Seed dormancy is being evaluated with a petri-plate assay. By determining which, if any, of these traits are linked, we expect to gain insights into how multiple herbicide resistance may evolve in waterhemp. If seed dormancy is linked to one or more of the resistances, then the results will also have practical implications for studies designed to determine the genetics of the resistances.

ASSAY COMPARISON FOR MEASURING SHIKIMATE ACCUMULATION IN GLYPHOSATE-TREATED PLANT SPECIES. Keith Kretzmer, Mason Hughes, Laylonda Maines and Doug Sammons, Monsanto Company, St Louis, MO 63146

Glyphosate inhibits 5-enolpyruvyl-shikimate-3-phosphate (EPSP) synthase in the shikimic acid pathway of susceptible plant species, resulting in the accumulation of shikimate. A limited survey was undertaken in order to measure shikimate levels in the leaves of both weed and crop plant species, either treated or untreated with glyphosate. Identification and quantification of shikimate was done by HPLC-MS and by HPLC-uv. Extracts from glyphosate treated leaves were also assayed spectrophotometrically and quantification of shikimate was compared between these assays.

The results showed that, as expected, shikimate accumulated in leaves of plants treated with glyphosate. The level of accumulation varied, depending onthe plant species, from 230 ug/gFW in cotton, to 7200 ug/gFW in both soybean and alfalfa. In many species, quinic acid also accumulated in treated leaves, and in certain species, to levels greater than shikimate. Further, in many species, there were significant levels of either shikimate or quinic acid, or both shikimate and quinic acid, in untreated leaves.

Finally, it was shown that velvetleaf accumulated shikimate and dehydroshikimate at approximately equal levels after glyphosate treatment (808 and 883 ug/gFW, respectively). Dehydroshikimate was not detected in any other species tested.

The shikimate values measured spectrophotometrically agreed reasonably well with those measured by HPLC for all plant sample extracts tested. It isshown that the spectrophotometric method also detects quinic acid, although the periodate oxidation of quinic acid is much slower than that of shikimate. It is proposed, then, that it may be possible to measure both shikimate and quinate in a single extract well simply by measuring absorbance at 2 timepoints: shikimate would be measured immediately after the addition of sodium hydroxide/sodium sulfite and quinate would be measured after an incubation time of 60 to 90 min.

Since plants treated with glyphosate may accumulate both shikimate and quinic acid, and in some cases more quinic acid than shikimate, a more sensitive analytical method such as HPLC-MS and HPLC-*uv* may be necessary for measuring a plant's response to glyphosate. In addition, there are likely several plant species which have significant levels of naturally occurring shikimate and quinic acid, so shikimate measurement alone may not necessarily be directly correlated to glyphosate treatment.

RESISTANCE TO PPO INHIBITORS IN COMMON RAGWEED: MOLECULAR INVESTIGATION OF TARGET-SITE GENES. Stephanie L. Rousonelos, Ryan M. Lee, Patrick J. Tranel, and Mark J. VanGessel, Graduate Research Assistant, Postdoctoral Research Assistant, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61820 and Professor, Department of Plant and Soil Sciences, University of Delaware, Georgetown, DE 19947.

Herbicides that inhibit protoporphyrinogen oxidase (PPO), like several other herbicide chemistries, have selected herbicide-resistant weeds. Common waterhemp was the first weed species to evolve resistance to this class of herbicides. It was determined previously that resistance in common waterhemp to PPO inhibitors was due to a single codon deletion in *PPX2L*. This gene is a longer version of *PPX2* and contains a 30 amino acid extension in the 5' end. *PPX2L* encodes for both mitochondria- and plastid-targeted isoforms of PPO. Two other genes were identified that encode PPO: *PPX1* encodes plastid- and *PPX2* encodes mitochondria-targeted isoforms of PPO.

The most recent weed species to develop resistance to PPO-inhibiting herbicides is common ragweed. Clones of *PPX1* and *PPX2* from a common ragweed cDNA library were isolated and sequenced. To test if a long form of *PPX2* is present in common ragweed, RACE amplification is being performed at the 5' end. A resistant common ragweed biotype from Delaware was crossed to a sensitive biotype to create an F_1 population. Sequence data from the cloned cDNAs were used to design primers to obtain *PPX1* and *PPX2* sequences from the F_1 population. Based on the presence of two peaks in the sequence chromatograms, polymorphisms between the parental alleles of *PPX1* and *PPX2* were identified from the F_1 population. Markers were developed, based on these polymorphisms, and are being used for segregation analyses of these target-site genes in backcross progenies to determine whether *PPX1* or *PPX2* co-segregates with the resistant phenotype.

UTILIZING **R** SOFTWARE PACKAGE FOR DOSE RESPONSE STUDIES: THE CONCEPT AND DATA ANALYSIS. Stevan Z. Knezevic, Jens C. Streibig, and Christian Ritz, Associate Professor, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828, and Professor and Post Doc, Royal Veterinary and Agricultural University (KVL), Copenhagen, Denmark **.**

Advances in statistical software allow both standard and more complex statistical methods for non-linear regression analysis of dose response curves to be carried out conveniently by non-statisticians. One such statistical software is the freely available program **R** with the *drc* extension package. The *drc* package can: (1) simultaneously fit multiple dose-response curves, (2) compare curve parameters for significant differences, (3) calculate any point along the curve as the response level of interest, commonly known as an effective dose (eg. ED30, ED50, ED90), and determine its significance, (4) generate graphs for publications or presentations. We believe that when it comes to dose response data, the *drc* package has advantages over many currently available statistical software programs for non-linear regression analysis. Therefore, our objectives are to: (1) provide a review of few common issues in dose response curve fitting, (2) facilitate the use of up-to-date statistical techniques for analysis of dose response curves and (3) invite further debate on the subject (sknezevic2@unl.edu).

DISTRIBUTION AND CHARACTERIZATION OF ALS RESISTANCE IN INDIANA HORSEWEED (*CONYZA CANADENSIS*) POPULATIONS. Greg R. Kruger, Vince M. Davis, Andrew M. Westhoven, Valerie A. Mock, Stephen C. Weller, and William G. Johnson, Graduate Research Assistant, Graduate Research Assistant, Graduate Research Assistant, Graduate Research Assistant, Department of Botany and Plant Pathology, Professor, Department of Horticulture and Landscape Architecture, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, 47907.

Horseweed has become a problematic annual weed in no-till soybean in Indiana. Horseweed has evolved glyphosate resistance, making it difficult to control in no-till systems which rely on glyphosate alone for weed control. Using chlorimuron or cloransulam-methyl are the two most commonly recommended herbicides for post-emergent herbicide control of glyphosate-resistant horseweed in soybean. However, populations have been found which are resistant to both glyphosate and ALS herbicides. In Indiana, glyphosate-resistant horseweed was found in 56% of samples collected from soybean fields between 2003 and 2005. In 2006, the same samples that were tested for glyphosate resistance were screened for ALS resistance in the greenhouse. Ten plants from each population were sprayed with 17.5 g ai/ha of chlorimuron-ethyl and ten were sprayed with 48 g ai/ha of cloransulam-methyl. Approximately 20% of the populations had resistance to chlorimuron, and approximately 10% were resistant to cloransulam-methyl. Less than 2% of the populations tested were resistant to both glyphosate and ALS herbicides. These results indicate nearly 75% of horseweed populations collected from soybean fields were herbicide-resistant to either glyphosate or ALS. Since few populations had resistance to both glyphosate and ALS, tank mixing the two herbicides may remain a viable short-term postemergence option for controlling horseweed in no-till soybean.

RESPONSE OF GLYPHOSATE-TOLERANT COMMON LAMBSQUARTERS BIOTYPES TO GLYPHOSATE. Melissa M. Kruger, Andrew M. Westhoven, and William G. Johnson, Research Associate, Graduate Research Assistant, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Common lambsquarters is found throughout Indiana and several biotypes with tolerance to glyphosate were identified in 2005 through greenhouse screens. Glyphosate dose response studies on common lambsquarters have not been extensively reported. The objective of this greenhouse study was to quantify the level of glyphosate tolerance among one susceptible and four tolerant biotypes. The susceptible biotype was subjected to rates of 0, 0.008, 0.084, 0.21, 0.42, 0.84, 2.1, 4.2, and 8.4 kg ae ha^{-1} of glyphosate. Tolerant biotypes were subjected to rates of 0, 0.084, 0.42, 0.84, 2.1, 4.2, 8.4, 12.6, and 21 kg ae ha^{-1} of glyphosate. Dry weight data was collected 21 DAT and converted to a percentage of the untreated control. Nonlinear regression parameters were estimated using a logistic model in R™. The dry weight GR_{50} values for the tolerant biotypes ranged from 1.48 to 3.22 kg ae ha^{-1} compared to 0.57 kg ae ha^{-1} for the susceptible biotype. R/S ratios determined from GR_{50}'s ranged from 2.6 to 5.6. GR_{90} R/S ratios ranged from 3.7 to 7.8. All GR_{50} and GR_{90} values for each tolerant biotype were significantly different than the susceptible biotype.

BIOLOGICAL CHARACTERISTICS OF COMMON LAMBSQUARTERS BIOTYPES WITH TOLERANCE TO GLYPHOSATE. Andrew M. Westhoven, Jeff M. Stachler, Mark. M. Loux, and William G. Johnson, Graduate Research Assistant, Purdue University, Extension Program Specialist, Professor, The Ohio State University, Columbus, OH, 43210, and Associate Professor, Purdue University, West Lafayette, IN 47907.

A number of common lambsquarters biotypes with elevated tolerance to glyphosate have previously been identified in Ohio and Indiana through greenhouse studies. However, information regarding their growth and fitness characteristics has not been reported. A field study was conducted in West Lafayette, Indiana, in 2006 and 2007 to determine the growth rate and seed production of eight glyphosate-tolerant biotypes in comparison to two glyphosate-susceptible biotypes. Acid-treated seed was germinated in 288-cell trays in the greenhouse and plants were transplanted in rows spaced 76 cm apart in the field in early June. Measurements from nontreated areas included height, growth stage, leaf area, dry weight, time to flower, and seed production at 2, 6, and 10 weeks after transplanting and 16 weeks after transplanting (plant maturity). Tolerant biotypes were grouped for comparison with susceptible biotypes via orthogonal contrasts. Tolerant biotypes amassed more height, leaf area, dry weight, and were further along in growth stage than susceptible biotypes early in the growing season. Tolerant biotypes were taller at 6 and 10 weeks after transplanting, but had significantly lower dry weight at plant maturity. Tolerant biotypes were observed to initiate floral primordia between 6 and 8 weeks after transplanting, while susceptible biotypes did not initiate floral primordia until approximately 12 weeks after transplanting. However, no apparent fitness penalty was observed from biotypes with tolerance to glyphosate based on seed production estimates. Other research has shown that advanced growth stage and taller common lambsquarters plants are correlated with higher levels of glyphosate tolerance. The early-season growth characteristics could contribute to common lambsquarters biotypes showing enhanced tolerance to glyphosate.

UNDERSTANDING THE *CHENOPODIUM* COMPLEX USING DNA-BASED MARKERS.
Sukhvinder Singh and Patrick J. Tranel, Graduate Research Assistant and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

The genus *Chenopodium* is a complex group as it includes several species that have considerable genetic and morphological variation, sometimes even within the species as is the case of *C. album*, known as common lambsquarters. Several species of *Chenopodium* (e.g. *C. album*, *C. berlandieri* and *C. bushianum*) resemble each other due to similar morphology. There have been several reports suggesting populations of common lambsquarters are not being controlled by commercial herbicides. A question that arises is whether these are really populations of *C. album*, or if they may be some other *Chenopodium* species. Thus, a study was initiated to identify the prevalent *Chenopodium* species found in the North Central States. *Chenopodium* species were obtained from the North Central Regional Plant Introduction Station, Ames, IA. These species were utilized as a test case to determine if they could be differentiated based on DNA sequence of the internal transcribed spacer (ITS) region of the ribosomal DNA (rDNA). ITS sequence data are commonly used for plant phylogeny studies. Hierarchical clustering of 18 plants of 12 species, based on ITS sequence data, grouped *Chenopodium* species into four main clusters. Each cluster had more than two species and in one case a species was grouped in two different clusters. To aid in species identification, we will further develop markers for the ITS region based on restriction site polymorphisms. These markers may be used to help distinguish among the weedy *Chenopodium* species; however additional molecular markers likely will also be needed for positive *Chenopodium* species identification.

SEED CHEMICAL AND PHYSICAL DEFENSE IN RELATION TO SEEDBANK PERSISTENCE.
Adam S. Davis, James Iannuzzi, and Karen A. Renner, Ecologist, Invasive Weed Management Unit, Urbana, IL 61801, REU Intern and Professor; Michigan State University, East Lansing, MI 68824.

Persistent soil seedbanks drive the long-term population dynamics of annual weeds of arable fields, yet most weed management tactics are targeted at the seedling stage. Development of effective strategies for weed seedbank management will depend upon better mechanistic understanding of the ecological determinants of seed persistence in the soil seedbank. Chemical and physical defense of seeds of common lambsquarters, field pennycress, giant foxtail, kochia, velvetleaf and yellow foxtail were quantified in relation to short- and long-term persistence of these seeds in the soil seedbank. Seed *ortho*-dihydroxyphenol content varied more than threefold between the least protected species (common lambsquarters, 9.2 μg g seed^{-1}) and the most protected species (kochia, 34.1 μg g seed^{-1}). The level of seed chemical protection was inversely related (r = -0.77, $P < 0.001$) to seed half-life in the soil estimated from long-term burial studies. Mechanical damage to the seed coat increased mortality for all six species during a two-month burial in field soil, regardless of the severity of damage. Mortality during burial for seeds subjected to the lowest intensity of damage was negatively associated (r = -0.35, $P < 0.01$) with seed phenol concentration and positively associated (r = 0.42, $P < 0.01$) with seed half-life in the soil. The results reveal an important weakness in the way seed defenses are constructed. Weed species with transient seedbanks appear to invest more in chemical defense than those species with highly persistent seedbanks. As a result, seeds in the latter category are relatively more dependent upon physical seed protection for persistence in the soil seedbank, and more vulnerable to management tactics that reduce the physical integrity of the weed seed coat.

EFFECTS OF CROP CANOPY LIGHT INTERCEPTION ON WEED EMERGENCE. Rutendo P. Nyamusamba*, Michael J. Moechnig, Darrell L. Deneke, Graduate Research Assistant, Assistant Professor, Integrated Pest Management Coordinator, Plant Science Department, South Dakota State University, Brookings, SD 57006

Understanding weed germination patterns is important for optimizing weed management programs in most cropping systems. Crop canopies may vary greatly based on crop species, agronomic practices or weather damage. However, there is limited information available regarding the effect of crop canopies on weed recruitment. Some studies suggest that canopy light interception may suppress weed emergence. If so, defining the effect of crop canopy cover on weed germination could increase our understanding of potential weed growth suppression using alternative agronomic practices such as cover crops, planting densities, row spacing and time of planting. Field experiments were conducted at Brookings, SD to 1) quantify the effect of crop canopies on weed germination rates and 2) relate our understanding of weed germination rates to weed management programs in soybeans.

Weed germination rates were quantified in corn, soybeans, spring wheat, field pea, alfalfa and fallow. The crop species treatments were established in an RCB design replicated four times. All crops were planted on May 9, 2007 using local standard agronomic practices for each species. Emerged weeds were counted twice a week for the first month after emergence and weekly thereafter until September 17 in three $1m^2$ subplots in each main plot. Emerged weeds were removed by hand after each counting. Counted weed species included crabgrass (*Digitaria sanguinalis*), foxtail species (*Setaria* spp.), common lambsquaters (*Chenopodium album*), pigweed species (*Amaranthus* spp.), and wild buckwheat (*Polygonum convolvulus*). Leaf area growth was measured for each crop species. Data loggers were used to measure daily soil moisture using a gypsum block moisture sensor (0-5cm below the soil surface) and temperature using a thermocouple (0-2cm below the soil surface) in each plot. Proportional weed emergence was fitted to a sigmoidal equation from which the days to 50% and 90% weed emergence in each crop was determined for each weed species. Weed emergence rates were similar ($P > 0.05$) among weed species and crop environments. However, crop leaf area and soil moisture differed among crop species. These results indicated that crop canopies did not affect weed emergence rates.

Results from the weed emergence experiment were used help explain weed growth and competition in a study regarding the critical period of weed control in soybean. To quantify the critical period of weed control, treatments included weed-free periods of 0, 1, 2, 3, 4 or 5 wks after soybean emergence and periods of no weed control of 2, 3, 4, 5 or 6 wks after soybean emergence. The timing treatments were established in an RCB design with three replications. Results indicated that the critical weed control period was between 2 and 4 wks after soybean emergence. According to the weed germination experiment, this time period would correspond to approximately 45-65% weed emergence. Although weeds that emerged after the critical period of weed control did not cause significant soybean yield loss, weed biomass was still produced. Weeds emerging 2 and 4 wks after soybean emergence produced approximately 270 and 3 g biomass m^{-2}, respectively. These results indicated that including weed emergence predictions with critical periods of weed control may help identify weed management programs that optimize crop yield and minimize weed biomass and seed production.

EFFECT OF TRANSGENES FROM SORGHUM ON THE FITNESS OF SHATTERCANE × SORGHUM HYBRIDS. Lilyrani Sahoo, John L. Lindquist, Donald J. Lee, University of Nebraska, Lincoln, NE, Jeffrey F. Pedersen, USDA-ARS, Lincoln, NE 68583, Rajvinder Kaur, Joshua H. Wong, Bob B. Buchanan and Peggy G. Lemaux, Department of Plant and Microbial Biology, University of California at Berkley, Berkeley, CA 94720.

Grain sorghum (*Sorghum bicolor L. Moench*), the fifth most important cereal worldwide, is widely used as feed and as food in selected areas (primarily Africa, India and China) because of its ability to grow in a hot, dry climate. The nutritional quality of sorghum is limited by storage proteins (kafirins) with disulfide linkages that interfere with starch and protein degradation, causing digestibility problems in humans and livestock. Research has shown that adding NADPH and proteins of the NADP/thioredoxin system [NADP-thioredoxin reductase (NTR) and a thioredoxin (Trx)] to flour or seed preparation from a number of cereals results in change in the redox state due to reduction of S-S linkages of storage proteins and an accompanying increase in protein digestibility. Sorghum was, therefore, engineered to overexpress a Trx gene (barley *Trx h*) in protein bodies of the seed endosperm to improve nutritional quality for both human consumption and livestock feed. Shattercane (*Sorghum bicolor ssp. drummondii*) is a problem weed in U.S. row crops and freely cross-pollinates with cultivated sorghum. It is, therefore, essential to assess the effect of introducing *Trx h* into shattercane before considering deployment of the transgenic sorghum. Since overexpression of *Trx h* in barley was shown to affect seed germination and seedling development, our research will focus on assessing the fitness of shattercane x transgenic *Trx h* sorghum relative to their parents. Four *Trx h* transgenic 296B sorghum lines were obtained, and we confirmed one parent line as a fixed transgenic line (NTR+TRX-2H-3t) using PCR analysis. PCR results showed amplification in all plant tissues tested from this line. To confirm that the primers specifically targeted barley *Trx h*, amplified fragments were purified and submitted for DNA sequencing. Preliminary experiments were conducted to determine the effect of temperature on germination of non-transgenic 296B sorghum vs. shattercane in germination chambers using standard 2006 Association of Official Seed Analysts (AOSA) procedures. Seeds were germinated at four constant temperatures (20, 25, 30, and 35 ºC) as well as three variable temperatures: standard germination for sorghum (varying from 20-30 ºC over the course of a day), cold germination (prechill at 10 ºC for 5 d followed by standard germination), and accelerated aging germination (accelerated aging at 43 ºC for 3 d followed by standard germination). Optimal germination of 296B sorghum seeds was achieved at 25, 35, (20-30), and [10+(20-30)] ºC, whereas shattercane seeds were nearly 100% dormant at all constant temperatures below 30 ºC and were partially dormant at 30, 35 ºC and at the variable temperature treatments. The germination period was prolonged in shattercane compared to sorghum in the partially dormant treatments. Shattercane dormancy was nearly completely broken in the [43+(20-30)] ºC treatment, and rate of germination was similar to that of sorghum in the standard germination treatment. We are in the process of crossing A3 cytoplasmic male sterile shattercane with the *Trx h* transgenic sorghum in the greenhouse. Progeny and parents will be grown in the greenhouse and tissue samples harvested to determine the presence of the transgene using PCR analysis. Expression analysis will be conducted using western blots to assess the level of expression from the *Trx h* transgene in seeds of transgenic vs. null-segregant shattercane and sorghum. Germination potential of progeny seeds will be evaluated using the same treatments as described above and compared to parental lines. Similar tests will be conducted with the transgenic vs. null-segregant shattercane and sorghum lines to evaluate the effects of water potential and of burial depth, temperature, and the presence or absence of interplant competition on seedling emergence and early vigor.

CHANGES IN WEED SEED BANK COMPOSITION AND DENSITY DURING TRANSITION TO ORGANIC PRODUCTION. Isabel Rosa and John B. Masiunas, Graduate Research Assistant and Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois, 1201 West Gregory Drive, Urbana, IL 61801.

Farmers transitioning to organic production are concerned about the potential increase in weeds due to difficulties in management and poor soils. Prior to starting transition, many growers have relied on herbicides and have not developed the expertise to use tillage, cover crops, and rotations to suppress weeds. Increases in weed populations during transition can discourage new organic farmers, reduce income, and increase seed banks resulting in future weed management problems. Our research studied the emerged and seed bank weed populations during a four-year transition to certified organic production. Expert organic growers identified our treatments and provided ongoing advice on weed management strategies. We evaluated three management intensity systems combined with three soil improvement treatments as transition strategies. The high management system had a vegetable crop rotation (tomatoes, cabbage and broccoli, and winter squash). This represented a situation where the farmer had limited land and required a large income during transition. The medium management intensity system had an agronomic rotation (soybeans, wheat, and corn). This management system was a common system used by midwestern farmers transitioning to organic production. In the low intensity system we established a perennial ley (clovers, timothy, orchard grass, vetch) and manage it similar to CRP land. In the fourth year all management intensities were planted to tomatoes and peppers. The goal of the soil improvement strategies was to improve the soil characteristics, add organic matter, and supply nitrogen needed for crop growth. The soil improvement treatments were cover crops alone, cover crops and compost, and cover crops and manure. In 2003, the dominant weed species were grasses in the ley system; common lambsquarters and velvetleaf in the agronomic system; and lambsquarters, grasses, and foxtails in the vegetable system. In 2003, the ley system had the most weeds in subsequent years it had fewer weeds than other management intensities. The low weed populations were due to establishment of a vigorous mixture of perennial plants and lack of disturbance in the ley system. In the vegetable system, during the first year we used plastic mulch and straw to control weeds. The straw had seed, so volunteer wheat was a problem. In 2004 and 2005, the grain system had more weeds than the vegetable system. The higher returns for vegetable production allowed hand-weeding which likely reduced weed populations compared to the agronomic system. The effect of soil amendment varied depending on year. In 2004, there were more weeds in the manure amendment and in 2005 there were more weeds in the cover crop only amendment. Weed species composition changed depending on management intensity and year. Common lambsquarters became less frequent, mainly due to later plantings. Amaranthus species (primarily redroot pigweed) became more frequent. Common purslane, a problem weed of vegetables, first was found in Brassica vegetables in 2005. Weed species diversity in the seed bank increased between 2003 and 2005. Species composition of the seed bank was similar to the composition of the emerged weed community with the exception that seed from Amaranthus species were the most common. A managed ley system may be a method for land-rich farmers to transition to organic production without increases in weed populations.

FEEDBACK RESPONSE OF COMMON SUNFLOWER AND GIANT RAGWEED GROWTH IN KANSAS' SOIL. Analiza Henedina M. Ramirez and J. Anita Dille, Graduate Research Assistant and Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Success of plants in any environment is due to many factors and among them, the presence of soil microbial communities, which are beneficial to the plant species and may influence species' persistence as well as abundance. A greenhouse study was conducted to quantify the plant-soil feedback response of giant ragweed and common sunflower in Kansas. Field soil was placed in 40 pots measuring 30.5 cm in diameter and 27 cm in height, which were divided into two sets of 20 pots. Seeds of giant ragweed from Illinois and common sunflower from Kansas were sown in a set of 20 pots. Six plants were established and allowed to grow in each pot for two cycles each lasting 10 weeks, known as the conditioning phase. After each cycle, plants were removed and soil from each set was remixed and made ready for the next planting. For the feedback phase, each set of soil was further divided into two with that subset being planted to either the same species previously grown in that soil (SAME) or with the other (DIFF, either giant ragweed or common sunflower). The plants were allowed to grow for another 10 weeks after which plants in each pot were harvested and individually measured for height, fresh and dry weights. The experiment was laid out in a randomized complete block design with 10 replications. Soil feedback scores for height and dry weight were calculated by subtracting average per pot values of DIFF from SAME. Results showed feedback response of common sunflower and giant ragweed to soil history for all parameters measured varied significantly. Common sunflower tended to grow well in Kansas' soil regardless of soil history (positive feedback score) while giant ragweed's growth was generally inhibited (negative feedback score). Dry weight feedback scores for common sunflower and giant ragweed were 2.08 and –2.35, respectively, while feedback scores for height were 8.07 and –20.78 for common sunflower and giant ragweed respectively, indicating significant inhibition. The results presented are from one trial, with another run of this study currently being done. If similar results are obtained, it might possibly explain common sunflower's predominance and giant ragweed's limited occurrence in Kansas.

EFFECT OF GLYPHOSATE-RESISTANT VOLUNTEER CORN ON GLYPHOSATE-RESISTANT CORN. Lizabeth A.B. Stahl, Milton J. Haar, Jodie K. Getting, Ryan P. Miller, and Thomas R. Hoverstad, Assistant Extension Professor, University of Minnesota, Worthington Regional Center, Worthington, MN 56187, Assistant Professor, Scientist, University of Minnesota, Lamberton, MN 56152, Assistant Extension Professor, University of Minnesota, Rochester, MN 55904-4915, Scientist, University of Minnesota, Waseca, MN 56093.

Corn acreage and corn-on-corn acres are increasing. In Minnesota, the number of acres planted to corn increased 12% from 2006 to 2007 (USDA National Agricultural Statistics Service). Glyphosate-resistant corn hybrids have gained wide acceptance and the potential exists for glyphosate-resistant volunteer corn in glyphosate-resistant corn. Storm damage, harvesting problems, poor stalk quality, and insect damage are among the factors that can lead to kernel and ear loss, and volunteer corn the following year. Limited information exists about the competitive effects of volunteer corn in corn and at what point management is needed to help protect yield. Management is complicated because both the crop and the volunteer crop are the same plant and both are resistant to the glyphosate used for weed management. This study was initiated to examine the effect of glyphosate-resistant volunteer corn in glyphosate-resistant corn and determine the potential for this situation to be a management problem.

Research was conducted in 2007 at two locations in MN, the Southwest Research and Outreach Center at Lamberton and the Southern Research and Outreach Center at Waseca. Treatments consisted of various populations of volunteer corn planted as kernels and whole ears. Carry-over seed from a glyphosate-resistant hybrid grown in the 2006 cropping season was hand-seeded at 2 to 3 times the target volunteer corn populations of 4046, 8093, 12139, 18209, 24279, 30349, and 36148 plants/acre. The intent was to thin plants after emergence to target populations. Plots were then field cultivated, and planted to a glyphosate-resistant corn hybrid. Various populations of corn ears, simulating a population of 650, 1600, and 32,000 (Lamberton only) volunteer corn clumps/acre, were hand seeded after planting. Three additional treatments included a low target population of volunteer corn clumps (650 ears/acre) combined with a low, mid or high population (12139, 24279, and 36418 plants/acre, respectively) of volunteer plants. DKC52-40 was planted on May 14, 2007 and DKC54-46 was planted on May 11, 2007 at 33,000 plants/acre in 30-inch rows at Lamberton and Waseca, respectively. Acetochlor plus atrazine was applied PRE followed by a POST application of glyphosate.

Volunteer corn populations were lower than the target populations. This was due in part to a lower-than-expected germination rate of the carry-over seed and loss of some volunteer plants by the POST glyphosate application. Because of segregation, not all progeny of the resistant hybrid were resistant. Average volunteer ear populations were closer to targeted populations. Compared to the untreated controls, corn yield was reduced 23.2 and 40.2 bu/acre by volunteer corn populations of 19348 (Lamberton) and 21152 plants/acre (Waseca), respectively, the highest rates evaluated. At Waseca, there was no difference among the whole ear and combination treatments, but all decreased yield compared to the untreated control. At Lamberton, treatments consisting of whole ears only had no effect while yield reductions were observed in the combination treatments consisting of the mid and high volunteer plant populations. Because ears alone did not have an effect, this result was attributed mainly to the volunteer corn planted as separate kernels.

INFLUENCE OF NO-TILL MANAGEMENT PRACTICES AND HERBICIDE APPLICATION TIMING ON WINTER ANNUAL WEEDS. Vince M. Davis, Kevin D. Gibson, and William G. Johnson, Graduate Research Assistant, Associate Professor, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Winter annual weeds such as common chickweed, purple deadnettle, smallflower buttercup, cressleaf groundsel, and annual bluegrass are common weeds in no-till cropping systems in the Eastern cornbelt. As densities of these weed species increase in no-till fields over time, they can delay crop establishment because of wet soil conditions. The objective of this study was to determine the influence of crop rotation, winter wheat cover crops, residual non-glyphosate herbicides, and burndown application timing on the population dynamics of winter annual weeds. A field study was conducted from 2003 to 2006 in a no-till field located in southeastern Indiana where winter annual weeds are a common occurrence in no-till fields. The experiment was a split-plot design with crop rotation (soybean-corn or soybean-soybean) as main plots and management systems as subplots. Management systems were evaluated by quantifying in-field plant density in the fall following crop harvest, and seedbank density. Seedbank and in-field densities responded to herbicide selection and crop rotation differently for different winter annual species, but herbicide applications in the fall reduced seedbank and in-field densities of all winter annual species.

SIMULATED GLYPHOSATE DRIFT TO IRRIGATED POTATO (*SOLANUM TUBEROSUM).* Collin P. Auwarter and Harlene M. Hatterman-Valenti, Research Specialist and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105

Field research was conducted at the Northern Plains Potato Grower's Association Irrigation Research site near Tappen, ND to evaluate simulated glyphosate drift applied to Russet Burbank potato. The objective of this study was to compare the injury from glyphosate applied at the tuber hooking (TH), tuber initiation (TI), early tuber bulking (EB), and late tuber bulking/early senescence stage (LB). Glyphosate was applied at rates one-third, one-sixth, one-twelfth, and one-twenty-fourth the standard use rate (0.25, 0.125, 0.0625, and 0.0313 lb ae/A) on July 6, July 26, and August 23 on the TI, EB and LB stages, and at 0.25 lb ae/A on June 20 on the TH stage with a CO2 pressurized sprayer equipped with 8002 flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. The amount of AMS added to the spray solution was also reduced accordingly.

Potatoes treated with glyphosate at the TH stage had a significantly lower yield of tubers >4 oz than the untreated, 51 cwt/A compared to 451 cwt/A.

Potatoes treated with 0.25 lb/A glyphosate earlier in the growing season (TH or TI) had >70% cull tubers (<4 oz).

Potatoes treated at the EB stage showed little total yield effects compared to the untreated, however potatoes treated at the EB stage yielded higher at the 0 to 4 oz, 4 to 6 oz, and 6 to 10 oz and yielded lower at the 10 to 12 oz, 12 to 14 oz, and >14 oz sizes.

Potatoes treated with 0.25 and 0.125 lb/A glyphosate at the LB stage showed a significant yield loss compared to the untreated. Potatoes treated with 0.25 lb/A at the LB stage had a yield loss of 200 cwt/A and potatoes treated with 0.125 lb/A at the LB stage a yield loss of 100 cwt/A compared to the untreated.

Daughter tubers are being stored throughout the winter to determine if daughter tubers from plants treated with glyphosate show any affects compared to daughter tubers from plants not treated with glyphosate.

ASSESSMENT OF CURRENT HERBICIDE OPTIONS IN DOUBLE CROPPED PUMPKINS FOLLOWING WHEAT IN SOUTHERN ILLINOIS. Robert J. Britenstine, Bryan G. Young, and S. Alan Walters, Graduate Research Assistant, Professor, and Associate Professor, Department of Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

There is growing interest in double cropping no-tillage pumpkins following winter wheat in southern Illinois. Although weed management is a major problem of no-tillage pumpkin production, wheat residues may provide some weed control along with other ecological and monetary benefits. Therefore, a field evaluation was conducted to determine the influence of harvested wheat residues on weed suppression along with various herbicide combinations in no-tillage 'Magic Lantern' pumpkin production during 2006 and 2007. The experiment was designed as a split-plot with four replications. The main plots were with or without harvested wheat stubble and subplots consisted of six herbicide treatments.

Plant stunting at 28 days after transplant (DAT) was greater for pumpkins planted into bare soil compared with pumpkins planted in to wheat residue in 2006. However, stunting was not evident at 56 DAT during 2006 or at both 28 and 56 DAT during 2007. The presence of wheat residues did not impact control of morningglory spp., common waterhemp, redroot pigweed, and common cocklebur during 2006 or 2007. In 2006, all herbicide combinations provided 65 to 80% control of common waterhemp and redroot pigweed at 56 DAT. Furthermore, morningglory spp. control was less than 50% for all herbicide treatments. In 2007, all herbicide treatments provided similar, yet insufficient, control ($\leq$30%) of common waterhemp and redroot pigweed. Common cocklebur control was greater in those treatments that included halosulfuron (54 to 80%) than treatments without halosulfuron. Pumpkin fruit size was greatest in treatments with wheat residues compared with bare soil over both years. All herbicide treatments produced a similar number of fruits per hectare in both 2006 and 2007. Although it is possible to successfully grow pumpkins following winter wheat, any additional weed control was generally not provided by wheat residue.

WEED CONTROL IN TRANSPLANTED CABBAGE. Harlene M Hatterman-Valenti and Collin P Auwarter, Associate Professor, and Research Specialists, Plant Sciences Department, North Dakota State University, Fargo, Fargo, ND 58105.

Weed control in cabbage is necessary for high yields and quality. However, the number of herbicides for weed control in cabbage is rather limited. This is especially true for broadleaf weed control. Clomazone, napropamide, and oxyfluorfen are the only herbicides registered for pre-emergence broadleaf weed control in cabbage. All three have factors associated with their use (e.g. carryover, availability, and short residual) that makes them less than ideal choices. In addition, Pyridate (WP formulation), the only herbicide registered for general post-emergence broadleaf control in cabbage is no longer marketed in the United States and supplies are now exhausted. Thus, field trials have been conducted the past two years to identify alternative weed control methods.

All herbicides were applied after cabbage were transplanted. Cabbage injury was greater than 20% with oxyfluorfen (emulsifiable concentrate formulation). Injury was also observed with the water-based formulation of oxyfluorfen (10%). Symptoms remained on older leaves but did not slow plant growth or affect head formation. Weed control evaluations indicated that at 3 WAT all herbicides provided at least 85% except pendimethalin on redroot pigweed, oxyfluorfen (water-based formulation applied twice) on common lambsquarters, and DCPA on field pennycress. A single application of oxyfluorfen at 0.06 lb/A was insufficient for any of the broadleaf weeds. By 7 WAT, broadleaf weed control remained acceptable (≥85%) for all treatments except those discussed at 3 WAT. The greatest total yield from two harvests was when cabbage was treated with pendimethalin (20.4 ton/A). However, total yield did not differ from any treatment except the single application of oxyfluorfen, which did not control any of the broadleaf weeds early on. The post-emergence application with the water-based formulation of oxyfluorfen appeared to be safer than the emulsifiable concentrate formulation, but the injury did not affect head formation or head measurements.

METHYL BROMIDE ALTERNATIVES FOR NURSERY PRODUCTION. Michael W. Marshall, Daniel A. Little, Robert J. Richardson, and B.H. Zandstra, Research Associate, Graduate Research Assistant, Former Research Associate, and Professor, Michigan State University, East Lansing, MI 48824.

Nursery and Christmas tree production is an important part of Michigan's economy. Michigan generates an estimated $351 million in annual sales and growers markets products in 35 states, Canada and Mexico. Methyl bromide has been an important pest management tool for growers in nursery and conifer seedling production. With the phase-out of methyl bromide, growers are seeking alternative weed control tools. Field studies were established in 2004 through 2007 to evaluate safety and effectiveness of various herbicide combinations on five herbaceous perennial species, six seedling conifer species, and various weed species. Herbaceous perennials tested included bugleweed (*Ajuga repens*), daylily (*Hemerocallis* spp.), Lupine (*Lupinus* spp.), Perwinkle (*Vinca minor*), and Hosta (*Hosta spp.*). Conifer species evaluated were Colorado blue spruce (*Picea pungens)*, Fraser fir (*Abies fraseri*), Balsam fir (*Abies balsamea*), white pine (*Pinus strobes*), and Douglas fir (*Pseudotsuga menziesii*). Methyl bromide and Telone C-35 treatments were applied when soil temperatures were above 21°C and were tarped for 10 days. All perennials and conifer seedlings were transplanted 12 days after the fumigation treatments and the herbicide treatments were applied over the top two days after transplanting. Experimental design consisted of a randomized complete block design with 3 replications. In all years, methyl bromide (98:2, 392 kg/ha) provided the least amount of crop injury and better than 70% control of the weed species evaluated, except vetch (*Vicia* spp.) which was not controlled. The herbicide combination of oryzalin (3.36 kg/ha) plus isoxaben (1.12 kg/ha) also provided greater than 70% control of all evaluated weed species, except large crabgrass (*Digitaria sanguinalis*), while causing less than 10% crop injury. Flumioxazin provided weed control of greater than 75%, but caused unacceptable crop injury to all crops except periwinkle. In the seedling conifer study, treatments containing oxyfluorfen (1.12 kg/ha) had weed control similar to methyl bromide, with minimal crop injury. Adding metolachlor (1.68 kg/ha) to oxyfluorfen provided greater than 75% weed control of all weed species rated in all years. Though not currently labeled for conifers, mesotrione (0.28 kg/ha) provided greater than 75% weed control of all weed species rated in 2004 and 2005 and crop injury was minimal in the fir spp. Overall, flumioxazin, oxyfluorfen, oxyfluorfen + metolachlor, and oxyfluorfen + dithiopyr provided the best overall weed control with acceptable safety on all crops.

DETECTION AND MANAGEMENT OF CUT-LEAVED TEASEL USING DIGITAL IMAGES.
Diego J. Bentivegna, Reid J. Smeda, Cuizhen Wang, and Harlan L. Palm, Graduate Research Assistant, Associate Professor, Assistant Professor, Research Assistant Professor, University of Missouri, Columbia, MO 65211.

Cut-leaved teasel is an invasive plant that has been declared a noxious weed in Missouri. It is a biennial plant capable of producing up to 33,000 seeds. Cut-leaved teasel colonizes along roadsides and unmanaged or low maintenance areas. Teasel plants reduce visibility to motorists and the diversity of desirable vegetation. Remote sensing can readily detect populations of invasive plants and is a useful tool for locating plants targeted for control. Analyzing digital aerial pictures provides information regarding the size of infestation and the effectiveness of management practices. The objective of this study was the detection of teasel patches and implementation of different control techniques to improve cut-leaved teasel management.

For pre-determined areas infested with cut-leaved teasel, digital aerial pictures were recorded at the Bradford Research and Extension Center and along Interstate 70 between mile markers 89-93 in July 2006 and 2007. Images were cut, rotated, georeferenced (real coordinates on the ground). In November 2006 and May 2007, herbicides including dicamba, triclopyr, aminopyralid and metsulfuron-methyl were applied on teasel at recommended label rates in a completely randomized design with 5 treatments and 4 replications along highway I-70. Tall fescue (*Festuca arundinacea* Schreb.), Canada Wildrye (*Elymus canadensis* L.), and Buffalograss (*Buchloe dactyloides* Nutt.) were seeded in November 2006 and May 2007 to provide competing vegetation for teasel.

Georeferenced images (less than 2 meter of error) were used to determine the spectral signature of teasel. With these images, cut-leaved teasel plants can be differentiated from other species with greater than 80% accuracy. Repeated treatments of aminopyralid or dicamba in the fall and spring resulted in greater than 98% control of teasel rosettes. There was no difference in the visual evaluation of grass establishment after the chemical treatments.

Sustained management of infested areas must include a combination of herbicides and desirable competitive grasses. Remote sensing is a tool that can successfully detect teasel infestations along large areas of Missouri highways. Teasel detection and implementation of management techniques should improve safety along Missouri roadways.

WEED MANAGEMENT IN GLYPHOSATE TOLERANT ALFALFA IN KENTUCKY: FOUR YEARS OF OBSERVATIONS. Sara K. Carter, Charles H. Slack, Bernard F. Hicks and Glen P. Murphy, Research Analyst, Research Specialist, Research Analyst, Department of Plant and Soil Sciences, University of Kentucky, Lexington, KY 40546, Technical Development Representative, The Monsanto Company, Coxs Creek, KY 40013.

Alfalfa with genetically modified qualities to exhibit tolerance to glyphosate herbicide was evaluated by the University of Kentucky for weed control and overall crop tolerance. The establishment of alfalfa at the University of Kentucky's Spindletop Research Facility began May 6, 2004. The experimental tolerant variety was drilled at 12.5 lbs/A to a depth of ¼" and spaced at 7" between rows. This trial was established on a Maury Silt Loam soil in a conventionally prepared seed bed. Plot size was 10 feet wide by 25 feet long and all applications were made at 24 gal/A of water with any necessary adjuvant. Herbicides evaluated were glyphosate (0.75 lbs ae/A), imazamox (0.047 lb ai/A), and clethodim (0.125 lb ai/A). The addition of surfactants and adjuvants was based on label recommendations. An application of paraquat was added to the clethodim plots between harvests. Visual ratings of weed pressure or control and crop tolerance were evaluated before each harvest. First year harvest data will be presented as establishment year is primarily when the weed pressure is greatest.

First harvest data showed that weed pressure was greatest in the untreated control plots where the primary species were giant foxtail, smooth pigweed and velvetleaf. The first application of all herbicides was made on May 27, 2004. The first harvest took place July 1, 2004. Both imazamox and glyphosate provided ≥ 90% control of all weed species present while, clethodim controlled only foxtail at 100%. No crop injury was observed. The second application took place July 21, 3 weeks after the first harvest. Only foxtail and pigweed were present and rated following the second application. As before, foxtail was controlled completely by all treatments, while glyphosate only controlled pigweed. Crop injury was present following this application where clethodim was followed by paraquat and where imazamox was followed by clethodim. Data from the first harvest showed that applications of glyphosate and imazamox yielded at least 30% alfalfa. By the second harvest, all plots were yielding some alfalfa with the largest percentage being 77 where glyphosate was applied alone. These were expected results. As the trial continued over several years, the weed pressure virtually disappeared. Stand counts were taken at the end of the first season. These counts reflected the same result as the weed control data. Counts were taken again in the spring of the following year and were found to increase slightly in most cases.

Glyphosate tolerant alfalfa showed excellent tolerance to multiple applications of glyphosate and moderate tolerance to the standard herbicides used for conventional alfalfa production. Excellent weed control was achieved during the establishment phase of this trial, thus allowing it to continue over many years. Though the widespread adaptation of this technology is still evolving, there are producers who have converted their crops to tolerant varieties only. Longevity of the original stand is yet to be determined. There are other traits that should be evaluated to determine the overall quality of the tolerant crop in relation to a conventional type.

TALL IRONWEED CONTROL IN COOL SEASON GRASS PASTURES. Daisy M. Fryman* and William W. Witt, University of Kentucky, Lexington, KY 40506-0198.

Four field studies were conducted in summers of 2006 and 2007 to evaluate the response of tall ironweed (*Vernonia altissima*) to pasture herbicides using three distinct application methods. The applications methods were broadcast foliar spray, rope-wick selective, and herbicide impregnated on dry fertilizer. The four studies were evaluated for control from 90 days to 1 year after treatment. All herbicide rates are expressed as g ae/ha or kg ae/ha. The first study conducted in 2006 consisted of a broadcast foliar spray of Milestone at 4 and 5 oz/acre (aminopyralid at 70 and 87.5 g /ha, respectively); Forefront R&P at 1, 1.5, 2, 3 pt/acre (aminopyralid + 2,4-D at 46.2 g +0.38 kg, 69.3 g + 0.6 kg, 92.4 g + 0.8 kg, and 138.6 g + 1.1 kg, respectively), 2, 4-D amine (1.1 kg /ha) and 2, 4-D ester (1.1 kg /ha), and Weedmaster (dicamba at 0.3 kg /ha + 2, 4-D at 0.8 kg /ha) at 2 pt/acre, and Banvel (dicamba at 0.6 kg. /ha) at 1 pt/acre. This study was a randomized complete block design, with four replications, and applied at 20 gpa. Tall ironweed control ranged from 84 to 89% with Milestone and Forefront R&P. 2, 4-D amine, 2, 4-D ester, Weedmaster, and Banvel provided 66 to 75% conntrol. A second study conducted in 2006 evaluated Milestone, Forefront R & P, and Grazon P + D either as a foliar broadcast foliar spray or impregnated on a complete dry fertilizer. The study was randomized complete block design, with four replications. Foliar broadcast applications were applied at 20 gpa and herbicide/fertilizer treatments were broadcast at 155 lb dry fertilizer per acre. The foliar broadcast treatments were Milestone at 5 oz/acre (aminopyralid at 87.5 g/ha) , Forefront R&P at 2 pt/acre (aminopyralid at 92.4 g /ha + 2, 4-D at 0.8 kg /ha) , and Grazon P + D at 2 pt/acre(picloram at 0.2 kg/ha + 2, 4-D at 0.6 kg /ha). The broadcast treatments provided from 87 to 93% and the control from impregnated fertilizer treatments ranged from 53 to 56%. Another study conducted in 2007 consisted of one broadcast treatment and six rope-wick selective application treatments. This study compared Forefront R&P at 2 pt/acre (aminopyralid at 92.4 g/ha + 2, 4-D at 0.8 kg/ha) as a foliar spray with Milestone at 1, 10 and 20% v/v, Roundup WeatherMax at 50% v/v, Remedy Ultra at 20% v/v, and Stinger at 20% v/v. Design of this study was randomize complete block with four replications. Foliar broadcast treatments were applied at 20 gpa, and rope-wick selective treatment was allowed to saturate ropes and then driven at 2.0 mph over plots. Control provided with the foliar broadcast treatment of Forefront R&P 95% and Milestone ranged from 92 to 97%. Control with Roundup WeatherMax, Remedy Ultra, and Stinger was 91%, 86%, and 88%, respectively. Another study in 2007 was an additional rope-wick selective and foliar broadcast combination study that used the same treatments and methods as the previous study with additional foliar broadcast applications of Milestone at 3, 4, 5 oz/acre (aminopyralid at 52.5, 70 and 87.5 g/ha) , PastureGard at 2.5 pt/acre (triclopyr at 0.5 kg /ha + fluroxpyr at 0.2 kg/ha), and Crossbow at 2 qt/acre (2, 4-D at 1.1 kg /ha + triclopyr at 0.6 kg /ha). Control of Tall Ironweed in this study ranged from 83-86% for Milestone foliar broadcast treatments and 88 to 96% for Milestone rope-wick selective treatments. Forefront R&P, PastureGard and Crossbow foliar broadcast treatment, respectively, had controls of 94, 93, and 96%. Roundup Weather Max had a control of 95%. Control with Remedy Ultra and Stinger rope-wick selective treatment was 89%.

SALTCEDAR CONTROL IN THE CIMARRON RIVER BASIN. Walter H. Fick and Wayne A. Geyer, Associate Professor, Department of Agronomy, and Professor Department of Horticulture, Forestry, and Recreation Resources, Kansas State University, Manhattan, KS 66506.

Saltcedar (*Tamarix ramosissima* Ledeb.) is an invasive woody plant found throughout most of the western U.S. in riparian areas. In Kansas, over 20,000 ha of saltcedar exists primarily along the Arkansas and Cimarron rivers. Once established saltcedar decreases forage production, reduces species richness, and affects water quality and quantity. The objective of this research was to compare the efficacy of several herbicides applied as cut-stump treatments for saltcedar control. The study sites were located in southwest Kansas in Morton and Stevens counties on land managed by the United States Forest Service. Saltcedar was cut during or at the end of the dormant period using a 71-cm rotary saw attached on the front end of a tractor. Herbicides were applied using a hand sprayer with 10 trees per treatment. Herbicides were applied prior to resprouting in 2004 (April 13), at resprouting in 2005 (May 6), and the day of cutting in 2006 (April 26). Mortality was determined at the end of the second growing season following treatment. Means were separated using chi square analysis ($P<0.10$). Treatments varied from year to year, but an untreated check, imazapyr at 23 g L^{-1} in water, triclopyr at 48 g L^{-1} in diesel, triclopyr + 2,4-D at 5 + 10 g L^{-1} diesel, and a ready to use formulation of triclopyr at 90 g L^{-1} were applied in all 3 years. All non-treated cut-stumps resprouted within 2 to 4 months. Glyphosate applied at less than 180 g L^{-1} water was ineffective. The addition of imazapyr to glyphosate at 12 + 18 g L^{-1} water and 24 + 36 g L^{-1} water provided 90 to 100% control. Imazapyr was equally effective (>90% control) when applied with water or diesel at 23 g L^{-1}. Triclopyr applied at 48 or 120 g L^{-1} diesel or in a ready-to-use formulation at 90 g L^{-1} provided 80 to 100% control. Triclopyr + 2,4-D at 5 + 10 g L^{-1} diesel provided variable control of saltcedar, but was more effective if applied prior to stump sprouting. Saltcedar can be effectively controlled using imazapyr or triclopyr applied as cut-stump treatments. Glyphosate at 180 g L^{-1} water also shows promise.

RESPONSE OF POISON HEMLOCK TO HERBICIDES. Carl A. Woodard and Reid J. Smeda, Graduate Research Assistant and Associate Professor, Division of Plant Sciences University of Missouri. Columbia, MO. 65211.

Poison hemlock (*Conium maculatum* L.) is an invasive, biennial plant that has become a significant problem weed along roadsides and in right-of-way areas across the central U.S. Poison hemlock is considered noxious in eight states, yet limited information is available on herbicidal control of this plant. The objectives of this research were to determine the initial response of poison hemlock with selected herbicides and to identify residual activity of selected herbicides. Studies were established in 2006 and 2007 at 2 locations, with 14 treatments and 4 replications in a RCB design. Applications were made 15-March in 2006 and 12-April or 27-April in 2007. In 2007, Missouri experienced unusually low night temperatures (3 nights of < -3 C) in early April, which damaged much of the plant tissue. Visual evaluations of herbicide activity were made 2, 4 and 8 weeks after treatment (WAT). Emerged seedlings were also counted in treated plots at 2, 4, 8, 12, and 24 WAT to monitor seedling suppression. Initial herbicide activity (4 WAT) was lower than the 8 WAT evaluations due to cool conditions during and shortly after herbicide application. By 8 WAT, imazapic, imazapic + glyphosate, chlorsulfuron, metsulfuron-methyl, and metsulfuron-methyl + 2, 4-D + dicamba all resulted in 80% or greater control of poison hemlock for all four site years. Triclopyr + clopyralid, triclopyr, and picloram + 2, 4-D resulted in 80% or greater control for 3 of the 4 site years. Dicamba and 2, 4-D activity were unacceptable (maximum of 68% control) for control of poison hemlock across all four site years, even at a rate of 0.12 and 2.11 Kg ai ha^{-1}, respectively. However, stronger growth regulators such as triclopyr and clopyralid were effective. The new herbicide aminopyralid resulted in less than 50% control of poison hemlock at 3 of 4 site years. Poison hemlock control was more consistent in 2007 than 2006, likely the result of frost damage in 2007. In the absence of herbicides, emergence of poison hemlock seedlings declined naturally because of increasing air temperature. However the ALS herbicides, chlorsulfuron, imazapic, and metsulfuron-methyl reduced poison hemlock emergence up to 42% by 2 WAT, 23% by 4 WAT, 71% by 8WAT, 48% by 12 WAT, and 71% by 24 WAT compared to areas treated with glyphosate (non-residual). Glyphosate and 2, 4-D were not effective at suppressing newly emerging seedlings of poison hemlock. Growth regulators triplopyr + clopyralid, aminopyralid, and picloram + 2, 4-D, at 2 WAT reduced seedling emergence by 70% compared to glyphosate alone. By 24 WAT, overall suppression of emergence had decreased. An effective season-long management program for poison hemlock may necessitate repeated application of herbicides.

WEED MANAGEMENT STRATEGIES TO INCREASE FORAGE PRODUCTIVITY OF PERMANENT GRASS PASTURES. J. D. Green, and David Appelman, Extension Professor and Extension Agent for Agriculture and Natural Resources, Department of Plant and Soil Sciences, University of Kentucky, Lexington, KY 40546.

Weed management strategies that would decrease weed biomass and increase the productivity of a permanent grass pasture were evaluated in a field study in northern Kentucky. Herbicide control options implemented in 2006 along with combinations of cultural practices were evaluated for their effectiveness the following season. The predominant weed species present included tall ironweed (*Vernonia altissima*) and wild blackberry (*Rubus fruticosus*). The experimental layout consisted of a 3-factor split-plot design. Main plots were composed of a herbicide prepackage mixture of triclopyr plus 2,4-D at 0.56 plus 1.12 kg/ha and a prepackage mixture of triclopyr plus fluroxypyr at 0.85 plus 0.28 kg/ha and an untreated check. A combination of sub-plot factors evaluated with and without herbicide options included treatments 1) with and without added soil fertility and 2) with and without additional forages seeded. Treatments receiving added fertility in the spring consisted of 6720 kg/ha agricultural lime and 56 kg/ha of nitrogen based on soil test results. Plots interseeeded with additional forages received a mixture of orchardgrass, red clover, and ladino clover which were seeded in the fall using no-till seeding methods.

Visual control of tall ironweed with triclopyr plus fluroxypyr and tricloppyr plus 2,4-D was similar at 78% and 85%, respectively, one year after treatment. Stem populations were reduced by approximately 67% by both herbicide treatments. Whereas, control of blackberry was significantly greater with triclopyr plus fluroxypyr (96%) compared to triclopyr plus 2,4-D (78%). Furthermore, triclopyr plus fluroxypyr reduced the blackberry stem population by 92% compared to the untreated check; whereas triclopyr plus 2,4-D only reduced blackberry stems levels by 56% one year after treatment.

No statistical interactions in weed biomass or forage yields were observed between herbicide treatments with or without added fertility or with or without fall seeding. Eleven months after herbicide treatments were applied dry matter produced from weed biomass and clover yields were significantly lower for both herbicide treatments compared to the untreated check. Triclopyr plus fluroxypyr produced significantly higher grass forage yields compared to triclopyr plus 2,4-D or the untreated check. When combined across herbicide treatments and fall seeding, forage yield increased by 157% in treatments receiving added fertility. Treatments with or without fall seeding had no impact on forage yield. Weed dry matter yields were not affected by treatments with or without added fertility or with or without fall seeding.

CORN AND VELVETLEAF TRANSPIRATION IN RESPONSE TO DRYING SOIL.
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Crop production in the Great Plains region is characterized by highly variable rainfall and soil water availability, which impacts all aspects of agroecosystems and their management, including the presence and abundance of weedy species. The supply of soil resources is critical for the establishment and long-term competitive success of a plant species. While there is considerable research on the effects of water supply on crop growth and productivity, there is little published research on the response of weedy and invasive plants to limiting soil water supply relative to that of the crop. The objective of this study was to determine the relative transpiration of corn 'Dekalb DKC60-19' and velvetleaf as the plants were subjected to drought stress. Four trials of a greenhouse experiment were conducted at differing stages of plant development. Corn and velvetleaf plants were seeded in pots (25 cm diam by 23 cm deep) filled with a constant 13.5 kg dry weight of a 8:1:1 mixture of soil:sand:perlite. Plants were thinned to one plant per pot and watered to saturation daily until the beginning of the experiment. Prior to the start of the experiment, pots were placed in 0.90 mil black plastic bags and sealed around the base of the plant stem so the only water loss was that due to transpiration. Sealed access tubes were inserted through the bags to allow periodic water replacement with minimal disturbance of plants. Daily transpiration was measured by weighing the pots at the same time each day. For each trial, five plants of each species were maintained at the well watered level by adding back the equivalent water loss each day, and five plants were subjected to drought stress by not replacing lost water. Leaf area was measured as leaves senesced, and at the culmination of the experiment. Actual leaf area on a given day of the trial was determined by subtracting the leaf area of senesced leaves on a daily basis for the drying plants. For the well-watered plants this was estimated by assuming the starting leaf area was equivalent to the average total leaf area of the drying plants. The difference between that and the total leaf area of each individual well-watered plant was added evenly for each day. Daily transpiration of the drought stressed plants was normalized relative to fully watered control plants (T_a/T_p) to offset any effect of environmental conditions. A second normalization was done to minimize any transpiration differences among individual plants and resulted in the final normalized transpiration ratio (NTR). Soil water content was expressed as the fraction of transpirable soil water (FTSW) and used as a measure of the level of drought stress. The relationship between NTR and FTSW was described using a logistic function and used to compare water use by corn and velvetleaf during drought stress conditions. Plants were considered stressed when NTR declined below 0.97. The FTSW at which NTR = 0.97 was 0.44 and 0.53 for corn and velvetleaf, respectively. This indicates that corn maintained normal, unstressed transpiration at lower soil water content than velvetleaf. The slope of the NTR vs. FTSW relationship is an indicator of how well the species can utilize the remaining soil moisture. The slope for corn was 4.84 while the slope for velvetleaf was 3.50, indicating that the velvetleaf, once drought stressed, proceeded to use the remaining soil moisture at a slower rate than the corn. Velvetleaf had a higher NTR than corn when the soil moisture was greatly diminished (FTSW<0.1) indicating that velvetleaf could survive better in a water deficit situation

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RESPONSE OF SELECTED SOUTHERN ILLINOIS HORSEWEED POPULATIONS TO BURNDOWN HERBICIDES WITH DIFFERENT MODES OF ACTION.
Brock S. Waggoner, Bryan G. Young, Julie M. Young, and Joseph L. Matthews, Undergraduate Research Assistant, Professor, and Researchers, Department of Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

In the fall of 2006, horseweed suspected to be resistant to glyphosate was collected from two commercial crop production fields near Murphysboro, Illinois. In field research studies conducted previously at the sites during the summer of 2006, horseweed was not completely controlled by glyphosate, 2,4-D or cloransulam. Thus, greenhouse studies were conducted to determine the response of the horseweed populations to glyphosate, cloransulam, 2,4-D, and paraquat. Seven rates of each herbicide ranging from 1/27 to 27 times the labeled use rate were applied when horseweed were 5 to 8 cm in diameter. In addition to the suspected glyphosate-resistant populations (denoted as Fager and Alstat), two populations susceptible to glyphosate (BRC and HRC) were evaluated. Dry weight data collected at 21 days after treatment was analyzed using linear regression as well as the R software package drc to calculate ED_{50} values.

The suspected glyphosate-resistant populations were 21 to 48 times less sensitive to glyphosate compared with the susceptible populations. There was no difference in sensitivity to glyphosate between the two suspected resistant populations. The Fager population was two times less sensitive to 2,4-D than the BRC population. There was no difference between populations in response to cloransulam. The ED_{50} for cloransulam was less than the lowest rate evaluated (0.65 g ai/ha). Paraquat completely controlled all populations of horseweed at the lowest rate evaluated (21 g ai/ha). Future research is justified to further characterize the reduced sensitivity of the Fager horseweed population to 2,4-D with a more refined rate structure and potentially including dicamba as another synthetic auxin herbicide.

TURFGRASS ESTABLISHMENT AND LARGE CRABGRASS CONTROL USING CELLULOSIC SEED AND FERTILIZER BLANKETS. Brandon Drzewicki, Jan Michael, Donald Penner, Michigan State University, East Lansing, MI 48824.

The role of a cellulosic blanket containing (3-4-2, N-P-K) 20.4% turf-type tall fescue, and 1.1% Kentucky bluegrass, was evaluated for turfgrass establishment, effect on weed emergence, and on weed control with preemergence applications of siduron. The experiments were done in the greenhouse with 56 x 28 x 10 cm trays filled with loamy sand soil. Large crabgrass was seeded into the trays (500 seeds per tray). The cellulosic blankets were applied before or after application of siduron. Treatments in which the blanket was applied to the soil without an herbicide application delayed emergence of both the large crabgrass and broadleaf weeds. Siduron was effective whether applied before or after the blanket was placed on the soil. Turfgrass establishment was uniform and rapid.

A SIMPLE CONTINUOUS ASSAY FOR EPSP SYNTHASE FROM PLANT TISSUE.
R. Douglas Sammons, Julie Meyer, Erin Hall, Elizabeth Ostrander and Stephen Schrader, Monsanto, St. Louis, MO 63167

The discovery of glyphosate-resistant weeds naturally leads to investigations of the mechanism of resistance. The most common mechanism is target site modification where a variant of the herbicide-targeted enzyme has been selected in the surviving weed. Hence, determining the sensitivity of the enzyme to the herbicide can result in identifying the resistance mechanism. We present a simple method to assay EPSPS in a continuous phosphate release assay which allows an estimation of the of the inhibition constant for glyphosate by determining the I50. The assay is an adaptation of the commercial phosphate assay kit sold by Molecular Probes. The enzyme purine nucleotide phosphorylase (PNPase) scavenges phosphate to phosphorylyze the nucleoside bond of 2-amino, 6-mercapto, 7-methyl-purine riboside (MESG) to create an increase in absorbance at 360nm due to the release of the modified purine. Maintaining an excess of the coupling enzyme PNPase, allows the rate of phosphate produced in the EPSPS reaction to be determined.

The procedure for the extraction, concentration and stabilization of an EPSPS protein for enzyme assay is reported. We demonstrate that the EPSPS from Palmer amaranth (Amaranthus palmeri), resistant to glyphosate, is actually more sensitive to glyphosate then the very well studied *E. coli* EPSPS. We do not believe that glyphosate resistant Palmer amaranth is utilizing a modified EPSPS for the resistance mechanism.

IDENTIFYING MAIZE DIVERSITY AREAS AND IMPLICATIONS REGARDING BIOSAFETY MEASURES. Francisca Acevedo*, José Sarukhán, Jorge Larson, Elleli Huerta, Patricia Koleff, Claudia Aguilar, Alejandra Barrios and Oswaldo Oliveros, National Commission for the Knowledge and Use of Biodiversity, CONABIO, Mexico City, Mexico and Ministry of the Environment and Natural Resources, Mexico City, Mexico.

In march 2005 Mexico approved the "Biosafety Law on Living Modified Organisms"(visit http://bch.cbd.int/database/record.shtml?id=8474) which among other things calls for a special regime to protect maize (article 2 fraction XI) and specifies the need to identify areas that are center of origin and current centers of genetic diversity for those species for which Mexico is center of origin and/or center of genetic diversity (articles 86 and 87), so as not to release GM related species in these areas.

Article 86 calls for the Ministries of Agriculture and Environment to arrange for "legal agreements" regarding these areas based on existing information coming from several governmental institutions, among those, the National Commission for the Knowledge and Use of Biodiversity (CONABIO, visit at www.conabio.gob.mx). In 2006 the Ministry of Agriculture asked CONABIO to provide the existing information on **maize and its related wild relatives** present in its biological databases. CONABIO generated a document called "General elements to determine the maize origin and genetic diversity centers, and the specific case of the experimental release into the environmental of transgenic maize in Mexico" (http://www.conabio.gob.mx/conocimiento/bioseguridad/doctos/Doc_CdeOCdeDG.pdf) which was sent to the two Ministers as information for the decision making process related to this particular issue.

This document includes distribution analysis both for maize landraces and teocintle species in a quadrant system of 0.5° x 0.5° (approximately 25 km per side) were landrace and species numbers present are enumerated. See maps that include all maize and teocintle information available to CONABIO through its biological databases.

It also includes four possible decision making scenarios related to spatial distribution, going from less to more conservative, the most conservative being a 32 km buffer around the quadrant according to *Luna et al.* 2001 as a safety area related to the maximum hypothetical linear distance of pollen flow. Article 86 calls for **current** genetic diversity areas, what this means is not clear. CONABIO decided that information coming from 1990 and onward would be considered current under its analysis, whilst only 20% of the data deposited in its biological databases fitted the criteria.

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The document makes recommendations, one of them being to “integrate all the existing information in the country as well as to update it to reduce uncertainty in delimitating the areas the law calls for”. Taking this recommendation into account, the two ministries plus CIBIOGEM, a interministerial commission on biosafety (visit http://www.cibiogem.gob.mx) donated funds so as to accomplish the task asked for in this recommendation.

The key question is if delimitating these areas will be enough so as to make sure that maize landraces and/or teocintle species present in these areas will be “protected” from GMO related species if grown in Mexican territory. Probably not. Even though buffers were chosen to be the most “conservative” possible, no biosafety measures will be enough at a commercial scale as to counteract traditional seed exchange between the rural farmers which happens to be the single most important factor to ensure genetic diversity existing in the first place. The law in question on the other hand does not describe the components of the regime. Delimitating areas will certainly be a component but seed management and other cultural practices should be considered. This is why an exercise to map land use to reflect the distribution of agroindustrial production (indicated by the presence of irrigation agriculture) and traditional rainfed agriculture would be useful as well in such an analysis.

Although the analysis here presented focuses on maize, the fact is that GMO have been developed and trials are underway for other crops for which Mexico is center of origin and/or center of genetic diversity. If other genera are added to the analysis what would emerge are centers of diversity of genetic resources for food and agriculture. These areas, viewed as regions which contribute to *in situ* conservation of genetic resources could then be subject to specific policies that promote and protect this diversity.

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"General elements to determine the maize origin and genetic diversity centers, and the specific case of the experimental release into the environmental of transgenic maize in Mexico" (visit http://www.conabio.gob.mx/conocimiento/bioseguridad/doctos/Doc_CdeOCdeDG.pdf)

INTERLOPER'S LEGACY: INVASIVE, HYBRID-DERIVED CALIFORNIA WILD RADISH (*RAPHANUS SATIVUS*) EVOLVES TO OUTPERFORM ITS IMMIGRANT PARENTS. Caroline E. Ridley, Rosamond F. Tsao and Norman C. Ellstrand, Graduate Student, Undergraduate Student and Professor of Genetics, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Hybridization between species and subspecies may lead to the evolution of invasive weeds by enhancing survival and reproduction in hybrid-derived lineages. California wild radish (*Raphanus sativus* × *Raphanus raphanistrum*) is a hybrid-derived species that has spread prolifically within the last 150 years, replacing all pure parental populations throughout California. Though highly plausible, a link between hybridization and invasiveness in California wild radish has never been empirically tested. In field experiments, we compared the survival and reproduction of several populations of California wild radish with that of populations of its pure parents in multiple years and varied environments. California wild radish has high survivorship and generally produces more fruits per plant, more seeds per fruit and more seeds per plant than either of its progenitors. In year one in Riverside, CA, it produced 3-times more seeds per plant than *R. raphanistrum* and *R. sativus*. In Irvine, CA, reproduction was higher overall and California wild radish produced 2-times and 20-times more seeds per plant than *R. raphanistrum* and *R. sativus*, respectively. Individual populations of California wild radish also display a strong genotype-by-environment interaction, indicating genetic diversity may be partly responsible for the weed's ability to invade California's vast and varied landscape. Our results demonstrate that by limiting the introduction and subsequent hybridization of congeners, we may be able to prevent the evolution of new invasive lineages.

SYMPATRY AND HYBRIDIZATION OF CANOLA AND BIRD RAPE (*BRASSICA RAPA* L.) IN QUÉBEC.

Marie-Josée Simard, Anne Légère, and Suzanne I. Warwick, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Québec, QC G1V 2J3; Research Scientist, AAFC, Saskatoon, SK S7N 0X2, Research Scientist, AAFC, Ottawa, ON K1A 0C6.

Hybridization between herbicide resistant (HR) transgenic canola (*Brassica napus* L.) and weedy bird rape (*B. rapa* L., also birdsrape mustard) has been documented in Québec. We evaluated the actual hybridization potential based on range overlap and *in situ* rates. We mapped the distribution of canola fields and bird rape herbarium specimens in Québec; collated information on the presence of bird rape in certified canola seed production fields; and surveyed for bird rape in, or close to canola field margins. Progeny from these populations was screened for herbicide resistance (HR) and for the presence of the HR transgene. Significant sympatry was observed in several areas and hybridization occurred in all eight populations (1.1-17.5% hybrid seed) located in field margins and in one (1.1%) out of three populations located less than 10 m from a canola field. Hybridization rates decreased exponentially as bird rape density increased, but rates across plants at any given density were highly variable (0 to 68%). At present, there are no compelling data suggesting that the presence of an HR transgene in a wild/weedy relative is inherently risky. However, our current knowledge might not fully describe the risks posed by other transgenes, particularly those that convey fitness-enhancing traits.

DO ESCAPED TRANSGENES PERSIST IN NATURE? THE CASE OF AN HERBICIDE RESISTANCE TRANSGENE IN WEEDY POPULATIONS OF *BRASSICA RAPA*. Suzanne .I. Warwick, Anne Légère, Marie-Josée Simard and Tracey James, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON K1A OC6; Research Scientist, AAFC, Saskatoon, SK S7N 0X2; Research Scientist, AAFC, Québec, QC G1V 2J3; Technician, AAFC, Ottawa, ON K1A OC6.

This is the first report of the persistence and apparent introgression of an herbicide resistance transgene from canola (*Brassica napus)* into the gene pool of its weedy relative, bird rape (*B. rapa* L., also birdsrape mustard), monitored under natural commercial field conditions. Hybridization between glyphosate-resistant (HR) *B. napus* and *B. rapa* was first observed at two Québec sites, Ste-Agathe and St-Henri, in 2001. *Brassica rapa* populations at these two locations were monitored in 2002, 2003 and 2005 for the presence of hybrids and transgene persistence. All plants were scored for the HR trait (HR+/HR-), presence of species-specific AFLP molecular markers from both parental species, pollen viability, and ploidy level. Hybrid numbers decreased over the 3-year period, from 85 out of ca. 200 plants surveyed in 2002 to only 5 out of 200 plants in 2005 (St-Henri site). Most hybrids had the HR trait, reduced male fertility, intermediate genome structure, and presence of both species-specific AFLP markers. Both F1 and backcross hybrid generations were detected. One introgressed individual, i.e. with the HR trait and diploid ploidy level of *B. rapa*, was observed in 2005. The latter had reduced fertility but produced ca. 480 seeds. Forty-eight of the 50 progeny grown from this plant were diploid with high pollen viability and 22 had the transgene (1:1 segregation). These observations confirm the persistence of the HR trait over time. Persistence occurred over a six year period, in the absence of herbicide selection pressure (with the exception of possible exposure to glyphosate in 2002), and in spite of the fitness cost associated with hybridization.

MEASURING THE EFFECTS OF CROP GENETIC LOAD ON PRODUCTIVITY AND FITNESS IN WEEDY *BRASSICA RAPA* (WILD TURNIP) × *BRASSICA NAPUS* (OILSEED RAPE) HYBRID POPULATIONS. Reginald J. Millwood*, Christy W. Rose*, and C. Neal Stewart, Jr. University of Tennessee, Knoxville 37966.

With the implementation of transgenic crops in agriculture, transgene flow to wild relatives is sure to occur. In the event transgenic hybrids are produced, the inherited transgene could supply a fitness advantage. This is a real agronomic and ecological concern, but only if transgene introgression occurs. In many cases, hybrids such as these exhibit lower fitness when compared to their wild parents. This may be due to the inheritance of disadvantageous crop/domestication genes present in the new host genome. These genes would certainly negatively impact transgene introgression and possible reduce the risk associated with many transgenes. In order to gain a better understanding of transgene introgression, we plan to assess how productivity and fitness of backcrossed hybrids are affected by the presence of a transgene in the company of crop/domestication alleles. Here, we use transgenic *Brassica napus* cv. westar as a model crop plant. *B. napus* has been transformed with the *Bacillus thuringiensis* endotoxin (*BtCry1Ac*) and the green fluorescent protein. Subsequently, we made hybrids between the transgenic *B. napus* and its wild weedy relative *Brassica rapa* ac. 2974. We produced mixed BC_1/F_2 populations in the field as well as advanced backcross generations (F_1, BC_1F_1, BC_2F_1 BC_2F_2, BC_3F_1 and BC_4F_2) by hand-crossing in controlled environment chambers. First, we plan to grow the BC_1/F_2 populations in competition with *Triticum aestivum* as well as with each other. Productivity and fitness data will be gathered for both the hybrids and wheat. Secondly, we will grow the advanced backcross populations under agronomic conditions. Productivity data such as seed yield and dry above ground biomass will be recorded. In addition, to gain an understanding of hybrid fitness, we will also grow these plants in competition with *B. rapa* and the number of transgenic progeny will be recorded. All of the above data will then be correlated to the amount of crop specific AFLP markers present in each population. These data together will determine if there is any relationship between inherited crop/domestication alleles and productivity or fitness of transgenic hybrids of *B. rapa* × *B. napus*.

STRATEGIES TO REDUCE TRANSGENE MOVEMENT. Hong S. Moon, Jason N. Burris, Reginald J. Millwood and C. Neal Stewart, Jr., Department of Plant Sciences, The University of Tennessee, Knoxville, TN 37996

Transgene escape is of a major ecological concern when growing transgenic plants in the field. To address these concerns, suitable strategies for transgene containment must be created. Currently, two strategies that can be utilized as transgene containment and control are male sterility and site-specific recombination. First, male sterility can be obtained by making interspecific hybrids of *Nicotiana tabacum* X *Nicotiana glaca*. By using the genetic "distance" and a large difference in chromosome number, we can produce non-functional gametes, and thus, create functional sterility. We will transform male sterile hybrids with fluorescent-protein markers to track the potential of pollen formed in the field. Secondly, a transgene excision system using a site-specific recombinase or a zinc finger nuclease will be created in order to remove transgenes from the pollen. A model plant, canola or tobacco, will be transformed via *Agrobacterium*-mediated methods with constructs containing site-specific recombinases or zinc finger nucleases. This system will employ a visual marker green fluorescence protein driven by pollen-specific promoter to ensure transgene excision. Pollen-specific promoters, *LAT52* and *LAT59*, will be used to activate the recombinase or zinc finger nuclease in pollen to induce the excision of transgenes.

ESTIMATING POLLEN-MEDIATED GENE FLOW IN COLORADO CORN FIELDS WITH THE BLUE KERNEL TRAIT. Patrick F. Byrne, Todd A. Gaines, Ron F. Meyer, and Robert Alexander. Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Extension Agronomist, Colorado State University Cooperate Extension, Burlington, CO 80807-1674, and Agricultural Resource Specialist, Boulder County Parks and Open Space, Longmont, CO 80503.

Pollen-mediated gene flow (PMGF) from genetically engineered (GE) corn (*Zea mays* L.) has become a topic of intense interest. Organic growers and others seeking to avoid the presence of transgenic material in their corn harvests want to know how far to isolate their crops from GE hybrids. Although similar studies on corn gene flow have been conducted in other parts of the U.S., to our knowledge none had been carried out under conditions similar to Colorado's corn growing areas. Our objective was to determine the percent cross-pollination that occurred across a range of distances in multiple locations and years in Colorado's Front Range and eastern plains. We used the dominant blue kernel trait to track cross-pollination. Plots of blue corn were planted as central islands surrounded by large fields of yellow corn. Dates of pollen shed and silk emergence were recorded to verify a sufficient overlap in flowering time between pollen source and recipient plants. At harvest, samples of 10 ears each were collected in several directions from the blue corn plot at distances that generally ranged from 0.75 to 300 m. For each sample, the number of blue and yellow kernels were counted and the percentage of blue kernels was calculated as an indication of the frequency of cross-pollination. Data from a total of 13 locations over six years were used in the analysis. As expected, the amount of cross-pollination was high at the closest sampling sites (mean of 29.3% at 0.75 m). Cross-pollination decreased rapidly with distance, dropping to a mean of 0.20% at 46 m and 0.05% at 92 m. The farthest distance at which any blue kernels were observed was 320 m. The information collected in this study helped a Boulder County technical advisory committee determine an isolation distance of 46 m between GE corn crops and organic corn crops on county-owned Open Space lands. This study will also be relevant elsewhere in Colorado and similar environments where there are concerns about cross-pollination from GE corn.

ASSESSMENT OF POTENTIAL IMPACT OF HYBRIDIZATION BETWEEN TEOSINTE (*Zea* spp.) AND MAIZE (*Zea mays* spp. *mays*) ON DORMANCY CHARACTERISTICS OF TEOSINTE. Baltazar M. Baltazar*, William J. Duncan, Daniel L. Kendrick and Michael J. Horak, Monsanto Company, St. Louis, MO 63167, USA.

Teosinte (*Zea* spp.) is an annual and perennial grass endemic to Mexico and Central America. Teosinte resembles maize (*Zea mays* spp. *mays*), but differs in various phenotypic characteristics including: pollen size and pollen viability, number of tassels per plant, and in the morphology of the pistillate inflorescence. In contrast to maize, teosinte populations survive as wild plants. This may be in part due to seed dispersal and dormancy mechanisms found in teosinte but absent in maize.

Research has demonstrated that gene flow and hybridization between teosinte and maize is possible. Furthermore, with the advent of genetically modified (GM) maize, questions have been raised regarding the potential ecological risks associated with the introduction of GM maize into areas where teosinte is present. However, there has been limited research on the biological effects of maize genes transferred to teosinte. One area of interest is on the effect of hybridization and introgression on seed dormancy (e.g., hard seed). One possible effect of hybridization between teosinte and maize would be decreased dormancy of hybrid seed.

Experiments to evaluate seed dormancy of *Zea* spp. were conducted during 2007. Four replicates of 25 seeds each of 8 *Zea* spp. were placed in rolled germination towels, arranged in a completely randomized block design and then placed in a germination chamber set at 25^{o}C for 8 days. Seed/seedlings were evaluated as germinated (normal and abnormal, dead, or hard following AOSA guidelines 5 and 8 days after planting. The percentages of each category were statistically compared for each species.

Results of the experiments revealed four significantly different groups for the *Zea* species evaluated according to their percentage of dormant seed; Group 1, *Zea nicaraguensis* with 55%; Group 2, *Zea luxurians* (34%), *Zea mays* spp. *mexicana* (30%) *and Zea mays* spp. *parviglumis* (25%); Group 3, *Zea huehuetenangensis* (20%) *and Zea perennis* (16%) and Group 4, *Zea diploperenis* (8%) *and Zea mays* spp. *mays* (0%).

Additionally, experiments are underway to evaluate seed dormancy characteristics of hybrid seed from crosses between teosinte and maize.

REGULATION OF DIURNAL POLLEN RELEASE. Brian Viner, Raymond Arritt and Mark Westgate. Graduate Research Assistant, Professor and Professor, Department of Agronomy, Iowa State University, Ames, IA 50011.

The ability to accurately model pollen dispersion is reliant on reasonably predicting the magnitude of pollen shed over the day. To develop a predictive equation, pollen was collected at two field sites from 29 July to 3 Aug 2003. Based on measurements of collected pollen, a rate of pollen shed was calculated over each day and normalized to the total amount of pollen collected. Our model predicts the rate of shed as a function of two processes. The first equation is a Gaussian curve that predicts the percentage of pollen that is available for shed as a function of vapor pressure deficit. The second process predicts the amount of available pollen that will be shed. The output from this model would provide the rate of pollen shed in terms of the percent of a day's total shed. Results from this model show R^2 values ranging between 0.54 and 0.99 when compared to our field observations.

LIFETIME FECUNDITY OF F1 CROP-WILD SORGHUM HYBRIDS: IMPLICATIONS FOR GENE FLOW FROM TRANSGENIC SORGHUM IN AFRICA. Allison A. Snow, Patricia M. Sweeney*, Cécile Grenier, Gebisa Ejeta, Tesfaye Tesso, Issoufrou Kapran, Gurling Bothma, and Jeffrey F. Pedersen, Professor and Research Associate, respectively, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210; Research Geneticist and Professor, respectively, Department of Agronomy, Purdue University, West Lafayette, IN, 47907; Researcher and Leader, National Sorghum Research Project, Ethiopian Institute of Agricultural Research, Melkassa Research Center, Nazareth, Ethiopia; Principle Sorghum Breeder, Institut National de la Recherche Agronomique du Niger, Niamey, République du Niger; Researcher, Agricultural Research Council-Roodeplaat, Pretoria, South Africa; and Research Geneticist, United States Department of Agriculture-Agriculture Research Service, University of Nebraska, Lincoln, NE, 68583.

Researchers are developing transgenic crops with enhanced nutrition and higher yields for Africa, but few studies have assessed environmental risks of growing these crops. Since wild relatives of sorghum (*Sorghum bicolor*) are often weedy and represent valuable germplasm, plans to release transgenic sorghum should consider consequences of gene flow. Our previous studies in Ethiopia and Niger showed that wild and cultivated sorghum often co-occur and flower simultaneously. Here, we tested for spontaneous hybridization between accessions of wild *S. bicolor* and local cultivars from eastern Africa at times when their flowering overlapped. Plants were grown in field plots in Ohio, with a ratio of more than 20 crop plants per wild individual. Microsatellite DNA markers showed that some seeds on wild plants were fertilized by crop pollen. We also studied the fecundity of F_1 hybrids between a male-sterile cultivar and three wild accessions. Wild and hybrid progeny were grown in Niger, Ohio, and Indiana. The relative fecundity of hybrids was fairly consistent across locations but differed somewhat among accessions. For two accessions, crop-wild hybrids produced more seeds per plant than their wild parent. For a third accession, hybrids produced similar numbers of seeds per plant in Niger, but fewer seeds per plant in the USA. However, this decrease in seed per plant in the USA was not significant. Although one hybrid had poor seedling survival, once established, all crop-wild F_1 hybrids were vigorous, and fertile, and could easily contribute pollen and seeds to subsequent generations. This study shows that selectively neutral or advantageous crop alleles are likely to persist in wild sorghum populations following hybridization. Before transgenic sorghum varieties are grown near wild relatives in Africa, ecological effects and other consequences of crop-to-wild gene flow should be examined for each transgenic trait.

CROP-WILD HYBRIDIZATION AND THE RATE OF EVOLUTION IN WEEDS. Lesley. G. Campbell, Allison A. Snow, and Patricia M. Sweeney, Post-doctoral fellow, Department of Plant Sciences and Landscape Architecture, University of Maryland, College Park, MD, 20742,
Professor, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210, and Senior Research Associate, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH, 43210.

When species hybridize their offspring routinely suffer from reduced fertility and poorly adapted phenotypes. Consequently, it seems unlikely that these plants could be successful weeds. Reflecting this belief, risk assessments of crop-wild hybrids often dismiss the potential for crop gene flow to produce ‘superweeds’. However, in the absence of empirical evidence, the evolutionary potential of early-generation hybrids remains hypothetical. Here, we explore the potential for *rapid* evolution in crop-weed hybrids and its consequences for crop allele introgression. Using hybrids of a cosmopolitan weed (*Raphanus raphanistrum*) and its cultivated relative (*R. sativus*), we compared the ability of hybrid and wild lineages to respond to artificial selection for early flowering and large size at reproduction, two life-history strategies which characterize weedy species. *Raphanus raphanistrum* grows a rosette with a thin, fibrous taproot, bolts within a few weeks after germination and produces yellow flowers soon after. On the other hand, crop breeding has emphasized delayed bolting with white flowers in *R. sativus* in order to produce the edible, enlarged roots (Snow and Campbell, 2005). Early flowering may be adaptive for weedy radishes because growing seasons for weeds are often curtailed by tilling schedules, herbivores, frost, and other causes of mortality or severe stress. The evolutionary potential to evolve earlier flowering may be more important for hybrid radishes given that hybrid fecundity, relative to wilds, may be limited by delayed flowering, a trait inherited from their cultivated parent and by low pollen fertility due to a reciprocal translocation that affects chromosome pairing (Snow et al. 2001; Campbell and Snow, in prep.). When hybridization occurs between species with such diverse life histories, the individual offspring will be phenotypically variable. Populations created with this initial diversity should have the opportunity to evolve along diverse trajectories with respect to life history. If crop-wild hybrids can evolve quickly from maladaptive intermediates to adaptive phenotypes, they may be more difficult to control. Large size in annual weeds is often correlated with rapid growth rates. In weedy radish, leaf length is correlated with high flower and seed production, suggesting that plants with rapid growth rates would also be highly fecund. If large size is adaptive, this may facilitate the introgression of additional adaptive quantitative traits into weed populations.

In wild and hybrid lineages, four generations of selection were performed to determine whether these traits exhibited a response to selection (i.e., were heritable) and the relative magnitude of their response across wild and hybrid lineages. Hybrid lineages exhibited a greater response to selection for early flowering suggesting its heritability is greater in hybrid lineages versus wild lineages. Early-generation hybrids had longer leaves than wild plants and they maintained this length difference after selection for longer leaves. This suggests that polygenic traits, such as size, inherited from domestic relatives may easily introgress into weed populations. Four generations of selection also resulted in the correlated evolution of hybrid flower petal color and hybrid pollen fertility. Large hybrid lineages exhibited higher than expected frequencies of plants with white petals, a crop-specific, simply inherited trait. Therefore, selection for a polygenic crop-specific trait accelerated the introgression of an additional crop-specific trait. Further, pollen fertility of early-flowering hybrid lineages was similar to that of wild lineages, and at least 12% higher than hybrid control lineages. Therefore, selection for earlier flowering in hybrid lineages led to rapid evolution of fertility, a key component limiting hybrid fitness. Despite selection for the early-flowering, wild phenotype, hybrid lineages maintained high frequencies of the crop-derived trait, white flower color, confirming persistent introgression. The persistence of white flower color and increase in pollen fertility after experimental manipulation of the selection environment may explain some results from our long-term studies in crop allele introgression (Snow et al., in prep; Campbell et al., 2006)

Both wild and hybrid lineages apparently possess substantial additive genetic variation for size at reproduction. Nevertheless, hybrid lineages evolved more rapidly under selection for age at reproduction and exhibited more extreme phenotypes under selection for large size at reproduction than their weedy parents. We suggest that hybrids have the potential to rapidly respond to newly invaded environments and may become more invasive weeds than their wild progenitors.

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BIOSAFETY ASSESSMENT AND BENEFITS FOR CO-EXISTENCE OF BIOLOGICAL CONTAINED PLANTS – REGULATORY ASSESSMENT IN THE EU-PROJECT "TRANSCONTAINER". Christiane Koziolek and Detlef Bartsch, Professor, Federal Office of Food Safety and Consumer Protection, Mauerstrasse 39-42, D-Berlin 10117.

The EU-project TransContainer[1] deals with the evaluation of environmental impact and benefits for coexistence between GM- and non-GM plants. Different containment strategies are applied to a broad spectrum of crops (*e.g.* oilseed rape, sugar beet, tomato) as well as to perennial plants like trees and grasses. The containment methods focus on three strategies: Chloroplast Transformation, Controllable Flowering and Controllable Fertility. Key issues are (a) safety assessment focussing on three points: molecular characteristics, ecology of the GM species and consequences of a potential break-down of the containment system. (b) Benefit assessment of the containment system for the co-existence of GM and non-GM plants. The environmental impact assessment is performed based on the criteria provided by the EFSA Guidance document (2006)[2] for the placing on the market of GM plants in the EU. Additionally to impact assessment, an economic evaluation is performed. The development of contained GM crop plants is still in an early stage and thus our evaluation is focussed on the safety assessment of the general methodical characteristics.

<u>Benefits of Chloroplast Transformed plants:</u> Chloroplast transformation is a promising containment system for plant species with strict maternal plastid inheritance by avoiding the out-crossing of recombinant genes via the pollen. The targeted insertion of a GM sequence in the chloroplast genome by homologous recombination has three advantages: (1) insertional inactivation of unknown functional genes is avoided, (2) endogenic *in-situ* promoters can be used, and (3) even though plastids harbour relatively small replicons, large insertions are tolerated. However, it has to be verified that the transgene is not inserted unintentionally in the nuclear genome since the transformation (*e.g.* particle bombardment technique) could be unspecific.

<u>Benefits of plants with Controlled Flowering:</u> The suppression of flowering is useful for plants that are cultivated for their vegetative parts, *e.g.* sugar beet, grasses or trees. For bi-annual sugar beet, the inhibition of undesired bolting and flowering will either prevent out-crossing and introgression into endogenous beet populations as well as facilitate the cultivation of beets for the farmer. In grasses, flower suppression will improve the fodder quality as the shoots have higher lignin content thus hampering the digestibility of the feed. In trees that are intended to be cultivated in plantations for biomass production, the suppression of flower development would offer certain advantages: GM trees with *e.g.* changed wood properties would neither develop pollen nor seeds containing the inserted DNA, avoiding any unintended hybridisation or spread of the GM seeds by wind. In contrast to trees that can be propagated vegetative, grasses as well as sugar beet need to flower for breeding purposes. Therefore, a molecular switch will be introduced, which will initiate flowering upon an external chemical stimulus. In case of flower induction for breeding, other (physical) measures are requested to avoid unintended out-crossing and spread of hybrids.

<u>Benefits for Co-existence:</u> Regarding the legislation on GM plants in the EU, the minimisation of GM escape via pollen into adjacent non-GM fields or wild relatives is an important point in the improvement of co-existence measures. In chloroplast transformed plants, the spread of inserted DNA is limited only at the pollen level, whereas the (transgene) seeds produced by the mother plant could still be lost or spilled unintended during harvest and transport. Upon complete flower suppression, neither pollen nor seeds will be released, thus gaining a very high level of restriction. The containment measures will allow (i) minimising the isolation distances between GM and non-GM fields, (ii) protecting the GM cultivating farmers for liability claims from neighbours, (iii) reduce conflicts with bee keepers, and (iv) avoid unintended mixtures with food products.

[1] See: http://www.transcontainer.org/UK/
[2] See: EFSA Guidance document of the scientific panel of genetically modified organisms for the risk assessment of genetically modified plants and derived food and feed (2006)

ADDRESSING GENE FLOW ISSUES IN COWPEA FOR WEST AFRICA. Remy Pasquet, Barry Pittendrigh, Mohammad Ishiyaku, Ibrahim Baoua, Clementine DaBrie, Malik Ba, Joseph Huesing, and Larry Murdock, ICIPE, IRD, Nairobi, Kenya; Purdue University, West Lafayette, IN 47907; Ahmadu Bello University, Zaria, Nigeria; INRAN, Maradi, Niger; INERA Ouagadougou, Burkina Faso; INERA, Ouagadougou, Burkina Faso; IITA Cotonou, Benin; Purdue University, West Lafayette, IN 47907; and Monsanto Company, St. Louis, MO 63167.

Cowpea (*Vigna unguiculata*), known in the U.S. as “black-eyed pea,” is a legume crop grown and consumed across West Africa. Native to East Africa, cowpeas are relatively drought resistant and the grain serves as an important source of quality protein. Like the grain, the leaves are rich in protein and are consumed in salads and used as animal fodder. Insects, particularly pod boring insects, can reduce yields as much as 90% or more. One of the primary limiting pests is the legume pod borer (*Maruca vitrata*), a lepidopteran insect closely related to the European corn borer, which has been successfully controlled by several different *Bacillus thuringiensis* (*Bt*) genes. An international group of scientists organized as the Network for the Genetic Improvement of Cowpea for Africa (NGICA) in cooperation with the African Agricultural Technology Foundation (AATF) is developing a transgenic cowpea variety engineered to express an insecticidal *Bacillus thuringiensis* (*Bt*) Cry1Ab protein to control this pest. Key issues to be addressed are gene flow potential and weediness particularly within areas of cultivation. To that end, assessments are under way to determine 1) outcrossing rates, 2) outcrossing distances, 3) the potential for insects to vector pollen, and 4) the consequences of gene flow as it relates to the fitness potential (insect resistance) of wild or weedy species. These data will be used in conjunction with cultivated cowpea production data to assess potential environmental effects of *Bt*-cowpea in West Africa.

EFFECT OF FUNGICIDES ON EFFICACY OF GLYPHOSATE IN SUGAR BEET. Darren E. Robinson, and Rob Nurse, Assistant Professor, Department of Plant Agriculture, University of Guelph, Ridgetown, ON, N0P 2C0, and Research Scientist, Agriculture and Agri-Food Canada, Harrow, ON.

Trials were conducted at two locations in southwestern Ontario in 2006 and 2007 to compare the effect of tank-mixing various fungicides with glyphosate on weed control, sugar beet visual injury, and sugar beet yield. In each trial, one half of each plot was kept weed-free by handweeding to test for visual injury and sugar beet tolerance to herbicides alone. The other half of each plot was not hand-weeded to determine the level of weed control of each treatment, and the effect of competition on sugar beet yield. Treatments included pyraclostrobin (250 g a.i. ha^{-1}), mancozeb (1800 g a.i. ha^{-1}), thiophanate-methyl (392 g a.i. ha^{-1}), or azoxystrobin (250 g a.i. ha^{-1}) applied 7 days after or as a tank-mix with glyphosate (900 g a.i. ha^{-1}) and glyphosate alone (900 g a.i. ha^{-1}). Untreated weed-free and weedy checks were included for comparison. None of the fungicide-herbicide tank-mixes caused significant visual injury or yield loss in sugar beet. Adding pyraclostrobin, thiophante-methyl or azoxystrobin to glyphosate did not reduce weed control compared to glyphosate applied alone. However, the addition of mancozeb to glyphosate reduced control of common lamb's-quarters and sugar beet yield.

WEED CONTROL IN GLYPHOSATE RESISTANT SUGARBEET. Aaron L. Carlson, John L. Luecke, and Alan G. Dexter, Research Technician, Research Specialist, and Professor, Department of Plant Sciences, North Dakota State University and University of Minnesota, Fargo, ND 58105.

Field experiments were conducted at seven locations in western Minnesota and eastern North Dakota in 2007 to evaluate sugarbeet injury and weed control from glyphosate used alone, glyphosate in combination with other herbicides, and registered herbicide treatments. 'Beta RZ02RR07' sugarbeet was seeded 1.25 inches deep in 22-inch rows. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Preemerge ethofumesate was applied to appropriate plots immediately after planting. Up to four postemergence treatments were made at 6 to 31 day intervals. Desmedipham & phenmedipham & ethofumesate plus triflusulfuron plus clopyralid plus clethodim M plus methylated seed oil were applied four times at a micro-rate of 0.08+0.004+0.03+0.03 lb ai/A +1.5%v/v; at a mid-rate of 0.12/0.12/0.16/0.22+0.004+0.03+0.03 lb/A+1.5%v/v; and at a conventional rate without oil at 0.25/0.33/0.33/0.5+0.008+0.06+0.03 lb/A. All treatments were applied in 17 gpa water at 40 psi through 8002 nozzles to the center four rows of six-row by 30-foot long plots. Sugarbeet injury and weed control were evaluated approximately 10 and 20 dat. Glyphosate was always applied at 1.0 lb ae/A.

All treatments of glyphosate or glyphosate plus a registered sugarbeet herbicide gave 0 to 4% sugarbeet injury. Glyphosate plus flumiclorac at 0.015 lb ai/A caused from 45 to 96% sugarbeet injury. Control of all weed species from glyphosate followed by glyphosate was similar to control from glyphosate plus flumiclorac fb glyphosate, glyphosate plus triflusulfuron at 0.008 or 0.032 lb/A fb glyphosate, glyphosate plus clopyralid at 0.03 or 0.06 lb/A fb glyphosate, glyphosate plus clethodim M at 0.09 lb/A fb glyphosate, or PRE ethofumesate fb glyphosate. Weed control from glyphosate applied once on the earliest date of application generally was less than weed control from all other glyphosate-containing treatments because weeds emerged after the early application.

Glyphosate alone gave greater pigweed or waterhemp control than the micro-rate at five locations and similar control at two locations. Glyphosate alone gave greater pigweed or waterhemp control than the mid-rate at four locations and similar control at three locations. Conventional-rate treatments or PRE ethofumesate at 3.75 lb/A fb POST desmedipham & phenmedipham & ethofumesate at 0.25/0.33/0.33/0.5 lb/A gave pigweed or waterhemp control similar to glyphosate alone at all seven locations. Micro-rate, mid-rate, conventional-rate, and PRE ethofumesate fb POST desmedipham & phenmedipham & ethofumesate gave common lambsquarters control similar to glyphosate alone at all locations.

At Cavalier ND, micro-rate, mid-rate, and conventional-rate treatments gave 62, 75, and 90% kochia control, respectively. Glyphosate applied four times gave 99% kochia control, better than from the micro-rate or mid-rate treatments. The conventional-rate treatment and PRE ethofumesate followed by POST desmedipham & phenmedipham & ethofumesate gave kochia control similar to glyphosate applied four times.

At Milan MN, micro-rate and mid-rate treatments which included MSO gave 91% velvetleaf control while the conventional-rate treatment without MSO gave 84% control. Preemerge ethofumesate fb POST desmedipham & phenmedipham & ethofumesate gave 46% velvetleaf control. Glyphosate alone gave 92% velvetleaf control. Velvetleaf control from glyphosate alone was similar to velvetleaf control from the micro-rate or mid-rate treatments.

PROPOXYCARBAZONE INJURY TO SUBSEQUENT CROPS BY SOIL RESIDUES. Angela J. Kazmierczak and Kirk A. Howatt, Graduate Research Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58015.

Weed population shifts require researchers to determine new chemical control for producers. Many parameters need to be considered before a herbicide can be labeled for a specified region, for example, persistence in the soil. Propoxycarbazone is labeled for use in spring, winter, and durum wheat in North Dakota; however a field bioassay is required the growing season following application. Field experiments were established in 2006 at three locations to determine propoxycarbazone effect on rotational crops sequence. Hard red spring wheat was established in half of the experiment, while the other half was left bare ground. Herbicide treatments were applied at the four-leaf stage of the wheat. Treatments included propoxycarbazone and mesosulfuron at various rates alone or in combination of and metsulfuron. In the spring of 2007, sugarbeet, soybean, canola, and barley were established in the experiment. Plant populations were determined at 14 and 28 d after emergence, visual evaluations were recorded throughout the season and yield was recorded at maturity. There were differences in plant stand counts, although they were small within species. When differences occurred among plant populations, the number of plants in the herbicide treatments were equal to or greater than populations in the untreated. Throughout the growing season, visual injury of crops was not affected by herbicide treatment, except canola flowering at one location with propoxycarbazone at 20 30 g ai/ha. Yield was not affected in any crop regardless of reduced plant population or delayed flowering effect.

PYROXSULAM EFFICACY TO WILD OAT INFLUENCED BY APPLICATION TIMING OR ADJUVANTS. Lindsey K. Hanson and Kirk A. Howatt, Graduate Student and Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051.

Pyroxsulam is a new herbicide for grass and broadleaf weed control in wheat. Field experiments were conducted at Fargo, ND, to determine the most effective timing of application of pyroxsulam for wild oat control and to identify the most effective adjuvant to maximize wild oat control with pyroxsulam. Plots were 3 by 9 m long in a randomized complete block design with 4 replicates. In the timing study, pyroxsulam at 11, 15, and 19 g/ha; flucarbazone at 25 g/ha; and clodinafop at 57 g/ha were applied at the 1-, 3- and 5-leaf stages. As the rate of pyroxsulam increased from 11 to 15 g/ha, better control was observed. However, no added benefit was observed by increasing the rate of pyroxsulam from 15 to 19 g/ha. Pyroxsulam applied at 3-leaf stage or earlier was most effective at controlling wild oats and preventing seed production. Pyroxsulam and flucarbazone applied at the 3-leaf stage gave similar control at 87%, while clodinafop applied at the same stage provided 95% control. In the adjuvant study, multiple adjuvant systems were applied with pyroxsulam at 11 g/ha on wild oats at the 3-leaf stage. Methylated seed oil (MSO), MSO + urea ammonium nitrate (UAN) and non-ionic surfactant (NIS) + ammonium sulfate (AMS) provided the best enhancement of pyroxsulam activity (97, 97 and 96% control, respectively), compared with 81% control without an adjuvant. With the exception of the MSO adjuvant, addition of UAN improved wild oat control with pyroxsulam by 5 to 10 percentage points within an adjuvant class.

INTRODUCTION TO HUSKIE ™ - A NEW BROADLEAF HERBICIDE FOR USE IN NORTHERN PLAINS CEREALS. Kevin B. Thorsness*, Dean W. Maruska, Mary D. Paulsgrove, Michael C. Smith, George S. Simkins, Thomas W. Kleven, and Mark Wrucke, Technical Service and Field Development Representatives, Product Development Manager, and Market Support Manager, Bayer CropScience, Research Triangle Park, NC 27709.

Huskie™ is a new postemergence broadleaf herbicide that has been developed by Bayer CropScience for use in spring wheat, durum, winter wheat, barley, and triticale. Huskie has a very favorable ecological, ecotoxicological, and environmental profile with low acute mammalian toxicity and no genotoxic, mutagenic or oncogenic properties noted. Huskie is a mixture of a novel active ingredient, pyrasulfotole plus bromoxynil in combination with the highly effective herbicide safener, mefenpyr-diethyl. Huskie includes both an HPPD and PSII inhibitor for a new and unique mode of action in cereal grains. This combination of active ingredients provides a consistent broad spectrum herbicide with excellent crop tolerance. Huskie provides fast control of numerous broadleaf weeds. The highly active safener, mefenpyr-diethyl ensures that Huskie exhibits excellent crop tolerance when applied alone or in tank mixtures. Rapid microbial degradation is the primary degradation pathway for pyrasulfotole in the soil environment. Therefore, Huskie has an excellent crop rotation profile, allowing re-cropping to all of the major crops grown in the northern cereal production area. Additionally, Huskie appears to inhibit second flushes of select weeds, such as redroot pigweed, kochia, and common lambsquarters.

Huskie is formulated as an emulsifiable concentrate for easy handling. Apply Huskie after the cereal crop has emerged and before flag leaf emergence. Broadleaf weeds should be treated with Huskie between the 1 - 8 leaf stage of growth depending on weed species. Huskie provides optimum weed control when it is mixed with AMS at 0.5 kg/HA or 28% UAN at 2.34 L/HA.

Huskie has been tested on more than 50 different weed species in numerous field experiments in the northern cereal production area of the United States. Huskie provides excellent control of key broadleaf weeds such as kochia, pigweed sp., wild buckwheat, common lambsquarters, mustard sp., Russian thistle, field pennycress, prickly lettuce, common waterhemp, white cockle, nightshade sp., and false chamomile. Excellent control of sulfonylurea resistant weeds such as kochia, prickly lettuce and Russian thistle biotypes has been confirmed with Huskie in field trials. Huskie has been tested on several spring wheat, durum wheat, and barley varieties. Crop tolerance with Huskie has been excellent on all varieties tested. The excellent weed control and crop safety combined with very favorable toxicological, ecotoxicological and environmental properties makes Huskie a valuable tool for cereal grain farmers.

HUSKIE ™ HERBICIDE – EFFICACY IN NORTHERN PLAINS CEREALS. Dean W. Maruska*, Kevin B. Thorsness, Mary D. Paulsgrove, Michael C. Smith, George S. Simkins, Thomas Kleven, and Mark Wrucke, Field Development and Technical Service Representatives, Product Development Manager, and Market Support Manager, Bayer CropScience, Research Triangle Park, NC 27709.

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Huskie provided control of kochia, redroot pigweed, common ragweed, white cockle, false chamomile, and hempnettle that was greater than with current broadleaf treatments in northern plains cereals. Wild buckwheat, Russian thistle, common sunflower, and common lambsquarters control was similar between Huskie and current broadleaf treatments in northern plains cereals.

Huskie has been tested on numerous spring wheat, durum wheat, and barley varieties. Crop tolerance with Huskie has been excellent on all varieties tested. In weed-free tolerance trials, excellent crop tolerance was observed in spring wheat, durum wheat, and barley. Crop yields in spring wheat, durum wheat, and barley following a Huskie application were equal to the weed-free untreated check. The excellent weed control and crop safety combined with very favorable toxicological, ecotoxicological and environmental properties makes Huskie a valuable tool for cereal grain farmers.

GRASS AND BROADLEAF WEED MANAGEMENT IN WINTER WHEAT. Ronald F. Krausz and Bryan G. Young, Researcher and Professor, Department of Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

No-till winter wheat production has increased in southern Illinois. However, weed control in no-till wheat production is more challenging compared with reduced-till wheat production. Therefore, the objective of this research was to evaluate the effectiveness of various herbicides applied in the fall on weed control in no-till winter wheat production. Herbicides applied postemergence at 1 to 3 inch grass in the fall provided 0 to 90% control of annual bluegrass 42 days after application (DAA). Mesosulfuron&propoxycarbazone controlled annual bluegrass , 90% 42 DAA. Mesosulfuron alone was less consistent with control of annual bluegrass ranging from 67 to 90% 42 DAA. By May 1, diclofop, mesosulfuron, mesesulfuron&propoxycarbazone, and pinoxaden alone controlled 93 to 99% of the annual bluegrass and Carolina foxtail. Pinoxaden plus thifensulfuron&tribenuron controlled 68% of the annual bluegrass by May1. Prosulfuron controlled henbit 80% 42 DAA. Mesosulfuron&propoxycarbazone controlled henbit 75% 42DAA and thifensulfuron&tribenuron or mesosulfuron controlled henbit 67% 42 DAA. By May1, these herbicides controlled 99% of the henbit. Thifensulfuron&tribenuron provided 80 to 99% control of common chickweed by May 1. Mesosulfuron, mesosulfuron&propoxycarbazone, prosulfuron, and thifensulfuron&tribenuron controlled smallflower buttercup, 99%, by May 1. None of the herbicides caused wheat injury with grain yield ranging from 38 to 67 bu/A. None of the herbicides caused double-crop soybean injury with soybean grain yield ranging form 32 to 45 bu/A. There were also no significant differences in grain yield between glyphosate-resistant and glyphosate-resistant/sulfonylurea-tolerant soybean.

DE-742 COMPARED TO STANDARDS FOR BROMUS CONTROL IN WINTER WHEAT. Patrick W. Geier and Phillip W. Stahlman, Assistant Scientist and Professor, Kansas State University Agricultural Research Center, Hays, KS 67601, Dallas E. Peterson, Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66502, and Mark M. Claassen, Professor, Department of Agronomy, Kansas State University, Hesston, KS 67062.

Experiments were conducted in 2006-07 to compare pyroxsulam (DE-742) at three rates and two application timings for winter annual brome control and crop response in winter wheat. Two experiments were conducted near Hays, KS, and one each near Manhattan and Hesston, KS. Competitive standards included sulfosulfuron, mesosulfuron, two rates of propoxycarbozone, and a premix of propoxycarbozone&mesosulfuron. Application timings were fall postemergence (FP) or spring postemergence (SP), and all experiments included a nontreated control plot.

Downy brome control at Hays increased from 73 to 84% as pyroxsulam rate increased when applied FP, and the 18.75 g/ha rate was similar to sulfosulfuron or propoxycarbozone at 44 g/ha (88 and 80%). When applied SP, pyroxsulam at any rate was 12 to 35% more efficacious on downy brome than other herbicides at Hays. Pyroxsulam at 15 or 18.75 g/ha FP was similar to sulfosulfuron, propoxycarbozone, and propoxycarbozone&mesosulfuron for downy brome control at Manhattan (90 to 97%). Pyroxsulam at 15 or 18.75 g/ha, mesosulfuron, and propoxycarbozone&mesosulfuron controlled downy brome 75 to 82% when applied SP at Manhattan. All herbicides except mesosulfuron controlled cheat completely when applied FP at Hays and Manhattan, and 99 or 100% when applied SP at Manhattan. At Hays, SP applications of pyroxsulam at 18.75 or propoxycarbozone alone at 44 g/ha controlled cheat best (81 to 86%). Averaged over application timings, pyroxsulam at any rate controlled cheat similarly to sulfosulfuron, propoxycarbozone, or propoxycarbozone&mesosulfuron at Hesston. When averaged over all herbicide treatments, FP treatments at Hesston were 7% more effective on cheat than SP treatments. Averaged over experiments, wheat injury from pyroxsulam was 5% or less and did not differ from sulfosulfuron or propoxycarbozone. Mesosulfuron alone or with propoxycarbozone caused 6 to 8% wheat injury. Due to a late spring freeze, yields could not be determined at Manhattan, and yields at Hesston were low and did not correlate well with herbicide treatments. Grain yields in the Hays cheat experiment did not differ between treated and nontreated wheat. Yields were similar between herbicide treatments in the Hays downy brome experiment, but herbicide-treated wheat yielded 7 to 9 bu/A more than nontreated wheat.

ORION™: NEW BROADLEAF HERBICIDE FOR WHEAT AND BARLEY. Peter C. Forster*, Donald J. Porter and Jason C. Sanders, Syngenta Crop Protection Inc., Greensboro, NC 27419.

Orion™ is a new selective postemergence herbicide being developed for the US market by Syngenta Crop Protection for the control of broadleaf weeds in wheat and barley. Orion contains two active ingredients, florasulam and MCPA ester. Florasulam is a triazolopyrimidine sulfonanilide and inhibits acetolactate synthase (ALS). Orion is absorbed primarily through leaves of treated broadleaves and is xylem and phloem mobile. Orion has excellent crop safety to wheat (including spring, winter and durum) and barley and can be applied from the 3-leaf stage up to the boot stage of crops. At the recommended use rate of 17 fl. oz/A, Orion controls wild buckwheat (*Polygonum convolvulus*), common lambsquarters (*Chenopodium album*), wild mustard (*Sinapis arvensis*), prickly lettuce (*Lactuca serriola*), redroot pigweed (*Amaranthus retroflexus)*, smartweed (*Polygonum spp*.), catchweed bedstraw (*Galium aparine*), mayweed chamomile (*Anthemis cotula*) and numerous other broadleaf weeds. Orion has a short soil half-life allowing for flexible crop rotations the following growing season. Based on its broad weed control spectrum, excellent crop safety and rotational crop flexibility, Orion will become a new standard for broadleaf weed control in wheat and barley crops.

AXIAL® XL: THE NEW STANDARD FOR GRASS CONTROL IN BARLEY AND WHEAT. Scott E. Cully, Jason Sanders, and Marty Schraer, Research and Development Scientist, Syngenta Crop Protection, Marion, IL 62959.

Axial XL is a new formulation of Axial Herbicide from Syngenta Crop Protection that contains the active ingredient pinoxaden, the safener cloquintocet-mexyl, and a novel built-in adjuvant system. Axial XL has shown excellent crop safety to all varieties of spring wheat, winter wheat and barley. Axial XL can be applied in the fall or spring from the 2-leaf stage up to the pre-boot stage of crops. At a use rate of 16.4 oz/A, Axial XL effectively controls wild oat, (*Avena fatua),* foxtails (*Setaria* species), Italian ryegrass *(Lolium multiflorum),* Persian darnel *(Lolium persicum),* barnyardgrass (*Echinochloa crus-galli*), as well as, several other annual grasses. Axial XL can be tank mixed with broadleaf herbicides for flexible one-pass grass and broadleaf weed control in wheat and barley crops. Based on its broad grass weed control spectrum, flexibility of use, excellent crop safety and convenience of a built-in spray adjuvant, Axial XL will be the new standard for grass weed control in wheat and barley.

ROTATIONAL CROP RESPONSE FOLLOWING APPLICATION OF PYROXSULAM IN WHEAT. Monte R. Weimer, Brett Oemichen, Roger Gast, and Mark Peterson. Dow AgroSciences, Indianapolis, IN.

A key component to exploit the economic and agronomic advantages in diverse cropping systems is having the flexibility to choose and produce a variety of crops at any given time. Chemical weed control is an important component in many cropping systems involving spring and winter wheat. The choice of the rotational crop following wheat may be constrained by the plant back restrictions from the herbicide used for weed control in wheat. Pyroxsulam is a new grass and broadleaf herbicide being developed by Dow AgroSciences for utility in spring and winter wheat. In order to characterize the cropping flexibility after a pyroxsulam application, a series of crop rotation experiments were conducted in the major spring and winter wheat production areas in the United States.

In spring wheat, rotational studies were conducted in North Dakota, Montana, and Idaho. Herbicide injury to oat, sugarbeet, canola, safflower, camelina, soybean, sunflower, barley, lentil, flax, alfalfa, dry bean, field pea, and/or potato was evaluated the season after a pyroxsulam application in spring wheat at 15, 30, and 60 g ha^{-1} (X, 2X and 4X of the anticipated label rate of pyroxsulam in spring wheat). The rotational crop response to pyroxsulam was compared to treatments of flucarbazone (20 and 40 g ha^{-1}) and propoxycarbazone + mesosulfuron (10 + 2.5 and 20 + 5 g ha^{-1}). In winter wheat, rotational studies were conducted in Oklahoma, Kansas, Colorado, Washington, and Idaho. Herbicide injury to field pea, canola, lentil, barley, sugarbeet, potato, chickpea, safflower, soybean, sorghum, sunflower, and/or cotton was evaluated to crops planted the spring following a fall application of pyroxsulam at 18.8, 37.5, and 75 g ha^{-1} (X, 2X, and 4X of the anticipated label rate of pyroxsulam in winter wheat). The winter wheat crop was terminated in the early spring by applying glyphosate to facilitate planting of the spring crops. This procedure simulates a scenario that results in crop failure and the need for emergency re-cropping. Rotational intervals (treatment to rotational crop planting date) of 142 to 176 days were experienced with this procedure. Pyroxsulam treatments were compared to sulfosulfuron (35 and 70 g ha^{-1}), propoxycarbazone (44 and 88 g ha^{-1}), or propoxycarbazone + mesosulfuron (15 + 10 and 30 + 20 g ha^{-1}).

In spring wheat, no visual injury greater than 5% was observed with pyroxsulam treatments (up to 4X rates) on any of the 14 rotational crops the season following application. Visual injury was observed with rates of 20 and 40 g ha^{-1} flucarbazone on oat (5-10% and >10%, respectively), sugarbeet (5-10% both rates), and lentil (>10%, both rates). Visual injury was observed with rates of 10 + 2.5 and 20 + 5 g ha^{-1} propoxycarbazone + mesosulfuron on sugarbeet (5-10% both rates), and lentil (>10%, at high rate). For rotational crops planted after a fall application in winter wheat, pyroxsulam demonstrated the greatest safety as compared to sulfosulfuron, propoxycarbazone, or propoxycarbazone + mesosulfuron. Slight injury (5-15%) from pyroxsulam treatments were observed on sugarbeet, chickpea, and corn at 2 and 4X application rates. No injury was observed on all other rotational crops from the 4X pyroxsulam treatment. At 70 g ha^{-1} sulfosulfuron (2X), which is known to persist in the soil, injury (>15%) was observed on all rotational crops except cotton. Propoxycarbazone applied at 88 g ha^{-1} injured all plant back crops except pea, potato, safflower, and cotton. Propoxycarbazone + mesosulfuron (30 + 20 g ha^{-1}) injured all rotational crops except potato and cotton. These data indicate that pyroxsulam has a good margin of safety, and will be non-injurious to the 19 crops tested even at 2X the proposed use rate the season following application. Additionally, pyroxsulam provides the least potential for injury in an emergency re-cropping situation compared to other products tested. This attribute of rotational crop safety in spring and winter wheat will offer growers greater flexibility in a variety of current and developing cropping systems throughout the U.S. wheat growing regions.

TOLERANCE OF SEVERAL CROPS TO KIH-485. Rich Zollinger, Kirk A. Howatt, and Brian M. Jenks, Professor and Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051 and Research Scientist, North Central Research Extension Center, Minot, ND 58701-7645.

Replicated field research was conducted in 2004 through 2007 to evaluate crop tolerance of KIH-485 (pyroxasulfone) applied preemergence on wheat, corn, soybean, dry edible bean, field pea, lentil, sunflower, safflower, and flax. Wheat was not visibly injured at rates of 1 to 3.5 oz/A. Cultivated tame oat varieties of ‘Beach’, ‘Dancer’, and ‘Maida’ was completed killed by KIH-485 at 3 and 4 oz/A suggesting the possibility of wild control from KIH-485 applied preemergence in wheat. Over 10 studies were conducted to evaluate corn tolerance to KIH-485 applied at 1 to 6 oz/A. No visible corn injury occurred. KIH-485 was applied preemergence to soybean at 1 to 3.5 oz/A. Only the 3.5 oz/A rate caused soybean injury no greater than 4% and injury was not visible after the first evaluation. All rates of KIH-485 from 1.8 to 6 oz/A injured ‘Maverick’ pinto, ‘Ensign’ navy, ‘Montcalm’ kidney, and ‘T-39' black dry beans types. Rates of 1.8 to 3.5 oz/A caused dry bean injury less than 7% at the first evaluation on June 25 but injury increased to 27% by July 27. Significant dry bean injury occurred (17 to 45%) from rates of 4.7 and 6 oz/A which was visible through July 27. Injury increased through time and as KIH-485 rates increased. Dry bean tolerance to KIH-485 is as follows: pinto>navy>kidney=black. Standing water in plots areas from rain in April and June 15 activated the herbicide but also caused dry bean plant death and injury. The studies were abandoned in August due to hail. Dry pea and lentil tolerance to KIH-485 at 2.4 to 4.7 oz/A was excellent in 2006 but dry pea injury was 14 to 37% and lentil was 17 to 33% in 2007. Dry conditions followed application in 2006 and over 13 inches of rain fell in June and July of 2007. Injury increased through time but did not result in yield loss compared to the untreated check. Several trials were conducted in 2004 through 2007 evaluating sunflower tolerance to KIH-485. In eastern North Dakota where soils tend to be more fine with higher organic matter, no significant sunflower injury was observed from KIH-485 at rates of 2.4 to 6 oz/A or with combinations of KIH-485 plus sulfentrazone at 1.5 to 2 oz/A. However, there was 20% sunflower injury from KIH-485 at 6 oz/A on a coarse textured soil at Valley City. At Minot (western North Dakota) where soils are more coarse with lower organic matter, KIH-485 rates up to 3 oz/A in 2006 did not significantly injure sunflower but rates of 4.8 and 6 oz/A caused 17 to 24% injury. There was no difference in sunflower yield from any treated plot compared to the untreated. In 2007 at Minot, no significant injury was observed with any KIH-485 treatment. Safflower had excellent tolerance to KIH-485 in 2006 and 2007 at rates up to 4.7 oz/A. Flax showed 1, 10, and 15% injury to KIH-485 at rates of 2, 3, and 4 oz/A, respectively at one rating 5 weeks after planting. The study was abandoned after the initial rating due to stand loss from standing water. A total of four carryover studies conducted in 2006 and 2007 showed no response of navy and pinto dry bean, flax, and barley from KIH-485 residues at rates up to 6 oz/A. Sugarbeet injury up to 40% and canola injury up to 25% was observed on these crops planted the year following application.

WEED CONTROL IN 'EXPRESSSUN' SUNFLOWER, PRO'S AND CON'S. Curtis Thompson, Brian Olson, Alan Schlegel, and John Holman, Professor, Assistant Professor, Professor, and Assistant Professor, Southwest Research Extension Center, Garden City, Northwest Research Extension Center, Colby, Southwest Research Extension Center, Tribune and Garden City, Kansas State University, 4500 E. Mary, Garden City, KS 67846.

There are few herbicides registered for use in sunflower and even fewer options for postemergence broadleaf weed control in sunflower. The objectives of these experiments were to evaluate tribenuron for postemergence broadleaf weed control in 'ExpressSun' sunflower and to evaluate crop response to tribenuron.

'ExpressSun' sunflower, Pioneer 63N81 was planted in 30 inch rows at 17,000 seeds/A into silt loam soil at Colby, KS on June 11, at 24,000 seeds/A into silt loam soil at Tribune, KS on June 4, and at 18,000 seeds/A into silt loam soil at Garden City, KS on June 6, 2007. Preemergence treatments, pendimethalin and sulfentrazone were applied June 16 at Colby, June 4 at Tribune and June 7, 2007 at Garden City. Tribenuron 'Express SG' formulation was applied at 0.125, and 0.25 oz ai/A tank mixed with 0.88 oz ai quizalofop and 1.5 pt COC to 4 to 7-leaf sunflower on July 5 at Colby, June 26 at Tribune, and July 4 at Garden City. The two postemergence tank mixes, were applied with or without each of the two preemergence treatments, pendimethalin or sulfentrazone. Treatments at Colby were applied with a sprayer delivering 15 gpa while treatments at Garden City and Tribune were applied with a backpack sprayer delivering 20 gpa for preemergence treatments and 10 gpa for postemergence treatments. All experiments were arranged as a RCB design with three or four replicates.

No sunflower injury was observed in the Colby experiment. Sunflower chlorosis was observed with tribenuron at all rates in the Garden City and Tribune experiments. No injury was observed from any other treatment. Observed injury did not affect growth and development of the sunflower.

Tribenuron controlled Russian thistle, common puncturevine, and tumble pigweed 90% or more at all locations. Palmer amaranth control with tribenuron was less than 50% at Garden City regardless of rate because of the presence of ALS-resistant Palmer amaranth. Treatments containing sulfentrazone controlled Palmer amaranth 90% or more. Volunteer wheat was controlled with all postemergence treatments because they contained quizalofop.

Tribenuron will provide broad spectrum broadleaf weed control in 'ExpressSun' sunflower. However the greatest limitations of the tribenuron system are ALS-resistant weed species. Tribenuron will not control ALS-resistant weeds. Also, tribenuron must be tank mixed with a grass herbicide to control grass weed species postemergence in sunflower.

COMPARISON OF DESICCANT TIMING AND HARVEST METHOD IN CANOLA. Brian M. Jenks, Gary P. Willoughby, Shanna A. Mazurek, North Dakota State University, Minot, ND 58701; John R. Lukach, North Dakota State University, Langdon, ND 58249; and Fabian D. Menalled and Edward S. Davis, Montana State University, Bozeman, MT 59717-3120.

A study evaluating the use of desiccants as a harvest aid in canola was conducted at three locations in 2005, 2006, and 2007: 1) North Central Research Extension Center, Minot, ND, 2) Langdon Research Extension Center, Langdon, ND, and 3) Montana State University, Bozeman, MT. The objectives of the study were to: 1) determine the effect of paraquat applied preharvest at three timings on canola yield, seed moisture, and seed quality, 2) determine the effect of diquat applied preharvest at three timings on canola yield, seed moisture, and seed quality, 3) compare yield, seed moisture, and seed quality of swathed canola to paraquat and diquat-treated canola, and 4) determine the effect of harvest timing following a paraquat or diquat application on canola yield, seed moisture, and seed quality. Paraquat and diquat were applied preharvest at three timings (early, optimum swath timing, and late). Paraquat was applied at 7.8 oz ai with NIS at 0.25% v/v. Diquat was applied at 6 oz ai with NIS at 0.25% v/v. One treatment was swathed with a plot swather on the same days the paraquat/diquat treatments were applied as a comparison to current grower practices. The paraquat, diquat, and swath treatments were harvested 7 and 14 days after treatment (DAT). The study was a 3-factor factorial (desiccant, timing, harvest date) arranged in a randomized complete block design. In Minot, paraquat- and diquat-treated plots produced similar canola yields compared to swathed treatments averaged across all timings and harvest dates. Canola yields were also similar for the 2 harvest dates averaged across desiccants and timings. Additionally, there were no significant differences in test weight and oil content between desiccated or swathed canola averaged across all timings and harvest dates. Seed lost due to pre-harvest shattering was less than 37 lb/A for any either desiccant or swathing. This loss would likely be considered minimal in canola production. At Langdon in 2005 and 2006, paraquat- and diquat-treated plots produced similar canola yields and seed weight compared to swathed treatments averaged across all timings and harvest dates. However, in 2005, the later desiccant/swath timing produced higher yield and seed weight than timing 2, which in turn, was higher than timing 1. Also, canola harvested 14 DAT yielded higher than that harvested 7 DAT. This is probably because of higher seed moisture at the first two application/swath timings where seed was less physiologically mature compared to the Minot location. In 2006, yield and seed weight results were similar for desiccants and timings. Seed lost due to pre-harvest shattering was less than 59 lb/A for any either desiccant or swathing. At Bozeman in 2005 and 2006, paraquat- and diquat-treated plots generally produced similar canola yield and test weight compared to swathed treatments averaged across all timings and harvest dates. Canola yields were also similar for the 2 harvest dates averaged across desiccants and timings. However, in 2005, canola swathed or desiccated at the third or latest timing produced higher yield than canola treated at the two earlier timings. Additionally, all canola desiccated or swathed at the earliest timing had a significantly lower test weight than canola desiccated or swathed at the later two timings. Furthermore, canola harvested 7 DAT had a lower test weight than canola harvested at 14 DAT. This may be due to lack of physiological maturity at earlier desiccation/swath timings. However, in 2006, canola yield and test weight was slightly lower at the latest timing. Test weight was slightly lower when harvested 14 DAT compared to 7 DAT. Seed lost due to pre-harvest shattering in 2005 was less than 59 lb/A for any either desiccant or swathing, but was 112-193 lb/A in 2006. Data from 2007 will be summarized.

INVESTIGATING THE HERITABILITY OF VARIABLE GLYPHOSATE-RESISTANCE LEVELS IN HORSEWEED (CONYZA CANADENSIS). Vince M. Davis, Greg R. Kruger, Stephen C. Weller, and William G. Johnson, Graduate Research Assistant, Graduate Research Assistant, Department of Botany and Plant Pathology, Professor, Department of Horticulture and Landscape Architecture, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Glyphosate-resistant horseweed (*Conyza canadensis*) biotypes have been reported in 15 states in the U.S., as well as reports in Brazil and China. Horseweed is a common and problematic weed in the Eastern cornbelt and glyphosate-resistant populations are particularly troublesome in no-till glyphosate-resistant cropping systems. Populations from several states have demonstrated variable levels of glyphosate tolerance in dose-response experiments. Different field populations collected with-in Indiana have also demonstrated resistance ranging from 4 to 110 fold resistance compared to susceptible field populations. However, little information is known about the inheritance of variable levels of glyphosate tolerance in horseweed. The objective of this experiment is to determine if variable levels of glyphosate resistance in field populations of horseweed are passed to first generation progeny. Initial glyphosate screens of 1.68 kg ae/ha were conducted on 85 horseweed populations comprised of 40 mother plants as a composite population. Resistant survivors that demonstrated varying levels of glyphosate tolerance were selected and allowed to self-pollinate. Seeds from individual plants were collected and grown in the greenhouse. Glyphosate dose response experiments were conducted on the field populations and the progeny of the selfed individual plants. The experiments were randomized complete block designs with nine glyphosate rates and 10 horseweed populations replicated four times. The correlation between glyphosate tolerance levels of mother plants to respective progeny was poor for growth parameters and visual control; however, the ranking of glyphosate tolerance in the mother plants corresponded well with progeny survival at the 1.68 kg ae/ha rate. Mother plants with a “high” level of resistance had progeny survival of 92%, while a population with a “low” level of resistance had progeny survival of 25% at the 1.68 kg ae/ha rate.

INVESTIGATING INDIANA HORSEWEED (*CONYZA CANADENSIS*) POPULATIONS FOR RESPONSE TO 2,4-D.

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The herbicide 2,4-D is often used as a preplant herbicide to help control horseweed and other existing broadleaf weeds in no-till soybean production. This is an especially important practice to control horseweed populations that are resistant to glyphosate. However, reports of poor horseweed control following preplant 2,4-D applications have occurred several times the last couple of springs. Between 2003 and 2005, approximately 450 horseweed populations were collected from across the state of Indiana and characterized for their response to glyphosate in previous experiments. In this experiment, we evaluated the response of previously collected horseweed populations to 2,4-D. Horseweed plants were grown in the greenhouse and 2.5 to 5 cm plants were sprayed with 280 g ai/ha of 2,4-D amine. Plants were evaluated for visual response at 28 days after treatment to determine if any populations had elevated tolerance to 2,4-D. All populations had greater than 90% visual control, and no resistant plants were found. However, differences were observed in the survivorship of horseweed plants in some populations. Four populations were selected for a subsequent dose response experiment with similar methods. The dose response results indicated one population had more tolerance to 2,4-D at rates below the maximum labeled rate. ED_{50} values for the more tolerant biotype were approximately twice as high for visual ratings and four times as high for dry weights. While differences at this level seem insignificant, increased selection pressure and applications under less than optimal conditions could lead to the evolution of resistant populations.

PREVALENCE OF AN UNUSUAL RESISTANCE MECHANISM FOR PPO INHIBITORS IN WATERHEMP. Ryan M. Lee, Aaron G. Hager, and Patrick J. Tranel, Post-doctoral Research Assistant, Assistant Professor, and Associate Professor, Department of Crop Sciences, University of Illinois, 1201 W. Gregory Dr, Urbana, IL 61801.

The mechanism of resistance to protoporphyrinogen oxidase (PPO)-inhibiting herbicides in waterhemp has been shown previously to be the result of a single codon deletion in the *PPX2L* gene, a gene encoding both plastidic- and mitochonridal-targeted PPO proteins. This mechanism of resistance is unique because it represents the first time a deletion mutation has been implicated in herbicide-resistance. Furthermore, when this mechanism was initially characterized it was presumed that waterhemp contained three *PPX* genes, *PPX1*, *PPX2S* and *PPX2L*, and that the resistant biotypes were missing *PPX2S*. First, to obtain a better understanding of this unique mechanism of resistance, we examined the relationship between the *PPX2* genes in waterhemp using allele testing and sequence data. Based on these experiments we conclude that *PPX2L* is the only *PPX2* gene present in waterhemp. Next, to determine the prevalence of the deletion mutation in Illinois waterhemp, we developed an allele-specific PCR marker that amplifies only the 3-bp deletion allele, ΔG210, of *PPX2L*. By utilizing this marker, we determine that the ΔG210 *PPX2L* gene was present in all six examined PPO-resistant waterhemp populations from Illinois. Thus, the ΔG210 mutation likely is the predominant mechanism of resistance to PPO-inhibiting herbicides in Illinois waterhemp.

SUSTAINABLE MANAGEMENT OF GLYPHOSATE-RESISTANT WEEDS IN ROUNDUP READY® CROPPING SYSTEMS. David I Gustafson, R. Douglas Sammons and Brett H. Bussler, Senior Fellow, Chemical Regulatory Affairs, Senior Fellow, Global Bio-Evaluations, and Manager, Global Bio-Evaluations, Monsanto Company, St. Louis, MO 63167.

Roundup Ready® (glyphosate-resistant) cropping systems enable the use of glyphosate, a non-selective herbicide which offers growers several benefits, including superior weed control, crop safety, fuel savings with the use of reduced tillage, flexibility in weed control timing, and economic advantages. The rapid adoption of such crops in North America has resulted in greater glyphosate use and some concerns over the potential for weed resistance to erode the sustainability of its benefits and efficacy. Monsanto has a broad internal and external effort to develop and implement sustainable weed control practices to help limit the spread of existing glyphosate resistant biotypes and avoid selecting new ones. The internal program includes the use of computer modeling and field sustainability trials intended to directly measure the net economic return to the grower among multiple weed control options. The options include factors other than choice of herbicide, such as tillage and crop rotation. The field tests should also help strengthen the assumptions on which the computer models are based, thereby making projections of future resistance trends more robust. Empirical evaluations of published data show that glyphosate resistant weeds have an appearance rate of 0.007, defined as the number of newly resistant species per millions of acres treated in the US, which ranks low among all herbicides used in this country. An important practical recommendation emerging from the computer modeling and field trials is for growers to include other herbicides in glyphosate-resistant cropping systems, to further lower the potential for new resistance to occur.

One particular group of five field sustainability trials is highlighted in this presentation. They are located in Alabama, Georgia, Illinois, Mississippi, and North Carolina. Two of the five trials have been established in areas with populations of glyphosate-resistant *Amaranthus palmeri* present, while the remaining three do not currently have any known populations of glyphosate-resistant biotypes. Each of these trials is being planted with two glyphosate-resistant crops, either as a continuous crop or in a two-year rotation, and some include tillage as a factor. Standard weed control ratings, weed counts, and crop yields are being measured. The trials are intended to be kept in these cropping systems for several years, with four herbicide programs compared within each crop. This set of trials was initiated in 2006, and the first two years of results will be discussed. Not surprisingly, the three locations without any glyphosate-resistant weeds showed excellent weed control and crop yields, and no differences were observed among the various herbicide programs. The two sites with populations of glyphosate-resistant *A. palmeri* are showing significant differences in weed control and yields among the various treatments. The trial site in Georgia showed poor control of this weed in 2007, due to the severe drought experienced at that site, and the associated lack of activating rainfall for the pre-emergent residual soil herbicides included in the treatments. This result is not surprising, as it is well known that such herbicide treatments lose effectiveness under such extreme conditions, and it is not a unique finding. Modifications of the treatments are under consideration to effectively and consistently manage these weeds, even under such extremely dry conditions.

As further results of these field sustainability trials become available, the information will continue to be published and incorporated into updated grower recommendations. The data available today suggest that continuous Roundup Ready® cropping systems can be managed in a sustainable manner, largely through the prudent use of additional herbicides in such cropping systems.

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IMPORTANCE OF THE P106S TARGET SITE MUTATION IN CONFERRING RESISTANCE TO GLYPHOSATE IN AN ELEUSINE INDICA BIOTYPE FROM THE PHILIPPINES. Shiv S. Kaundun, Ian A. Zelaya, Richard R. Dale, Amy Lycett, Patrice Carter, Kate Sharples, and Eddie McIndoe, Syngenta Ltd., Weed Control Research, Jealott's Hill International Research Centre, Bracknell, Berkshire, RG42 6EY, UK.

Few studies on herbicide resistance report co-segregation analysis to unambiguously establish the correlation between genotype and phenotype. Herein we report on the importance of the EPSPS prolyl^{106} point mutation to seryl (P106S) in conferring resistance to glyphosate in a goosegrass (*Eleusine indica*) population from Davao, Island, The Philippines. The resistance factor estimated when comparing the Davao population to a known susceptible *E. indica* biotype was 4.4 fold. Evaluation of potential resistance mechanisms identified the presence of P106S in EPSPS whilst no consistent differences were observed in glyphosate absorption or translocation patterns. PCR amplification of specific alleles (PASA) analysis established that the mixed-resistant Davao population was comprised of 39.1% homozygous proline wild-type (PP106), 3.3% heterozygous serine mutant (PS106) and 57.6% homozygous serine mutant (SS106) genotypes. Rate response estimate of plants with a predetermined genotype confirmed that Davao SS106 individuals were at least 2 fold more resistant to glyphosate compared to Davao PP106 individuals. Further, extensive co-segregation analysis at different growth stages and glyphosate rates confirmed a strong correlation ($P < 0.01$) between presence of SS106 and the resistant phenotype. Bioinformatics evolutionary conservation analysis of prolyl^{106} indicated that the residue is less conserved compared to highly-conserved structural or functional residues in EPSPS; the potential structural implications of P106S mutation on vicinal residues in EPSPS are discussed.

EFFECTS OF ROOT SEGMENTATION ON CANADA THISTLE SUPPRESSION. Richard Crow and Edward Luschei, Research Assistant and Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Canada thistle has earned a reputation of being difficult to manage due, in large part, to its spreading root system. Standard low-soil-disturbance control measures include mechanical actions, like periodic mowing, leaving the below-ground root system intact. We hypothesized that segmenting the root system might substantially improve control by inducing increased stem production, potentially increasing the amount of stored reserves converted into actively growing tissue. To test our hypothesis, we setup a 2x2 factorial experiment with mowing and root segmentation as factors. During each of the two replications, data was collected on biomass and stem production. We found a statistically significant interaction between the mowing and segmenting treatments on stem production in both temporal replications; as well as a significant interaction on biomass production in one of the two replications. There was no significant difference between the simple effects of mowing and mow plus segmentation on stem production, while the significant difference between the simple effects on biomass production was inconsistent. The simple effect of segmentation on stem production was an increase of 67% in 2006 and 9% in 2007 compared to a non-treated check. Root segmentation of Canada thistle was shown to increase stem production, but when combined with mowing, showed no significant difference from mowing alone.

SUPPRESSION OF CANADA THISTLE WITH SUMMER ANNUAL COVER CROPS AND MOWING – YEAR 2. Abram Bicksler and John B. Masiunas, Graduate Research Assistant and Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois, 1201 West Gregory Drive, Urbana, IL 61801.

Canada thistle (*Cirsium arvense*) is a vigorous, creeping perennial weed that forms dense patches. There are few options to manage Canada thistle in organic cropping systems. Tillage creates propagules from the deep, fibrous root system, further spreading the problem and causing larger patches. It can take many years of intensive mowing to suppress thistle. Warm season annual cover crops grow when Canada thistle root reserves and ability to regenerate are low and when seedlings first emerge. Competitive summer annual cover crops may prevent thistle growth, flowering and seedling establishment. In preliminary research, Sudangrass reduced Canada thistle while cowpeas alone did not. Combining Sudangrass and cowpea may reduce thistle populations while supplying legume-derived nitrogen for subsequent crops. In 2006, field studies were conducted on organic farms and the University of Illinois Cruse Research Farm using established patches of Canada thistle. Prior to planting cover crops, we tilled to kill emerged thistle, slice the upper roots into small pieces, and prepare the seedbed for planting cover crops. The cover crop treatments were no cover crop (weedy fallow), buckwheat, Sudangrass, and Sudangrass + cowpea. The cover crop treatments were mowed either none, one or two times. Cowpea could not compete with Sudangrass and most cover crop plants in the mix were Sudangrass. Even without treatment, the number of Canada thistle shoots decline over the growing season. This decline in number of shoots in a patch of Canada thistle is natural and is likely due to failed establishment, competition between thistle plants, and pest attack. Cover crops and mowing acted independently to reduce thistle patches. At 3 months after planting cover crops, thistle was 21 and 3% of initial numbers in the buckwheat and Sudangrass (alone or with cowpea), respectively. At 3 months, mowing once reduced thistle more than mowing twice. Two mowings further damaged growing points of thistle but made other weeds and cover crops less competitive and triggered emergence of new thistle shoots. In 2007, at the Cruse Research Farm we determined if previous year treatments affected Canada thistle patches. The field was intensely tilled and we planted organic food-grade soybeans. In soybeans, the areas formerly with Sudangrass or Sudangrass + cowpea had Canada thistle populations approximately 2% of those the previous spring. Canada thistle shoots emerging in these areas were stunted and not competitive with the soybeans. Areas mown once had fewer thistle shoots than areas mown twice. Mowing and buckwheat only suppressed thistle for a single growing season. Sudangrass rapidly grows, tilling extensively, forms a tall dense canopy, tolerates mowing, quickly regrows, and forms thick mulch. Sudangrass combined with mowing controls Canada thistle due to competition for resources and leaching of allelopathic compounds from roots. Mowing also defoliates thistle (mown at 7-10 leaf stage) and causes Sudangrass re-growth and tillering resulting in more competition for light. The thick mulch can smother thistles, modify the soil environment (cooler temps, increased moisture), and release allelochemicals.

RESPONSE OF CORN TO PALMER AMARANTH, WATER, AND NITROGEN STRESSES. J. Anita Dille, Ella K. Ruf, and Dwain M. Rule. Associate Professor, Graduate Research Assistant, and Graduate Research Assistant, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Palmer amaranth is a competitive weed in corn fields and has been known to cause variable corn yield losses in the diverse environments of Kansas. If corn yield losses could be partitioned among water and nitrogen stresses, perhaps we could improve the prediction of the impact of Palmer amaranth on corn yield loss. The objective was to evaluate corn growth, yield, and yield losses when grown alone or in competition with Palmer amaranth under dryland and irrigated environments with three different nitrogen rates. Field experiments were conducted in 2005 and 2006 at the Department of Agronomy Ashland Bottoms Research Farm near Manhattan, KS. The experiment was arranged in a side-by-side design with whole plots being dryland and furrow irrigation. Within each soil moisture environment, subplot treatments were 0, 112, or 224 kg N ha^{-1}, and sub-subplot treatments were monoculture Palmer amaranth at 1 plant m^{-1} of row, and corn with 0, 1, 4, and 8 Palmer amaranth plants m^{-1} of row. Water stress occurred earlier and caused more drought-like conditions in 2006 than 2005. Corn height was impacted more by water stress than palmer amaranth when N was not limiting. Corn leaf number, LAI, and biomass were reduced with increasing water stress and were further reduced in the presence of Palmer amaranth. Corn biomass at VT in 2005 was less for dryland, less for 0 N, and less in the presence of Palmer amaranth. In the 2006 dryland environment, corn biomass at VT had a negative linear relationship with Palmer amaranth density and declined more rapidly with addition of N. In the 2006 irrigated environment, corn biomass at VT had a negative curvilinear relationship with Palmer amaranth density, and less biomass produced with each decrease in N rate. Weed-free corn grain yields in the dryland environment were approximately 48% of the irrigated environment across years. Under irrigation in both years, 0 N applied produced 36% less corn grain than high N rates. In contrast with the dryland environment in 2006, no N applied produced 47% less grain compared to high N rates. In 2005, dryland corn yield was reduced by 19% when no N was applied. In order to compare across soil moisture environments, percent corn yield loss was calculated. Only in the irrigated environment of 2006 were interactions observed in percent corn yield loss in response to palmer amaranth density with N rate. With no additional N, more corn yield loss was observed with increasing Palmer amaranth density compared to either 112 or 224 kg N ha^{-1}. In the drought-stressed dryland environment of 2006, maximum percent corn yield loss was estimated to be 95% compared to 62% in the 2006 irrigated environment with 224 kg N ha^{-1} or 74% with 0 or 112 kg N ha^{-1}. In 2005, the maximum predicted percent corn yield loss with high Palmer amaranth densities, pooled across N rates, was 45% in irrigated and 54% in dryland environments and these were not different. Overall, water stress reduced corn yield potential the most (52%), followed by the addition of one Palmer amaranth plant (32 to 73%), and followed by the impact of N stress (19 to 47%). These empirical data provide a basis for improved prediction of corn yield losses in variable KS environments.

NET INFLUENCE OF EARTHWORMS (LUMBRICUS TERRESTRIS) ON GIANT RAGWEED (AMBROSIA TRIFIDA) SEEDLING RECRUITMENT. J. Liu, E. Regnier, K. Harrison, C. Holloman, J. Schmoll, F. Diekman, and D. Barker. The Ohio State University, Columbus, OH.

Lumbricus terrestris, the common nightcrawler, buries large numbers of giant ragweed seeds over a range of depths inside its vertical burrows. Seed burial by *L. terrestris* can protect seeds by removing them from the soil surface where they are easily detected and consumed by seed predators, but it can also reduce seedling recruitment when seeds are buried inside burrows below optimum depths for emergence. Field experiments were conducted in 2005 and 2006 in Columbus, OH to determine the net effects of *L. terrestris* on giant ragweed seedling establishment in the presence and absence of seed predators. A hierarchical Bayesian model indicated that the probability of emergence was highest when neither predators nor earthworms were present. Adding predators decreased the probability of emergence more than adding *L. terrestris*. To determine if *L. terrestris* had a protective effect on giant ragweed in the presence of seed predators, we calculated a protectiveness ratio as the ratio of the observed emergence probability when predators and *L. terrestris* were both present to the expected emergence probability based on individual effects of *L. terrestris* and predators. The ratio ranged from 1.33 to 1.57 in 2005, suggesting that *L. terrestris* protected seeds from predation. There was no protective effect in 2006, possibly due to low predation intensity. A separate study of seed burial by earthworms and seed predation was conducted in sites with varying degrees of vegetative cover. The proportion of seeds buried by earthworms and consumed by predators varied widely among sites. The results indicate that the interaction of earthworms and seed predators is complex and depends on habitat and the relative activity-density of seed predators and *L. terrestris*. It is likely that *L. terrestris* increases giant ragweed seedling recruitment when the probability of recruitment losses due to seed predation exceeds the probability of recruitment losses due to deep burial by the earthworms. *Lumbricus terrestris* may facilitate giant ragweed establishment in no-tillage fields and successional sites with vegetative cover that provides a suitable habitat for vertebrate seed predators and few opportunities for seed burial.

ASSESSING ORGANIC SEED TREATMENTS FOR ENHANCED CORN ESTABLISHMENT. Nicholas J. Goeser*, Janet L. Hedtcke, Edward C. Luschei, and Erin M. Silva, Research Assistant, Agronomy Department, University of Wisconsin-Madison, Madison, WI, 53706, Senior Research Specialist, Agronomy Department, University of Wisconsin-Madison, Madison, WI, 53706, Assistant Professor, Agronomy Department, University of Wisconsin-Madison, Madison, WI, 53706, and Associate Scientist, Agronomy Department, University of Wisconsin-Madison, Madison, WI, 53706.

The first line of defense in the cultural weed management strategy is having a good stand and vigorous crop. Poor crop seed germination, emergence, and early seedling vigor can result in uneven crop stands that leave resources available for weed invasions. Delayed corn planting, when soil temperatures warm > 50° F, is a common strategy for organic farmers to increase the probability of a uniform crop stand, but this can reduce yield potential if weather further delays planting. Even with delayed planting, it is common to observe poor crop seed germination, emergence, and early seedling vigor due to pathogens, insects or variability in soil moisture availability. Field-scale studies were conducted to compare several of organically approved corn seed treatments with a non-treated control: Agricoat LLC's "Natural II", Bioworks' "T-22 Planter Box Treatment", and Agrienergy Resources' "Myco Seed Treat". Corn growth and development traits were used to assess seed treatment effects. These traits included emergence rate and terminal percentage, seedling vigor (as assessed through above ground plant height of the last collared leaf at the V3 and V5 stages), and terminal grain yield. Field studies were conducted near Arlington and Columbus, WI in 2007. In the spring of 2007, crops were planted at an early (cooler soils) and late (warmer soils) date in May. In the early planted Arlington environment, terminal emergence for Natural II coated seed was significantly greater than the control. In the late planted Arlington environment, T-22 had a significantly lower terminal emergence percentage than the other three treatments. In the early planted Columbus environment, Natural II had a significantly greater terminal emergence percentage than the control and Myco Seed treated seed. In the late planted Columbus environment, T-22 had a significantly greater terminal emergence percentage than the control and Myco treated seed. Corn seed treated with Natural II had the greatest average plant height at the V3 stage at both planting dates, followed by T-22 and Myco Seed Treat, respectively. At the V5 stage, Myco Seed Treat was significantly lower in height than the other three treatments. At both the Arlington and Columbus sites, end of season grain yield comparisons resulted in significant differences between the early and late planting dates. However, there were no significant grain yield differences between the corn seed treatments. Though seed treatments effects on final grain yield were not detectable, the differences in crop density and seedling vigor warrant further investigation. Increases in crop density and seedling vigor reduce the sites and resources (i.e. light, nutrients, and water) available for weed invasions, which is especially critical in organically managed cropping systems.

THE MANAGEMENT OF GLYPHOSATE RESISTANCE THROUGH POLLEN IN COMMON RAGWEED. Johnathan P. Dierking and Reid J. Smeda, Graduate Student and Associate Professor, Division of Plant Sciences, University of Missouri-Columbia, Columbia, MO 65211.

In Missouri, glyphosate-resistant (Gly-R) common ragweed (*Ambrosia artemisiifolia*) has been identified in a 52 hectare area, which has been under continuous production of glyphosate-resistant soybeans since their introduction in 1996. Of concern is the spread of Gly-R to adjacent areas. The objective of this research was to determine if pollen from Gly-R plants could spread resistance, and the distance that resistance could be transmitted. A block of Gly-R plants was established as pollen source plants at the edge of the known infested area. Glyphosate-susceptible (Gly-S) seedlings were established in repeated groups of 2-3 plants equidistant and downwind from Gly-R plants. Gly-S seedlings were located a distance of 1, 3, 11, 30, 91, 198, and 580 meters from Gly-R plants. All Gly-S seedlings were located in a field containing glyphosate-resistant soybeans. As common ragweed plants matured, pollen from Gly-R plants was permitted to freely flow across the area containing Gly-S plants. Mature seed from Gly-S and Gly-R common ragweed were collected and planted in a professional potting mix under greenhouse conditions. As seedlings reached 7 to 13 cm in height, they were treated with 1.68 kg ae/ha glyphosate, and evaluated visually 3 weeks later for injury [0-30% injury = R, 31-89% injury = intermediate (I) and 90-100% injury = S]. In 2005, pollen from Gly-R plants resulted in detection of Gly-R seedlings up to 91 meters away from the source plants with a minimum of 411 seedlings evaluated per arc. The percentage of Gly-R seedlings from Gly-S plants were 1, .01, 1, 0, 1.8, and 4.6% for the 1, 3, 11, 30, and 91 meter distances from Gly-R source plants, respectively. There were no Gly-R seedlings found greater than 91 meters from Gly-R plants, indicating no probability for Gly-R plants to pollinate Gly-S plants at distances beyond 91 meters. Data from 2006, minimum of 213 plants evaluated, indicate the percentage of Gly-R seedlings from the Gly-S plants collected from the 1, 3, 11, 30, 91, and 198 meter distances from the Gly-R source plants were 2, 0, 1.7, 0.75, 0, and 0.32%, respectively. There were no Gly-R seedlings found greater than 198 meters from Gly-R plants, indicating no probability for Gly-R plants to pollinate Gly-S plants at distances beyond 198 meters. Glyphosate resistance can spread through pollen of common ragweed a sufficient distance to cross field borders and roadsides, thus leading to new area infested.

GENETICS OF GLYPHOSATE RESISTANCE IN A MISSOURI WATERHEMP POPULATION.
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A common waterhemp population from Missouri was confirmed to be resistant to glyphosate when compared with susceptible populations from Illinois. Resistant (R) individuals from this Missouri population were then crossed with susceptible (S) individuals (R x S and S x R) to produce F_1 lines. The F_1 lines were screened for resistance to glyphosate, and they appeared to demonstrate an intermediate level of resistance (I) relative to the parents with no dependence on the direction of the cross. Thus, resistance appears to be a nuclear inherited, incompletely dominant trait. One of the more uniform F_1 lines was selected to create F_2 plants (F_1 x F_1) as well as backcrosses to susceptible individuals (F_1 x S and S x F_1). The progeny were then screened for resistance in an attempt to determine the number of genes responsible for conferring resistance by analyzing segregation ratios of the R, S, and I phenotypes.

In addition to these experiments, a crossing scheme utilizing vegetatively cloned plants was designed to rapidly obtain a homozygous R line from the Missouri population. Plants were screened for resistance with glyphosate, and 15 R individuals were selected for cloning. Cuttings were taken from these R individuals and were grown for several weeks until flowering began, at which time female plants could be identified. Eight of the cloned females were used in five different crosses (four with resistant Missouri males, and one with a sensitive male), with a clone from each of the eight females being used in each cross. Each of these crosses also contained at least one S female. Next, the progeny of these crosses were screened in order to determine which of the Missouri parents were homozygous for resistance. To find homozygous R males, progeny from the S x R crosses were examined for uniformity, and one homozygous R Missouri male was identified. To find homozygous R females, progeny from the R x S crosses were screened for uniformity, and two of the Missouri females appeared to be homozygous. In this way, two putative homozygous resistant lines were obtained (the two homozygous R females crossed with the one homozygous R male) and can be used in future experiments to determine the physiological and molecular basis of glyphosate resistance.

SEED ECOLOGY AND BIOMASS PRODUCTION OF POISON HEMLOCK. Carl A. Woodard and Reid J. Smeda, Graduate Research Assistant and Associate Professor, Division of Plant Sciences University of Missouri. Columbia, MO. 65211.

Poison hemlock (*Conium maculatum* L.) is an invasive, biennial weed that is native to Europe. Considered noxious in eight states, poison hemlock has been recognized as a newer problem weed in pastures and roadside right-of-ways. Seed production and seed dormancy data are limited, with the most documented aspect of poison hemlock concerning its toxicity. The objectives of this research were: 1) to determine the amount of poison hemlock seed produced by plants; 2) identify if seed dormancy limits the establishment time for seedlings; and 3) estimate the amount of above ground biomass plants produce during early spring. Seed production studies included 3 locations in central Missouri in 2006 and 2007. Sixteen fully mature plants were harvested from each location, 6-July-2006 and 6-July-2007, and categorized into 4 height ranges (1.2 to 3.4 m) with 4 plants per range. Seed was collected from the plants and quantified. Poison hemlock was capable of producing between 1,700 and 39,000 seeds per plant. Plants from 2006 yielded dramatically more seed than plants from 2007, likely the result of extremely low nightly temperatures during early-April. Taller plants produced the greatest amount of seed for all 6 site years. Seed for the dormancy study was collected from senescing plants at 2 locations 6-July-2007 and stored in nylon mesh bags and placed on the ground at the respective locations. At 0, 18, 36, 54 and 72 days after collection, seed germination was estimated in a growth chamber (14 hour day period; constant temperature of 24 C). Freshly mature seed germinated, indicating a lack of dormancy. Percent germination of seeds collected 72 days after maturity increased 60 to 85% compared to seeds collected 0 days after. Percent germination was greatest for seed collected 72 days after senescing (approximately 46%). Plant biomass studies consisted of 2 locations, with 4 poison hemlock densities (1, 3, 9, and 27 plants per square meter) and 5 harvest dates (15-March, 1-April, 15-April, 1-May, and 15-May). Total plant fresh and dry weights were recorded upon harvest. Plant biomass produced 15-May increased 93 to 98% compared to biomass produced 15-March. At high densities (9 and 27 plants per square meter), poison hemlock produced up to 2,600 Kg ha^{-1} of dry plant material, while lower densities (1 and 3 plants per square meter) produced up to 1,900 Kg ha^{-1} of dry plant material. The amount of dry matter produced in given area is important when considering poisoning of livestock. Poison hemlock is prolific in both seed and biomass production. Seed readily germinates at maturity enabling seedlings to become established in new areas.

FIRST INDICATION OF ADAPTIVE EVOLUTION IN NORTH AMERICAN MICROBES AS A RESULT OF GARLIC MUSTARD INVASION. Rachel N. Nodurft, Steven G. Hallett, and Kevin D. Gibson, Graduate Student, Department of Botany and Plant Pathology, Purdue Universty, West Lafayette, IN 47907-2054, and Professors, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907-2054.

Invasive species have the potential to not only alter community composition and ecosystem functions but also to stimulate evolutionary change in the native species with which they interact. Garlic mustard (*Alliaria petiolata*), a biennial herb native to Europe, invades forests and appears to inhibit arbuscular mycorrhizal fungi (AMF) which may inhibit the growth of AMF-dependent forest species. Since garlic mustard has been present in the United States for at least 150 years, we hypothesize that fungal communities in areas long exposed to this weed may have evolved higher levels of resistance to the allelochemicals produced by garlic mustard. Soil samples were collected during the summer of 2006 from sites along a transect of invasion of from New York, where the presence of garlic mustard was first recorded , to more recently invaded sites in Kansas and Missouri. Paired soil samples were taken from directly underneath patches of garlic mustard and from a meter outside each patch. DNA was extracted from the soil samples and processed using PCR with universal fungal primers. PCR products were separated by DGGE and the percent similarity between the fungal communities from within and outside garlic mustard patches measured. Initial results suggest greater similarity in the fungal communities between paired samples from sites with a longer history of garlic mustard duration as opposed to sites fairly naïve to its presence. Thus, in older sites, North American fungi appear to have evolved increased resistance to garlic mustard suppression.

RESPONSE OF SOYBEAN CYST NEMATODE TO WINTER ANNUAL WEED REMOVAL TIMINGS. Valerie A. Mock, J. Earl Creech, William G. Johnson. Graduate Research Assistant, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Assistant Professor, University of Nevada Cooperative Extension, University of Nevada, Fallon, NV, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Winter annual weeds are becoming more problematic due to the reduced reliance of residual herbicides, and the increased adoption of conservation tillage. Six winter annual weeds have been found to be alternate hosts to soybean cyst nematode (*Heterodera glycines* Ichinohe; SCN). The strongest winter annual weed alternative hosts to SCN are purple deadnettle (*Lamium purpureum*), and henbit (*Lamium amplexicaule*). In addition, we have shown that SCN can reproduce on purple deadnettle during the fall after soybeans have been harvested. The objective of this study was to determine if SCN population densities are influenced by winter annual weed removal timings during the fall and early spring when soybean is not present in the field. This experiment had two plant species, SCN-susceptible soybean and *Lamium spp*. The soybeans were present at densities of zero or 108 m^{-2} and the *Lamium spp*. were present at densities of zero or 161 m^{-2}. Four winter weed removal timings were established which included no weed removal, and October, December, or May weed removal. At these removal timings plants samples in 0.19 m^2 area were collected for dry weight determination, and soil samples were collected for SCN egg extraction and enumeration. Examination of *Lamium spp.* dry weight $plant^{-1}$ suggest that within the October timing *Lamium* species reduced the dry weight of soybean, but soybean did not reduce the *Lamium spp.* dry weight. In addition, the longer *Lamium spp*. were in the field in the fall the higher SCN population densities. When eggs counts were compared against the initial August soil sample timing, the only significant weed removal timing was in October, where the treatments with soybean only had the highest SCN population and the plots with no plants had the lowest SCN population density.

COMPETITION OF ANNUAL MORNINGGLORY (*IPOMOEA SPP*.) IN CORN AND SOYBEAN.
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Field research was conducted at Urbana, IL in 2006 and 2007 to determine the competitiveness of *Ipomoea* species in corn and soybean crops. Stage of crop and weed density were significant factors in leaf area and biomass. The two way interactions of weed location on stage of crop, and weed density on crop stage were significant to leaf area and biomass in corn and soybean. The three way interaction of weed location, weed density and stage of crop was also significant to leaf area and biomass in corn and soybean.

Introduction:

Annual morningglory species are becoming a problem in production agriculture in Illinois due to recent weed management strategies. Morningglory has a continuous emergence. This along with increased use of glyphosate as a post emergence treatment alone is a potential reason for morningglory to become a problematic weed. Experiments concerning competition were conducted in Urbana in both corn and soybean test plots.

Materials and Methods:

Fields with high densities of Ipomoea sp. were chosen for the study. Test rows of morningglory were created by using tiling pipe over row crop or between rows during post-emergent broadcast applications of herbicide. Soybean plots were applied with a pre-emergent spray of Dual II Mag (2pt) and a post-emergent Firstrate (0.75oz) and Roundup (0.75#a.e.). Corn plots were applied with a post-emergent spray of Atrazine (2pt) and Roundup (0.75#a.e.). Densities were manually developed at 0, 16, 32 and an excess of 64 plants per square meter. Strips were only six inches, which translates to 0, 3-4, 6-7 and about 12 plants per square meter of strip. Harvest times for morningglory were at V4, R1, R3 and R6 stages of the soybean, and at V5, V6, V9, VT and R6 stages of the corn. Data collection included total leaf area (cm^{-2}) and biomass (g).

THE EFFECT OF VARIABLE WATER SUPPLY ON CORN AND VELVETLEAF.
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Rainfall during the corn growing season is highly variable throughout Nebraska and the north central USA and greatly impacts crop production. Better understanding of the growth response and competitiveness of crop and weed species to varying water supply can improve both crop and weed management decisions. A field experiment was initiated at Clay Center, NE in 2007 to determine the effects of variable water supply on corn and velvetleaf interference. Corn planted at 7.6 plants m^{-2} was grown in monoculture and in mixture with velvetleaf at densities of 2, 6, and 12 plants m^{-1} row. A linear move irrigation system was used to maintain water treatments at 0, 25, 50, and 100% full replacement of predicted evapotranspiration (ET). Volumetric water content was measured in selected treatments within the top 20 and 50 cm of soil using time-domain reflectometry (TDR). Weed-free corn yield was greatest (11.0 Mg ha^{-1}) in the 100% ET replacement treatment but did not differ between the 0, 25 and 50% ET replacement treatments (8.6 Mg ha^{-1}). Corn yield loss in velvetleaf mixture treatments increased with velvetleaf density in all treatments. Corn yield loss as weed density approaches zero was greatest (50 $plant^{-1}$) in the 25 and 50% ET replacement and smallest (5 $plant^{-1}$) in the 100% ET replacement treatments. Yield loss in the 0% replacement treatment was intermediate between the 100 and 25% replacement treatments. Volumetric soil water content was smallest in the 0% ET replacement treatment between emergence and the V7 stage of corn development (ca. 25 DAE) and may have reduced velvetleaf growth during this period. A substantial drought period occurred between 30 and 50 DAE, during which the 25 and 50% ET replacement treatments had the smallest volumetric water content. We believe that the smaller plants in the 0% ET treatment during early growth were not able to reduce the soil water content to the same level as the larger 25 and 50% ET plants during the later drought period. This resulted in reduced interspecific competition for water, contributing to lower yield losses at 0% ET replacement compared to the 25 and 50% levels. Number of velvetleaf seed capsules produced per unit area increased with increasing velvetleaf density in all water treatments. Greatest capsule production (ca. 130 capsules m^{-2}) occurred at 12 plants m^{-1} row in the 0% ET replacement and smallest at 2 plants m^{-1} row in the 100% ET replacement treatment. Corn yield loss and velvetleaf capsule production were lowest in the 100% ET replacement treatment, indicating that velvetleaf is less competitive under ample water supply conditions. Our results suggest that crop tolerance to velvetleaf interference is greatest when there is sufficient soil water available to supply the full ET demand of the corn crop.

RELATIONSHIPS AMONG SWEET CORN CANOPY TRAITS AND COMPETITIVE ABILITY. Yim F. So* (1), Martin M. Williams II (2), Jerald. K. Pataky (1), and Adam Davis (2), Univ. of Illinois, Urbana, IL 61801 (1), Invasive Weed Management Unit, USDA-ARS, Urbana, IL 61801. (2).

Sweet corn canopy development influences crop competitive ability, as measured by the crop's ability to maintain yield in the presence of weeds (crop tolerance - CT) and the crop's ability to reduce weed growth and fitness (weed suppressive ability - WSA). A quantitative understanding of relationships among phenomorphological traits and competitive ability could lead to improvements in weed management in sweet corn. Twenty three commercially available sweet corn hybrids from nine seed companies were grown in the presence and absence of wild proso millet in Urbana, Illinois in 2006 and 2007. Seventeen weed-free crop traits were measured from emergence to maturity, and CT and WSA of each hybrid was determined relative to competitor-free controls. Hybrids were chosen based on *a priori* qualitative observations of variation in canopy architecture and stress tolerance. Hybrids differed for all traits, including: seedling vigor , chlorophyll content , leaf angle (upright to horizontal), height (122 to 252 cm), leaf area index (LAI, 2.0 to 6.7, intercepted light (PAR, 42 to 98%), shoot biomass (34 to 247 g per plant), per plant leaf area (1,050 to 11,000 cm^2 per plant), thermal time to silking (503 to 721 growing degree days, GDD) and maturity (760 to 941 GDD). A principal component factor analysis revealed that seven of the seventeen weed-free crop traits measured near or after anthesis loaded highly (0.62 to 0.91) into the first factor, including height, shoot biomass, per plant leaf area LAI, and intercepted PAR, as well as thermal time to silking and maturity. All seven factors were highly correlated (0.42 to 0.90) and were interpreted as a 'late canopy and maturity' factor. Five of the seventeen traits formed two additional principal factors that were a 'seedling vigor' factor and an 'early canopy' factor. Relationships between principal factors and competitive abilities were analyzed by least-square linear regression. The 'late canopy and maturity' factor was significant for all measures of CT. Both the 'seedling vigor' factor and the 'early canopy' factor related to WSA. Based on these results, we conclude that crop traits that are associated with early canopy development relate consistently to WSA, while traits associated with late-season canopy development and morphology are most relevant to measures of CT.

INFLUENCE OF SELECTED HERBICIDE TREATMENTS ON TALL GOLDENROD CONTROL, TOTAL FORAGE YIELD, AND TOTAL FORAGE QUALITY IN TALL FESCUE PASTURES.
Kristin K. Payne*, Travis R. Legleiter, Jimmy D. Wait, Kevin W. Bradley, University of Missouri, Columbia, MO 65211.

Field experiments were conducted in 2006 and 2007 to evaluate the effect of various herbicides and herbicide combinations on tall goldenrod (*Solidago altissima* L.) control, total forage yield, and total forage quality in mixed tall fescue (*Festuca arundinacea* Schreb.) and legume pastures in Missouri. In separate experiments, aminopyralid, aminopyralid plus 2,4-D, aminopyralid plus metsulfuron-methyl, aminopyralid plus metsulfuron-methyl plus 2,4-D, metsulfuron-methyl, metsulfuron-methyl plus dicamba plus 2,4-D, and 2,4-D plus picloram were applied at various rates to goldenrod that was 26 to 28 cm in height on May 4, 2006 and May 11, 2007. In both years, aminopyralid and aminopyralid plus 2,4-D provided lower within-season tall goldenrod control compared to the remaining herbicide treatments. One year after treatment (YAT), all herbicides and herbicide combinations except aminopyralid provided 71 to 98% tall goldenrod stem reduction. Applications of aminopyralid alone provided virtually no tall goldenrod stem reduction 1 YAT when compared to the untreated control. In both years, total forage yield was higher in untreated compared to herbicide-treated plots for the first forage harvest conducted in June and few differences in acid detergent fiber (ADF), neutral detergent fiber (NDF), or crude protein (CP) content were observed between forage harvested from herbicide-treated and untreated plots. However, 1 YAT forage harvested from untreated plots was lower in ADF and NDF content and higher in CP content than herbicide-treated plots, which may be partially explained by the presence of red clover (*Trifolium repens* L.) in untreated compared to herbicide-treated plots 1 YAT. Analyses of pure samples of tall fescue and tall goldenrod collected at each harvest revealed that CP content of tall fescue and tall goldenrod was similar, but that ADF and NDF content was lower in tall goldenrod than tall fescue. Results from these experiments indicate that goldenrod infestations may not necessarily reduce the quality or quantity of total forage harvested from tall fescue and legume pastures, but that additional research is needed to investigate the palatability and/or intake of cattle grazing or fed tall goldenrod, as this species continues to be a common weed of pastures and hay fields in Missouri.

BIOLOGY, ECOLOGY AND MANAGEMENT OF INVASIVE WEEDS IN MISSOURI. Kevin W. Bradley and Reid J. Smeda, University of Missouri, Columbia, MO.

Currently, some of the most common invasive species encountered in Missouri pastures, hay fields, roadsides, and other non-crop environments are common teasel (*Dipsacus fullonum* L.), cut-leaf teasel (*Dipsacus laciniatus* L.), johnsongrass [*Sorghum halepense* (L.) Pers.], musk thistle (*Carduus nutans* L.), sericea lespedeza [*Lespedeza cuneata* (Dumont) G. Don], spotted knapweed (*Centaurea biebersteinii* DC.) and bush-type blackberry species like Himalaya blackberry (*Rubus armeniacus* Focke). Of these species, only johnsongrass, musk thistle, and common and cut-leaf teasel are officially listed as noxious weeds in Missouri; the list also includes Canada thistle, field bindweed, kudzu, marijuana, multiflora rose, purple loosestrife, and scotch thistle. Although some of these species have been present in Missouri for decades, cut-leaf teasel, sericea lespedeza, and spotted knapweed appear to have spread the most in recent years and have been the focus of several field experiments in Missouri.

Research conducted on the management of Sericea lespedeza in Missouri has revealed that herbicides containing metsulfuron or triclopyr will provide the most effective control of this species, while aminopyralid or picloram are some of the more effective herbicides for the control of spotted knapweed. Research conducted on the biology of cut-leaf teasel has also demonstrated that peak emergence of seedlings is April and October and that seedling growth begins in early March and continues through October. Each biennial plant produces from 4,000 to 17,000 seeds, and seed viability remains at 10 to 15% up to 3 years after dispersal. Mowing is a common technique intended for suppression of cut-leaf teasel growth or improving aesthetics along roadsides. However, because mature cut-leaf teasel seed are produced in as few as 10 days from the initiation of flowering, mowing serves as a means of spreading infestations. There are a number of herbicides effective for control of cut-leaf teasel including ALS inhibitors such as metsulfuron-methyl and imazapyr, glyphosate, and growth regulators such as dicamba, 2,4-D, triclopyr, picloram, and clopyralid. This presentation will provide a brief overview of characteristics that typify successful invasive weeds, control strategies for various invasive weeds in Missouri, and the outlook for re-establishing desirable native species. The use of remote sensing as a means of locating populations and assessing control techniques will also be discussed.

INVASIVE SPECIES AND THE MISSOURI DEPARTMENT OF CONSERVATION. Lia Bollmann, Wildlife Biologist, Missouri Department of Conservation, St. Charles, MO. 63304

The Missouri Department of Conservation is responsible for the management of approximately 890,000 acres on nearly 1,000 conservation areas across the state. Due to past land use, varying degrees of natural integrity remain within the habitats and natural communities found on these conservation areas. The introduction and spread of exotic plant species is one factor which continues to negatively impact the quality of our natural habitats and poses a serious threat to the sustainability of healthy and viable wildlife populations. There are approximately 850 naturalized exotic plant species in Missouri. Deciding which habitats are most worthy of protection and/or restoration is a challenging and on-going process. This presentation will examine some of the most serious invaders of Missouri's natural communities and the factors which guide invasive species management on Department lands.

MANAGEMENT OF INVASIVE PLANTS AND ALGAE IN AQUATIC SYSTEMS. Carole A. Lembi, Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Aquatic habitats range from shallow wetland sites to deep water. Native aquatic plants and algae play essential roles in these habitats by providing oxygen, food, and shelter for consumer organisms. One of the first invasive plant species studied in the United States was water hyacinth, which appeared as a major problem in waterways in the southeast in the early 1900s. In the past 20 years, the introduction and spread of invasive plants and algae seems to have accelerated, with potentially negative consequences for aquatic food chains. Species that have invaded Midwestern wetland sites, such as purple loosestrife (*Lythrum salicaria*) and Phragmites (*Phragmites australis*), are managed in much the same way as invasives of terrestrial wildlands. Mechanical and physical methods can be used if soil conditions permit. Chemical treatments with glyphosate and imazapyr are usually effective, but follow up treatments are frequently needed because of seed germination in the case of purple loosestrife. Biological control agents have also been released for purple loosestrife. Native plant communities can be restored by seeding or transplanting, and a growing number of environmental companies are now providing the plant materials, labor, and expertise to do this.

In-water problems require a different set of strategies. In this talk I will report on the movement northward of two invasive species within the past few years. One is a toxic alga, *Cylindrospermopsis raciborskii*. The second is the submersed (underwater) flowering plant *Hydrilla verticillata*. Hydrilla was first reported in Indiana in August 2006 and was again found in Wisconsin in 2007. Of all the aquatic plant species, it has the greatest potential to seriously damage aquatic resources and habitats in the Midwest. Known as the “perfect weed”, it propagates by tubers, rhizomes, stolons, fragmentation, turions, and possibly seeds (in the case of the monoecious strain). Instant response on the part of state agencies is absolutely essential to eliminate initial infestations and stop the spread of this plant. The best approach at the current time is to use whole lake treatments of fluridone, which can selectively remove hydrilla from native plant communities. This approach, which is very expensive, must be repeated for at least 3-5 years in order to kill germinating tubers and turions. Intensive, follow-up surveys must be conducted to insure that no new plants have regenerated. Because of the selectivity, replanting of natives is not required. In fact, restoration of deep water sites in general is left to nature because of the difficulties of planting, monitoring, and managing plants that are difficult to see and access because they lie underwater.

INTEGRATING RESTORATION TECHNIQUES WITH MANAGEMENT METHODS FOR INVASIVE WEEDS. Mark J. Renz, Assistant Professor University of Wisconsin, Madison, WI 53715.

Invasive weeds impact natural areas in multiple ways that can dramatically affect the plant and animal communities. Typically management is recommended when the goals of the land being managed oppose how these invasive plants impact the habitat. While land managers employ a wide range of management methods, often restoration and weed management methods are not integrated. As a result either some initial management is or is not conducted followed by planting of a wide range of desirable plant species. After plantings, desirable plants are either slow or fail to establish due to competition with invasive weeds. Careful consideration of the life history and biology of the weed species and desirable plants are required to successfully integrate weed control with restoration techniques as management of invasive weeds often need to be repeated for multiple years to eradicate populations. By planting plant species that can tolerate management methods to be employed, land managers can initiate revegetation with desirable species while managing invasive plants. When weed populations have been reduced to low enough levels, additional plant species can be planted to obtain the desired plant community. While restoration of natural lands often take many years, the integration of weed management methods with revegetation can reduce the time-span for establishment of desirable and diverse plant communities.

MANAGING VEGETATION FOR WHITE-TAILED DEER HABITAT: PERSPECTIVES FROM THE QUALITY DEER MANAGEMENT ASSOCIATION. Kip P. Adams, Certified Wildlife Biologist and Northern Director of Education and Outreach, Quality Deer Management Association, Knoxville, PA 16928.

The Quality Deer Management Association (QDMA) is an international nonprofit wildlife conservation organization specializing in education. The QDMA helps hunters, landowners and land managers across North America improve their wildlife habitats, white-tailed deer herds and hunting opportunities. Habitat management is a cornerstone of quality deer management and is necessary for healthy deer populations. Proper habitat management provides adequate forage, nutrition and cover for deer in all age classes, and can be divided into forest, old field and food plot management. Wise forest management provides year around food and cover and includes a diversity of age classes interspersed across the landscape. Old field management provides seasonal food and cover and is used to complement a forest management program. A proper food plot program supplements natural vegetation and provides additional forage and high-quality nutrition for deer and other wildlife species. Some food plot species also provide cover. A well-planned habitat management program provides healthy habitats, productive wildlife species and great recreational opportunities.

MANAGING VEGETATION FOR WILD TURKEY, PERSPECTIVES FROM THE NATIONAL WILD TURKEY FEDERATION. Loran Brinkmeier, Biologist, National Wild Turkey Federation, Wyoming, IL 61491

The National Wild Turkey Federation has been a leader in the restoration and relocation of wild turkeys in North America for over a quarter century. With trapping and transferring of wild turkeys coming to a close, the NWTF has refocused its mission to conserve the wild turkey and the hunting heritage. To conserve wild turkeys, you must conserve the wild turkey's habitat. One NWTF program that was created to increase and improve wild turkey habitat is the Energy for Wildlife Program. The Energy for Wildlife program is a membership based wildlife management and certification program for energy companies. The primary goal of the program is to enhance wildlife habitat on right of ways and other company properties for the benefit of all wildlife. The program assists member companies in achieving their vegetation management goals for the benefit of native plants and both game and non-game wildlife. The program also assists companies with permitting and regulatory processes, public relations, and serves as a liaison with federal and state agencies.

The Energy for Wildlife promotes Integrated Vegetation Management (IVM) on right of ways and other properties. IVM is the controlling of vegetation by using a process that balances the use of cultural, biological, and chemical treatments to establish and maintain a vegetative cover type that is compatible with the environment, economically feasible, and socially acceptable.

The wild turkey in North America is thriving and direct funding to support wild turkey habitat projects is limited. Therefore, wildlife habitat projects for wild turkeys must be tailored to other wildlife species that have direct funding. Wild turkeys are generalists and almost any habitat enhancement from wetlands to grasslands will benefit the wild turkey. 21st century wild turkey habitat projects include wetland restoration, grassland restoration and enhancement, timber stand improvement and timber harvesting, timber edge feathering, and both annual and perennial food plots. All of these practices use mechanical, cultural, and chemical treatments to achieve desired results. These projects can only exist with partnerships between non-profit conservation organizations, corporations, and local, state, and federal agencies.

MANAGING VEGETATION FOR QUAIL AND UPLAND BIRDS, PERSPECTIVE FROM QUAIL UNLIMITED. Jef Hodges, Wildlife Habitat Consultant, Clinton, MO 64735.

Northern bobwhite and upland bird habitat is generally characterized as diverse herbaceous cover dominated by grasses and interspersed bare ground with low growing shrubby cover adjacent. Current threats to quail and upland bird habitat are succession, monocultures, invasive species, loss and fragmentation. Management requires techniques that maintain or create the general habitat requirements. Mechanical and chemical methods as well as cultural practices and political policy are necessary to preserve and produce appropriate habitat.

UTILITY OF HERBICIDE AND APPLICATION TECHNOLOGIES IN WILDLIFE HABITAT IMPROVEMENT PROGRAMS. Daniel D. Beran, Market Development Specialist, BASF, Des Moines, IA 50310, Byron B. Sleugh, Product Technology Specialist, Dow AgroSciences, Des Moines, IA 50266, Jack J. LeClair, Range and Pasture Specialist, DuPont, Wilmington, DE 19898, and Robert A. Masters, Product Development Leader, Dow AgroSciences, Indianapolis, IN 46268.

Invasive plants degrade wildlife habitat quality. Managing invasive plants requires use of integrated programs that favor desirable species and wanted changes in plant community structure. Reasons for the arrival, establishment, and spread of invasive plants should be understood before effective wildlife habitat improvement strategies are developed. Removing invasive plant species without attention to plant community dynamics often only opens niches for other undesirable species to occupy. The integrated weed management paradigm provides a context for managing invasive plants in a sustainable manner that leads to improved wildlife habitat quality. Prevention, detection, and control are key components of integrated management strategies. The suitability of weed control tools (biological, chemical, mechanical, and cultural) will vary according to the invasive plant and invaded site characteristics. The merits of each control measure when applied in appropriate sequences and combinations should be considered when developing habitat restoration programs. Herbicides can serve as catalysts to expedite vegetation change, which leads to improved wildlife habitat quality. The variety of herbicides currently available, with different modes of action and selectivity, and readily available precise and accurate application technologies provide restoration specialists with many options to selectively alter plant composition, manage plant community succession, and accelerate wildlife habitat quality improvement.

SEED-MEDIATED GENE FLOW IN CANOLA. Linda M. Hall, Robert H. Gulden and Hugh J. Beckie, Research Scientist/Adjunct Professor, Alberta Agriculture and Food, University of Alberta, Edmonton, AB, T6G 2P5; Assistant Professor, Department of Plant Science, University of Manitoba, Winnipeg, MB, R3T 2N2; and Research Scientist, Agriculture and Agri-Food Canada, Saskatoon, SK, S7N 0X2.

Canola or oilseed rape (*Brassica napus* L.) is a relatively newly domesticated oilseed crop grown in Canada and in temperate regions around the world. Canola resistant to glyphosate, glufosinate or imidazolinone (IM) herbicides was introduced in Canada in 1996 and has been widely adopted, occupying 45, 42 and 10% of canola acres, respectively. Herbicide-resistant canola is planted on 97% of acres but seed sources are not necessarily pure. In a study of admixture in certified canola seed, the permitted threshold of 0.25% was frequently exceeded. Harvest loss in canola due to pod shatter prior to and during harvest averaged 5.9% of the seed yield, or approximately 3,000 viable seeds m^{-2}, however, harvest losses ranged from 9 to 56 times the normal seeding rate of canola. Canola can develop secondary seed dormancy that varies with genotype, and is induced most effectively by low water potential in combination with warm temperatures. Fall tillage promotes the persistence of high dormancy genotypes. While the majority of canola volunteers are recruited in the year following dispersal, seed banks can persist for 3 to 4 years. Seed bank deletion occurs by predation, pathogenesis and desiccation, in addition to germination in spring and fall. High densities of seed can germinate pre-seeding and within a crop. Canola can be a competitive weed within cropping systems, and weed surveys have ranked it as the 14th most abundant weed in the 2000's, occurring in 11% of fields surveyed. Volunteer control options exist for all herbicide-resistant biotypes. However, with naive herbicide rotations, resistant canola can be difficult to control - for example if glyphosate is used alone pre-seeding on glyphosate-resistant canola, or if ALS inhibitors are used alone in-crop to control IM resistant canola. Seed losses along transport corridors have led to feral herbicide-resistant populations along roadsides and rail lines in Canada and Japan. These populations may persist and spread, and contribute to gene flow. Seed-mediated gene flow is a significant temporal and spatial factor in the spread of herbicide-resistant genes locally and internationally.

POLLEN-MEDIATED GENE FLOW IN CANOLA. Hugh J. Beckie and Linda M. Hall, Plant Scientist, Agriculture and Agri-Food Canada, Saskatoon, SK S7N 0X2 and Research Scientist/Adjunct Professor, Alberta Agriculture and Food, University of Alberta, Edmonton, AB T6G 2P5.

Outcrossing in canola or oilseed rape (*Brassica napus* L.) is highly variable, averaging 30%. The crop is partially pollinated by insects, particularly honey bees and bumble bees, but is also known to release large amounts of air-borne pollen. There is consensus that insects can be important contributors to short-distance pollination; in addition, bees and other insects such as pollen beetles can also contribute to long-distance pollen movement. However, the relative importance of wind vs. insects in long-distance gene flow in canola is uncertain. Coexistence among transgenic and non-transgenic cropping systems and identity preservation at the field level are increasingly important issues in many countries. Different types of pollen-mediated transgene flow models for canola have been released during the past decade primarily as a decision-support tool to achieve the European Union (EU) 0.9% transgenic labeling threshold for adventitious presence (AP) of authorized transgenes in food and feed. Many empirical models simulate gene flow well, although their utility is usually restricted by datasets with limited environmental variability or spatial scale. Development of predictive mechanistic models and simulation of transgene flow via insects and wind across agroecosystem landscapes are still in their infancy, although recent progress is promising. Experimental and modeling outcrossing studies reveal that no isolation distance is required between transgenic pollen donor and non-transgenic (conventional) receptor fields of realistic size to meet the EU threshold if AP from other sources (e.g., volunteers, admixture) is minimal. Because seed loss and volunteerism are common in canola, however, transgene flow via seed, not pollen, may be a greater source of AP.

INTER-SPECIFIC GENE FLOW IN CANOLA. Suzanne I. Warwick, Research Scientist, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON K1A OC6.

Canola (*Brassica napus*) is capable of genetic exchange with related *Brassica* crop species as well as with several wild relatives. The large-scale use of herbicide-resistant (HR) canola has allowed us to examine inter-specific gene flow on realistic field scales. The HR trait is easy to monitor, provides accurate assessments, and is highly suited for extensive screening programs. Recent studies documenting gene flow distances of up to 200m between HR canola fields and Polish canola (*Brassica rapa*) and oriental mustard *(Brassica juncea*) fields will be presented. *Brassica napus* can potentially hybridize with four related weedy species in Canada and the United States (bird rape, *Brassica rapa*; wild radish, *Raphanus raphanistrum*; dog mustard, *Erucastrum gallicum*, and wild mustard *Sinapis arvensis*). Interspecific gene flow results with these four species will be reviewed, and will include the first report of the persistence and apparent introgression of an HR transgene from canola into the gene pool of *B. rapa*, monitored under natural commercial field conditions. Subsequent studies in eastern Canada confirm that hybridization is frequent throughout the sympatric ranges of these two species. Additional canola-quality *Brassica* crops (*B. juncea*, *B. carinata*) are under development, and interspecific gene flow concerns for these species will be reviewed and recent data from *Sinapis arvensis* x *B. juncea* hybridization studies presented. Consequences of hybridization and introgression are dependent on the traits that are introduced and their effect on hybrid fitness. The results from recent fitness trials for herbicide resistant (HR) and insect resistant Bt weed-crop hybrids (*B. rapa* x *B. napus*), suggest a cost to hybridization, independent of the transgenic trait. Future research needs will be outlined including a need for empirical data on: ecological effects of fitness-enhancing traits such as stress-tolerances, the consequences of transgene spread to non-agricultural habitats (now largely undocumented), and what specific environmental risks transgenic hybrid weed populations pose under field conditions.

IMPACT OF DISTINCT INSECT POLLINATORS ON GENE FLOW. Johanne Brunet and Karsten G. Holmquist, research ecologist and postdoctoral associate, United States Department of Agriculture, Agricultural Research System, Vegetable Crops Research Unit, University of Wisconsin, Madison, WI 53706.

The vast majority of fruits and vegetables, together with some hay crops (alfalfa) and some oil-producing crops (canola) are pollinated by insects. However we have little information on how insect pollinators affect the movement of genes via pollen and even less on how distinct insect pollinators may differentially affect pollen flow. In this study we examined whether two types of insect pollinators, bumble bees and hawkmoths, differentially affected gene flow via pollen in the rocky mountain columbine, our model system. In one experiment, we used paternity analyses to contrast the movement of genes via pollen by bumble bees and hawkmoths within and between patches within a population. In a second experiment, we genotyped seeds from many target females located within a 40 km^2 area, and used the Kindist module of Poldisp v.1.0 to fit the exponential power model to the haplotype data in order to calculate the average distance, axial variance and kurtosis of pollen dispersal for each pollination treatment. Both pollinator types were as efficient at moving pollen around (male function). In addition both pollinator types visited the same number of females and each female received similar progeny diversity whether pollen was carried by hawkmoths or by bumble bees. Moreover bumble bees did not limit their movement to nearest neighbor plants but frequently moved pollen among patches. On a larger geographical scale, dusk and night flying pollinators (hawkmoths) moved pollen 2-5 X as far as day flying pollinators (bumble bees). Pollen dispersal was fat tailed with relatively high kurtosis indicating the importance of long distance gene dispersal.

ECOLOGICAL EFFECTS OF VIRUS-RESISTANT TRANSGENIC SQUASH ON WILD SQUASH POPULATION DYNAMICS. Holly R. Prendeville*, Graduate student, and Diana Pilson, Associate Professor, University of Nebraska, 348 Manter Hall Lincoln, NE 68588-0118.

Several genetic and environmental factors can influence the degree of assortative mating in natural plant populations. In many, perhaps most, natural plant populations assortative mating occurs because plants do not have identical flowering schedules. When only one phenotype is in bloom, mating is necessarily assortative, leading to increased genetic variance for flowering phenology. This is important because increased genetic variance allows a trait to be more responsive to natural selection. Thus, fixation of a trait favored by selection will be faster when a population mates assortatively. For example, if the presence of a transgene in a wild population leads to assortative mating, then the transgene will introgress into that population more rapidly than expected. In a common garden experiment healthy and virus-infected squash had different flowering phenologies. These differences in flowering phenology will lead to assortative mating among virus susceptible and virus resistant plants. In another set of common garden experiments we found that bumbles bees spent more time in flowers on virus infected plants, while squash bees spent more time in flowers on healthy plants. These data suggest that if a transgene for virus resistance were present in a wild population it could lead to assortative mating, and thus increase in frequency more rapidly than anticipated. In contrast to differences in flowering phenology and pollinator preference, which cause assortative mating, temporal variation in sex ratios results in disassortative mating. Thus, different flowering phenologies and pollinator preferences will lead to assortative mating and increased genetic variance, while temporal variation in sex ratios will lead to disassortative mating and reduced genetic variance. Interactions between these processes and their effect on character evolution (e.g. transgenic virus-resistance) are under investigation.

LONG-TERM FIELD STUDIES OF THE EVOLUTION OF CROP-WEED HYBRIDS IN RADISH: IMPLICATIONS FOR INVASIVENESS. Allison A. Snow, Lesley G. Campbell, Theresa M. Culley, and Caroline E. Ridley, Professor, Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, OH 43210, Postdoctoral Associate, Departments of Plant Science, Landscape Architecture, and Entomology, University of Maryland, College Park, MD 20742, Assistant Professor, Department of Biological Sciences, University of Cincinnati, Cincinnati, OH 45221, and Graduate Student, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Many cultivated plants hybridize naturally with wild and weedy relatives, but little is known about the evolutionary effects of this process on recipient populations. To examine the dynamics of introgression in a natural setting, we monitored crop-specific genetic markers in replicated field populations of weedy *Raphanus raphanistrum* in Michigan, USA, for ten years. Four isolated hybrid populations were established in 1996 using a 1:1 ratio of *R. raphanistrum* and F_1 crop-wild hybrids (*R. raphanistrum* x *R. sativus*). The sites were tilled and fertilized annually to mimic agricultural fields, and plants were exposed to local biotic and abiotic selective pressures. Initially, F_1 hybrids had reduced fitness relative to wild genotypes, but the populations quickly regained wild-type pollen fertility, presumably by losing a crop-specific reciprocal translocation. Recombination and natural selection allowed the populations to absorb two crop-specific allozyme markers at relatively high frequencies in all populations, even exceeding their initial frequency of 0.25 in a few cases. Frequencies of a crop-specific white petal color allele were much lower, but this allele also persisted in all populations. Overall, frequencies of the three crop-specific alleles varied considerably among locations, years, and loci. In the tenth year, plants from each hybrid population were grown in a common garden experiment along with wild genotypes. The lifetime fecundity of these advanced-generation hybrids was similar to that of the wild genotypes. This long-term study provides a unique example of how easily certain crop alleles can become established in weed populations while others remain rare or disappear.

In a second study, we tested the hypothesis that crop-wild hybridization can allow weeds to be more successful. A third study was carried out simultaneously to determine whether cultivated radish could generate feral populations. We established replicated populations of wild, hybrid, and “volunteer” cultivated radishes in Michigan and let them evolve for three growing seasons, starting in 2002. Three of the five volunteer populations died out. The two remaining populations became contaminated with wild genes and evolved traits that were similar to crop-wild hybrids (Campbell and Snow, in prep.). Although we did not find evidence for ferality in the absence of hybridization with *R. raphanistrum*, further studies involving more populations and locations might detect ferality. Results from the wild and hybrid populations were reported in Campbell et al. (2006) and are summarized briefly here. The initial frequency of crop alleles in these hybrid populations was 0.50 (twice the level in our introgression study above) because all plants were F_1 hybrids. Frequencies of white-flowered plants declined slightly, unlike our previous study, and then remained relatively constant. We suspect that the sharp drop in white-flowered plants in our earlier study was due to the fact that many hybrid plants flowered very late or not at all, and the white petal allele is linked to delayed reproduction [Campbell, 2007]. In 2005, advanced-generation hybrid and wild seedlings were grown in common garden experiments in Michigan and California. Hybrid-derived plants had slightly lower fecundity than wild plants in Michigan, but exhibited ~270% greater lifetime fecundity and ~22% greater survival than wild plants in California. These results support that hypothesis that crop-wild hybridization may create genotypes with the potential to displace parental taxa in new environments, which is consistent with other studies of hybrid-derived wild radish populations in California (C. E. Ridley et al., in prep.). In summary, our combined field studies of evolving crop-wild hybrids show that conventional crop alleles can persist in wild populations and may increase the fitness of wild relatives in some cases. Further research is needed to confirm the common assumption that enhanced fitness results in more abundant weed populations.

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WEED-TO-WEED GENE FLOW – WHAT IS THE POTENTIAL FOR GLYHPOSATE RESISTANCE MOVEMENT VIA INTERSPECIFIC HBRIDIZATION? Micheal D.K. Owen and Ian A. Zelaya, Professor, Agronomy Department, Iowa State University, Ames, IA 50011-1011 and Project Team Leader, Syngenta Ltd., Weed Control Research, Jealott's Hill International Research Centre, Bracknell, Berkshire RG42 6EY, United Kingdom

When evaluating herbicide resistance and the potential for herbicide resistance dissemination within agroecosystems, most studies focus on weed seed production, viability and dispersal, the species mating system, and the genetics associated with the resistance trait. However, far less attention has been centered on the potential for herbicide resistance spread though interspecific hybridization (introgression). For that matter, the ability of weeds to hybridize with near relatives has not been well-studied or documented in agro-ecosystems, however some data exists for Amaranthaceae. While some studies describe gene flow and successful transmission of herbicide resistance alleles from cultivated crop species to their weedy relatives, little data exists regarding the between weed species gene flow. Part of the problem describing weed hybridization is recognition of the hybrids in the field; this is particularly challenging since hybrids in most cases resemble (phenotipically) the parents.

Herbicide resistance potentially represents an effective marker to document hybridization between weed species. This study assessed the introgression of herbicide resistant alleles in the important genii *Ambrosia*, *Conyza* and *Helianthus*, considering the importance of Asteraceae weeds in current agroecosystems. The study used the cross resistant triazolopyrimidine, sulfonanilide and sulfonylurea (SU) giant ragweed (*A. trifida* L.; $2n$ = 24) and imidazolinone and SU common sunflower (*H. annuus* L.; $2n$ = 34) populations from Iowa, in addition to a glyphosate resistant horseweed (*C. canadensis* L. Cronq.; $2n$ = 18) population from Delaware. The herbicide susceptible common ragweed (*A. artemisiifolia* L.; $2n$ = 36), Jerusalem artichoke (*H. tuberous* L.; $2n$ =102), and dwarf fleabane (*C. ramosissima* Cronq.; $2n$ = 18) populations originated from Iowa. In all three genii evaluated, herbicide resistance was expressed as a nuclear allele, partially dominant (*Ambrosia* and *Helianthus*) or over dominant (*Conyza*) trait in first filial interspecific hybrid generation (F_1^H). Herbicide resistance transfer frequency in the F_1^H ranged from 40 to 60%, 0 to 9%, and 30 to 50% in *Ambrosia*, *Conyza*, and *Helianthus*, respectively.

Inheritance of herbicide resistance in the selfed F_1^H generation (F_2^H) followed the mono-factorial model in all evaluated genii; F_1^H backcrosses confirmed successful introgression of the herbicide resistance allele to parents. Thus, interspecific hybridization is possible and may be a potentially important avenue for the dissemination of herbicide resistance, specifically glyphosate resistance, and the promotion of genetic diversity within compatible weed species.

The occurrence of glyphosate resistant hybrid weeds may complicate the containment of glyphosate resistance in current crop production systems. However, it has yet to be determined if interspecific hybridization of weed species is frequent and pervasive within the agro-ecosystems. If the occurrence of weed hybridization is relatively frequent, important ecological studies should be conducted to determine if the weedy hybrids are well-adapted to current crop production systems and thus may evolve into economically important weed problems. The movement of glyphosate resistance via gene flow as a companion to the hybridization process could improve the adaptation of weedy hybrid progeny to the agro-ecosystem. Despite the likely negative implications of evolved glyphosate resistance and weed hybridization , the occurrence of glyphosate resistance could be a useful marker to assess weed hybridization.

GENE FLOW AND RISK ASSESSMENT: CASE BY CASE CONSIDERATIONS.
Michael J. Horak and Thomas E. Nickson, Monsanto Company, St. Louis, MO.

A fundamental tenant of risk assessment is that risk is a function of *hazard* and *exposure*. For biotechnology-derived crops, a risk assessor considers potential *hazards* associated with the crop that could include altered pest potential and potential adverse environmental impacts including adverse effects on non-target organisms. A risk assessor also considers e*xposure* by examining reasonable pathways for release into the environment, the environmental fate of the plant and trait, and potential routes of exposure to non-target organisms. The assessor would also evaluate information on potential gene flow via pollen, seed and tissue, and information on potential consequences of gene flow. The hazard and exposure information is then incorporated into the overall risk assessment.

During the risk assessment planning phase, the nature of the crop, the nature of the trait, the likely receiving, and the interactions among these factors are considered to identify potential hazards. Then comparative plant characterization data are generated on the biotechnology-derived crop. The comparative data are assessed for unintended and/or potentially adverse differences in the plant, and trait advantages to the crop that potentially affect the weediness of the crop. This information is used in an assessment of potential hazards of the crop. Concurrently, data are generated for an assessment of the potential effects to non-target organisms. The data from the hazard characterization are then considered in the context of a gene flow assessment (a portion of the exposure assessment). The gene flow assessment considers gene flow within the crop species and the likelihood of trait introgression into a sexually compatible species. Together the information from the hazard assessment and the exposure assessment, including gene flow information, are used in an overall assessment of risk.

GENE FLOW DYNAMICS AND CONFINEMENT: A REGULATORY PERSPECTIVE. Subray Hegde*, Biotechnology Regulatory Services/Animal and Plant Health Inspection Service, /United States Department of Agriculture, Riverdale, MD.

Gene flow is a natural biological process with potential evolutionary consequences. For a few human activities, however, gene flow from certain source populations into the environment is undesirable, which prompted the development of confinement protocols to contain gene flow to a defined physical space. A variety of confinement protocols are currently in use to prevent unintended gene flow from genetically engineered (GE) crops beginning from their creations to their intended use. Because gene escape from focal populations can occur in time and space, and is affected by a variety of genetic and ecological factors, the existing confinement protocols have gradually been evolving to address new issues and concerns raised by stakeholders. A few issues that could significantly alter the confinement principle in the future are: (i) an acceptable level of gene flow from GE plant populations into the environment, (ii) the cost and benefit of doing business with alternate gene flow containment strategies, and (iii) the public perception about genetically modified plants and plant products.

INTRODUCTION OF A NEW ISSUE PAPER FROM CAST--IMPLICATIONS OF GENE FLOW IN THE SCALE-UP AND COMMERCIAL USE OF BIOTECHNOLOGY-DERIVED CROPS: ECONOMIC AND POLICY CONSIDERATIONS. David R. Gealy, Kent J. Bradford, Linda Hall, Richard Hellmich, Alan Raybould, Jeffrey Wolt, and David Zilberman, United States Department of Agriculture–Agricultural Research Service, Dale Bumpers National Rice Research Center, Stuttgart, AR, Seed Biotechnology Center, Department of Plant Sciences, University of California, Davis, CA, Alberta Agriculture, Food and Rural Development/University of Alberta, Edmonton, Canada, United States Department of Agriculture–Agricultural Research Service, Corn Insects and Crop Genetics Research Unit, and Department of Entomology, Iowa State University, Ames, IA, Product Safety, Syngenta, Berkshire, United Kingdom, Biosafety Institute for Genetically Modified Agricultural Products, Iowa State University, Ames, IA, and Department of Agricultural and Resource Economics, University of California, Berkeley, CA.

This paper reviews the concept of gene flow—the successful transfer of genetic information between different individuals, populations, and generations (to progeny) and across spatial dimensions. The paper also discusses the relatively limited situations in which gene flow is likely to cause economic problems in the production of commercial biotech crops. Gene flow is presented in the context of an associated phenomenon, adventitious presence, in which unwanted substances unavoidably make their way into the production, channeling, and marketing system of grain and crop products.

Because reproductive biology differs markedly among crop species, so does the potential for outcrossing and subsequent gene flow. Economically or environmentally significant gene flow into weedy relatives of these crops often is limited because of restricted geographical overlap of the crop and weed regions or because the weedy relatives are not exceptionally competitive or invasive.

Numerous useful traits are being imparted into biotech (transgenic) and nonbiotech crops. Most of these traits are likely to have little impact on the dynamics of gene flow, especially outside of agricultural fields. Precommercialization procedures that take into account the specific trait being introduced will help to insure that impacts of gene flow remain low. Where trait characteristics warrant, a variety of production practices can be used to mitigate gene flow, and novel genetic/molecular containment technologies are being developed to accomplish similar goals.

The economic consequences of gene flow from biotech crops may differ in crops produced for seed (to be planted) vs. crops produced for commodity uses (to be consumed or woven into textiles), or in traditional vs. niche marketplaces. Approaches to minimize potential negative impacts are discussed.

Potential risks and benefits of maintaining or altering the existing safety and regulatory mechanisms are addressed in the context of public policy considerations. These considerations include the potential benefits of establishing thresholds for unapproved biotech substances in any commodity and for approved biotech substances in a commodity labeled as nonbiotech. Existing regulations are costly and can discourage development of beneficial products. Regulatory approaches that consider benefits and costs more holistically may facilitate improved development of these technologies.

To date, there have been no major health or environmental setbacks due to gene flow from biotech crops; in fact, these crops have led to significant, documentable improvements and, in some instances, decreased environmental risks. Education addressing the realistic advantages and challenges of continued development and commercialization of biotech crops, as well as nonbiotech crops, will be a key to public understanding and discourse related to future policy toward biotech crops.

CROP TOLERANCE TO FLAMING. Stevan Z. Knezevic*, and Santiago Ulloa. Associate Professor and Graduate Student Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Flaming can be an additional tool for weed control in organic cropping systems. However, tolerance of major crops must be determined in order to optimize proper use of flame. Therefore, objective of this study was to collect a baseline information on crop tolerance to broadcast flaming. Field experiments were conducted during summer of 2007 utilizing six rates of propane and six crops including: field corn (*Zea mays*), sorghum (*Sorghum halepense*), soybean (*Glycine max*), sunflower (*Helianthus annuus*), alfalfa (*Medicago sativa*) and red clover (*Trifolium pratense*). The propane rates applied were 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha (0, 2.5, 6.5, 10.5, 14.4 and 18.4 gal/a). Flaming treatments were applied using a constant speed of 6.5 km/hour (4MPH). Species response to propane rates were described by log-logistic models based on visual estimates of crop injury. Overall response to flame varied depending on the species, growth stage and propane rate. Corn and sorghum were more tolerant than the broadleaf crops. Soybean and sunflower were severely injured when flamed at early growth stages (VE-VC), however they could tolerate more heat at later stages (V9-R1). Alfalfa and red clover were the most susceptible to flaming regardless of the growth stage. Perennial crops such as alfalfa and clover may show more tolerance to flaming in their 2nd or 3rd year of growth. Of all crops tested, broadcast flaming has the most potential for use in field corn and sorghum. More research is needed to evaluate flaming procedures (eg. positioning of the flame) in other grass-type crops, and various broadleaf crops (sknezevic2@unl.edu).

RESISTANCE TO ACETOLACTATE SYNTHASE-INHIBITING HERBICIDES IN GRAIN SORGHUM. Kassim Al-Khatib, Kellan S. Kershner, and Mitch Tuinstra, Kansas State University, Manhattan, KS, and Purdue University, West Lafayette, IN.

Weed infestations is a major problem in sorghum production. A 2006 survey of sorghum producers in the United States by Kansas State University Sorghum Improvement Center showed that new technologies for controlling weeds was thought to be one of the highest priorities for research. In addition, producers repeatedly noted the need to develop better and more economical weed management strategies for sorghum. Currently, many grain sorghum producers use preplant herbicides such as atrazine and metolachlor, followed by postemergence herbicides such as atrazine, 2,4-D, and dicamba. These herbicides generally work well for managing weeds given adequate precipitation; however, erratic rainfall and poor soil moisture are common in most sorghum producing regions. Under dry conditions, preplant herbicides often fail or perform poorly and weeds can become a problem.

Nicosulfuron and rimsulfuron are acetolactate synthase (ALS)-inhibiting herbicides that widely used to control broadleaf and grass weeds in corn. These herbicides are popular with corn growers because of relative low use rate, low mammalian toxicity, low surface and ground water contamination, and high selectivity. These herbicides control several troublesome grass weeds that are common in corn fields. Unfortunately, nicosulfuron and rimsulfuron can not be used on sorghum because sorghum is susceptible to these herbicides.

A project was initiated in 2003 to develop and ultimately commercialize sorghum varieties with tolerance to ALS-inhibiting herbicides. The development of this technology would allow for more effective postemergence grass control for sorghum producers and also improve crop rotation and replant options for farmers interested in planting sorghum in fields sprayed with ALS-inhibiting herbicides in the previous crop (e.g. hail- or frost-damaged wheat). A natural sorghum mutant with high levels of tolerance to ALS-inhibiting herbicides was identified. Genetic crossing and backcrossing was used to transfer this trait into elite grain sorghum varieties. Tolerance appeared to be controlled by a single, incompletely-dominant, target-site mutation and at least 2 other modifier genes and provides cross-resistance to several different herbicides in the imidazolinone (IMI) and sulfonylurea (SU) chemical families. As part of this effort, Kansas State University and the Kansas State University Research Foundation developed and released two sets of sorghum materials with tolerance to ALS-inhibiting herbicides in 2007. The first set of materials was released in the spring season with seed of 18 ALS-herbicide tolerant sorghum families representing an array of commercially important sorghum seed and pollinator genetic backgrounds made available to commercial seed industry. A second release of 34 ALS herbicide tolerant sorghum inbred lines was released in the fall season as potential parent lines for development of ALS-herbicide tolerant hybrids.

Despite these potential benefits, concerns have been raised regarding the development and commercial release of herbicide tolerance traits because of risk for development of herbicide-resistant weeds, weed population shifts, and gene flow of the herbicide tolerance trait to wild relatives. Sorghum crosses freely with several wild relatives including shattercane. Although we anticipate concern over development of herbicide tolerance in sorghum, the mutants used in these studies were found in wild sorghum accessions so there is no risk of transferring new herbicide tolerance genes into natural sorghum populations. The herbicide tolerance genes are already present in nature. Based on this and other arguments, the most difficult registration and risk assessment hurdles can be overcome.

VARIABILITY OF TEMBOTRIONE EFFICACY AS INFLUENCED BY COMMERCIAL ADJUVANT PRODUCTS. Bryan G. Young, Richard K. Zollinger, and Mark L. Bernards, Associate Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901, Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051, and Assistant Professor, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583-0915.

Tembotrione is a new HPPD-inhibitor herbicide. It is labeled for use in corn and has postemergence activity on many broadleaf and grass weeds. The activity of many postemergence herbicides can be increased by selecting an appropriate adjuvant as a tank-mix partner. Our objectives in this study were to 1) screen common commercial non-ionic surfactants (NIS), crop oil concentrates (COC), methylated seed oils (MSO), and high surfactant oil concentrates (HSOC) to determine if there were differences within adjuvant classes and between adjuvant classes in enhancing the activity of tembotrione, 2) compare a NIS, COC, and MSO adjuvant tank-mixed with the postemergence HPPD-inhibitors tembotrione, mesotrione, and topramezone to determine if the herbicides responded similarly to the adjuvant classes; and 3) compare tembotrione tank-mixed with a NIS, COC, or MSO adjuvant at spray solution pH's of 5.0, 7.0, and 9.0 to determine the effect of pH.

Field experiments were conducted at research facilities associated with North Dakota State University, Southern Illinois University, and the University of Nebraska-Lincoln. Herbicide treatments were broadcast at 10 gpa. Tembotrione (0.0273 lb ai/a), mesotrione (0.0312 lb ai/a), and topramezone (0.00547 lb ai/a) were applied at 1/3 the recommended use rates. The weed species varied by location, and were a minimum of 6-8 inches at the time of application.

The response to adjuvant class (e.g., NIS, COC, MSO, and HSOC) varied by species. There was a wide range of response between adjuvants within each adjuvant category. The general trend between adjuvant categories was NIS ≤ COC = MSO = HSOC.

Tembotrione, mesotrione, and topramezone responded similarly to the three adjuvant classes. On species were there was a response to adjuvants, phytotoxicity increased in the order of NIS < COC ≤ MSO.

Weed control activity of tembotrione increased as spray solution pH increased from pH 5 to pH 7. There was little or no response as pH increased from 7 to 9. Weed control activity in response to adjuvant categories was consistent across pH levels, and was again NIS < COC ≤ MSO.

COMPARISON OF GRASS SPECTRUM FOR AE 0172747, MESOTRIONE, AND TOPRAMEZONE AS INFLUENCED BY ADJUVANTS. Mark A. Waddington and Bryan G. Young, Graduate Research Assistant and Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

The experimental herbicide AE 0172747, along with mesotrione and topramezone are HPPD-inhibiting herbicides for postemergence grass and broadleaf control in corn. Greenhouse research was conducted to evaluate the efficacy of these herbicides on large crabgrass, giant foxtail, shattercane, and fall panicum at the 2- to 3- and 4- to 6- leaf growth stages. A rate titration (1/32 to 2X the normal use rate) for each herbicide was used in combination with the adjuvants nonionic surfactant (NIS), crop oil concentrate (COC), or methylated seed oil (MSO). Data on foliar dry weight at 14 days after treatment was analyzed using regression and the R software.

Of the herbicides tested, AE 0172747 and topramezone had a wider spectrum of grass activity than mesotrione. AE 0172747 had greater activity than topramezone or mesotrione on 2- to 3- leaf large crabgrass and shattercane, regardless of adjuvant. On 2- to 3- leaf giant foxtail, topramezone had greater activity than AE 0172747 or mesotrione, regardless of adjuvant. Similarly, topramezone had greater efficacy than AE 0172747 and mesotrione on 2- to 3- leaf fall panicum, but only when NIS or COC was used. Similar levels of herbicide efficacy were observed on 2- to 3- leaf fall panicum from applications of AE 0172747 and topramezone, when applied with MSO. When the herbicides were applied to 4- to 6- leaf large crabgrass, shattercane, and giant foxtail AE 0172747 had greater efficacy than topramezone or mesotrione in most instances. The use of MSO decreased these differences between the herbicides when applied to 4- to 6- leaf grasses. In general, herbicide combinations with MSO had the greatest activity, and the lowest level of herbicide activity was observed with combinations using NIS.

WEED MANAGEMENT WITH POSTEMERGENCE HERBICIDE TANK MIXES IN ACETOLACTATE SYNTHASE (ALS) RESISTANT GRAIN SORGHUM. D. Shane Hennigh, Kassim Al-Khatib, and Mitch Tuinstra, Graduate Research Assistant, Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506 and Professor, Department of Agronomy, Purdue University, West Lafayette, IN 47907.

Postemergence herbicide treatments to control grasses are limited in grain sorghum. Acetolactate synthase (ALS)-inhibiting herbicides are very effective in controlling many grass species in corn, however, uses of these ALS-inhibiting herbicides is not an option in conventional grain sorghum due to grain sorghum being highly susceptible to these herbicides. With the development of ALS-resistant grain sorghum, several postemergence ALS-inhibiting herbicides can be used to control weeds in grain sorghum. Field experiments were conducted near Manhattan, KS in 2007 to evaluate the efficacy of nicosulfuron + rimsulfuron (26 + 13 g ha^{-1}) applied alone or in combination with, atrazine (1.2 L ha^{-1}), bromoxynil (1.2 L ha^{-1}), carfentrazone-ethyl (36.5 mL ha^{-1}), halosulfuron + dicamba (47 g + 0.3 mL ha^{-1}), prosulfuron (35 g ha^{-1}), 2,4-D (0.9 mL ha^{-1}), metsulfuron methyl + 2,4-D (7 g + 0.6 mL ha^{-1}), or a combination of these herbicides with atrazine on grass and broadleaf weeds. Herbicide treatments were applied when weeds were 7.5 to 15 cm in height. Barnyardgrass, green foxtail, giant foxtail, velvetleaf, ivyleaf morningglory, common sunflower, overall grass, and overall broadleaf control was visually determined 2 and 4 weeks after treatment (WAT) based on a scale where 0% = no control, and 100% = complete control. Percent control of barnyardgrass, green foxtail and giant foxtail was greater than 90% and 80% for all herbicide treatments 2 and 4 WAT respectively except for the treatment nicosulfuron + rimsulfuron + carfentrazone-ethyl + atrazine 4 WAT. Overall broadleaf control was greater than 70% for all treatments except nicosulfuron + rimsulfuron + atrazine 2 WAT and 60% for all herbicide treatments 4 WAT. Nicosulfuron + rimsulfuron + metsulfuron methyl + 2,4-D and Nicosulfuron + rimsulfuron + halosulfuron + dicamba both controlled greater than 96% of all grasses and broadleaf weeds 2 and 4 WAT. Overall control of grass and broadleaf weeds was greater when nicosulfuron + rimsulfuron was applied with various broadleaf herbicides as compared to when it was applied alone.

RESISTANCE TO ACETYL-COENZYME A CARBOXYLASE-INHIBITING HERBICIDES IN SORGHUM SPECIES. Kellan S. Kershner, Mitchel R. Tuinstra, and Kassim Al-Khatib, Graduate Research Assistant, Department of Agronomy, Kansas State University, Manhattan KS 66506, Professor, Department of Agronomy, Purdue University, West Lafayette, IN 47907, and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Grain sorghum (*Sorghum bicolor*) is the third-most common cereal planted in the United States trailing corn and wheat around a factor of ten. Grain sorghum is planted as a drought and heat tolerant cereal in challenging environments. Under these conditions, weed control is very important and escalates into a major problem if the preemergent herbicide application does not provide adequate control. Unfortunately sorghum has not observed the increase in flexible options for weed control enjoyed by soybean, corn and wheat in recent years. There is not a single herbicide option available for post-emergence control of grass species.

This study sought to identify natural sources of herbicide resistance that could be deployed in grain sorghum. Four sources with resistance to Acetyl-Coenzyme A Carboxylase-inhibiting herbicides were evaluated for the possibility of incorporating the trait into *S. bicolor*. This included using embryo rescue and tissue culture on wide crosses.

The first source was a johnsongrass (*S. halepense)* population that is resistance to clethodim. This source was dropped out once it became apparent that the level of resistance was not adequate. The second source was derived by mutagenesis of an elite sorghum parent line. Again, the level of resistance was not adequate. The third resistance source was a johnsongrass population from Mississippi. Wide-crosses were made onto elite sorghum parents and embryos rescued. Fertility problems plagued this source and work focused on the final source. The fourth source was *S. sudanense* from South America. It expressed a level of resistance and genotype similar to the third source. It was fully fertile with elite sorghum parents and the trait is being introgressed into several elite parents. Two populations with this trait were released to the sorghum breeding community in Fall 2007.

IMPLICATIONS OF SOIL RESIDUAL HERBICIDES ON THE CONSISTENCY OF GLYPHOSATE EFFICACY IN GLYPHOSATE-RESISTANT CORN. Daniel D. Schnitker, Bryan G. Young, William G. Johnson, and Mark M. Loux, Graduate Research Assistant and Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Professor, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

The implementation of glyphosate-resistant corn has led to an increased reliance on postemergence glyphosate applications with less dependence on preplant soil residual herbicides. Less emphasis on early-season weed management may potentially compromise the consistency of glyphosate efficacy applied postemergence. Two field studies were each conducted in Illinois, Indiana, and Ohio in 2006 and 2007. The objective of the first study was to evaluate residual herbicide rate and timing effects on weed densities and heights preceding a planned postemergence glyphosate application. Applications at both 14 days before planting and preemergence were performed for the following herbicide treatments: atrazine, atrazine plus simazine, atrazine plus isoxaflutole, atrazine plus acetochlor, and acetochlor plus flumetsulam plus clopyralid. The objective of the second study was to determine the effects of residual herbicide rate and postemergence glyphosate timing on weed densities and heights prior to the postemergence glyphosate application. Herbicide treatments were applied preemergence and included atrazine, atrazine plus simazine, atrazine plus isoxaflutole, atrazine plus acetochlor, and atrazine plus *s*-metolachlor plus mesotrione. Two postemergence glyphosate timings were implemented based on weed sizes prior to application (early post and late post).

Applying residual herbicides early preplant resulted in increased densities of fall panicum, common waterhemp, giant ragweed, and velvetleaf plants exceeding the glyphosate label limitations at the postemergence timing compared with the residual herbicides applied preemergence. This difference was not consistently resolved by applying increased rates of the residual herbicides at the early preplant timing. Differences in weed heights across herbicide treatments and timings were not observed for redroot pigweed or common lambsquarters. All herbicide treatments across timings reduced the heights of giant foxtail, redroot pigweed, and common lambsquarters to within glyphosate label limitations.

Delaying the postemergence application of glyphosate resulted in weed heights over the labeled limitations for glyphosate products for fall panicum, common waterhemp, giant ragweed, velvetleaf, and morningglory species. Treatments including acetochlor or *s*-metolachlor plus mesotrione provided the lowest densities of giant foxtail, fall panicum, redroot pigweed, and common waterhemp. Velvetleaf densities were lowest when an HPPD-inhibiting herbicide was included, such as isoxaflutole or mesotrione. Increasing herbicide rates tended to reduce weed densities of some species. This research suggests that a preemergence application of a broad-spectrum residual herbicide will reduce the weed densities and heights of most species to provide increased flexibility and consistency regarding the postemergence application of glyphosate.

TIMING OF WEED REMOVAL IN ROUNDUP READY® CORN 2 SYSTEMS. Tony White* and Dan Zinck, Monsanto Company, St. Louis, MO.

Timing is crucial when it comes to weed control in corn. In fact, numerous studies have indicated that allowing weeds to grow beyond four inches in height increased weed competition with corn and resulted in reduced corn yield compared to earlier control. A planned preemergence (PRE) plus postemergence (POST) approach to weed management generally results in more effective weed control and maximum crop yield potential compared to an approach consisting of only POST herbicides. Many experts recommend using the PRE followed by POST approach when planting Roundup Ready Corn 2 as well as conventional hybrids. Because growers continue to ask questions around proper weed control timing in Roundup Ready® Corn 2 systems, various studies were established between 2003 and 2007 at the Monsanto Learning Center near Monmouth, Illinois to better understand the value of proper weed control timing in corn.

As expected, yearly results varied slightly relative to the yield differences (positive or negative) among treatments. In 2006, the use of a PRE application of acetchlor/atrazine (premix as Degree Xtra®) at 2 qt A^{-1} followed by a POST application of glyphosate (Roundup WeatherMAX®) at 0.75 lb AE A^{-1} provided the best overall weed control among all treatments. The addition of a PRE treatment provided nearly a 38 bu A^{-1} yield advantage over a POST program alone. A study conducted in 2003 showed that the best yields were obtained when the first glyphosate application in a sequential POST program was made when weeds were approximately 2 inches tall. The timing of the second application, based on weed height of the second flush of weeds, did not significantly affect corn yield. This suggests that the application timing of the first application of a sequential POST herbicide program in corn is the most critical.

WEED MANAGEMENT OPTIONS IN GLYPHOSATE TOLERANT CORN. Peter H. Sikkema[1], Nader Soltani[1], Robert E. Nurse[2], Laura L. Van Eerd[1] and Richard Vyn[1]. [1]University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada. N0P 2C0; [2]Agriculture and Agri-Food Canada, Harrow, Ontario, Canada N0R 1G0.

Seven field trials were conducted at various locations in Ontario over a two-year period (2006 and 2007) to study the effect of various weed management strategies in glyphosate tolerant corn on weed control, corn yield, environmental impact and net income. There was no visible injury with the postemergence herbicides evaluated. Results were field specific. At 56 days after treatment, depending on location, glyphosate EPOST, glyphosate LPOST, dicamba/atrazine plus glyphosate EPOST, isoxaflutole/atrazine PRE fb glyphosate LPOST, and glyphosate EPOST fb glyphosate LPOST provided 45-97, 91-100, 40-98, 97-100, and 98-100% control of annual grasses and 65-97, 69-100, 83-100, 97-100, and 98-100% control of annual broadleaf weeds in glyphosate tolerant corn, respectively. The most consistent weed control was provided by the two-pass programs when a residual herbicide (PRE) was followed by glyphosate LPOST or when a sequential application of glyphosate was applied EPOST followed by LPOST. Yield was reduced as much as 86% when weeds were not controlled. There was no difference in yield among the two-pass herbicide programs evaluated. The isoxaflutole/atrazine PRE fb glyphosate LPOST had the lowest environmental impact of the two-pass herbicide programs evaluated. On average, the most profitable weed management program in corn was a sequential application of glyphosate.

HALEX GT: NEW POSTEMERGENCE HERBICIDE FOR GLYPHOSATE TOLERANT CORN. Gordon D. Vail and Carroll M. Moseley, Technical Brand Manager and Brand Manager, Syngenta Crop Protection, Greensboro, NC 27419.

Halex™ GT is the latest product in the Callisto Plant Technology™ family of herbicides. Halex GT is a new post-emergence corn herbicide specifically designed for glyphosate tolerant (GT) corn that provides the convenience of a one-pass, post-emergence glyphosate program that also includes residual weed control. Halex GT was developed for growers committed to a total post-emergence weed control program. Five years of product development has demonstrated that Halex GT can deliver higher corn yield versus one application of glyphosate and equal or higher yield versus two applications of glyphosate. Because Halex GT controls emerged weeds and provides residual weed control, it is more flexible and effective than glyphosate alone.

HALEX GT WEED CONTROL IN GLYPHOSATE TOLERANT CORN. Brett R. Miller, Ryan D. Lins, B. David Black and Gordon D. Vail, Research and Development Scientists and Technical Brand Manager, Syngenta Crop Protection, Greensboro, NC 27419.

Halex™ GT is a new post-emergence corn herbicide specifically designed for glyphosate tolerant (GT) corn that provides the convenience of a one-pass, post-emergence glyphosate program plus residual weed control. It combines the active ingredients mesotrione, s-metolachlor and glyphosate into a unique product with excellent crop safety that controls tough grass and broadleaf weeds in corn. The target use rate of 2.21 to 2.46 kg ai/H (3.6 to 4 pt/acre) controls the most important weeds including those that have developed resistance to glyphosate, triazine or ALS-inhibiting herbicides. Halex GT will require the addition of a non-ionic surfactant (NIS) for optimal weed control. Halex GT can be tank mixed with atrazine for added broadleaf weed control or when glyphosate resistant broadleaf weeds are present or suspected. The mixture of active ingredients in Halex GT when tank mixed with atrazine provides an effective glyphosate resistance management strategy in GT corn.

THIENCARBAZONE-METHYL: A NEW MOLECULE FOR PRE AND POSTEMERGENCE WEED CONTROL IN CORN. Brent D. Philbook[1]* and Hans-Jochim Santel[2], [1]Bayer CropScience Research Triangle Park, NC 27709, and [2]Monheim, Germany.

Thiencarbazone-methyl is a new sulfonyl-amino-carbonyl-triazolinone (SACT) from Bayer CropScience that controls grassy and broadleaf weeds trough inhibition of acetolactate synthase. Thiencarbazone-methyl is taken into the weeds through aerial portions of the plants and from the soil. Thiencarbazone-methyl therefore provides a strong residual component for weed control. Thiencarbazone-methyl controls weeds of corn at rates as low as 8 grams active ingredient per hectare (g ai/Ha), and will be used up to 15 g ai/Ha per postemergence application. Lower rates have also been demonstrated to be effective at controlling key weeds in wheat. As a soil-applied herbicide, Thiencarbazone-methyl will be applied at rates up to 37 g ai/Ha per single application. In corn, Thiencarbazone-methyl will be combined in various premixtures with other complimentary herbicides and proprietary crop safeners.

EFFICACY OF RIMSULFURON AND ISOXAFLUTOLE MIXTURES FOR WEED CONTROL IN FIELD CORN. Susan K. Rick, Larry H. Hageman and Gregory R. Armel. Field Development Representative, Farm Manager and Product Development Specialist, DuPont Crop Protection. Wilmington, DE 19880.

Field studies were conducted in 2007 to evaluate postemergence control of emerged weeds and residual weed control with a tank mixture of rimsulfuron and isoxaflutole. Various ratios and rates of rimsulfuron plus isoxaflutole were evaluated for early season control of emerged weeds as well as residual control of summer annuals in reduced tillage systems or residual control in conventional tillage systems. The two way mixture was tested with or without atrazine and was compared to various competitive standards. Reduced rates of rimsulfuron, isoxaflutole plus atrazine were also evaluated as a setup program for in season glyphosate or glufosinate applications.

Mixtures of rimsulfuron and isoxaflutole gave excellent control of emerged giant ragweed, fleabane, henbit, deadnettle, Virginia pepperweed, corn gromwell, cressleaf groundsel, chickweed, buttercup and purslane speedwell. Downy brome and volunteer wheat control was greatest at higher rates. Adding atrazine to the tank mix improved control of star-of-Bethlehem, corn speedwell and annual bluegrass. Tank mixing with glyphosate also improved control of grass species and to a limited extent wild garlic, star-of-Bethlehem and corn speedwell. Rimsulfuron and isoxaflutole or atrazine mixtures tended to give quicker postemergence control than observed with rimsulfuron alone or with glyphosate. Residual control in notill with the rimsulfuron plus isoxaflutole mixture was similar to the commercial mixture of mesotrione, metolachlor and atrazine (Lumax). The addition of atrazine to the tank slightly improved control of several broadleaf species especially nightshade but did not affect residual grass control.

In conventional tillage systems, three way mixtures with rimsulfuron, isoxaflutole and atrazine provided better control of velvetleaf, sandbur, smartweed and cocklebur than commercial formulations of acetochlor. The mix also provided better control of smartweed than Lumax. Control of species such as waterhemp, ragweeds, common lambsquarters and morningglory were similar to the standards. Reduced rates of the rimsulfuron, isoxaflutole plus atrazine used as a planned preemergence treatment prior to in crop applications of glyphosate or glufosinate provided similar control to commercial acetochlor plus atrazine premixtures followed by glyphosate program.

RESPONSE OF SPECIALTY CORN TO CONVENTIONAL HERBICIDES. Damian D. Franzenburg, Micheal D.K. Owen, Dean Grossnickle and James F. Lux, Agricultural Specialists and Professor, Department of Agronomy, Iowa State University, Ames, IA 50011.

Experiments were conducted near Ames, IA in 2006 and 2007 to determine the effect of several PRE and POST applied herbicides on crop injury for specialty corn varieties. The experimental design was a split plot with three replications. Corn varieties were the whole plots and herbicides were the split plots. Corn varieties in 2006 included 'Asgrow RX 776W' (white), 'Asgrow RX 818W' (white), 'Dekalb DKC 60-20' (waxy), 'Pfister SK 2540-19' (high oil) and 'Zimmerman 1851W' (white). Herbicide treatments in 2006 included PRE S-metolachlor & atrazine & CGA-154281 plus POST mesotrione, PRE dimethenamid-P & atrazine plus POST diflufenzopyr & dicamba, and PRE Isoxaflutole plus POST foramsulfuron. A control treated with S-metolachlor & CGA-154281 was also included. Corn varieties in 2007 included the addition of 'Northrup King NK 1713' (white) but did not include 'Asgrow RX 776W' and 'Pfister SK 2540-19'. Herbicide treatments in 2007 were the same as 2006 with the exception of the substitution of diflufenzopyr & dicamba & isoxadifen-ethyl for diflufenzopyr & dicamba. A control with PRE S-metolachlor & CGA-154281 was included again in 2007. Split plots were 3 by 7.6 m and experiments were planted with 76 cm row spacing on soybean ground prepared by spring field cultivation. All herbicides were applied at labeled rates appropriate for V4 dent corn. Corn stand and percent visual crop injury for PRE treatments was evaluated in 2006 at 15 and 20 Days after PRE application (DAA). No injury from PRE treatments was apparent in 2007, and corn stands were not taken. Percent visual corn injury from POST treatments was evaluated for both years at 1, 2, 3 and 4 weeks after application (WAA).

Crop stand differences in 2006 were due only to variety differences, and no PRE herbicide treatments caused corn injury. Crop injury from POST treatments in 2006 revealed significant main effect differences for herbicides at each observation date and main effect differences for corn varieties at 1, 3 and 4 WAA. There was significant variety by herbicide interaction at all observation dates. Injury resulting from mesotrione and diflufenzopyr & dicamba varied significantly for different varieties at all observation dates. Injury ranged from 2 to 15% at 1 WAA and 0 to 12% by 4 WAA. Foramsulfuron, conversely, demonstrated injury that ranged from 18 to 23% at 1 WAA and from 5 to 12% at 4 WAA. Mesotrione injury was characterized by chlorotic upper leaves. Foramsulfuron and diflufenzopyr & dicamba injury appeared as shortening of upper internodes and chlorosis. All POST herbicides demonstrated the greatest reduction in herbicide injury from 1 to 2 WAA. However, mesotrione injury to 'Dekalb DKC 60-20' was persistent with injury that decreased from only 13 to 12% from 1 to 4 WAA, respectively. Mesotrione injury decreased from 7 to 0% across the other varieties.

No corn injury due to PRE treatments was observed in 2007. POST applications caused significant corn injury. Herbicide, as a main effect, was significant at all observation dates. The main effect of corn variety was significant at only 2 WAA. Variety by herbicide interaction occurred at 1, 2 and 3 WAA. Foramsulfuron demonstrated the highest injury across varieties at 1 and 2 WAA. Diflufenzopyr & dicamba & isoxadifen-ethyl consistently caused only 5% injury at 1 WAA and only 2% injury for 'Zimmerman 1851W' for 2, 3 and 4 WAA. Mesotrione injury fluctuated, depending on corn variety, from 7 to 23% at 1 WAA to 7 to 17% at 2 WAA. As in 2006, 'Dekalb DKC 60-20' responded uniquely to mesotrione in 2007 with higher injury relative to the other corn varieties.

EFFECT OF PREPLANT N SOURCE ON WEED MANAGEMENT IN CORN. Kelly A. Nelson, Associate Professor, Division of Plant Sciences, University of Missouri, Novelty, MO 63460.

Field research was conducted in 2006 and 2007 to determine the impact weed management systems and preplant N source selection on no-till corn grain yield and weed control. Variablity in weed control with early postemergence treatments of residual herbicides may be expected depending on the N source due to early weed growth, soil disturbance, or aggressive weed growth that may result from readily available N sources. This research was arranged as a split-plot design with N source as the main plot and weed management system as the sub-plot. Preplant N sources included anhydrous ammonia, urea, polymer coated urea, and ammonium nitrate applied at 168 kg N/ha. Weed management systems included atrazine preemergence followed by glyphosate, early postemergence atrazine + dimethenamid, and postemergence applications of atrazine + dimethenamid + glyphosate, and glyphosate applied early and late post. Crop and weed growth rates were determined to help farmers predict herbicide application timings for N sources that may differ in crop or weed availability. There was no interaction between weed management systems and N sources on weed control or corn yield. Weed biomass was affected by N source and was greatest with anhydrous ammonia and polymer coated urea treatments. Tillage and slow release N sources may result in greater weed biomasses (giant foxtail, common lamsquarters, and common waterhemp) at harvest; however, limited effects on grain yield were observed. Grain yield was similar among polymer coated urea, ammonium nitrate, and anhydrous ammonia N sources. There was no difference in weed control among preemergence, early postemergence, and postemergence treatments in 2006, and slight yield differences were observed when compared to the weed-free control. Differences in weed control were observed in 2007, but yields were similar to the weed-free control. In a medium and high yield environment, recommendations for weed management systems should not vary based on the preplant N source selection.

IMPACT OF CORN POPULATION, IRRIGATION, AND HAIL INJURY ON PALMER AMARANTH.
Randall S. Currie and Norman L. Klocke, Associate Professor and Professor, Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846.

A crop is most vulnerable to defoliation as it approaches maximum leaf area. For corn, this growth stage often coincides with one of the seasonal peaks of hail activity throughout most corn growing regions in North America. In 2005, while executing a long-term experiment to measure the dose response relationship of irrigation and corn grain yield, the leaf area index (LAI) of the corn was significantly reduced by a hail storm. This occurred again in 2006 at approximately the same stage of growth. Replicated studies of natural hail injury and the resulting weed flushes are rare. Therefore, our objectives were redirected to study these effects. Corn had a preemergence application of isoxaflutole, atrazine, s-metolachlor and 2,4-D at 0.05, 1, 1.9, and 1 lbs a^{-1} followed by two or more postemergence applications of glyphosate at 0.75 lbs a^{-1} to maintain weed-free conditions at canopy closure. The six irrigation treatments, replicated four times, were 100, 84, 71, 55, 42, and 30% of what locally-derived models predicted for non-rate limited irrigation. Corn populations for each treatment were 9,500, 22,000, 24,500, 27,000, 29,500, and 32,000 plants $acre^{-1}$, increasing as irrigation level increased. No hail injury occurred in 2004 or 2007 so these years are used for comparisons. Palmer amaranth biomass samples were taken at corn harvest. In 2005, hail injury reduced the LAI to the same level in all but the highest corn populations. In 2005 and 2006, all but the highest corn population had statistically significant reductions in LAI. Reductions in LAI correlated well with reductions in corn yield. In 2005, hail opened up the canopy and produced a dramatic flush of Palmer amaranth. At the lowest level of corn population and irrigation inputs, Palmer amaranth biomass (PABM) at corn harvest was twice that seen in the two highest corn populations. This was predicted by the equation: Pounds of PABM a^{-1} = 945 (corn yield in bu a^{-1}) -7.76 (corn yield bu $a^{-1})^{2}$ +.029 (corn yield in bu $a^{-1})^{3}$ - 18883 (LAI) + 3249 $(LAI)^{2}$ -184 $(LAI)^{3}$, with an R^2 of 0.87.

In 2006, regardless of irrigation level or corn population, hail-induced increases in PABM were consistently high across all levels of treatment. Perhaps hail in the previous year increased the amount of weed seed dropped and elevated weed pressure, which might have buffered the effects of differences in canopy damage. Although differences between treatments were difficult to measure, the relationship among corn grain yield, LAI, and PABM clearly showed a curvilinear trend at higher levels of each factor. This trend was predicted by the equation: Pounds of PABM a^{-1} = 3129 (LAI) -531 $(LAI)^2$ -871 (inches of irrigation) +49.6 (inches of irrigation)^{2} with an R^2 of 0.78. Corn injury was severe enough to remove corn grain yield as a predictor of PABM. In 2007, PABM was 4- to 15-fold less than in 2005 or 2006. Even under these much more competitive conditions, similar trends in PABM were seen with increasing levels of inputs. More than 4-fold reduction in PABM was seen with increasing corn populations and irrigation.

EVALUATION OF BEST MANAGEMENT PRACTICE (BMP) RATES OF ATRAZINE TANK MIXED WITH SEVERAL BROADLEAF HERBICIDES IN FIELD CORN AT ROCHESTER, MINNESOTA. Lisa M. Behnken, Ryan P. Miller, Fritz R. Breitenbach, and Jeffery L. Gunsolus, Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, Assistant Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, Associate Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, and Professor, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108-6026.

Field research was conducted at Rochester, MN in 2007 to investigate the effect of BMP rates of atrazine, 0.56 to 0.86 kg ai ha^{-1}, tank mixed with several broadleaf herbicides, on weed control and grain yield in field corn in southeastern Minnesota. The research site was a Lawler loam series with a pH of 7.0 and soil test P and K levels of 16 ppm and 160 ppm, respectively. The field was spring disked twice and field cultivated once prior to planting. The corn hybrid, Pioneer 38H65, was planted on April 27, 2007 at a depth of 3.8 cm in 76-cm rows at 79,073 seeds ha^{-1}. A randomized complete block design was used with four replications. Preemergence and postemergence treatments were applied with a tractor-mounted sprayer delivering 187 l ha^{-1} at 221 kpa using 11002 flat fan nozzles. A one-half label use rate of s-metolachlor at 1.07 kg ai ha^{-1} was applied preemergence to the entire plot area and served as a control. In addition, a one-pass preemergence comparison that consisted of a package mixture of atrazine at the BMP rate of 0.86 kg ai ha^{-1} and s-metolachlor at 1.07 kg ai ha^{-1} was also applied. Six treatments with s-metolachlor at 1.07 kg ai ha^{-1} applied preemergence and followed by a postemergence application of mesotrione at 0.105 kg ai ha^{-1}, flumetsulam & clopyralid at 0.039 & 0.105 kg ai ha^{-1}, or dicamba at 0.56 kg ai ha^{-1}, with and without atrazine at 0.56 kg ai ha^{-1}, were evaluated. The addition of soil applied BMP rates of atrazine tank mixed with s-metolachlor had no full-season effect on broadleaf weed control or corn grain yield. Postemergence BMP rates of atrazine had a significant effect on giant ragweed weed control with all paired comparisons. Common lambsquarters and common waterhemp control were similar for mesotrione and mesotrione plus atrazine treatments. Common lambsquarters and common waterhemp control were statistically lower with the flumetsulam & clopyralid and dicamba alone treatments when compared to the flumetsulam & clopyralid plus atrazine and dicamba plus atrazine treatments. Corn grain yields were statistically higher for the mesotrione plus atrazine and flumetsulam & clopyralid plus atrazine treatments when compared to their non-atrazine partners. The dicamba and dicamba plus atrazine comparison was not statistically different.

BENTAZON FOR POSTEMERGENCE WEED CONTROL IN ONION. Bernard H. Zandstra and Eric J. Ott. Professor and Research Assistant, Michigan State University, East Lansing, MI 48824.

Yellow nutsedge is a serious and persistent weed in onion. Some preemergence herbicides provide preemergence yellow nutsedge suppression, but no labeled herbicide provides sufficient postemergence yellow nutsedge control in onion. Bentazon has good postemergence burndown activity on yellow nutsedge and moderate safety on onion. An experiment was conducted at the MSU Muck Research Farm in 2007 to compare several rates and timings of bentazon application to onion to control yellow nutsedge, avoid crop injury, and obtain maximum yields. Bentazon was applied at 0.28, 0.56, and 1.12 kg/ha either 2 or 4 times, beginning at the 2 leaf stage (LS) or 3 LS. The maximum total rate per plot was 2.24 kg/ha. The onion cultivars Highlander, Nebula, and Yellow Sweet Spanish (YSS) were planted. Bentazon 0.28 kg/ha applied 4 times beginning at the onion 2 LS gave 50% yellow nutsedge suppression and resulted in yield reduction of Nebula, Highlander and YSS. Bentazon at 0.56 kg/ha applied 4 times beginning at the onion 2 LS gave 60-70% yellow nutsedge suppression and good Nebula yield but Highlander and YSS yields were reduced. Addition of crop oil concentrate (COC) to bentazon 0.56 kg/ha increased yellow nutsedge suppression to 70-80% when treatments began at the 3 LS, which resulted in good Nebula yield but reduced Highlander and YSS yield. Bentazon at 1.12 kg/ha applied twice beginning at the 2 LS gave almost 90% yellow nutsedge suppression and good yield of Nebula and Highlander. Bentazon 1.12 kg/ha applied at the 3 LS and later provided only 30-50% yellow nutsedge control, and significantly reduced yield of Nebula, Highlander, and YSS. Addition of COC to bentazon 1.12 kg/ha improved yellow nutsedge control slightly, but did not increase crop injury or yield significantly.

Early control of yellow nutsedge, starting at the onion 2 LS, was an important factor in obtaining maximum onion yields. Some onion cultivars appear to be more sensitive to bentazon than others. Further testing with additional cultivars, timings, and rates will help develop an effective use pattern for bentazon on onion.

MULTIPLE REDUCED RATE HERBICIDE TREATEMENTS FOR WEED CONTROL IN ONION. James R. Loken* and Harlene M. Hatterman-Valenti, Graduate Research Assistant, and Assistant Professor, Plant Sciences Department, North Dakota State University, Fargo, ND 58105.

Onion (*Allium cepa* L.) is a crop with tremendous yield potential and economic return in North Dakota. However, due to the poor competitiveness of onion and the relatively short North Dakota growing season, weed control in onion has no margin for error. Weed competition is most damaging to yield as the onion plant grows to the two-leaf stage because of slow onion establishment to this point. Currently, no herbicides are labeled that provide broad-spectrum annual broadleaf weed control prior to the onion two-leaf stage. Thus, the importance of effective weed control in onion prior to the two-leaf stage is obvious.

Much like the multiple reduced-rate herbicide management practices (micro-rates) used for sugarbeet production in the Red River Valley, this project evaluated the effect of labeled and non-labeled herbicides applied at micro-rates to emerging annual broadleaf weeds, such as redroot pigweed and common lambsquarters, when onion ‘Teton’ was at growth stages less than two leaves.

The herbicides bromoxynil, oxyfluorfen, metribuzin, and acifluorfen were applied at rates 1/4, 1/8, and 1/16 the lowest labeled rate, and either two or three times at 1 wk intervals. A hand-weeded check and conventional herbicide application check were maintained for comparison to the micro-rates for overall weed control effectiveness. To determine herbicide micro-rate effectiveness, weed counts were taken seven days after each application in a 0.093 m^2 quadrant and a mid-season visual evaluation was performed.

In the factorial analysis, there was a herbicide-by-rate interaction for percent control of common lambsquarters and redroot pigweed. The 1/4 rate of bromoxynil provided the best control of common lambsquarters. The 1/4 rates of bromoxynil and oxyfluorfen provided the best control of redroot pigweed. In the analysis with checks, three applications of bromoxynil or oxyfluorfen at the 1/4 rate (70.1 g ae/ha and 70.1 g ai/ha, respectively) provided excellent early-season broadleaf weed control. Two applications of bromoxynil at the 1/4 rate and three applications of oxyfluorfen at the 1/8 rate (35.0 g ai/ha) provided adequate early-season control of common lambsquarters and redroot pigweed. Micro-rate applications of metribuzin and acifluorfen did not effectively control common lambsquarters or redroot pigweed. Yield data supports these results.

UTILITY OF HALOSULFURON FOR CONTROL OF VOLUNTEER HORSERADISH. Nathan R. Johanning, Bryan G. Young, and S. Alan Walters, Graduate Research Assistant, Professor, and Associate Professor, Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Horseradish (*Armoracia* rusticana) is commonly grown in rotation with other agronomic field crops. Due to the perennial growth habit of horseradish, volunteer plants often emerge at high densities in these crops. Volunteer horseradish plants do not generally cause significant yield loss in agronomic crops although volunteer plants reduce the benefit of crop rotation. These volunteer plants serve as hosts of major horseradish soil-borne pathogens and can lead to mixed cultivars since the crop is asexually propagated.

The efficacy of fall applications of 2,4-D, glyphosate, 2,4-D plus glyphosate, dicamba, 2,4-D plus iodosulfuron, 2,4-D plus rimsulfuron and thifensulfuron, and 2,4-D plus halosulfuron were evaluated on volunteer horseradish. Treatments were applied to soybean stubble after harvest where the crop prior to soybeans was horseradish. All herbicide applications demonstrated reduced volunteer horseradish density the following spring. A greater reduction in volunteer horseradish density was observed in treatments containing 2,4-D or dicamba, compared with glyphosate applications alone. Volunteer horseradish plants were reduced the greatest by applications of halosulfuron plus 2,4-D.

The corn herbicide halosulfuron has utility in control of volunteer horseradish, but there are concerns about the safe replant interval for horseradish after the application of halosulfuron. From 2005 to 2007, studies evaluated the injury to commercial horseradish root segments planted at 0, 1, 2, 4, 10, and 12 months after the application of halosulfuron. Applications of 0.5, 1, and 2X the standard field use rate in corn were used to simulate applications of reduced rate, labeled rate, and overlap in a field situation. No differences in plant injury from halosulfuron were observed between the two horseradish cultivars ‘1038’ and ‘1573’. When only half the standard rate of halosulfuron was applied, no injury was seen one month after herbicide application. Furthermore, after 10 months, no significant injury was observed with halosulfuron at 1 or 2X the standard field use rate. Currently, the label for halosulfuron in corn restricts the planting of horseradish to 18 months. This research suggests that a shorter replant interval may be possible and allow for greater utility of halosulfuron for management of volunteer horseradish in rotational crops.

SWEET CORN HYBRID TOLERANCE: FROM FIELD EVALUATIONS TO GROWER RECOMMENDATIONS. Joseph D. Bollman, Chris M. Boerboom, Roger L. Becker, Mark J. VanGessel, Robin R. Bellinder, and Ed Peachey, Graduate Research Assistant, Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706, Professor, Department of Agronomy and Genetics, University of Minnesota, St. Paul, MN 55108, Professor, Department of Plant and Soil Sciences, University of Delaware, Georgetown, DE 19947, Professor, Department of Horticulture, Cornell University, Ithaca, NY 14852, and Assistant Professor, Department of Horticulture, Oregon State University, Corvallis, OR 97331.

Sweet corn weed management can be challenging because of the limited number of postemergence herbicides and the potential for these herbicides to cause injury. Currently, nicosulfuron, mesotrione, and topramezone are labeled for use in sweet corn. Dicamba plus diflufenzopyr and tembotrione are being developed for postemergence applications in sweet corn. Two field studies were conducted to evaluate hybrid tolerance to these postemergence herbicides.

The first study evaluated hybrid tolerance to nicosulfuron, mesotrione, topramezone, and dicamba plus diflufenzopyr in experiments with a strip-plot arrangement and a single replication at sites in Oregon, Minnesota, Wisconsin, Illinois, New York, and Delaware. The main plot at each site was herbicide treatment and the subplot was sweet corn hybrid. Hybrids were planted in 6-m long single-row plots and hybrid order was randomized among sites. Seed companies entered hybrids to be evaluated for each herbicide treatment. Treatments were nicosulfuron at 70 g ai/ha; mesotrione at 210 g ai/ha; topramezone at 37 g ai/ha; dicamba at 28 g ae/ha plus diflufenzopyr at 11 g ae/ha plus the safener isoxadifen-ethyl; and a nontreated control for each herbicide treatment. Herbicide rates were twice the labeled or anticipated labeled rate to differentiate among tolerant and susceptible hybrids. Herbicides were applied at the V3 growth stage. Crop injury ratings were taken at 3, 7, and 14 days after treatment (DAT).

The second study was designed as a preliminary study to determine the potential need for future hybrid tolerance testing to tembotrione and if dicamba plus diflufenzopyr affected late-season sweet corn development. The study had a strip-plot arrangement with a single replication at sites in Minnesota, Wisconsin, New York, and Delaware. Twenty-eight hybrids were planted in 6-m long single-row plots and hybrid order was randomized among sites. Treatments were tembotrione at 184 g ai/ha plus the safener isoxadifen-ethyl; dicamba at 28 g/ha plus diflufenzopyr at 11 g/ha plus the safener isoxadifen-ethyl; and a nontreated control. Crop injury ratings were taken at 3, 7, and 14 DAT and sweet corn was harvested for yield.

In the first study, 58 of the 87 topramezone-treated hybrids had 1% or less chlorosis at 7 DAT. No hybrid exceeded 5% chlorosis when treated with topramezone. All of the 72 hybrids treated with dicamba plus diflufenzopyr had lodging of at least 10% of the plants within the plot at 3 DAT. Stunting of at least 10% occurred in 43 of the 72 hybrids by 14 DAT. At least 10% general leaf wrapping occurred in 42 of 72 hybrids. Hybrids treated with mesotrione or nicosulfuron exhibited differential hybrid response as expected. The 59 hybrids that were evaluated for mesotrione tolerance had 0 to 51% chlorosis at 7 DAT. At least 10% chlorosis was observed in 21 of 59 hybrids evaluated. The 64 hybrids that were evaluated for nicosulfuron tolerance ranged from no injury to plant death. At least 10% stunting was observed for 33 of 64 hybrids evaluated.

In the second study, Merit was the only hybrid of the 28 hybrids that had significant injury from tembotrione and was killed. Dicamba plus diflufenzopyr caused greater than 10% lodging for 27 of the 28 hybrids in the study. At least 10% stunting occurred in 17 of 28 hybrids at 14 DAT while leaf wrapping was observed on 23 of 28 hybrids at 30 DAT.

Field research has been conducted for 3 years to determine the postemergence tolerance of 185 and 179 hybrids to nicosulfuron and mesotrione applications, respectively. The tolerance of the field-tested hybrids was classified as tolerant, intermediate, sensitive, or highly sensitive. Guidelines to manage the risk of nicosulfuron or mesotrione injury of specific sweet corn hybrids based on their tolerance have been developed to supplement guidelines on the label provided by DuPont for Accent® or Syngenta for Callisto®.

GENETIC BASIS OF SWEET CORN SENSITIVITY TO AE 0172747. Martin M. Williams II and Jerald K. Pataky, Ecologist, United States Department of Agriculture – Agricultural Research Service, Urbana, IL 61801 and Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Tembotrione (AE 0172747) inhibits the 4-hydroxyphenyl-pyruvate-dioxygenase (HPPD) enzyme and is presently being considered for registration for use in all types of corn, including sweet corn. Some sweet corn hybrids are severely injured or killed by tembotrione, yet a mechanistic understanding of sensitivity in sweet corn to tembotrione has not been reported. Field studies were used to 1) test the hypothesis that the genetic basis of sweet corn sensitivity to tembotrione is the same recessive gene that conditions sensitivity to mesotrione (also an HPPD inhibitor), and 2) compare the extent of early-season herbicide injury from tembotrione and mesotrione on sweet corn hybrids. The first objective was tested using a total of 136 S_2 families derived from a cross of two inbreds; one known to be sensitive to mesotrione and one known to be tolerant. The numbers of S_4 plants with and without injury symptoms in each family were used to classify families as sensitive, segregating, and tolerant seven days after application of 184 g tembotrione ha^{-1} plus isoxadifen-ethyl at the four- to five-leaf stage. Based on Chi-square goodness of fit tests, responses of families both years fit a 3 sensitive : 2 segregating : 3 tolerant ratio ($p=0.24$), which would be the expected segregation pattern if sensitivity to tembotrione was conditioned by a single recessive gene. The second objective was tested in six field experiments by quantifying the extent of early-season injury to 249 sweet corn hybrids from application of tembotrione (184 g ai ha^{-1}) plus isoxadifen-ethyl or mesotrione (210 g ai ha^{-1}). An association between sensitivity to tembotrione and mesotrione was also evident among sweet corn hybrids; 193 hybrids had minimal (<10%) injury from both herbicides, while seven hybrids were severely (>50%) injured or killed by both herbicides. Responses of hybrids to tembotrione and mesotrione shared a distinct pattern for hybrids that previously were identified as being homozygous for alleles at a locus on chromosome 5S conditioning sensitivity to mesotrione, homozygous for alleles conditioning herbicide tolerance, or heterozygous. We conclude that the single recessive gene that conditions sensitivity to tembotrione is the same gene or a closely linked gene that conditions sensitivity to mesotrione and several other postemergence herbicides. Despite the apparent common genetic basis for sensitivity to tembotrione and mesotrione, important practical differences were observed in early-season response to these two herbicides for plants that were presumably homozygous recessive and heterozygous for the allele conditioning herbicide sensitivity.

EVALUATION OF S-METOLACHLOR AND MESOTRIONE IN SWEET SORGHUM.

Joseph G. Masabni and William K. Vencill, Assistant Professor, Department of Horticulture, University of Kentucky, Princeton, KY 42445 and Associate Professor, Department of Crop and Soil Sciences, University of Georgia, Athens, GA 30602.

Introduction

Sweet sorghum is an important crop for Amish and Mennonite growers in Kentucky who rely on sweet sorghum syrup (popularly known as sorghum molasses) to attract tourists who enjoy watching cooking and bottling of the syrup. Very few herbicides are currently labeled for use in sweet sorghum due to the reluctance of pesticide companies to register chemicals. Syngenta Company is interested in this crop and continues to evaluate various herbicides and their combinations for their safety and efficacy.

A cooperative study with Syngenta was initiated to evaluate mesotrione herbicide applied alone or tank-mixed with s-metolachlor at various rates applied at 2 timings. Two similar studies were also established in Athens and Blairsville, GA with similar protocols and treatment lists. S-metolachlor and mesotrione and currently labeled for a variety of vegetable crops and have proven to be safe and effective in many crops.

Materials and Methods

In Kentucky, herbicides were applied using a CO_2-pressurized backpack sprayer with a four 11002-nozzle boom calibrated to spray a 1.8 m band at 30 psi and 5.1 kph. The nozzles were set at 20.3 cm above ground to obtain good spray overlap and complete spray coverage. Plots were 1.8 m x 7.6 m long. The experimental design consisted of a randomized complete block with 3 replications with 1 row of ‘Dale’ and 1 row of ‘M81-E’ in each treatment.

The experimental design specified applying the same set of herbicide treatments at 2 dates. The first set of treatments or the preplant (Pre-Plant) treatments (trts. 1 to 8) were applied on 14 June 2007. The second set of treatments or the preemergence treatments (PRE) (trts 9-15) were applied 15 days later on 29 June 2007. All treatments were applied early in the morning when the wind was calm, and soil and air temperatures were 18.3-21.1C and 29.4-30.5C, respectively. Concep III-treated sweet sorghum cultivars, ‘Dale’ and ‘M81-E’, were seeded immediately after PRE herbicide application. Each plot consisted of 1 row of each sweet sorghum cultivar with rows 0.76 m apart and seed spacing of 10 cm within rows. At harvest, plants were cut at ground level and whole plant fresh weight was measured for each cultivar separately.

In Georgia, the experiment was replicated at two locations, Blairsville and Athens. Herbicides were applied using a CO_2-pressurized backpack sprayer with one 11003-nozzle boom calibrated to spray a 1.8 m band at 30 psi and 5.1 kph. The nozzles were set at 36 cm above ground to obtain good spray overlap and complete spray coverage. Plots were 3 m x 7.6 m long. The experimental design consisted of a randomized complete block with 4 replications.

The experimental design specified applying the same set of herbicide treatments at 2 dates. The first set of treatments or the preplant (Pre-Plant) treatments (trts. 1 to 8) were applied on 16 May 2007 at Blairsville’s site and on 2 May 2007 at Athens’ site. The second set of treatments or the preemergence treatments (PRE) (trts 9-15) were applied on 30 May 2007 at Blairsville’s site and on 15 May 2007 at Athens’ site. Concep III-treated sweet sorghum cultivar ‘M81-E’ was the only cultivar used in GA.

Results and Discussion

In Kentucky, at 22 days after Pre-Plant, sweet sorghum was 3.8 to 5 cm tall. At this date, visual injury ratings were taken for both cultivars combined (data not presented). No stunting was observed in any treatment at 22 days after Pre-Plant. The highest bleaching counts were found with mesotrione 0.42 kg ai/ha applied PRE alone (treatment 11) or tank-mixed with s-metolachlor at 1.39 kg ai/ha. Bleaching ranged from 15-22%. No significant bleaching levels were observed with the lowest rate of mesotrione tank-mixed with s-metolachlor (treatment 12). In general, more bleaching instances were observed in the PRE treatments than with the Pre-Plant treatments.

In the s-metolachlor and mesotrione tank-mix treatments, honeyvine milkweed was also bleached with yellowing of the growing point and weak growth. At 15 days after PRE, very few plants showed bleaching or stunting injury (data not presented). It appears that sweet sorghum has totally recovered from any initial injury whether treatments were applied Pre-Plant or PRE. At 29 days after PRE, sweet sorghum cultivars were at the 3 to 4 leaf stage and 25.4-35.6 cm tall. No bleaching or stunting was evident in any plot at this date either (data not presented).

Table 1 lists the plant fresh weight (kg/plot) at harvest. None of the herbicide treatments applied on either date resulted in significant yield reduction compared to the handweeded control. In addition, yields of the 2 cultivars were similar and ranged from 48 to 65 kg/plot for 'Dale' and 45 to 65 kg/plot for 'M81-E'.

This study indicated that mesotrione and s-metolachlor applied alone or in tank mixes are safe herbicides for use in sweet sorghum.

In Blairsville, GA, cool and dry conditions made for a challenging growing season. Access to irrigation water was very limited. The sweet sorghum displayed generally good tolerance to mesotrione although visual injury was present for several weeks at the highest rate. Weed control and yields trended higher from the PRE combination of mesotrione and s-metolachlor (Table 2). S-metolachlor alone did not provide adequate weed control and yields reflected this. The addition of mesotrione improved weed control and yield.

In Athens, GA, sweet sorghum tolerance to mesotrione was generally good although mostly cosmetic mesotrione injury could be seen several weeks after planting. Weed control was generally better from mesotrione/s-metolachlor combinations applied at planting. Unexpectedly, yields were higher from preplant applications. This may have resulted from early season injury from mesotrione. S-metolachlor alone did not provide adequate weed control and the mesotrione/s-metolachlor combination worked very well in that regard.

EVALUATION OF AE 0172747 IN SWEET CORN. Joseph G. Masabni, Assistant Professor, Department of Horticulture, University of Kentucky, Princeton, KY 42445.

An experiment was conducted at Princeton, KY in 2007 to evaluate the performance and safety of AE 0172747 (Laudis) applied postemergence at the V3-V4 stage on four sweet corn cultivars 'Candy Corn,' 'Incredible,' 'Providence,' and Silver Queen.' Laudis was applied at 0.092 and 0.18 kg ai/ha in tank mixtures with atrazine 0.56 kg ai/ha and with MSO and UAN adjuvants. Western Kentucky experienced a long draught period in 2007 which resulted in reduced weed pressure in all treatments including the untreated controls. Sweet corn was seeded at the rate of 33 seeds per cultivar per plot. Sweet corn cultivars were harvested between 70 and 79 days after seeding for 'Candy Corn' and 'Silver Queen,' respectively. No significant differences were observed in terms of number and weight of ears per plot for 'Candy Corn' and 'Incredible.' Number of ears ranged between 27 and 35 ears/plot for 'Candy Corn' and 35 to 55 ears/plot for 'Incredible,' while weight of ears/plot ranged between 7 to 10 kg/plot and 11 to 14 kg/plot for 'Candy Corn' and 'Incredible,' respectively. Number of ears/plot for 'Providence' wasn't significantly different among all treatments and ranged from 16 to 29 ears/plot. However, harvest weight for 'Providence' was reduced from 9 kg/plot to 5 kg/plot in treatments that included atrazine in the treatment mix, for both rates of Laudis. No trend was observed with 'Silver Queen' cultivar where harvest weights was non-significant for all treatments, while number of ears/plot was highest for Laudis 0.18 kg ai/ha tank-mixed with atrazine and lowest for Laudis 0.092 kg ai/ha applied alone.

Introduction

AE 0172747 (Laudis 3.5 lb ai/gal) is an experimental herbicide being developed by Bayer CropScience. Laudis is a postemergence herbicide for potential use in popcorn and sweet corn. Bayer CropScience has evaluated Laudis and is interested in evaluating its safety and efficacy on Kentucky local sweet corn cultivars. An experiment was conducted at the Princeton research station to evaluate Laudis performance and safety when applied at the 3 to 4 leaf stage, alone or tank-mixed with atrazine.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a four 11002-nozzle boom calibrated to spray a 1.8 m band at 30 psi and 5.1 kph. The nozzles were set at 20.3 cm above ground to obtain good spray overlap and complete spray coverage. Plots were 3.6 m x 7.6 m long. The experimental design consisted of a randomized complete block with 3 replications.

On 30 April 2007, plots were seeded with 4 sweet corn cultivars, namely, Candy Corn (76 d, Sh2, bi-color); Incredible (83 d, se, yellow); Providence (80 d, se, bi-color); Silver Queen (92 d, su, white). Spacing between rows was set at 76 cm and spacing within rows at 23 cm.

The preemergence (PRE) treatments were applied on 1 May 2007. The postemergence (POST) treatments were applied on 25 May 2007, when plants were 15 to 25 cm tall at the 3 to 4 leaf stage (V3-V4). All treatments were applied early in the morning when the average wind speed was 4 kph, and soil and air temperatures were 10-13C and 19.4-20C, respectively.

Visual weed control ratings were made on 1 June (7 days after treatment or 7 DAT). Ratings were on a scale of 1 to 10, where 1 = no control or no injury observed and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value. The 2007 season was very hot and dry resulting in very low weed pressure. All plots were very clean from weeds and didn't require multiple weed control evaluations. All plots were irrigated 1 to 2 times per week. The hot and dry weather also resulted in a sweet corn harvest 6 to 12 days earlier than expected based on the varietal descriptions.

Results and Discussion

At 22 DAT, all sweet corn plots appeared healthy and vigorous, with no visible sign of herbicide injury. At 7 days after POST application, few weeds were present in all plots. This was attributed to the drought that occurred in May since all plots were weed-free, even in the untreated control (treatment 1). Yellow nutsedge, ryegrass (fall cover crop), curly dock, johnsongrass were found occasionally and randomly in some plots. Large crabgrass was found in untreated control plots. Honeyvine milkweed that were already germinated at time of POST treatment application, were bleached white and stunted. Newly emerged honeyvine milkweed appeared healthy, except in treatment 6. All 4 sweet corn cultivars appear normal.

Sweet corn yields in terms of numbers of ears per plot and total ear weigh per plot didn't differ for 'Candy Corn' and Incredible' cultivars (Table 1). Some differences in total yields were observed for numbers of ears/plot for 'Providence' and weight of ears/plot for 'Silver Queen' (Table 2).

It appears that the non-labeled herbicide Laudis has a great potential for use on sweet corn as a postemergence herbicide for use at the V3-V4 stage. Additionally, a split application of atrazine, 0.56 kg/ha preemergence and 1.12 kg/ha at the V3-V4 stage, appears to be safe and very effective on controlling weed escapes and difficult weeds such as honeyvine milkweed.

WEED CONTROL FEASIBILITY IN LARGE-SCALE ORGANIC SNAP BEAN AND SWEET CORN PRODUCTION. Heidi J. Kraiss, Jed B. Colquhoun, and Richard A. Rittmeyer, Graduate Research Assistant, Associate Professor, and Research Associate, University of Wisconsin, Madison, WI 53706.

The upper Midwest produces over 50% of the processed sweet corn and snap beans in the U.S. Recent organic market growth has stimulated interest in expanding this industry to include organic processing vegetables. A significant hurdle in developing this industry is the ability to grow organic vegetables on a larger scale where existing weed control methods, such as hand weeding, are not practical. This study focused on the feasibility of managing weeds in organic sweet corn and snap beans, utilizing methods that are practical and economical in large acreage. Organic weed management treatments consisted of either a single management tactic or combinations of tactics including different methods and number of cultivations and utilization of a stale seedbed. An herbicide-based conventional treatment was also included for comparison. Organic weed management was feasible in a short season crop, such as snap beans, with similar yield between organic and conventional management. However, in a long season crop, such as sweet corn, organic weed management was more difficult. Weeds competed more effectively and for a longer period with the crop and thus sweet corn yields in organically managed plots were less than in those managed conventionally. Results are discussed within the context of the economics of organic production methods and premium prices received for organically produced vegetables.

PERENNIAL WEED CONTROL IN A JUNEBERRY ORCHARD. Harlene M Hatterman-Valenti and Collin P Auwarter, Associate Professor, and Research Specialists, Plant Sciences Department, North Dakota State University, Fargo, Fargo, ND 58105.

Currently no selective herbicides are registered for use on juneberry in an orchard. However, once the EPA revised pesticide tolerance crop-grouping regulations are completed; juneberry will be included in the berry group along with blueberry. In an orchard setting, perennial weed control is extremely important and very difficult. The objectives of the trial were to compare perennial weed control when herbicides were applied either in the fall after leaf drop or in the spring prior to bud break.

Spring-applied herbicides provided better common dandelion control compared to fall-applied herbicides. Application timing did not affect Canada thistle, perennial sowthistle, or quackgrass control. This may have been attributed to their lower densities and patchiness in comparison to common dandelion. None of the herbicides injured juneberry regardless of the application timing. Dichlobenil and rimsulfuron provided the best season-long control of the four perennial weeds, even though control decreased with time. Fumioxazin, sulfentrazone, and mesotrione generally provided poor control of the four perennial weeds. In 2006, perennial sowthistle numbers increased following the mesotrione applications compared to the untreated. Further research will focus on tank-mixes to broaden the spectrum and enhance perennial weed control.

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THE USE OF MESOTRIONE FOR WEED CONTROL IN MINOR CROPS. Venance H. Lengkeek, Darren Lycan and Gordon Vail, Syngenta Crop Protection, Greensboro, NC 27419.

Field studies were initiated in 2004 to evaluate mesotrione for use in minor crops. Trials in 2005, 2006 and 2007 were conducted to further refine the level of crop tolerance and weed control from mesotrione. These field trials confirm that mesotrione is effective for control of weeds in asparagus, blackberry, blueberry, cranberry, flax, grasses grown for seed (tall fescue, Kentucky bluegrass, perennial ryegrass), millet (proso and pearl), oats, okra, raspberry, rhubarb, sugarcane, sorghum (grain and sweet).

PRE- AND POSTEMERGENCE WEED CONTROL IN CULINARY HERBS. Eric J. Ott, Chad M. Herrmann, and Bernard H. Zandstra, Research Assistant, Graduate Research Assistant, and Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824.

The demand for culinary herbs has greatly increased over the past two decades. Culinary herb producers have few herbicide options, and most weed control practices include labor intensive practices such as cultivation and hand weeding. Three field experiments utilizing six crops were established in 2007 near Momence, Illinois at Van Drunen Farms to evaluate new herbicide options for weed control in culinary herb production. The crops included in these trials include basil (*Ocimum basilicum* L.), chive (*Allium schoenoprasum* L.), cilantro (*Coriandrum sativum* L.), dill (*Anethum graveolens* L.), fennel (*Foeniculum vulgare* L.), and parsley (*Petroselinum crispum* L.).

All three experiments utilized three replications in a randomized complete block design. Plot dimensions 4 feet wide by 30 feet long. All PRE herbicides were applied May 8, and all POST herbicides were applied June 6. Experiments were visually rated twice (June 6 and June 29). Crop varieties utilized in experiments included ‘Caesar’, ‘Genova’, ‘Esmeralda’, ‘Plenty’ basil, ‘Slobolt’ cilantro, ‘Monmouth’ dill, ‘Zefafino’ fennel, ‘Green Curled’ parsley, and ‘Talman’ chive. Basil, chive, cilantro, and dill were harvested June 29, and fennel and parsley were harvested July 31.

In basil, napropamide at 2 lbs/acre, clomazone at 0.25 lbs/acre, and ethalfluralin at 0.74 lbs/acre applied PRE provided 90-100% grass and broadleaf control without significant crop injury or yield reduction. Bentazon at 0.5 lbs/acre applied POST also provided 90-100% broadleaf control without significant crop injury or yield reduction. S-metolachlor at 0.63 lbs/acre and pendimethalin at 0.7 lbs/acre applied PRE severely reduced basil stand and yield.

In cilantro, dill, fennel, and parsley, there was no significant crop injury, or yield reduction from linuron at 0.5 lbs/acre, prometryn at 0.5 lbs/acre, pendimethalin at 0.5 lbs/acre, trifluralin at 0.5 lbs/acre, and clomazone at 0.25 lbs/acre when applied PRE. S-metolachlor at 0.63 lbs/acre and ethofumesate at 1 lb/acre were slightly injurious to dill and fennel 29 days after application when applied PRE. However, dill and fennel were able to overcome the early season injury, and no significant reduction in yield occurred. POST applications of linuron at 1 lb/acre slightly injured dill and parsley, but did not reduce yield significantly. Fennel was injured slightly from POST applications of linuron at 1 lb/acre and prometryn at 1 lb/acre, but yields were not reduced.

In established chive, PRE applications of pendimethalin at 0.7 lbs/acre, dimethenamid-P at 0.56, ethofumesate at 1 lb/acre, and oxyfluorfen at 0.125 lb/acre did not significantly injure or reduce yield of established chive. PRE application of s-metolachlor at 0.63 lbs/acre did not visually injure established chive, but did reduce yield compared to the untreated check. POST applications of bentazon at 0.5 lbs/acre, oxyfluorfen at 0.063 lbs/acre, ethofumesate at 1 lb/acre, and flumioxazin at 0.032 lbs/acre did not significantly injure or reduce yield of established chive.

DEVELOPMENT OF A CULTIVAR COMPETITIVENESS RANKING SYSTEM FOR POTATOES. Christopher M. Konieczka, Jed B. Colquhoun, and Richard A. Rittmeyer, Graduate Research Assistant, Associate Professor, and Research Associate, University of Wisconsin, Madison, WI 53706.

Potato producers rely heavily on herbicides for the majority of weed control. However, recent occurrences of herbicide resistant weeds and the lack of new herbicide registrations have stimulated interest in alternative strategies. While most alternative strategies, such as cultivation and flame weeding, rely on additional energy inputs, the most important weed control decision may be made when loading the planter. The choice of a potato cultivar that suppresses or tolerates weeds can be a component of an integrated weed management system that reduces the reliance on herbicides. The objective of this research was to develop a potato cultivar competitiveness ranking system based on emergence and canopy development, weed suppression, and ability to maintain crop yield in the presence of weeds. Ten potato cultivars (‘Atlantic,’ ‘Bannock Russet,’ ‘Dark Red Norland,’ ‘Goldrush,’ ‘Rodeo,’ ‘Russet Burbank,’ ‘Russet Norkotah,’ ‘Snowden,’ ‘Superior,’ and ‘Villetta Rose’) were evaluated in 2006 and 2007 in Hancock, Wisconsin. The study was arranged in a randomized complete block split-plot design with cultivar as the main plot factor and weed pressure as the sub-plot factor. Weed pressures included: 1) potatoes that remained weedy throughout the season; 2) potatoes that were hand-weeded for four weeks after emergence; and, 3) potatoes that were hand-weeded for the duration of the season. Early season emergence was slowest where ‘Bannock Russet’ and ‘Rodeo’ were grown. Early-season canopy development was greatest for ‘Russet Burbank’ and least for ‘Bannock Russet.’ In 2006, weed biomass in potatoes that were hand-weeded for four weeks after emergence was greatest in ‘Bannock Russet’ and least in ‘Atlantic,’ ‘Dark Red Norland,’ ‘Snowden,’ and ‘Superior.’ Early-season emergence, canopy development and light interception, and weed biomass were strongly related to potato yield. In 2006, ‘Bannock Russet’ potato yield was reduced compared to ‘Russet Burbank’ both when potatoes were left weedy throughout the season and when they were hand-weeded for four weeks after emergence. ‘Goldrush’ yield was also less than that of ‘Russet Burbank’ when left weedy throughout the season. In 2007, yield was lowest when ‘Bannock Russet’ remained weedy throughout the season.

RESPONSE OF COMMERCIAL PROCESSING TOMATO CULTIVARS TO POSTEMERGENCE APPLICATIONS OF THIFENSULFURON-METHYL. Douglas Doohan, Greg Kruger, and Stephen C. Weller, Associate Professor, Ohio Agriculture Research and Development Center, The Ohio State University, Wooster, OH, 44691 Graduate Research Assistant and Professor, Purdue University, West Lafayette, IN 47907.

Experiments in Ohio and Indiana in 2007 evaluated the effect of postemergence applications of thifensulfuron-methyl to several cultivars of commercially grown processing tomatoes. In Ohio, cultivars evaluated were: TR12, 818, 611, 9704, 401,7983, 46TJ and 331. In Indiana, cultivars evaluated were: 818, 611, 9704, 401, 7983 and 331. Treatments of thifensulfuron-methyl included 0g/ha, 8g/ha or 16 g/ha rate + 0.25% non-ionic surfactant applied to tomatoes approximately one month after transplanting. Evaluations included leaf chlorosis at one and two weeks after treatment based on a 0 to 10 scale (where 0 = no chlorosis and 10 equals complete plant chlorosis) and fruit yield at the end of the season. Evaluations were similar at both locations and treated plants were compared to an untreated control for each cultivar. All cultivars, at both locations, showed initial chlorosis of leaves at the shoot tip, although, injury was mild for all cultivars except TR-12. All cultivars except TR-12 recovered within 3 to 4 weeks of treatment and there were no other negative effects observed relating to plant growth. Yields were measured when untreated control plants had 90% or greater ripe fruit. For all cultivars, except TR-12, there were no differences in the weight of ripe fruit or green fruit compared to the untreated control plants at either location. TR-12 plants were severely injured and yield was reduced. Thifensulfuron-methyl appears to be a good candidate herbicide for postemergence broadleaf weed control in processing tomatoes. Similar experiments conducted in Ohio and Indiana over the past 3 years support this conclusion. TR-12 does appear to be a susceptible cultivar to thifensulfuron-methyl as it exhibited more injury than any other cultivar tested.

RESPONSE OF PROCESSING TOMATOES TO SIMULATED DRIFT OF DICAMBA AND GLYPHOSATE. Stephen C. Weller, Ben Alkire, Triston Tucker and Greg Kruger Professor, Research Associate and Graduate Research Assistants, Purdue University, West Lafayette, IN 47907.

Simulated drift studies with either dicamba or glyphosate were conducted in 2007 in Indiana to assess the potential for damage from off-site movement of these two herbicides. The study used tomato cultivar 611 which is a commonly grown processing variety of tomato in the Midwestern US. Experiments were initiated to gather more quantitative data relating to the time of drift related to crop growth stage and any effects the timing of drift or the amount of drift had on crop growth, development, and yield.

Tomato plants were transplanted on May 3, 2007 and simulated drift treatments were made to separate groups of plants 20 and 48 days after transplanting. These timing were selected based on usual spray dates of these herbicides in agronomic crops. These timings were also selected to determine what effect herbicide drift had on tomatoes that had recovered from transplant shock (20 DAP) or had initiated flowering (48 DAP). Dicamba and glyphosate treatments were 0.33X, 0.1X, 0.033X, 0.001X, 0.003X and .0001X with X being the normal use rate for either herbicide. Dicamba X rate was 0.56 kg/ha (1.18L ae/ha) and glyphosate X rate was 0.875 kg/ha (1.48 ae L/ha). The glyphosate formulation used did not contain any additives. AMS and non-ionic surfactant were added to each drift concentration spray at 2.8 kg/ha and 0.25% respectively. All sprays were applied over the top of the tomatoes with a CO_2 pressurized backpack sprayer at 270 L/ha spray volume at 165 kPa. The experiment was a split plot with timing being the main plot and rate being the subplot. Measurements taken were crop injury at 1 and 2 weeks after treatment and final crop yield.

Timing of the drift incident was a significant factor for both herbicides as was rate response. Glyphosate applied to plants 20 DAP caused greater visual injury but less loss of fruit yield at all drift rates than treatments applied at 48DAP. Injury was observed as plant death at 0.33X and severe yellowing of the plants up to 0.01X for both timings. Reduction in ripe fruit at the time of harvest was most severe for the 48 DAP treatment. For instance, a 50% reduction in ripe fruit at time of harvest required a rate of 0.18X at 20 DAP but only a 0.04X rate at 48 DAP. Dicamba pattern of plant injury, primarily epinasty, was apparent at both application timings at all rates but more severe at rates above 0.003X. As with glyphosate, the pattern of yield loss was greater with 48 DAP treatments than from 20 DAP treatments. The biggest difference between the two herbicides was that dicamba drift at 48 DAP caused more severe yield loss at much lower rates than glyphosate. A 50% reduction in ripe fruit was caused by a drift rate of 0.01X at 48 DAP while at 20 DAP a rate of 0.11X was required. Results of this study show that timing of drift is important in the total amount of fruit yield reduction observed. Drift early in the season causes problems, however, a drift incident at the time of flower formation results in the greatest delay in fruit maturity and loss of fruit yield.

WEED CONTROL IN NO-TILL PUMPKINS. Elizabeth T. Maynard, Regional Extension Specialist, Purdue University, Westville, IN 46391-9542.

No-till production systems for pumpkins are of interest to Midwest producers, but achieving acceptable weed control without cultivation can be difficult. Research was conducted in Wanatah, IN in 2007 to evaluate postemergence (POST) weed control options for pumpkins no-till (NT) planted into a fall-seeded, spring-killed winter wheat cover crop. Weed control and yield in the no-till system were compared to those for conventional tillage with one cultivation (CT). Winter wheat in NT plots was treated on 21 May and 8 June with glyphosate at 0.75 lb ae/A. After seeding 'Magic Lantern' pumpkins on June 11, four NT treatments and CT were sprayed with a premix of ethalfluralin + clomazone (Strategy) at 0.8 + 0.25 lb ai/A. A fifth NT treatment received no herbicide (WDY). On July 13 CT plots were cultivated and the following POST treatments were applied to separate NT treatments: nothing (ST), halosulfuron broadcast at 0.375 oz/A (SAN), or glyphosate between rows at 0.75 lb ae/A using a hooded sprayer (GLY). One of the remaining NT treatments was handweeded (HW) between July 13 and Aug. 3. Three wk after planting overall weed control was worst in WDY plots. For the most prevalent weeds, common lambsquarters and carpetweed, there was no difference in control between other treatments. Eight d after POST treatments, crop injury was worse for SAN than for GLY and other treatments showed no injury. Overall weed control was better in GLY and CT than ST; weed control in HW and SAN was intermediate between GLY and ST; WDY had the heaviest weed pressure. Control of common lambsquarters was best in CT but not significantly different from GLY. Thirty-three d after POST treatments, crop vigor was better in CT and GLY than ST, SAN or WDY; HW plots were between GLY and ST. Crop injury remained highest in SAN. Overall weed control was better in HW than CT, SAN, ST or WDY; GLY plots were between HW and CT. Control of common lambsquarters was best in CT, GLY and HW, followed by SAN and ST, and worst in WDY. Marketable yield and fruit number per acre were highest in GLY and HW treatments, followed by CT which was not significantly lower, and lowest in WDY. ST and SAN treatments produced yields between CT and WDY treatments. Average fruit size was larger for GLY, CT, HW, and ST than for SAN and WDY. The results suggest that weeds in no-till pumpkins can be controlled reasonably well using a combination of a preemergence herbicide and a row-middle application of a nonselective herbicide with no residual activity, resulting in yield and fruit size comparable to conventional tillage with a preemergence herbicide and one cultivation. Additional measures would be required to prevent weed seed production and shed. Future trials could include additional herbicides labeled for preemergence or row-middle use, different cover crop management practices, and treatments designed specifically to minimize weed seed additions to the soil.

EVALUATION OF HERBICIDES UNDER PLASTIC MULCH IN BELL AND HABANERO PEPPER. Joseph G. Masabni, Assistant Professor, Department of Horticulture, University of Kentucky, Princeton, KY 42445.

Clomazone and trifluralin are labeled for use in pepper. However, labels don't specifically allow or prohibit their use under plastic before transplanting. An experiment was conducted in Princeton KY to evaluate clomazone and trifluralin safety and performance when applied under plastic before transplanting Bell and Habanero peppers.

Habanero pepper showed more initial injury than Bell peppers for all similar herbicide treatments. Injury ratings ranged from 30-50% for Habanero and 20-30% for bell pepper. Both pepper cultivars later recovered from the initial herbicide injury. No treatment differences were observed for Habanero pepper yields. Total yields at end of harvest for Habanero peppers ranged from 315 to 946 fruits/plot and 3.1 to 6.5 kg/plot. Clomazone applied alone or tank-mixed with trifluralin resulted in significantly higher yields from the untreated control of Bell pepper in terms of fruit number and weight per plot. The high rate of trifluralin 1.12 kg ai/ha (treatment 10) was not significantly different from the untreated control in terms of total yield (kg/plot) of Bell pepper. Trifluralin 1.12 kg ai/ha rate applied alone (treatment 10) appears to have injured both pepper cultivars resulting in reduced yields comparable to the untreated control. Trifluralin 0.9 kg ai/ha had no negative effect on either cultivar.

Introduction

Clomazone and trifluralin are preemergence herbicides for the control of many broadleaves and grasses. Both are labeled for use in pepper when incorporated before transplanting pepper. Most vegetable growers in Kentucky grow transplanted peppers on plastic mulch and struggle with weeds growing through the planting hole. Although the clomazone and trifluralin labels don't specifically prohibit their use under plastic, the labels don't clearly allow that use either. Growers would like to apply herbicides under plastic.

An experiment was conducted at the Princeton research station to evaluate clomazone and trifluralin and efficacy and safety when applied pre-transplant under the plastic mulch on Bell and Habanero peppers.

Materials and Methods

Herbicides were applied using a CO_2-pressurized backpack sprayer with a two 11002-nozzle boom calibrated to spray a 1.8 m band at 30 psi and 5.1 kph. The nozzles were set at 20.3 cm above ground to obtain good spray overlap and complete spray coverage. Plots were 0.9 m x 3 m long. The experimental design consisted of a randomized complete block with 3 replications.

The pre-transplant (PRT) treatments were applied on 15 May 2007. All treatments were applied early in the morning when the average wind speed was 3.2 kph, and soil and air temperatures were 15.5C and 16.6C, respectively. Herbicides were sprayed on the top of newly formed beds, after which the plastic was laid down. Pepper plants were transplanted 4 hrs after completion of herbicide sprays. One row of each pepper cultivar was transplanted on each bed, with 30.4 cm spacing within plants and between the 2 rows.

Visual weed control ratings were made on 23 May (8 days after treatment or 8 DAT), 12 June (28 DAT) and 22 June (38 DAT). Ratings were on a scale of 1 to 10, where 1 = no control or no injury observed and 10 = complete kill or no weeds present. A rating of 7 (70-75% control) or more is considered a commercially acceptable value. Bell peppers were harvested 5 times between 10 July and 13 August. Habanero were about 1 week later in harvest. Habanero peppers were harvested 5 times from 19 July to 21 August.

Results and Discussion

At 8 DAT, Habanero pepper showed more injury than bell peppers for all similar herbicide treatments. Injury ratings ranged from 30-50% for Habanero and 20-30% for bell pepper (Table 1). Although this injury was not economically significant, it was statistically significant compared to the untreated or handweeded control. By 28 DAT, both pepper cultivars recovered slightly from the initial herbicide injury. Bell pepper injury ranging from 10-20% and was not significantly different from the controls. Habanero injury was still statistically significant at this date and ranged from 20-40%. Both pepper plants continued growth and development by 28 DAT with the injury rating reflecting some stunting and white bleaching in clomazone-containing treatments.

By 38 DAT, few weeds were found in all herbicide treatments (3 to 10) compared to the untreated control. At this date, surviving honeyvine milkweeds were severely stunted and bleached white. By 38 DAT, both pepper cultivars have completely recovered from all herbicide treatment. At harvest completion (Table 2), clomazone applied alone or in tank mixes with trifluralin resulted in significantly higher yields for both pepper cultivars in terms of fruit number and weight per plot, except for treatment 3. Yields ranged from 8.4-9.9 kg/plot for treatments 4, 5, 6, and 8. Low rate of clomazone 0.7 kg ai/ha (treatment 3) and the high rate of trifluralin 1.12 kg ai/ha (treatment 10) were not significantly different from the untreated control. Treatment 3 (clomazone 0.7 kg ai/ha) resulted in the highest total number and fruit weight of Habanero pepper at harvest completion. Trifluralin 1.12 kg ai/ha rate applied alone (treatment 10) appears to have injured both pepper cultivars resulting in reduced yields comparable to the untreated control. Trifluralin 0.9 kg ai/ha had no negative effect on either cultivar.

This study clearly indicated that clomazone at 0.7 or 1.4 kg ai/ha and trifluralin at 0.9 kg ai/ha are viable options for use under plastic in plasticulture production, even when plants are transplanted within 4 hours of herbicide application.

DOES PHENOLOGICAL DEVELOPMENT RATES EXPLAIN DIFFERENCES IN CHLOROACETANILIDE INJURY TO WHITE AND RED OAKS? Jayesh Samtani and John B. Masiunas, Graduate Research Assistant and Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois, 1201 West Gregory Drive, Urbana, IL 61801.

In the landscape, loss of interveinal tissue in developing leaves (leaf tatters) is common for white oak but not red oak. Our previous research identified the cause of leaf tatters as exposure of unfolding leaves to low concentrations of chloroacetanilide herbicides. The swollen bud or the expanded leaf stages are not susceptible to injury from chloroacetanilide herbicides. We found that both white and red oaks were injured by chloroacetanilide herbicides at the leaf unfolding stage. These findings led us to theorize that white and red oak leaves emerge at different times and white oaks were more likely to be at the leaf unfolding stage when farmers apply chloroacetanilide herbicides. A comparative leaf phenology study of the white and red oak was done at three sites in Urbana, IL: the University of Illinois Arboretum, Illini Grove and Crystal Lake Park. At each of these sites, we made phonological observations on paired white oaks and red oaks (four pairs at the Arboretum, five pairs at the Crystal Lake Park and six pairs at Illini Grove). Phenological events (expressed in Julian days) occurred when the entire canopy was at the 50% swollen buds, 50% leaves unfolding and 50% fully expanded leaves stages. The red oak expanded leaf stage occurred earlier during the Julian calendar year then the same stage in white oak. The duration in number of days between phenological events however was similar between the two oak species. The earlier emergence of the leaves on red oak could play a major role in explaining why leaf tatters are less common on red oak than white oak.

PLANT DISEASE CONTROL WITH GLYPHOSATE. Keith A. Kretzmer and Frank C. Kohn, Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, MO 63167.

Field activity of glyphosate against wheat rusts was demonstrated on glyphosate tolerant wheat at University of Minnesota and Washington State University. Additional laboratory and field studies have confirmed glyphosate activity against Asian soybean rust (ASR), caused by *Phakopsora pachyrhizi*, in glyphosate-resistant soybeans. Disease spectrum evaluations have demonstrated glyphosate activity against other plant diseases besides ASR. Studies showed that glyphosate provides both preventive and curative activities against ASR. Application of glyphosate prior to rust inoculation delayed the onset of disease. Glyphosate also displayed curative activity when applied within 6 days after rust inoculation. ASR activity was attributed to systemic glyphosate that required plant absorption and translocation, and little to no activity was observed with the surfactant system in a commercial glyphosate formulation. Field studies with Roundup Agricultural Herbicide formulations have demonstrated reduction in ASR severity and increased yield compared to untreated controls. Our results indicate that glyphosate is active against ASR and could provide incremental disease control benefits in glyphosate-resistant soybeans.

CHARACTERIZATION OF A WATERHEMP POPULATION WITH MULTIPLE HERBICIDE RESISTANCE ACROSS THREE MODES OF ACTION. Travis R. Legleiter*, Eric B. Riley, Kristin K. Payne and Kevin W. Bradley, University of Missouri, Columbia, MO.

Greenhouse experiments were conducted to determine the distribution and extent of resistance to glyphosate, acetolactate synthase- (ALS), and protoporophyrinogen oxidase-inhibiting (PPO) herbicides in a waterhemp (*Amaranthus rudis* Sauer) population located in Platte County, Missouri. Fourteen individual common waterhemp seedheads were harvested across a 5-km area at the Platte County site in 2006 and the location of each waterhemp accession (W01-W14) was recorded using a handheld global positioning system. Seed from each waterhemp accession and from two susceptible waterhemp accessions were gleaned from the collected seedheads, stored at 5° C for 3 months, and then planted in 25 by 50 cm greenhouse flats. After emergence, waterhemp seedlings were thinned to 20 plants per flat. All plants were treated with the potassium salt of glyphosate at 1.7 kg ae ha^{-1}, lactofen at 0.44 kg ha^{-1}, or thifensulfuron at 0.009 kg ha^{-1} once waterhemp reached 15 cm in height. An untreated check was also included for comparison. Visual ratings and survivorship were recorded at weekly intervals up to three weeks after treatment (3 WAT), at which time all plants were harvested and fresh and dry weights determined. All 14 accessions from the Platte County site exhibited greater than 65% survivorship in response to glyphosate and greater than 70% survivorship in response to thifensulfuron. Four of the Platte County waterhemp accessions also exhibited a differential response to lactofen. Utilizing the previously-recorded GPS coordinates, the results from these experiments indicate that glyphosate- and ALS-resistance occurs across the entire 5 km area at the Platte County site that was surveyed in 2006 while multiple resistance to glyphosate, ALS-, and PPO-inhibiting herbicides is more sporadic and confined to an area of approximately 2 km or less.

MANAGEMENT OF GLYPHOSATE-RESISTANT HORSEWEED FOR SOUTHERN ILLINOIS.
Tracy G. Mellendorf, Bryan G. Young, Joseph L. Matthews, Graduate Research Assistant, Professor, and Researcher, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

As glyphosate-resistant horseweed becomes more prevalent across southern Illinois, it is becoming increasingly important to incorporate additional modes-of-action with glyphosate applications. Glyphosate-resistant horseweed was confirmed in Illinois in 2006. Recommendations in adjoining states suggest 2,4-D and cloransulam as tank-mix partners with glyphosate to establish control of marestail. However, commercial experience in southern Illinois in 2006 demonstrated these tank-mix partners were inconsistent and often inadequate to meet grower expectations. Two field studies were conducted in 2006 and 2007 near Murphysboro, Illinois to evaluate herbicide strategies for control of glyphosate-resistant horseweed in soybeans. The majority of the horseweed populations were glyphosate-resistant with a small percentage remaining as glyphosate-susceptible.

The first study evaluated the potential interaction between glyphosate rate (860, 1260, and 1740 g ae/ha) and 2,4-D rate (530 and 1070 g ae/ha) as well as the efficacy of paraquat and glufosinate applied alone. Glyphosate applications resulted in slight chlorosis and temporary stunting prior to resuming normal growth. Glyphosate applied alone resulted in 53% or less control at 28 days after treatment (DAT) and no benefit was observed for increasing the rate of glyphosate. The combination of 2,4-D applied at 530 g/ha with glyphosate improved control of marestail but did not exceed 79% control. The maximum level of control observed with the higher rate of 2,4-D (1070 g/ha) applied with glyphosate was 92%. Interestingly, control of marestail was greater with 2,4-D applied at 1070 g/ha when the rate of glyphosate was increased from 860 g/ha to 1260 g/ha. This may be an artifact of the higher adjuvant concentration contributed from the glyphosate formulation rather than a true interaction of the herbicide active ingredients. Control of marestail at 28 DAT with paraquat and glufosinate averaged 97 and 94%, respectively.

In the second study all herbicide treatments consisted of two-pass programs that included a preplant burndown herbicide application and a subsequent postemergence in-crop application. Control of marestail at 14 days after the postemergence application was less than 75% when only glyphosate was used in the burndown and either cloransulam, chlorimuron and thifensulfuron, or 2,4-DB was used as a tank-mix with glyphosate for the postemergence application. This highlights that growers must achieve control of glyphosate-resistant marestail prior to planting since herbicide options after planting have limited efficacy. Applying cloransulam in combination with glyphosate in the burndown application resulted in greater control of marestail than cloransulam postemergence. Furthermore, utilizing cloransulam in the burndown application followed by cloransulam in the postemergence application did not result in any improvement in marestail control compared with cloransulam applied only in the burndown application. Thus, applying sequential applications of an ALS-inhibiting herbicide to emerged marestail plants will not improve control compared with the initial application of an ALS-inhibiting herbicide. Burndown applications that included paraquat, even when followed by just glyphosate postemergence, resulted in 96% or greater control of marestail at 14 days after the postemergence treatment. Only herbicide treatments that included 2,4-D or paraquat resulted in maximum soybean yield. This research suggests that paraquat, glufosinate and 2,4-D (1070 g/ha) have the greatest utility in burndown applications for control of glyphosate-resistant marestail with the ALS-inhibiting herbicides being used for in-crop management of glyphosate-resistant marestail or soil residual activity.

GLYPHOSATE-RESISTANT HORSEWEED CONTROL IN SOYBEAN TOLERANT TO BOTH DICAMBA AND GLYPHOSATE. Lawrence E. Steckel and Robert F. Montgomery, Assistant Professor Department of Plant Sciences, The University of Tennessee, Jackson, TN 38301 and Technology Development Representative, Monsanto Company, Union City, TN 38261.

Introduction

Glyphosate-resistant (GR) horseweed (*Conyza canadensis*) is a serious pest problem in no-till soybean production in Tennessee (Heap 2007). Currently, the typical GR horseweed management program in Tennessee is 0.25 lb ae/A of dicamba tank mixed with 0.75 lbs ae/A of glyphosate applied 30 to 14 days before planting (Steckel et al. 2007). The draw back to the dicamba and glyphosate tankmix is that in dry soil conditions horseweed control has been inconsistent and soybean injury from the dicamba has occurred. In addition, GR horseweed emerges 11 months out of the year in Tennessee (Main et al. 2006) and even fields that are weed free at planting can have subsequent GR horseweed emergence. In 2007 in Tennessee Monsanto field tested soybean varieties that have a glyphosate tolerance trait stacked with a dicamba tolerance trait. Soybean tolerance to dicamba could provide producers a number of possible application timing options to control GR horseweed. Therefore, the objectives of our studies were to (1) determine how effective post emergence applied programs that center around dicamba controlled GR horseweed and (2) evaluate soybean tolerance to the herbicide applications.

Materials and Methods

Two studies were conducted in 2007 in a soybean field near Union City, TN and at Agricenter International located in Germantown, Tennessee. One study primarily looked at a weed management system that contained glyphosate and dicamba while the other study incorporated some soil residual containing Pre applied herbicides. The soybean variety was provided by Monsanto and contained both glyphosate tolerance and dicamba tolerance traits. The dicamba salt used in the study was diglycolamine. Herbicide applications were made with a CO_2 pressurized backpack sprayer equipped with Flat Fan 1100015VS nozzles under a pressure of 40 psi which provided an application volume of 10 gallons/acre. Application timings for the Germantown site are listed on Table 1. The treatments evaluated at Germantown are listed on Table 2. Application timings for the Union City site are listed on Table 3. The treatments evaluated at Union City are listed on Table 4. GR horseweed ratings were taken 21, 30 and 50 days after treatment (DAT).

Table 1.

Location	Application Timing	Date	Horseweed Size
Germantown	PRE	June 8	3”
Germantown	Early Post	July 7	8”
Germantown	Post	July 16	12”
Germantown	Sequential	July 26	20”

Table 2.

All Roundup Weather Max (RWM) applications were made at 1.12 lbs ae/A.

Trt 1. RWM Pre/fb RWM Early Post/ fb RWM Sequential.

Trt 2. RWM + Cloransulam 0.25 oz ai/A/fb RWM + dicamba 0.5 lbs ae/A Early Post / fb RWM + dicamba 0.5 lbs ai/A Sequential.

Trt 3. RWM Pre/ fb RWM + dicamba 0.5 lbs ae/A Early Post/ fb RWM + dicamba 0.5 lbs ae/A Sequential.

Trt 4. RWM + dicamba 0.5 lbs ae/A + flumioxazin Pre/ fb RWM + dicamba 0.25 lbs ae/A Early Post / fb RWM + dicamba 0.5 lbs ae/A Sequential.

Trt 5. RWM Pre/ fb RWM + dicamba 0.25 lbs ae/A Early Post / fb RWM + dicamba 0.5 lbs ae/A Sequential.

Trt 6. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM Early Post / fb RWM Sequential.

Trt 7. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM + dicamba 0.5 lbs ae/A Early Post / fb RWM Sequential.

Trt 8. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM + dicamba 0.5 lbs ae/A Early Post / fb RWM + dicamba

0.5 lbs ae/A Sequential.
Trt 9. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM Early Post / fb RWM + dicamba 1.5 lbs ae/A Sequential.
Trt 10. RWM + dicamba 0.5 lbs ae/A + sulfentrazone 0.25 lbs ai/A + cloransulam 0.25 oz ai/A Pre/ fb RWM + dicamba 0.5 lbs ae/A Early Post/ fb RWM Sequential.

Table 3.

Location	Application Timing	Date	Horseweed Size
Union City	PRE	June 11	12”
Union City	Early Post	June 29	18”
Union City	Late Post	July 2	24”
Union City	Sequential	July 23	30”

Table 4.

All Roundup Weather Max (RWM) applications were made at 0.75 lbs ae/A.
Trt 1. RWM Pre/fb RWM Late Post / fb RWM Sequential.
Trt 2. RWM Pre/fb RWM + dicamba 0.25 lbs ae/A Late Post / fb RWM + dicamba 0.25 lbs ai/A Sequential.
Trt 3. RWM Pre/ fb RWM + dicamba 0.25 lbs ae/A Late Post/ fb RWM + dicamba 0.25 lbs ae/A Sequential.
Trt 4. RWM Pre/ fb RWM + dicamba 0.125 lbs ae/A Early Post / fb RWM + dicamba 0.25 lbs ae/A Sequential.
Trt 5. RWM Pre/ fb RWM + dicamba 0.125 lbs ae/A Late Post/ fb RWM + dicamba 0.25 lbs ae/A Sequential.
Trt 6. RWM + dicamba 0.25 lbs ae/A Pre/ fb RWM Late Post/ fb Sequential.
Trt 7. RWM + dicamba 0.25 lbs ae/A Pre/ fb RWM + dicamba 0.25 lbs ae/A Late Post/ fb RWM Sequential.
Trt 8. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM + dicamba 0.5 lbs ae/A Late Post/ fb RWM + dicamba 0.5 lbs ae/A Sequential.
Trt 9. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM Late Post / fb RWM + dicamba 1.5 lbs ae/A Sequential.
Trt 10. RWM + dicamba 0.5 lbs ae/A + sulfentrazone 0.25 lbs ai/A + cloransulam 0.25 oz ai/A Pre/ fb RWM + dicamba 0.5 lbs ae/A Late Post / fb RWM Sequential.

Results and Discussion

At the Germantown location GR horseweed control was very good with all treatments by the 8/28 ratings. At that location, GR horseweed populations were low and horseweed size was also small which could factor into the good overall control. At the Union city location treatments 5 and 7 that contained back to back post dicamba applications were the only treatments that provided better than 95% GR horseweed control by the 8/18 rating. The remainder of the treatments provided inadequate control (<77%). At the Union City location GR horseweed size was much larger (Table 3) and GR horseweed populations were much heavier (roughly 20/m^2) which contributed to the poorer control. At the Germantown location some soybean leaf burn was observed (<10%) with the sequential dicamba and glyphosate tankmixes. Across all of the treatments at both locations the soybeans showed no leaf cupping or epinasty typical of dicamba injury on soybeans. The data from this study would suggest that GR horseweeds can be successfully controlled in a system where dicamba can be sprayed up to 0.5 lbs ae/A either pre emergence or over the top of soybeans. It also showed that the dicamba tolerance in the trait provides excellent crop safety to dicamba and that stacking glyphosate tolerance and dicamba tolerance traits offers a viable system for control of glyphosate resistant horseweed.

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GIANT RAGWEED BIOTYPES WITH RESISTANCE TO GLYPHOSATE AND ALS INHIBITORS. Mark M. Loux and Jeff M. Stachler, Professor and Extension Program Specialist, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

Field research was conducted in 2007 with giant ragweed biotypes from Licking and Pickaway Co, OH, which were suspected of having resistance to both glyphosate and ALS-inhibiting herbicides. Objectives of the research were to characterize the response of biotypes to PRE and POST applications of ALS inhibitors, glyphosate, and PPO inhibitors, and determine the role of alternatives to glyphosate for POST control in glyphosate-resistant soybeans. The response of individual plants and overall control were measured 21 DAT and in October. In a characterization study at Pickaway Co., ALS inhibitors controlled less than 50% of the giant ragweed when applied PRE or POST, and POST application of glyphosate at rates up to 1.7 kg ae/ha controlled less than 60% of the giant ragweed. Individual plant survival at 21 DAT ranged from 79 to 91% for POST application of ALS inhibitors, and 78 to 93% for glyphosate. A mixture of cloransulam and glyphosate did not improve control, compared with application of either alone. At the end of the season, survival of individual plants exceeded 62% for these same treatments, even where glyphosate was applied again three weeks after the initial postemergence treatment. Most effective control of giant ragweed resulted from POST application of fomesafen, which controlled 88 and 100% of the ragweed 21 DAT at rates of 0.34 and 0.67 kg/ha, respectively, and killed 75 and 96% of individual plants.

An additional study was conducted at both locations to determine the most effective POST strategies for control of giant ragweed with multiple resistance. Treatments included glyphosate, fomesafen, lactofen, and cloransulam applied alone and in various combinations, and glyphosate was applied again to one-half of each plot 21 days after the initial POST treatment. At Pickaway Co., survival of individual plants at the end of the season ranged from 62 to 80% where glyphosate or cloransulam was applied alone or in combination initially, and followed with a later application of glyphosate. Application of fomesafen with methylated seed oil and ammonium sulfate resulted in 17 to 23% survival of individual plants, but fomesafen applied with glyphosate and ammonium sulfate (no methylated seed oil) resulted in 50 to 75% survival. Overall control did not exceed 71% for any treatment at 21 days after the initial POST application, or at the end of the season.

At the Licking Co. site, resistance to glyphosate and ALS inhibitors appeared to be of lower level and more variable throughout the study area, compared with Pickaway Co. Survival of individual plants at the end of the season ranged from 67 to 80% where glyphosate or cloransulam was applied initially, and followed with a later application of glyphosate. Survival decreased to 23 to 57% where cloransulam and glyphosate were applied in combination. Overall control at the end of the season did not exceed 79%, with the exception of the initial application of a combination of cloransulam and methylated seed oil plus either fomesafen or lactofen. These treatments, when followed by application of glyphosate three weeks later, controlled 96 and 89% of the ragweed, respectively, but this decreased to 60 and 37% without the later glyphosate application.

These results confirm the presence in Ohio of giant ragweed biotypes with multiple herbicide resistance, to glyphosate and ALS inhibitors. The glyphosate resistance appears to be present at a higher level compared with the biotypes in our 2006 field studies. Fomesafen and lactofen can be important components of POST herbicide programs to control multiple-resistant giant ragweed, but additional research is needed to determine specifically how they should be managed in these programs.

MULTIPLE HERBICIDE RESISTANCE IN COMMON RAGWEED. Jeff M. Stachler and Mark M. Loux, Extension Program Specialist and Professor, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

Field research was conducted in Ohio in 2007 to characterize the response of two common ragweed populations from Clinton County, Ohio to POST application of PPO inhibitors, ALS inhibitors, and glyphosate. The response of individual plants and overall control were measured 21 DAT and in September. At the site where resistance to PPO and ALS inhibitors was suspected, application of up to twice the recommended rate of ALS inhibitors (chlorimuron-ethyl, cloransulam-methyl, and imazamox) controlled less than 25% of the common ragweed 21 DAT. Control with PPO inhibitors (fomesafen and lactofen) did not exceed 40% at 21 DAT or in September. A mixture of cloransulam plus fomesafen did not improve control, compared with application of either alone. Nearly all of the individual plants that were marked prior to application survived treatment with ALS inhibitors into September, and 87 to 100% survived application of PPO inhibitors or a mixture of cloransulam and fomesafen. Glyphosate applied at 0.84 kg ae/ha controlled 96% of this population. Results from a related study involving combinations of PRE and POST herbicides showed that it was not possible to obtain adequate control of this population without the use of POST glyphosate treatments.

At the site where resistance to glyphosate and ALS inhibitors was suspected, POST application of glyphosate resulted in less than 35% control 21 DAT, and less than 20% control in September. A second application of glyphosate, 21 days after the first, improved late-season control by less than 20%. Cloransulam failed to provide any control, and mixtures of cloransulam and glyphosate controlled only 25 to 35% of the common ragweed in September. Survival of individual plants ranged from 80 to 93% at the end of the season for cloransulam and glyphosate treatments. Fomesafen (0.35 kg/ha) applied with methylated seed oil and ammonium sulfate controlled only 59% of the common ragweed at the end of the season, but this improved to 98% when followed with a POST application of glyphosate three weeks later. The combination of fomesafen, glyphosate (1.7 kg/ha), and ammonium sulfate (no methylated seed oil) controlled 50% of the common ragweed, and this improved to 90% when followed with a POST glyphosate application. Lactofen-containing treatments did not result in more than 60% control at the end of the season, regardless of whether methylated seed oil was used or glyphosate was applied later.

These studies confirmed the presence in Ohio of common ragweed biotypes with multiple herbicide resistance, to PPO and ALS inhibitors, or glyphosate and ALS inhibitors. Results indicated that glyphosate can still have activity on small glyphosate-resistant plants that have been partially controlled by a previous application of a non-glyphosate herbicide, but that the activity of the previous herbicide should be optimized for most effective control (i.e. use of methylated seed oil with fomesafen).

PREEMERGENCE EVALUATIONS OF TWO NEW CHLORIMURON-ETHYL, THIFENSULFURON-METHYL PLUS FLUMIOXAZIN BLENDS IN COMPARISION TO KEY COMMERCIAL STANDARDS IN SOYBEAN. Marsha J. Martin, Gregory R. Armel, Helen A. Flanigan, Susan K. Rick. DuPont Crop Protection. Newark, DE. 19711.

In 2007, university and DuPont small plot, replicated field studies were conducted throughout the US soybean growing regions to compare preemerge performance of two new chlorimuron-ethyl, thifensulfuron-methyl and flumioxazin containing herbicide blends to competitive standards. The first herbicide blend has a lower rate of chlorimuron-ethyl, enabling it to be used on any pH soil, and is composed of: 2.85% chlorimuron-ethyl, 36.21% flumioxazin, and 8.8% thifensulfuron-methyl (Enlite™). The second herbicide blend has a higher rate of chlorimuron-ethyl and is composed of: 9.2% chlorimuron-ethyl, 29.2% flumioxazin, and 2.9% thifensulfuron-methyl (Envive™). In 18 field trials, both blends gave good to excellent control of velvetleaf, common lambsquarters, waterhemp, redroot pigweed, palmer amaranth, common ragweed, prickly sida, and eastern black nightshade, with fair to good suppression of annual grasses. Residual control was equal to or better than the competitive standards. The marketing direction for Envive™ and Enlite™ will be primarily as a planned preplant or preemerge application followed by a post herbicide program in a glyphosate tolerant soybean system.

UTILIZATION OF SEQUENTIAL HERBICIDE APPLICATIONS AND TANK MIX COMPONENTS TO IMPROVE GLYPHOSATE EFFICACY. Ryan P. Miller, Lisa M. Behnken, Fritz R. Breitenbach, and Jeffery L. Gunsolus, Assistant Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, Associate Extension Professor, University of Minnesota, Rochester Regional Center, Rochester, MN 55904-4915, and Professor, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108-6026.

Field research was conducted at Rochester, MN in 2007 to determine which tank mix components and sequential applications improved glyphosate efficacy. Sequential treatments included: preemergence products followed by glyphosate, tank mixtures including glyphosate or two postemergence glyphosate treatments. A randomized complete block design with four replications was used. Soybean variety ‘Dairyland DSR 199’was planted 3.8 cm deep in 76 cm rows at a rate of 370,500 seeds ha^{-1} on May 17, 2007. All herbicide applications were made with a tractor-mounted sprayer delivering 187 l ha^{-1} at 221 kpa using 11002 flat fan nozzles. Adequate rainfall was received after each treatment date. Preemergence applications were made on May 18th, the first postemergence treatment was made to 7.5-12.5 cm tall weeds on June 15, and sequential postemergence treatments were made to 7.5-12.5 cm tall weeds on June 20th and to 5-7.5 cm weed regrowth on July 6th. A reduced rate of 0.42 kg ae glyphosate ha^{-1} was used to better determine the effect of corresponding tank mix and sequential treatments. Preemergence treatments included: flumioxazin and cloransulam-methyl at 89 & 29.4 g ai ha^{-1} (Gangster); flumioxazin at 89 g ai ha^{-1} (Valor); sulfentrazone and cloransulam-methyl at 130 & 16.6 g ai ha^{-1} (Sonic); s-metolachlor and fomesafen at 0.53 & 116 g ai ha^{-1} (Prefix), and sulfentrazone and metribuzin at 126 & 189 g ai ha^{-1} (Authority MTZ). Postemergence treatments were 0.42 kg ae glyphosate ha^{-1} alone or tank mixed with one of the following components: fomesafen at 197 g ai ha^{-1} (Flexstar); lactofen at 105 g ai ha^{-1} (Cobra); flumiclorac pentyl ester at 30 g ai ha^{-1} (Resource); cloransulam methyl at 19.4 g ai ha^{-1} (FirstRate); chlorimuron ethyl at 4.37 g ai ha^{-1} (Classic); chlorimuron ethyl at 6.63 g ai ha^{-1} (Classic); chlorimuron ethyl and thifensulfuron methyl at 5.7 & 1.8 g ai ha^{-1} (Synchrony XP), thifensulfuron methyl at 17.4 g ai ha^{-1} (Harmony GT), imazethapyr at 70 g ai ha^{-1} (Pursuit). Weeds were visually rated for percent control on June 6, 14, 20 and July 6, 18, and September 14. Plots were machine harvested and yields were calculated and adjusted to 13.5% moisture. Sequential treatments that included a preemergence application tended to have greater grain yields and better weed control than sequential glyphosate treatments or glyphosate with the various tank mix treatments.

INFLUENCE OF ROW SPACING AND APPLICATION TIMING ON WEED CONTROL IN GLUFOSINATE RESISTANT SOYBEANS. Michael Weber* and Jayla Allen, Bayer CropScience, Research Triangle Park, NC.

Since the first introduction of glyphosate resistant crops in the mid 1990's, US growers have become accustomed to the use of a non-selective herbicide. Rapid adoption of this technology in some crops including soybeans has dramatically changed the way in which growers approach weed control. Some areas of the Midwest have seen a market share of glyphosate resistant soybeans approach 95%. With the increase in acreage planted to glyphosate resistant soybeans, most basic manufacturers have abandoned the discovery for new and novel herbicides for soybeans. Coupled with the rapidly increasing acres of glyphosate resistant corn, it would be expected that more glyphosate resistant weeds will develop and spread across the Midwest. Glufosinate has a unique mode of action that can provide an alternative control measure for weeds resistant to glyphosate.

Weed control trials for LibertyLink Soybeans were conducted by Bayer CropScience and Midwestern universities. In 2007, 21 locations evaluated the use of glufosinate in LibertyLink Soybeans for general weed efficacy across a broad spectrum of grass and broadleaf weeds. Weed control was influenced by row spacing, timing and when a preemergence herbicide was used following a glufosinate application.

2007 – A YEAR TO REMEMBER. James R. Martin, Jonathan D. Green, and William W. Witt. Extension Professors and Professor, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445.

It is not unusual for a single weather event on a local level to cause weed control problems in a single growing season. However, 2007 had several major weather events that impacted weed management decisions throughout much of Kentucky and made it unique compared with other seasons. The warm temperatures in late February through March provided a favorable environment for early season plant growth. This unusually warm period ended abruptly April 5th when temperatures dipped into the teens at night and stayed in the 40's during the daytime for a period of 5 days. Following the unexpected freeze the precipitation levels fell nearly ten inches below normal from April 1 through mid October. The duration and severity of this drought set records for many communities in Kentucky.

These unusual weather patterns impacted weed management decisions throughout the state. Horseweed (*Conyza canadensis*) plants emerged early and became larger than normal and were somewhat hardened off as a result of extreme freezing temperatures and dry soil in early April. In some instances burndown applications with 2,4-D were not successful and growers had to resort to tillage as a means of controlling horseweed.

Much of the early planted wheat in Kentucky was developing rapidly and in Feekes 6 and 7 growth stages when the April freeze occurred. As a result of the freeze damage, approximately 104,000 acres of wheat were either harvested for hay or silage or treated with a burndown herbicide to convert damaged fields to full season soybeans or corn. A section 18 label was issued to allow wheat growers to harvest their crop for hay or silage where thifensulfuron or the premix of thifensulfuron plus tribenuron were applied. There was some concern that stem damage from the freezing temperatures would limit translocation of glyphosate; consequently, paraquat was discussed as the preferred burndown treatment to control of wheat where corn or soybeans would be planted. A study initiated on April 20 compared glyphosate and paraquat for controlling freeze damaged wheat. Results showed that control was better with glyphosate than with paraquat, but activity was slow. Label restrictions limited the opportunity to rotate to corn in freeze damaged wheat that was treated with mesosulfuron.

Furthermore, the unusually warm March temperatures tempted growers to plant corn earlier than normal, only to be injured or killed by the April freezing temperatures. It is estimated approximately 100,000 acres of early planted corn had to be replanted due to poor stands. Growers had limited opportunities to control the surviving corn plants when the original planting was a glyphosate-tolerant hybrid.

The prolonged drought and high temperatures throughout the summer reduced stands of fescue and orchardgrass in pastures and hayfields; consequently, very high populations of ragweeds (*Ambrosia* spp.) and crabgrass (*Digitaria* spp.) developed. These stress conditions also limited the effectiveness of herbicides for controlling such weeds as common ragweed (*Ambrosia artemisiifolia*), tall ironweed (*Vernonia altissima*), and Canada thistle.(*Cirsium arvense*).

Toward the end of the year the dry conditions that prevailed through the summer months caused concern that herbicides such as atrazine or clomazone would persist longer than normal and injure fall planted crops such as wheat.

50 YEARS OF WEED CHANGES ON THE HOME FARM. Jerry D. Doll*, Extension Weed Scientist Emeritus, University of Wisconsin-Madison, Department of Agronomy, 1575 Linden Dr., Madison, WI 53706

First I should tell you where the home farm, known as Dolls Orchard, is located. I grew up near Pocahontas, IL (Bond Co.), 40 miles east of St. Louis, MO, just south of Interstate 70. My father raised corn, soybeans, oats, alfalfa, wheat, red clover, pastures, apples, and peaches and we milked about 15 cows and had hogs (farrow to finishing) and a few chickens. Grain sorghum (milo to southern Illinois farmers) and Sudangrass have been and are still grown on occasion. Except for the commercial orchard, it was a rather typical farm for southern Illinois in the 1950s. We sold the hogs, built a milking parlor and expanded the dairy operation to30 to 40 milking cows in the late 1950s, but that had little impact on the cropping system. The farm had 360 acres 50 years ago and has doubled to around 700 acres today; approximately 100 acres are in the Shoal Creek flood plain, hereafter called the bottomlands. My brother Joe now operates the home farm. He sold the dairy cows in the late 1990s, now has a cow-calf beef operation, ceased planting oats about 25 years ago and the orchard is now only an apple orchard.

I always liked knowing what weeds we had on the farm. I never recorded them nor do I recall that Dad did either so I'm trusting my memory and that of my farming brother to assess the weed changes on the home farm since my grade school days until now.

Probably the biggest change is the explosion of winter annuals. These include purple deadnettle, chickweeds, downy bromegrass, smallflower buttercup, shepherds purse, cutleaf groundsel (commonly called butterweed in the area), little barley, pennycress, henbit and flixweed. Other cropland weeds that have increased include giant foxtail (it first appeared in the early 1960s), shattercane, giant ragweed (especially problematic in the bottomland fields), wild garlic, prickly sida, and waterhemp (exploded in the early 1990s). The new biennial in the area is poison hemlock and it is very prominent in fence rows, roadsides and around feedlots. Musk thistle is found occasionally behaving as a winter annual in no till crop fields as seeds drift in from roadside infestations in the area. Weeds that were never found on the farm 50 years ago include purple deadnettle, cutleaf groundsel, little barley, prickly sida, flixweed, and spurred anoda. Of these, purple deadnettle (routinely infesting winter wheat, orchards and summer seeded alfalfa) and little barley (forming monocultures some years before spring tillage is done) are the most widespread and abundant.

Spiny amaranth is more common in pastures today that previously while redroot pigweed is somewhat less common on the farm. Other weeds that have declined in abundance in cropland include cocklebur, common lambsquarters, jimsonweed, eastern black nightshade, morningglory spp., velvetleaf and field bindweed. In the bottomlands, honeyvine milkweed and trumpetcreeper were once serious problems and greatly interfered with row cultivation. Today these vines are essentially eradicated. Curly dock was somewhat common in alfalfa but is less prominent today. Pennsylvania smartweed, fall panicum, green foxtail and large crabgrass can still be found but these species neither were nor are serious problems.

Hemp dogbane and yellow nutsedge have remained as weeds in scattered patches in just a few fields. A single area of bermuda grass appeared in a former apple orchard in the 1990s and occupied less than one quarter acre. It has since been eradicated. Today in the orchard, poison ivy, pokeweed and honeyvine milkweed are serious problems below and in the trees; these were found just occasionally 50 years ago. Converting an orchard into cropland often results in fields with serious pokeweed infestations. These are quickly diminished with a cycle or two of glyphosate resistant soybeans.

Woody invasive weeds such as honey locust have been a constant presence in our long-term pastures (most are on rolling hills that have never been cultivated) but the honey locust population has changed little. Dad planted hundreds of multiflora rose seedlings in the mid 1950s and these have infested a few fence lines but most infestations appear in thin woods around the several farm ponds built in the

1950s and early 1960s with few if any in the pastures. Multiflora rose on the farm has never reached the impenetrable densities we often find in Wisconsin. Rose rosette disease is common in our multiflora rose bushes, probably limiting its invasiveness. Poison ivy on the other hand, has expanded greatly and now forms dense stands in the woods around the ponds and is a serious problem beneath apple trees. This year for the first time I noticed prickly sida in soybeans and Japanese honeysuckle at the edge of a wooded area and Russian olive in a fence row and pasture on the farm.

Wild garlic has a very interesting history on the farm. We had a small infestation (less than half an acre) in an upland field that was rotated between row crops and alfalfa. It was not found in the bottomland. Today wild garlic can infest nearly every acre of some bottomland fields (which typically have 3 to 4 years of soybean followed by a year of corn). Winter wheat is never grown in the bottomland as Shoal Creek floods many springs. It is interesting that a weed most often associated with small grains is now a common occurrence in a soybean-corn cropping system. And we find some wild garlic in upland sites well beyond the original infestation.

Why have some of these changes happened? An increasing acreage of wheat over time and the use of no tillage on many acres may explain the increase in winter annual weeds and perhaps the decrease in velvetleaf. In particular, no-till planting of winter wheat is a perfect setting for an abundance of winter annual species. Thus wheat has gone from a crop that rarely needed an herbicide to one that is routinely treated. My brother no longer owns a moldboard plow so even fields that are tilled have less aggressive soil disturbance than 50 years ago. The tandem disk and spike-tooth harrow (drag) are also obsolete, but I doubt that this has directly affected weed abundance.

The basic cropping system has changed little in 50 years, but planting soybeans following winter wheat harvest (called “double crop beans,” which are always planted in narrow rows without tillage) is now a routine practice (unless red clover was frost seeded into the wheat and this is done on 10 to 15% of the wheat acres). Double cropping prevents weeds from going to seed after wheat harvest because the beans are kept nearly weed free. In contrast, winter wheat seeded with red clover often allows weeds to produce seed as no herbicides are used in the red clover phase of the rotation.

Waterhemp exploded during the years of frequent ALS herbicide use in soybeans, moving from the bottomland to upland fields on harvest equipment. It remains a weed of concern in soybeans due to its long period of germination. The once common practices of rotary hoeing and row cultivation are now seldom practiced on the farm so weeds escaping the cultural and chemical practices are home free. Fifty years ago our corn row spacing was 38 inches and whole ears were harvested; 25 to 30 years ago, row spacing dropped to 30 inches and harvesting was done with a combine. Soybeans were grown in narrow rows (10-inch spacing) long before it was a common practice. Skip rows were left so that row cultivation could be done with a beet cultivator to complement the early soybean herbicides (cloramben, trifluralin and linuron). Large-seeded broadleaf weeds thrived in this system so in many summers my brothers and I walked fields to remove jimsonweed, cockleburs and velvetleaf. This practice ceased with the advent of selective soybean postemergence broadleaf herbicides.

Today glyphosate resistant soybeans are grown on most acres but conventional herbicides are used in corn to avoid over using glyphosate. Even with that approach, most of the cropped acres receive in-crop applications of glyphosate 50% (soybean-corn system) to 67% (soybeans-wheat/soybean-corn) of the time in the upland fields and up to 75% of the time in bottomland fields. The effectiveness of glyphosate resistant soybean systems to prevent weed seed production has dramatically reduced the abundance of many cropland weeds including cocklebur, field bindweed, eastern black nightshade, morningglories, velvetleaf, jimson weed and lambsquarters and the vines in the bottomlands.

Many changes have occurred on the farm in my lifetime. And the process will continue. I would like to say that a nephew or niece might give an update 50 years down the road, but it is doubtful that the Doll Orchard Farm will survive another generation under our name. And that’s a change of far greater impact on us than the tug-of-war between weed species.

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THE SELECTION OF SPRAY NOZZLE TIPS TO MAXIMIZE EFFICACY WHILE MANAGING DRIFT. Robert N. Klein, Jeffrey A. Golus, Amanda S. Cox, Professor, Technician, Technician, University of Nebraska, West Central Research and Extension Center, North Platte, NE 69101

Most spray nozzle tips used in the application of pesticides produce a distribution of droplet sizes. The droplet sizes produced by a nozzle tips are affected by many factors besides the nozzle tip design. These include: pressure, pesticide formulation and adjuvants. Because different nozzle tips are affected differently by pesticide formulation and adjuvants, equipment such as lasers used to evaluate the particle size distribution of the spray solution are very valuable. Spray droplet size affects efficacy of the pesticide and spray drift. Contact herbicides with the same carrier rate will need a smaller droplet size than translocated post-emergence herbicides. Nozzle tips which produce the smallest amount of a spray volume in small droplets (those susceptible to drift or evaporation) are preferred unless the particle size is too big for the coverage needed for efficacy. Many of the new nozzle tips designed to reduce drift can aid in increasing the performance of a pesticide if the correct selection is made. Some of these new nozzle tips, such as the venture, need to be operated at higher pressures than many operators are accustomed.

The introduction of extended range nozzle tips in the venturi types has allowed the lowering of pressure. For example the particle size of an AIXR11004 nozzle at 2.8 bars vs. an AI11003 nozzle at 4.8 bars (both from Spraying Systems) have almost identical spray particle sizes with water and 0.65 L of Roundup WeatherMax in 94 L/ha of water + 2% v/v AMS. The amount of the spray volume in 210 microns and less was almost identical for these two nozzle tips at the pressure of 2.8 bars and 4.8 bars.

Nozzle tips with the tip being built into the cap and with automatic spray alignments are usually the applicators best choices. Ceramic is also usually the best choice of spray nozzle tip material when available.

WEED MANAGEMENT AFFECTS THE MAXIMUM RETURN TO NITROGEN IN FIELD CORN.
Timothy L. Trower, Chris M. Boerboom, Carrie A. M. Laboski and Todd W. Andraski, Senior Outreach Specialist, Professor, Assistant Professor and Researcher, University of Wisconsin, Madison, WI 53706.

Many corn growers are interested in adopting new nitrogen application rate guidelines to improve profitability. However, the potential exists that weeds may compete and limit the nitrogen available for the corn. Field studies were conducted at Arlington, WI in 2006 and 2007 to determine the economic optimum nitrogen rate (EONR) at two postemergence weed removal timings compared to weed-free and weedy controls. Nitrogen was applied pre-plant as 28% UAN at 0, 45, 90, 135, 180, and 225 kg ha^{-1} and incorporated prior to planting glyphosate-resistant corn. The previous crop was soybean. Mesotrione plus s-metolachlor plus atrazine at 0.22 plus 2.2 plus 0.8 kg ai ha^{-1} was applied preemergence in 2006 while mesotrione plus s-metolachlor at 0.22 plus 2.2 kg ha^{-1} tank mixed with simazine at 1.1 kg ai ha^{-1} was used in 2007. Glyphosate was applied postemergence at 0.84 kg ae ha^{-1} following the 2007 preemergence treatment due to poor activation caused by low rainfall. These preemergence treatments provided the weed-free control. Weeds were removed when they reached 10- and 30-cm heights by applying glyphosate at 0.84 kg ae ha^{-1}. Weed biomass was collected from 0.25 m^2 quadrats at the weed removal timings. Corn and weed biomass collected in 2006 was analyzed for nitrogen concentration. Corn was harvested for yield and grain was adjusted to 15.5% moisture. The study had a randomized complete block design with four replications.

Giant foxtail and common lambsquarters were the predominant weed species in both years. Weed densities averaged 890 and 390 plants m^{-2} in 2006 and 2007, respectively, at the 10-cm weed removal timing and 1090 and 660 plants m^{-2} in 2006 and 2007, respectively, at the 30-cm weed removal timing. Weed biomass at the 10-cm weed removal timing averaged 52 and 67 g m^{-2} in 2006 and 2007 and 96 and 183 g m^{-2} at the 30-cm weed removal timing in 2006 and 2007. Weeds accumulated an averaged of 13 kg ha^{-1} of nitrogen at the 10-cm removal timing compared to 28 kg ha^{-1} at the 30-cm weed removal timing. Corn biomass was sampled at tassel and nitrogen accumulation averaged 95 kg ha^{-1} for the weed-free control, 92 kg ha^{-1} for the 10-cm weed removal timing, and 78 kg ha^{-1} for the 30-cm weed removal timing. Grain yields did not differ between the weed-free control and the 10-cm weed removal timing. Yields were reduced 7 and 11% with the 30-cm weed removal timing compared to the weed-free control in 2006 and 2007, respectively. The yield of the weedy control was reduced an average of 37 and 56% in 2006 and 2007, respectively, compared to the weed-free control. The EONR was determined using a nitrogen fertilizer to corn price ratio of 0.15. In 2006, the EONR was 108 and 109 kg N ha^{-1} for the weed-free control and 10-cm weed removal timing, respectively, and 225 kg N ha^{-1} for the 30-cm weed removal timing. In 2007, the EONR was 44 kg N ha^{-1} for the weed-free control, 88 kg N ha^{-1} for the 10-cm weed removal timing, and 246 kg N ha^{-1} for the 30-cm weed removal timing. Corn yields were similar among the weed-free control, 10-cm and 30-cm weed removal timings when 225 kg N ha^{-1} was applied, which suggests that high nitrogen rates may compensate for greater weed competition. These results document that early season weed competition for nitrogen contributes to corn yield loss when postemergence herbicide applications are delayed and may increase the EONR. Weed management programs that limit early season weed competition will optimize nitrogen use.

CONTROLLING GLYPHOSATE RESISTANT VOLUNTEER CORN. Robert N. Klein, Jeffrey A. Golus, Amanda S. Cox, Professor, Technician, Technician, University of Nebraska, West Central Research and Extension Center, North Platte, NE 69101

A popular rotation in the High Plains is the winter wheat, ecofallow corn, pre-winter wheat fallow rotation. Much of the ecofallow corn is now glyphosate resistant and much of the pre-winter wheat fallow is now no-till. Several applications of glyphosate are being made during the pre-winter wheat fallow period and producers want a herbicide that could be added to the glyphosate to control the volunteer glyphosate resistant corn.

A field study was conducted at North Platte, Nebraska with glyphosate resistant corn planted on May 8, 2007 in 6, 76 cm rows. Early applications were applied on June 15 with corn in the 2-3 leaf stage and late applications were applied on June 23 with corn in the 5-6 leaf stage.

Treatments included clethodim (Select Max), glyphosate potassium salt (Roundup WeatherMax), paraquat dichloride (Gramoxone Inteon), glufosinate-ammoinium (Liberty), and metribuzin (Sencor DF), used at various rates. Additives also included in the treatments included non-ionic surfactant (NIS) at 0.25% v/v and/or 2.8 kg/ha smmonium sulfate (AMS).

Ratings were taken on June 24 and July 14. All but one of the treatments applied June 15 with the glyphosate resistant corn in the 2-3 leaf stage gave 100% control by the second rating date of July 14. The other treatment was 99.3%. Only one treatment that was applied on the second application date of June 23 with the corn being in the 5-6 leaf stage gave over 75% control. This treatment included 0.067 kg/ha of clethodim with NIS and AMS, and gave 99.7% control.

From the research, it can be concluded that the glyphosate resistant corn must be controlled early. In some situations two treatments may be needed because of the varied germination period by volunteer glyphosate resistant corn.

COMPETITION AND MANAGEMENT OF ANNUAL MORNINGGLORY (*IPOMOEA* SPP.) IN CORN AND SOYBEAN. Dawn E. Refsell, Phillip J. Parrish, and Emerson D. Nafziger, Extension Specialist, Department of Crop Sciences, University of Illinois, Urbana, IL 61801, Graduate Student, Department of Crop Sciences, University of Illinois, Urbana, IL 61801, and Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Annual morningglory species are becoming a problem in production agriculture in Illinois due to current weed management strategies. Continuous emergence in combination with increased use of glyphosate as a post emergence treatment alone is a potential reason for morningglory to become a problematic weed. Field research was conducted at Urbana, IL in 2006 and 2007 to evaluate herbicide options for *Ipomoea* spp. control in glyphosate-resistant corn and soybean. Fields with naturally high densities of *Ipomoea* spp. were chosen for the study. All postemergence applications included 0.84 kg/ha of glyphosate. Treatments were evaluated at 15, 30, and 60 DAT for morningglory control and 15DAT for crop injury.

Soybean injury was observed 15 DAT in the cloransulam methyl followed by glyphosate plus carfentrazone, cloransulam methyl followed by glyphosate plus acifluorfen, and the cloransulam methyl followed by glyphosate plus fomesafen treatments. The control of *Ipomoea* spp. in soybean ranged from 33 to 85% control over all three evaluation times. Five herbicide treatments provided greater than 70% control of morningglory through 60 DAT. These treatments were flumioxazin followed by glyphosate plus fomesafen, flumioxazin followed by glyphosate plus cloransulam methyl, cloransulam methyl followed by glyphosate plus cloransulam methyl, cloransulam methyl followed by glyphosate plus carfentrazone, and cloransulam methyl followed by glyphosate plus fomesafen.

Injury to corn was only observed in the atrazine followed by glyphosate plus carfentrazone treatment 15 DAT at 8%. The level of morningglory control was much greater in corn than soybean, with some treatments obtaining greater than 90% control. Only three treatments provided greater than 70% control of *Ipomoea* spp. through 60 DAT. These treatments included atrazine followed by glyphosate plus 2,4-D, atrazine followed by glyphosate plus bromoxynil/atrazine, and atrazine followed by glyphosate plus nicosulfuron/rimsulfuron/atrazine.

CONTINUING RESEARCH INTO COMMON LAMBSQUARTERS CONTROL WITH GLYPHOSATE. Andrew R. Kniss, Assistant Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071.

A field study was conducted in Laramie, Wyoming in 2007 to elucidate factors that may contribute to poor glyphosate efficacy. The field study was located on a site where over 150 biotypes of common lambsquarters had been planted and allowed to produce seed 2 yr earlier in order to ensure wide genotypic and phenotypic variability across the study. A total of 120 individual common lambsquarters plants were randomly selected along 8 transects located 3 m apart across the study site. Stem diameter at ground level, height, width, and leaf thickness of each plant were measured for each plant. Glyphosate with or without ammonium sulfate was applied at a rate of 840 g ae/ha along the transects 1 d after plant measurements were taken. Plant mortality was evaluated 28 d following herbicide application. Preliminary analysis indicated that a polynomial model may be appropriate, so a generalized linear model was fit to the data using mortality data as a binary response variable and all measured variables and their squared values as independent variables. Plant height, leaf thickness, and the squared terms associated with these variables were determined to have a significant impact on plant mortality in response to glyphosate application. The significant squared terms indicate that some unquantified physiological process may cause a decrease in glyphosate susceptibility during early growth followed by increasing susceptibility as the plant continues to age.

AN ILLINOIS WATERHEMP POPULATION RESISTANT TO GLYPHOSATE. Aaron G. Hager, Michael S. Bell, Patrick J. Tranel, Dean E. Riechers, and Adam S. Davis, Assistant Professor, Graduate Research Assistant, Associate Professors, and Ecologist, Department of Crop Sciences and United States Department of Agriculture/Agricultural Research Service, University of Illinois, Urbana, IL 61801.

Common waterhemp is considered the most problematic broadleaf weed species in Illinois agronomic cropping systems. Soybean producers have only a limited number of herbicide options that control common waterhemp after crop emergence. Lactofen, fomesafen, and acifluorfen were widely utilized for common waterhemp control prior to commercialization of glyphosate-resistant soybean. Currently, glyphosate is the most widely utilized herbicide for postemergence control of common waterhemp in soybean and its in-crop use in glyphosate-resistant corn is increasing.

Research was conducted in 2007 to quantify the response of an Illinois common waterhemp population to foliar applications of glyphosate. Anecdotal reports in 2006 suggested this common waterhemp population was not adequately controlled following multiple glyphosate applications in a soybean production field. At full maturity, seed was collected from individual female common waterhemp plants growing on site and subsequently planted for greenhouse experiments. Common waterhemp plants were treated with either 0.84 or 3.4 kg ha^{-1} glyphosate acid when they were 10-cm tall. Results from greenhouse experiments showed plants treated with 0.84 kg ha^{-1} glyphosate demonstrated minimal injury and greater than 90 percent of plants survived treatment with 3.4 kg ha^{-1} glyphosate acid. Field research trials were initiated at the location where poor waterhemp control with glyphosate purportedly occurred in 2006. A range of glyphosate rates was applied when common waterhemp plants were either 10-or 30-cm tall. Treatment evaluations 21 days after either application timing revealed 50 percent or less common waterhemp control with glyphosate at rates labeled for in-crop use. A small percentage of common waterhemp plants survived treatment with 13 kg ha^{-1} glyphosate acid.

THE STATUS OF GLYPHOSATE-RESISTANT WATERHEMP IN MISSOURI.
Kevin W. Bradley and Travis Legleiter, University of Missouri, Columbia, MO; Leon Hunter, Craig Nichols, and Chuck Foresman, Syngenta Crop Protection, Greensboro, NC.

Corn and soybean growers and agricultural retailers throughout Missouri were surveyed during 2006 and 2007 to determine the extent of glyphosate-resistant waterhemp (*Amaranthus rudis* Sauer) in Missouri. The survey was also conducted to assess current herbicide-use patterns utilized in soybean production, and understand perceptions about glyphosate performance and glyphosate-resistance in other weed species. When asked about the level of concern surrounding the development of glyphosate resistance in weed species, 39% of the agricultural retailers and crop consultants surveyed indicated they were very concerned about this issue compared with only 12% of the growers surveyed. More than half of the farmers, crop consultants, and agricultural retailers surveyed indicated that waterhemp was the most common weed escape in soybeans. Of the agricultural retailers who failed to control waterhemp with glyphosate in 2007, 35% believed the waterhemp was glyphosate-resistant. Greenhouse experiments were also conducted with waterhemp seed collected from 12 separate locations across Missouri in 2006 and these experiments confirmed glyphosate-resistance in waterhemp in at least six counties located in central and northwestern Missouri. Following waterhemp, survey respondents listed morningglory species (*Ipomoea* spp.) and giant ragweed (*Ambrosia trifida* L.) as the second and third most common species, respectively, that were poorly controlled or not controlled by glyphosate in soybeans.

CAN GLYPHOSATE-RESISTANT HORSEWEED BE USED AS AN INDICATOR FOR OTHER SPECIES DIFFICULT TO CONTROL WITH GLYPHOSATE? Andrew. M. Westhoven, Vince. M. Davis, Greg. R. Kruger, Valerie. A. Mock, and William. G. Johnson, Graduate Research Assistant, Graduate Research Assistant, Graduate Research Assistant, Graduate Research Assistant, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN, 47907.

Current U.S. soybean production practices place heavy reliance on glyphosate for weed management. An exhaustive in-field survey was conducted in Indiana during September and October of 2003, 2004, and 2005. In the survey, common lambsquarters and giant ragweed plants were present in 11 and 22%, respectively, of randomly surveyed soybean fields that also contained glyphosate-resistant horseweed biotypes. The objective of this research was to determine if the presence of glyphosate-resistant horseweed was correlated with the presence of common lambsquarters and giant ragweed biotypes with elevated tolerance to glyphosate. The survey database was queried for fields that contained glyphosate-resistant horseweed plus giant ragweed and/or common lambsquarters. In the falls of 2005 and 2006, sites with these weed species combinations were surveyed again. We surveyed 81 sites in 29 counties, and collected 13 common lambsquarters and 22 giant ragweed seed samples. Seed samples were screened for response to glyphosate in the greenhouse and 10 common lambsquarters and 7 giant ragweed populations showed tolerance to glyphosate. Horseweed was found in approximately 69% of all soybean fields in the subsequent survey. When horseweed was documented as glyphosate-resistant 1 to 3 years earlier, 81% of the fields had horseweed present in the subsequent survey. Of the fields that had glyphosate-resistant horseweed, 31 and 57% of the fields in the subsequent survey also had glyphosate-tolerant giant ragweed and common lambsquarters populations, respectively. Contrastingly, of the fields that had glyphosate-susceptible horseweed, 33 and 100% of the fields in the subsequent survey had glyphosate-tolerant giant ragweed and common lambsquarters populations, respectively. Therefore, the results from this research demonstrate that glyphosate-resistant horseweed was not an indicator for glyphosate tolerance in common lambsquarters and/or giant ragweed.

HAVE WE BECOME RESISTANT TO USING THE TERM TOLERANCE? Andrew R. Kniss, Assistant Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071.

Discussions on differential herbicide susceptibility within a weed species have typically been centered around the question “When should a weed be classified as resistant?” In order to confirm resistance, researchers will typically compare a putatively resistant biotype with a known susceptible bioytype of the same species. This method is appropriate and generally conclusive when a high level of resistance is observed, as typically found in ALS resistant weeds. However, recent investigations into common lambsquarters susceptibility to glyphosate conducted at the University of Wyoming, The Ohio State University, and Purdue University have produced results that are difficult to interpret. It has been demonstrated repeatedly that biotypes of common lambsquarters do indeed respond differently to glyphosate. However, the low magnitude of this difference has led to a discussion on whether this species has become 'resistant' to glyphosate. By definition, a herbicide resistant population must have been selected over time. This typically occurs by selecting for a rare resistant biotype with repeated use of a single herbicide mode of action. The speed at which a resistant population develops is largely dependent on the initial proportion of resistant plants in a population. Estimates of this initial proportion of resistant biotypes vary widely depending on the weed species and herbicide of interest.

Tolerance is the term reserved by the WSSA for species which are naturally less susceptible to a herbicide. That is, the species has a very high proportion of biotypes which are relatively insensitive to the herbicide. When analyzed critically, it seems that the difference between the two definitions lies largely with the initial proportion of individuals in a population that are susceptible to the herbicide. If the initial proportion of insensitive plants is 1 in a million, or 1 in 10,000, then the population was obviously not tolerant to the herbicide to begin with. However, what if one out of every ten plants is insensitive? Five out of ten? How many plants must survive the first application of a herbicide for the species to be tolerant?

GROWER PERCEPTIONS OF PROBLEM WEEDS IN GLYPHOSATE-RESISTANT CROP SYSTEMS: EVOLVED GLYPHOSATE RESISTANCE AND WEED POPULATION SHIFTS.
Micheal D. K. Owen, Greg Kruger, William G. Johnson, Stephen Weller, Robert G. Wilson, David R. Shaw, John Wilcut, and Bryan G. Young, Professor, Agronomy Department, Iowa State University, Ames, IA 50011-1011, Graduate Research Assistant, Associate Professor and Professor, Purdue University, West Lafayette, IN 47907, Professor, University of Nebraska, Scottsbluff, NE 69361, Professor, Mississippi State University, Mississippi State, MS 39762-9555, Professor, North Carolina State University, Raleigh, NC 27695-7620, Associate Professor, Southern Illinois University, Carbondale, IL 62901.

A survey of growers in Illinois, Indiana, Iowa, Mississippi, Nebraska, and North Carolina provided information about what growers thought about the influence of glyphosate-resistant (GR) crops and glyphosate-based weed control on weed populations. Questions were developed to ascertain the perceptions of 1200 growers about weed population density, weed community composition and changes in the weed community in fields where glyphosate-resistant crops had been grown for a minimum of three years on at least 101 hectares. Five crop systems were represented; continuous GR soybean, continuous GR cotton, GR corn/soybean rotation, GR soybean/non-GR crop rotation, and GR corn/non-GR crop rotation. Weed population density was assessed by growers on a relative scale of “light”, “moderate” or “heavy”. Differences in tillage systems, no tillage, reduced tillage, and conventional tillage, were also determined. A majority of growers suggested that weed population densities had declined or remained the same with the adoption of GR crops. When tillage system was considered, there were slight but inconsistent differences in grower assessments of weed population densities but 93 to 100% of the growers perceived that weed population densities had declined or remained the same with the introduction of GR crops. Interestingly, the GR corn/non-GR crop had the highest percentage of growers reporting an increase in weed population density (5 to 7% depending on the tillage system). Growers reported on a number of problem weeds in the GR cropping systems. These weeds included Johnsongrass, foxtail spp., morningglory spp., ragweed spp., common cocklebur, pigweed spp., common waterhemp, velvetleaf, sicklepod, and common lambsquarters. The occurrence of these weeds was somewhat regional and affected by GR crop system. Importantly, there was no indication by growers that the problem weeds had increased in response to the adoption of GR crop system. Growers in Illinois, Indiana, Iowa and Nebraska reported that common waterhemp was a common weed found in the GR crop systems and consistently listed in these states. Indiana growers also listed ragweed spp., Johnsongrass and horseweed as common problem weeds. In Mississippi and North Carolina, morningglory spp. and Johnsongrass were prominent as was pigweed spp. It is noteworthy that all of the weed species that growers perceived as problematic and common in GR crop systems, with the exception of morningglory spp., has been reported as having evolved resistance to glyphosate. Thus, while grower perceptions are that GR crop systems and the use of glyphosate has provided an important and consistent opportunity to manage weed problems, the possibility of weeds within these GR crop systems evolving resistance to glyphosate exists resulting in weed population shifts.

ASSESSING LONG-TERM VIABILITY OF GLYPHOSATE-RESISTANT TECHNOLOGY AS A FOUNDATION FOR CROPPING SYSTEMS - ON-FARM COMPARISONS OF WEED MANAGEMENT PROGRAM EFFICACY. Robert G. Wilson, William G. Johnson, Stephen C. Weller, Micheal D. K. Owen, David R. Shaw, John W. Wilcut, Bryan G. Young, Professor, Department of Agronomy & Horticulture, University of Nebraska, Scottsbluff, NE 69361, Professors, Crop Sciences, Purdue University, West Lafayette, IN 47907, Professor, Department of Agronomy, Iowa State University, Ames, IA 50011, Department of Plant & Soil Sciences, Mississippi State University, Mississippi State, MS 39762, Professor, Department of Crop Sciences, North Carolina State University, Raleigh, NC 27695, Department of Agriculture, Southern Illinois University, Carbondale, IL 62901.

Weed scientists from Illinois, Indiana, Iowa, Nebraska, North Carolina, and Mississippi conducted similar studies from 2006 to 2007 at 156 on-farm sites to determine the viability of various crop management strategies for the preservation of glyphosate programs as an effective tool for weed control. On-farm sites were divided into seven cropping systems: continuous glyphosate-resistant (GR) corn, soybean, or cotton, GR soybean followed by GR corn, GR soybean followed by non GR corn, GR cotton followed by GR soybeans, and GR soybean followed by a non GR crop. In the spring of 2006, growers selected fields that had previously been in a GR cropping system for a minimum of 3 yr to enroll in the project. The field was divided into two sections with each section approximately 8 ha in size. On the grower side of the field the farmer continued with his established glyphosate based weed management program. In the second half of the field the weed control program was managed by the university weed scientist with the goal of expanding the weed management program to include herbicides with several modes of action. In both the grower and university sections of the field, 20 0.5 m^2 observation points were established in a W pattern across the field. Each point was mapped using a GPS positioning instrument so each observation point could be examined throughout the growing season and in following years. Weed populations were observed at four times during the growing season: in early spring before crop planting, after crop emergence but before the first POST treatment, 2 wk following the last POST treatment, and before crop harvest in the fall. When averaged within the different cropping systems initial weed populations in the grower and university sections of the field were similar. In both 2006 and 2007 weed populations recorded after crop emergence were greater in continuous GR corn and least in a GR soybean followed by GR corn rotation. Implementing a POST weed control program in all cropping systems effectively reduced weed density. Members of the *Amaranthus* and *Setaria* genuses were two of the more prevalent weeds observed at study sites 2 wk following the last POST treatment and their density varied with cropping systems.

GROWER AWARENESS OF GLYPHOSATE-RESISTANT WEEDS AND RESISTANCE MANAGEMENT STRATEGIES. William G. Johnson, Greg Kruger, Stephen Weller, Robert G. Wilson, Micheal D. K. Owen, David R. Shaw, John Wilcut, David Jordan and Bryan G. Young, Associate Professor, Graduate Research Assistant and Professor, Purdue University, West Lafayette, IN 47907, Professor, University of Nebraska, Scottsbluff, NE 69361, Professor, Agronomy Department, Iowa State University, Ames, IA 50011-1011, Professor, Mississippi State University, Mississippi State, MS 39762-9555, Professor and Professor, North Carolina State University, Raleigh, NC 27695-7620, Professor, Southern Illinois University, Carbondale, IL 62901.

Corn, soybean, and cotton farmers from four Midwestern states (IN, IL, IA, NE) and two southern states (NC, MS) were surveyed to assess their perceptions and awareness of weeds resistant to glyphosate and what management tactics they use to prevent or manage glyphosate-resistant weed populations. This survey was the baseline analysis prelude to a six-state, four-year study of weed management tactics in agronomic systems using glyphosate-resistant crops. The survey indicated that farmers with large farms were more concerned about glyphosate resistance and its prevention than those with smaller farms. However, only 30% thought the ability of weeds to evolve glyphosate resistance was a serious issue. A majority of farmers thought following recommendations on the glyphosate product label was the most effective strategy to reduce or prevent glyphosate resistance in weeds. Few thought field tillage and/or using a non- glyphosate resistant crop in rotation with glyphosate resistant crops would be an effective strategy to manage glyphosate resistant weeds. The majority of farmers felt that printed farm publications were the most important source of information about glyphosate resistance in weeds and their management. Agriculture chemical dealers/retailers and Universities/Cooperative Extension Service were viewed as less important sources of information. A majority of farmers do not recognize the role that the recurrent use of an herbicide plays in development of herbicide resistance. Furthermore, a substantial percentage of farmers underestimated the potential for glyphosate resistant weed populations to develop in an agroecosystem dominated by glyphosate as the weed control tactic. Survey results suggest that the long-term sustainability of glyphosate resistant based cropping systems must include effective weed management programs that integrate scientific knowledge and multiple tactics to avoid the wide-spread development of glyphosate resistance and loss of this important weed control tool.

GROWER-IMPLEMENTED HERBICIDE STRATEGIES FOR WEED MANAGEMENT IN GLYPHOSATE-RESISTANT CROPS. Bryan G. Young, Southern Illinois University, Carbondale, IL 62901; Robert G. Wilson, University of Nebraska, Scottsbluff, NE 69361; William G. Johnson and Stephen C. Weller, Purdue University, West Lafayette, IN 47907; Micheal D. K. Owen, Iowa State University, Ames, IA 50011; David R. Shaw, Mississippi State University, Mississippi State, MS 39762; John W. Wilcut, North Carolina State University, Raleigh, NC 27695.

During 2006 and 2007 a total of 156 commercial fields in Illinois, Indiana, Iowa, Nebraska, North Carolina, and Mississippi were monitored for weed management practices implemented by growers. Fields were initially selected and categorized into three cropping systems based on a minimum history of three years: 1) a single continuous glyphosate-resistant (GR) crop, 2) a rotation of two GR crops, and 3) a GR crop rotated with a non-GR crop. The primary crops included corn, cotton, and soybean. Data on weed management strategies were collected over a period of two years to allow for each field to go through a complete crop rotation cycle.

When pooled over crop, growers in a continuous GR cotton, corn, or soybean production system used glyphosate as their sole herbicide for weed management in 45% of the fields in 2006 which declined to only 33% of the fields in 2007. In the same continuous GR crop system, a 15% increase in the use of residual herbicides was evident from 2006 (39%) to 2007 (54%). When rotating two GR crops growers used only glyphosate for weed management in 38% of the fields over 2006 and 2007 compared with 56% of the fields receiving a residual herbicide. The residual herbicide was most commonly used in the production of cotton and corn rather than soybean. Grower tendencies to use glyphosate alone or residual herbicides for weed management were similar for fields where two GR crops were rotated compared with a GR crop rotated with a non-GR crop. In summary, the reliance on glyphosate as the only herbicide used for weed management by growers has decreased in these study fields over the past two years with a concomitant increase in the use of residual herbicides. However, herbicide use patterns by growers still remain in conflict with best management practices to help mitigate glyphosate-resistant weeds from evolving.

MODELING THE BIOLOGY OF OUT-CROSSING BY ADVENTITIOUS POLLEN. Mark Westgate, Juan Astini, Agustin Fonseca, Jon Lizaso, Craig Clark, and Ray Arritt, Professor, and Graduate Student, Agronomy Department, Iowa State University, Ames, IA 50011, Research Scientist, Monsanto Company, Williamsburg, IA 52361, Crop Modeler, McNair Bostick Simulation Laboratory, University of Florida, Gainesville, FL 32611-0570, Assistant Professor, Department of Geography and Meteorology, Valparaiso University, Valparaiso, IN 46383-6493, and Professor, Agronomy Department, Iowa State University, Ames, IA 50011.

Risk of out-crossing from adventitious maize pollen results from complex interactions between the biology of flowering and pollination processes as well as the physical nature of pollen transport in the atmosphere. To quantify this risk, we have developed biological models of maize pollen production and viability, physical atmospheric models for pollen dispersal, and a biological model of pollen-silk interaction leading to kernel formation. We will show how these biological and physical models are linked to predict out-crossing events associated with adventitious pollen production and transport. Examples include results from field trials designed for production of non-transgenic grain, hybrid seed, and pharmaceuticals.

APPLICATION OF A 3D WINDBREAK MODEL TO COMPARE FIELD PLOT DESIGNS FOR LIMITING POLLEN DISPERSAL. Craig A. Clark, Juan Astini, Raymond W. Arritt, Mark E. Westgate and A. Susana Goggi, Graduate Students and Professors, Department of Agronomy, Iowa State University, Ames, IA 50011.

Placing windbreaks or shelter around a field may help reduce the escape of transgenes into the environment. An optimal configuration of such designs is desirable, but the cost and labor involved in field studies imposes practical limitations on the number of candidate designs that can be tested. We propose that a combined shelter flow model and a Lagrangian dispersion model can be used as a screening tool to test the effect of border design, field geometry, wind climatology, and other factors on pollen transport. This allows field studies to focus more efficiently on designs that are likely to be successful. We tested a the model by simulating results from field projects in the 2005 and 2006 growing seasons in which a tall annual grass (sorghum sudangrass) was planted as a border around a small maize plot. Field measurements for both 2005 and 2006 showed that a sorghum sudangrass border reduced the maximum distance of pollen dispersal from 300 m to 160 m. Model results show a decrease in downwind transport of pollen but predicted patterns of pollen deposition are much smoother than observed. We propose that this limitation derives partly from incomplete knowledge of the diurnal timing of pollen shed and partly from limitations in sampling observed pollen deposition.

APPLICATION OF LARGE EDDY SIMULATION TO QUANTIFY DISPERSAL OF VIABLE MAIZE POLLEN. Brian Viner, Ray Arritt, Mark Westgate and Susana Goggi. Graduate Research Assistant, Professor, and Professor, Department of Agronomy, Assistant Professor, Department of Seed Science, Iowa State University, Ames, IA 50011.

The creation of genetically modified (GM) crops has raised concerns regarding the transfer of genes from GM crops to wild relatives. To assess the risk of outcross, the development of numerical models that can accurately predict the movement depositional viability of pollen is needed. In maize, the primary mode of pollination is the transport of pollen by wind. Large Eddy Simulation (LES) is a tool to model turbulent motions that have the potential to lift pollen high into the atmospheric boundary layer and transport it over distances of at least five kilometers.

A LES model has been combined with a Lagrangian Dispersion Model to predict the transport and viability of pollen in the atmosphere. Predictions have been made for the deposition of maize pollen and of pollen viability upon deposition, as well as for vertical profiles of concentration and viability through the boundary layer. Viable pollen is modeled to be distributed throughout the boundary layer and transported over five kilometers before reaching the ground.

POLLEN FLOW IN THE ENVIRONMENT - DEVELOPMENT OF A RESEARCH PROGRAM. John A. Glaser, Biotechnology Research Program Leader, USEPA, Office of Research & Development, National Risk Management Research Laboratory, Cincinnati, OH 45268.

The USEPA Office of Research and Development seeks to provide to the agency and society the best information relating to the status of the environment and any related technology maintaining environmental quality. In this effort, a recent research workshop (Pollen Mediated Gene Flow in the Environment) was conducted to assess the level of knowledge and possible future research directions related to pollen flow of transgenic crops. In the development of future research directions, several questions are needed to focus the inquiry. What are the important technical issues? How should the selection or prioritization of research goals be developed? What are the best research questions for field scale experimentation? Thinking of potential uses of this research, can we assemble decision making aids for transgenic crop pollen effect evaluation?

SEED-TO-SEED AND HAY-TO-SEED POLLEN MEDIATED GENE FLOW IN ALFALFA. Larry R. Teuber*, Shannon Mueller, Allen Van Deynze, Sharie Fitzpatrick, James R. Hagler, and Jose Arias, University of California, Davis 95616, Forage Genetics, Inc, West Salem, WI 54669, and ARS-USDA, Arid-Land Agricultural Research Center, Maricopa, AZ 85239.

Honey bees (*Apis mellifera* L.) are predominantly used in California as pollinators for alfalfa (*Medicago sativa* L.) seed production. In some areas there is an increasing use of leafcutter bees (*Megachile rotundata* Fabricius.) in combination with honey bees. It is well known that honey bees will forage up to several miles from their hive. A study conducted in 2003 by our group conducted a gene flow study with a 6 acre Roundup Ready® source plot and eleven 0.54A trap plots at regular intervals extending East and West of the source. That study demonstrated adventitious presence (AP) in excess of 1.5% 900 ft from the marker gene source plot. Furthermore, the marker gene was detectable at very low frequency out to 2.5 miles – the outer limit of the study. The objectives of the current studies were to 1) evaluate the effectiveness of commercially available test kits in detecting the presence of the CP4 EPSPS (Roundup Ready) protein in seed samples from the 2003 study and known to have low levels of the trait based on extensive seedling growouts, 2) to determine the degree to which genes present in alfalfa fields being produced for hay are transferred to adjacent seed fields located the minimal legal distance of 165 ft from the hay field, and 3) to study gene flow between commercial scale production fields to further determine the extent of potential gene flow between alfalfa cultivars within the foraging range of honey bees.

To assess the effectiveness of the Roundup Ready test strips for seed we used seed produced on each of the 0.54 A trap plots during the 2003 study. All evaluations we conduced in accordance with the manufacturer's instructions. A total of 125 test strips were used to determine if the CP4 EPSPS protein was present in each of the traps. Strip test results from traps with a percentage AP less than 1% as determined by seedling growouts of seventy- to ninety-thousand seedlings provided virtually identical AP percentages based on determinations using "Seed Calc". AP percentages approaching and in excess of 1% could not be quantified because the frequency of AP seeds caused all the test strips to give positive results. For research purposes, we reduced the number of seeds tested when we started getting all positive strips, but kept all the other procedures the same. Results with this modification have also been in agreement with AP percentages found in large scale seedling growouts.

Conventional seed production fields were planted radiating out from a Roundup Ready hay production field. On all sides of the hay field the seed field was planted to within 165 ft and pollinated using honey bees. During the pollination period of approximately 8 weeks, the hay field was allowed to develop approximately 20% bloom (at least one open flower on 20% of the stems in the field) prior to being cut for hay. This is an amount of bloom the will occur with some commercial hay production and results in an opportunity for bees to visit the flowers and tripping does occur. Under this protocol, however, no seed is produced in the hay field. This degree of bloom was allowed to occurred in two consecutive cutting cycles during pollination. Seed was harvested at maturity from the seed fields at 50 foot intervals between 165 ft from the hay field (0 to 3 ft into the seed field) out to 615 ft from the hay field. Based only on test strip assessment, AP percentage was 0.29 % at 165 ft and dropped to less than 0.1% within 200 feet (365 ft of the hay field). This percentage of AP is well within current standards for varietal purity in the Federal Seed Law.

Seed to seed gene flow was studied in commercial seed production fields in the San Joaquin Valley of California. The source field was a 240A planted to cultivar bred to express the CP4 EPSPS protein. This field was isolated from all other seed production, except fields within the study area, by three miles in all directions. Within in the study area, a conventional cultivars was being produced for seed at 1 mile (240A), 3 miles (40A), and 5 miles (100A). All commercial seed production was pollinated by a combination of honey bees and leafcutter bees. 1.8A bridged trap plots were located on one edge of the study at 900 ft intervals between the source field and the conventional cultivar located 1 mile away. The first of these traps was located 165 ft from the source field. Current results are preliminary and are based on test strips. Equal size (1.8A) study areas were intensely sampled within each of the commercial. Among the small bridged traps, AP averaged 2.3% at 165 ft and rapidly decreased to 0.9% at 900 feet and 0.6% at approximately 4000 ft. At one mile AP percentage was less than 0.2%. At three miles the AP percentage was less than 0.03%. AP was not detected 5 miles from the source plot. Growouts of seedlings from form these test areas are still in progress. However, current data from this study using strip tests is in very close agreement with seedling growout data from our previous study.

SEED-TO-SEED AND HAY-TO-SEED POLLEN MEDIATED GENE FLOW IN ALFALFA. Larry R. Teuber*, Shannon Mueller, Allen Van Deynze, Sharie Fitzpatrick, James R. Hagler, and Jose Arias, University of California, Davis 95616, Forage Genetics, Inc, West Salem, WI 54669, and ARS-USDA, Arid-Land Agricultural Research Center, Maricopa, AZ 85239.

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RED RICE DIVERSITY AND PLANTING DATE EFFECTS ON RISK OF GENE FLOW. Nilda R. Burgos, Vinod K. Shivrain, David R. Gealy, Kenneth L. Smith, and Robert C. Scott, Associate Professor, Graduate Assistant, Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR 72704, Plant Physiologist, Dale Bumpers National Rice Research Center, Stuttgart, AR 72160, Professor, University of Arkansas Cooperative Extension Service, Monticello, AR 71656, and Associate Professor, University of Arkansas Cooperative Extension Service, Lonoke, AR 72086.

Red rice (*Oryza sativa* L.) is a problematic weed in rice production worldwide. Red rice control is difficult with conventional herbicides due to its similar biology and physiology as cultivated rice. Herbicide-resistant (HR) rice provides a valuable tool for red rice management, but with a risk of transferring HR gene to red rice populations. Diversity in red rice populations mainly in flowering time, plant height, and sexual compatibility with cultivated rice and the wide window of planting time can affect the rate of HR gene transfer from rice to red rice. Thus, experiments were conducted to understand the effect of: a) red rice biotype, b) rice cultivar, and c) sexual compatibility of rice and red rice on outcrossing rate.

Small plot experiments were conducted at the Rice Research Extension Center, Stuttgart; and Southeast Research and Extension Center, Rowher, AR from 2005 to 2007. Experimental design was a split-split plot with 3-4 replications, with planting date as main plot, Clearfield (CL) rice cultivar as subplot, and red rice biotype as sub-subplot. Rice and red rice were planted from early April to late May at 2-week intervals. CL161, CL hybrid and 12 red rice accessions were used. Red rice was planted in the middle row of each plot, flanked by four CL161 or CL hybrid rice on each side. Emergence, flowering, and plant height of red rice and CL rice were recorded. Red rice seed was harvested and a sub-sample of 100 g was planted in the field in subsequent years. Red rice seedlings were sprayed twice with imazethapyr at 0.14 kg ai/ha. Red rice plants which survived imazethapyr applications were counted and confirmed as outcrosses by DNA analysis. Manual crosses also were performed between the 12 red rice accessions and CL161 to determine their sexual compatibility.

The red rice accessions were 100 to 160 cm tall, with a flowering period ranging from 88 to 128, 87 to 117, 79 to 118, and 71 to 116 days after planting in the first, second, third, and fourth planting, respectively. Outcrossing rate differed between locations, but trends of outcrossing rate affected by red rice biotypes, CL rice, and planting dates were similar at both locations. At any given planting date, outcrossing rates differed between red rice accessions due to differences in flowering time. Planting date by CL cultivar and planting date by red rice accession interactions were significant ($p < 0.05$) for outcrossing rate. The outcrossing rate in different red rice accessions ranged from 0 to 0.3% across planting dates. Brownhull red rice had the highest outcrossing rate regardless of the CL rice cultivar pollen donor, and strawhull had the lowest outcrossing rate in general. Averaged over planting dates, the outcrossing rate between CL hybrid rice and red rice accessions was 0.3% compared with 0.06% in CL161. In experiments related to compatibility, brownhull, blackhull, and strawhull had 91, 78, and 71% seed set, respectively, which corroborate the results of field experiments. The data suggest that the interaction of planting date, red rice biotype, and rice cultivar can result in no gene transfer in some cases to significantly high risk of gene transfer in others. Hence, these factors need to be considered in planning HR gene transfer mitigation strategies for rice.

GENE FLOW BETWEEN SUGAR BEET AND WEED BEET: FROM FACTS TO MODELS. Henri Darmency, Nathalie Colbach, Yann Tricault, Mathilde Sester, Etienne Klein and Marc Richard-Molard, Seniors and graduate scientists, Weed Biology and Management, Institut National de la Recherche Agronomique, BP 86510, 21065, Dijon, Senior scientist, Biostatistics, Institut National de la Recherche Agronomique, 84914 Avignon cedex 9 and Director, Institut Technique de la Betterave, 45 rue de Naples, 75008 Paris, France.

Farm-scale monitoring was conducted at two locations in root production fields during six-years to study the occurrence and the mechanisms of gene flow between transgenic herbicide-resistant sugar beet and weed beet. We investigated the impacts of cultivar properties and control of bolting plants on the frequency of the transgene presence in weed beet populations. Specific experiments were carried out to quantify biological parameters affecting competition response, flowering, pollen flow, seed set and survival in the soil. These quantifications were incorporated as sub-models in the GeneSys model to simulate the effects of various farming systems (crop succession, cultivation techniques) on the dynamics and genetic composition of weed beet populations in a small region, and to propose the best agricultural practices to control weed beet and to prevent the advent of herbicide resistance in weed beet.

COMMERCIAL-SCALE POLLEN–MEDIATED GENE FLOW IN WINTER WHEAT IN THE CENTRAL WESTERN GREAT PLAINS. Todd A. Gaines, Patrick F. Byrne, Philip Westra, Scott J. Nissen, W. Brien Henry, Dale L. Shaner, and Phillip L. Chapman, Graduate student, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523-1170, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177, Research Geneticist, USDA/ARS Corn Host Plant Resistance Research, Mississippi State, MS 39762, Plant Physiologist, USDA/ARS Water Management Research, Fort Collins, CO 80526, and Professor, Department of Statistics, Colorado State University, Fort Collins, CO 80523-1877.

Pollen-mediated gene flow (PMGF) in wheat (*Triticum aestivum* L.) has been investigated in several studies, but most have been conducted on relatively small experimental plots. The introduction and widespread planting of a Clearfield (imidazolinone herbicide resistant) wheat cultivar in Colorado provided the opportunity to examine PMGF in commercial-scale production fields. We sampled a total of 56 large wheat fields in eastern Colorado in 2003, 2004, and 2005, and tracked the movement of the resistance gene from resistant cultivars to adjacent susceptible cultivars at distances up to 61 m. The highest level of PMGF we observed was 5.3% at 0.23 m, and the farthest sample at which we detected PMGF was 61 m. All 18 sampled cultivars showed some level of PMGF, with earlier heading cultivars having higher levels of cross-pollination than those that were late heading. At least in some cases, higher PMGF in early cultivars appeared to be due to late frosts that rendered recipient plants male sterile and therefore more susceptible to fertilization by foreign pollen. We used these data to develop a generalized linear mixed model with a random location effect. Based on the model results for cultivars heading earlier than the pollen source, the required separation distance between fields to ensure 95% confidence that 95% of locations have PMGF less than 0.9% is 41.1 m. For cultivars heading later than the pollen source, the equivalent required distance is 0.7 m. These are conservative confidence limits that should represent the highest levels of PMGF occurring in winter wheat in the central western Great Plains.

TIER 1 EVALUATION OF CROSSABILITY BETWEEN TRITICALE (X *TRITICOSECALE* WITTMACK) AND COMMON WHEAT, DURUM WHEAT AND RYE. Linda M. Hall, Melissa J. Hills, Francois Eudes, Research Scientist and Adjunct Professor, Alberta Agriculture and Food/University of Alberta, 410Ag/ForBuilding, Edmonton, AB, T6G 2P5, Instructor, Grant MacEwan, 10700-104 Avenue, Edmonton, AB T5J 4S2, Research Scientist, Alberta Agriculture and Food, Lethbridge, AB.

Development of transgenic triticale as a platform for novel bio-industrial products is predicated on an environmental biosafety assessment that quantifies the potential risks associated with its release. Pollen-mediated gene flow to related species and conventional triticale varieties is one pathway for transgene movement. A tier 1 quantification of triticale hybridization was conducted by emasculating and hand pollinating flowers under greenhouse conditions. Approximately 2000 manual pollinations were conducted for each cross and its reciprocal between two triticale genotypes: a modern triticale cultivar (AC Alta) and primary triticale (89TT108), and common wheat, durum wheat and rye. The frequency of outcrossing, hybrid seed appearance and weight, and F_1 emergence and fertility were recorded. Outcrossing, F_1 emergence and fertility rates were high from crosses between triticale genotypes. Outcrossing in inter-specific crosses was influenced by the species, and the genotype and gender of the triticale parent. In crosses to common and durum wheat where triticale was the male parent, outcrossing was $\geq$73.0% and $\geq$69.5%, respectively, but $\leq$23.9% and $\leq$3.0% when triticale was the female parent. Overall, outcrossing with rye was lower than with common and durum wheat. F_1 hybrid emergence was greater when triticale was the female parent. With the exception of a single seed, all wheat-triticale F_1 hybrid seeds were non-viable when triticale was the male parent in the cross. Only 7 durum wheat-triticale F_1 hybrids emerged from 163 seeds sown and all were produced with triticale 89TT108 as female parent. With rye, 8 F_1 hybrids emerged from 38 seeds sown and all were produced from crosses to AC Alta; 5 with AC Alta as the female parent and 3 as the male. Interspecific F_1 hybrids were self-sterile, with the exception of those produced in crosses between common wheat and triticale where triticale was the female parent. Tier 2 hybridization quantification will be conducted under field conditions.

Full paper of this abstract

BLOGGING AND PODCASTING IN A WORLD OF “NEW MEDIA”. Chuck Zimmerman, President, ZimmComm New Media, LLC, Holts Summit, MO, 65043.

What do today’s web savvy growers do when in need of information? Just like most anyone else they go online and search for it with services like Google. So how do you join the online conversation so your message gets through the clutter? One of the best ways is with frequently updated topical blogs and podcasts. The investment in creating your own blog or podcast is minimal other than your time. If you’re passionate about your subject and like to write or talk then let your inner voice out through new media tools.

The benefits to using new media mechanisms include communicating in a very personal way directly with your target audience, allowing your audience to subscribe to your content, becoming easy to find in search engines searches and creating an online archive of your work. With the use of RSS (really simple syndication), which is the mechanism that drives the subscription element of new media, you’ll be reaching growers in a way you’ve never thought possible. Chances are they’ll be the thought leaders who adopt new technology first. Do you know a grower without a mobile phone today? Those phones are the device that much of this new media technology is built to feed. Why not be one of the first to provide vital information they need on the device they carry around with them?

SCIENTIFIC WRITING: MEETING THE READER'S NEEDS. Kent Harrison, Professor, Department of Horticulture & Crop Science, Ohio State University, Columbus, OH 43210.

Scientific writing is an expectation and responsibility of any professional weed scientist. It is a painstaking task for which most scientists are poorly trained, and their efforts often result in wordy, pretentious, or cryptic screeds that are destined for rejection or obscurity. Science is complex, but communicating it to readers effectively is always possible. However, scientific writing requires more than just a sound knowledge of grammar and composition. The writer's ability to meet the reader's needs comes from an understanding of how readers perceive and interpret scientific information and concepts during the reading process. Serious scientific readers rely wittingly or unwittingly on their knowledge of the scientific method to interpret and assimilate new information, so they expect to see the method's logic, organization, and clarity reflected in the stuff they read. The critical reader's mind poses the following questions in chronological order: What is the problem being addressed? Why is it important? What have others done to address the problem? What have the authors done to address the problem and how is their approach different from previous work? What are their findings and how do they interpret the results? Where do we go from here? Once the writer formulates appropriate responses to these questions, the interaction of substance and structure can be fine-tuned to make the responses as comprehensible as possible. Simple guidelines are available for optimizing sentence and paragraph structure in scientific writing, so that in the end the reader is allowed to focus on the substance of the paper rather than the structure of its content.

PRESENTING RESEARCH TO A SCIENTIFIC AUDIENCE. Karen A. Renner, Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

Preparing and giving oral presentations is an integral component of many careers in weed science. Scientific talks are one of the accepted ways that knowledge and information are exchanged. How well you present your material directly impacts how well it is received. Well-prepared scientific talks provide your audience with knowledge presented in a way that best enables them to absorb and retain it. We retain information best if we see the information and hear it at the same time. Therefore content and organization, as well as delivery, are important. There are ten essential pieces in a well-prepared and presented talk to a scientific audience. These pieces include: an intriguing title, an interesting introduction, a brief background, clear objectives and hypotheses, succinct methods, compelling data, sound conclusions, important implications, and a dashing delivery style with outstanding visual support. Preparation, followed by practice, will result in an effective scientific presentation.

CREATING THE PERFECT POSTER: CATCHY, CLEAR, AND CONCISE. Christy L. Sprague, Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

Catchy, Clear, and Concise are three words that can describe the development of a perfect poster. Focusing on a single message, utilizing images and graphs to tell the story, and keeping the sequence of the poster well-ordered are all key points that need to be followed when creating the perfect poster. The development of a poster should start with a carefully crafted concise message. The main points and conclusions of the research should be clearly stated and the only visuals and text included in the poster should relate to those main points and conclusions. The poster should include a bold-explicit title that contains the full contact information of the authors. An introduction that explains why the research is important, research objectives, a brief methodology section, results including graphics, and clear conclusions and recommendations are the most important aspects of a poster. When a reader approaches a poster the first thing that catches his/her eye is the overall appearance. An effective poster should be pleasing to the reader’s eye. Posters should be neat and uncluttered, using white space to help organize sections. Color choices, graphics, and text amounts and sizes are all important elements in “Catching” the reader’s eye. Colors should be chosen carefully. Dark colors on light backgrounds are the easiest to read. Consider using no more than two to three colors in the overall theme of the poster. Whenever possible use graphics and/or images to help describe your research. Too much text on a poster is distracting to a reader. Text should be limited to no more than 50 to 75 words per section and the fonts should be large enough to read from one to two meters away. Text size should be a minimum of 24 point font with headings a minimum of 36 point font. Organizing the poster in a columnar format helps the reader follow the logical flow from top to bottom first and then from left to right. A poster presentation does not end with the printing of a poster, this is just the beginning. Readers will often ask “walk me through your poster”. It is important to be able to provide a three to five minute verbal explanation of your poster to make it an award winning poster. For more information on creating an effective poster presentation, refer to http:/www.ncsu.edu/project/posters. This cite authored by Hess et al. provides several helpful points in crafting the perfect poster.

TARGETING A CERTIFIED CROP ADVISER AUDIENCE: IS THERE SOME MIDDLE GROUND? Bryan G. Young, Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Certified Crop Advisers (CCAs) serve a critical role in relaying pertinent research findings and practical implications to growers for the purpose of improving environmental stewardship, crop production, or profitability. In general, a CCA may be viewed as someone that is a liaison from the technical research/education side of the agricultural industry to the practitioner or crop producer. In fact, the range in educational level for CCAs is extremely broad from less than a high school diploma to a Ph.D. Thus, the CCA audience may range from those who are comfortable with scientific methodology to those who just want to know what your message has to do with their job focus and production practices. Thus, the CCA audience can be challenging in terms of knowing what level of expertise to focus your presentation on and trying to find the middle ground to make your presentation effective for all in the audience. That middle ground may very well be that all CCAs share a common knowledge and appreciation for the technical aspects of crop production which can serve as a base for all presentations.

The content of a presentation to a CCA audience must be filled with technical information that can be readily adapted to improve crop management or improve the audience's understanding of the science behind some of the current issues in crop production. The presentation should start by demonstrating to the audience that you understand the current status of their industry and by explaining how your information relates to their circumstances. In other words, it's best if you come with some field credibility or the group may choose to disregard your comments as it may be evident that you are not familiar with their situation. It is not necessary to include a literature review in the introduction of your presentation. The CCA audience will acknowledge your expertise and will not hold you to describing all your research methods to prove you conducted the research correctly. Instead, a few pictures and a general approach to the research methods is all that is necessary. Again, the CCA audience is not there to question your knowledge of the literature or your ability to conduct research. They just want to hear how your information may be able to help them perform their job duties. Slides with data (graphs, tables, figures, etc.) are well within the comfort level of CCAs. However, don't go overboard with very technical data that does not easily translate to the field (ie Southern Blots, complex soil physics, enzyme kinetics, etc.). Feel free to use a simple bullet point or picture in lieu of data to deliver your message or summarize some research. You should conclude your presentation with a summary of the practical importance your message or findings have on crop production and how it may be used to improve crop management. You should deliver a convincing message on the importance of your information and at the same time push the audience to their technical limits so they can continue their education in crop management. Lastly, keep the presentation as informal as possible and consider entertaining questions during your presentation.

DELIVERING A MESSAGE TO THE PRODUCER: PRESENT THE FACTS, YOU ARE THE AUTHORITY! Fred Whitford, Coordinator. Purdue Pesticide Programs, Purdue University, West Lafayette, IN 47907.

What is the purpose of communicating with a grower? Is it to impress them with slides, your degree, facts and figures? You can probably recall the last time you saw someone stand behind a podium, using one unreadable chart after another. What you remembered was click, click, click, or something to the effect, you can't read these but let me tell you what it means. A one hour lecture with no time for questions—boring and unproductive—and a waste of the grower's time.

Think about the type of speaker you really enjoy listening too! They talk with the audience seemingly one-on-one using language and terms the audience understands. They share their own experiences allowing the audience to relate to the speaker and feel their presence was important. They take questions as they go and engage the audience to actively listen to their main message that was built from just a couple clear points. These are the type of speakers which effectively use their communication skills to not just deliver their main points, but educate their audience. As communicators, our success in educating the grower hinges largely on our ability to make the information understandable and important. Educators communicate in ways that make the facts and figures pertinent to the grower. In return, there is a greater probability your main message will be remembered, implemented, and positively impact the grower.

INTERVIEWING WITH THE MEDIA: BE CAREFUL LITTLE MOUTH WHAT YOU SAY. Steve Leer, Senior News Writer, Agricultural Communication Service, Purdue University, West Lafayette, IN, 47907.

What comes to mind when you think of the news media? Unbiased? Factual? Fair? Unbalanced? Malicious? Scum of the earth? OK, let's stop while we're ahead. Regardless what images journalism might conjure up, you likely will have to deal with reporters at some point in your career. So it's good to be prepared when the phone rings and a member of the news media is on the other end of the line. In "Interviewing with the Media," subtitled, "Be Careful Little Mouth What You Say," you will learn how to successfully communicate with the people who communicate with news consumers. We'll discuss such topics as the importance of plain English, avoiding industry jargon, answering tough questions, staying on message, word choice and what to do if a reporter gets under your skin. You'll see and hear examples of good media interviews and not-so-good media interviews. This session will provide practical advice for those who've never experienced a media interview, as well as those who regularly rub shoulders with the scum of the earth — er, reporters.

AQUATIC WEED MANAGEMENT CONCERNS OF ILLINOIS POND OWNERS.
George F. Czapar, Extension Educator, University of Illinois Extension, Springfield, IL 62791.

There are an estimated 100,000 ponds in Illinois and approximately 500 new ponds are being installed each year. Pond owners often identify aquatic weed management as one of their biggest challenges. In 2005, a survey of 428 pond owners was conducted in Illinois to help describe common characteristics of ponds, identify aquatic weed concerns, and determine the preferred methods for accessing educational materials. Survey respondents identified excessive algal growth as the most common aquatic plant management concern. Most ponds were 0.5 to 1 acre in size and over 20 years old. Pond owners listed workshops and seminars as preferred methods for receiving information.

NICOSULFURON PLUS METSULFURON COMBINATIONS FOR JOHNSONGRASS CONTROL IN BERMUDAGRASS. Walter H. Fick, Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Johnsongrass is a perennial warm-season grass that reproduces by rhizomes and seeds. Johnsongrass is a noxious weed in Kansas and is particularly troublesome in the southeastern part of the state. The objective of this research was to compare the efficacy of single and sequential applications of nicosulfuron plus metsulfuron for Johnsongrass control in bermudagrass pasture. The study site was located in Montgomery County. Herbicides were applied in 187 L ha^{-1} spray volumes using a CO_2-pressurized backpack sprayer. Individual plots were 4 by 7.6 m in size and treatments were replicated in 3 blocks. Herbicides were first applied July 13, 2007 to 40-cm tall Johnsongrass plants about 15 days after harvesting the bermudagrass for hay. The sequential treatments were applied on August 17, 2007, 18 days after a second hay harvest. Plots were evaluated for percent control 2 weeks after the first application, at the time of the sequential treatment applications, and at the end of the season on September 28, 2007. Single applications contained 7.2 to 10.8 g ha^{-1} nicosulfuron plus 1.1 to 1.7 g ha^{-1} metsulfuron. Sequential treatments contained 5.4 to 10.8 g ha^{-1} nicosulfuron plus 0.9 to 1.7 g ha^{-1} metsulfuron. Other treatments applied only once included nicosulfuron + metsulfuron + diuron (7.2 + 1.1 + 147 g ha^{-1} and 10.8 + 1.7 + 147 g ha^{-1}) and sulfosulfuron at 11.5 g ha^{-1}. All treatments except those containing diuron provided greater than 70% control of Johnsongrass 2 weeks after treatment. Diuron appeared to be antagonistic with nicosulfuron and/or metsulfuron and initially caused significant leaf burn on the bermudagrass. On August 17, at the time of applying the sequential treatments, all treatments provided greater than 80% control of Johnsongrass. At the end of the growing season, only the sequential treatments and sulfosulfuron provided greater than 90% control of Johnsongrass.

SCOURINGRUSH CONTROL WITH HERBICIDES. Kirk A. Howatt, Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051.

Questions regarding the control of *Equisetum* spp. are resulting from the encroachment and invasion of crop and rangeland by field horsetail and scouringrush in the Dakotas, Minnesota, and Montana. An experiment was established twice near Britton, South Dakota, to evaluate the efficacy of individual active ingredients to control an infestation of scouringrush in cropland. Seven auxinic herbicides and six ALS-inhibiting herbicides were applied in June. Four of the auxinic herbicides and two of the ALS-inhibitors also were applied to separate plots in October. Triclopyr at 24 oz ae/A applied in June provided 86% control in July and maintained 86% control in October. MCPA at 16 oz ae/A and imazapic at 3 oz ae/A provided less control, near 70%, than triclopyr, but the remaining treatments gave less than 57% control in October. The effect of each herbicide applied in June dissipated by the next season and did not affect the number of stems 12 months after application. Each herbicide applied in the fall provided greater than 80% control the following June, with triclopyr providing the best control at 98%. Activity of triclopyr persisted through the summer and was 95% visible control with 94% fewer stems 12 months after application compared with the control. Activity of fall-applied MCPA or metsulfuron at 0.6 oz ai/A 12 months after application varied between the years, while other herbicides gave less than 20% control. Triclopyr provided control of scouringrush for a full season regardless of June or October application. However, considering soil residuals and expenses of products, MCPA may be the best option for controlling scouringrush in cropland.

MANAGEMENT OF KEY NOXIOUS AND INVASIVE WEEDS WITH AMINOPYRALID AND OTHER HERBICIDES. B.Sleugh, P. Burch, M. Halstvedt, W. Kline, V. Langston, R. Masters, M. Melichar, V. Peterson, Dow AgroSciences LLC, 9330 Zionsville Rd., Indianapolis, IN 46268.

With the introduction of aminopyralid, an innovative, non-restricted use active ingredient from Dow AgroSciences, successful strategies for managing many noxious and invasive species in some of the most ecologically sensitive sites, including pastures and rangeland, can be developed. Aminopyralid is a pyridine carboxylic acid herbicide developed for selective broadleaf weed control in sites such as rangeland, pastures, rights-of-way, non-cropland, and natural areas and was registered under the Environmental Protection Agency's Reduced Risk Pesticide Initiative. Aminopyralid is effective at rates between 53 and 120 g acid equivalent (ae) ha^{-1} in rangeland and pastures with no injury to many cool- and warm-season grasses and is available commercially in the USA and Canada in two products, Milestone® and ForeFront R&P™ herbicides. Aminopyralid and other Dow AgroSciences active ingredients consistently provide excellent control of invasive and noxious weeds such as Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), spotted knapweed (*Centaurea maculosa*), Sericea lespedeza (*Lespedeza cuneata),* and kudzu (*Pueraria lobata***)**, and others in a wide variety of environments. Two years after fall applied aminopyralid treatments to Canada thistle regrowth, 87%, 90%, and 93% control was observed for 90, 105, and 120 g ae ha^{-1}, respectively. Spotted knapweed was controlled 100% at 426 days after application of 105 to 120 g ae ha^{-1} aminopyralid in May, June or September. PastureGard® herbicide at 420 + 105 g ae ha^{-1} (triclopyr + fluroxypyr, respectively) or approximately 2 pints of product $acre^{-1}$, provided greater than 90% sericea lespedeza control 428 days after treatment. These results indicate that herbicides are an important part of integrated approaches to managing noxious and invasive weeds in various habitats.

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ESTABLISHMENT OF FORAGE GRASSES AND LEGUMES IN THE SPRING FOLLOWING A FALL APPLICATION OF AMINOPYRALID. Mark J. Renz, Assistant Professor University of Wisconsin, Madison, WI 53715.

In Wisconsin, herbicides applications to pastures are common during the fall, while fields are replanted or renovated during the spring. Limited information is available as to how fall herbicide applications of aminopyralid can affect establishment of forage grasses and legumes the following spring. Experiments were established at two locations in Arlington and Lancaster Wisconsin to evaluate establishment of a range of legume and grass forages after applications of aminopyralid and other common pasture herbicides. Treatments included aminopyralid (0.054, 0.087 and 0.122 kg ae ha^{-1}), clopyralid (0.420 kg ae ha^{-1}), metsulfuron (0.042 kg ha^{-1}), imazapic (0.210 kg ha^{-1}), 2,4-D + dicamba (0.560 + 1.57 kg ae ha^{-1}) and an untreated control. To access the tolerance within each species, two varieties of the following species were planted in each plot: Italian ryegrass (Aurelia & Monarque), tall fescue (Fawn & Seine), orchardgrass (Cristosis and Okay), switchgrass (Blackwell & Sunburst), alfalfa (54V46 & WL357Hq), red clover (Cardinal & fsg960), and white clover (Alice & Colt). Plots were treated on October 25th and 20th 2006 and then forage species were planted the following May on the 16th and 18th at Arlington and Lancaster respectively. Frequency of species per plot were counted in 12 locations within each plot and divided by untreated controls 6 to 7 weeks after establishment to allow for the analysis of varieties within the same species with differing establishment rates. Data were analyzed by ANOVA for each species separately.

Significant differences ($p<0.05$) between sites existed for tall fescue and between varieties for orchardgrass. Data for all other species were combined for both factors. None of the treatments showed any differences in frequency of switchgrass or tall fescue. Orchardgrass frequency in metsulfuron treatments was less than other herbicides, while Italian ryegrass frequency was reduced with both imazapic and metsulfuron. Alfalfa and white clover frequency was less than other treatments with aminopyralid at 0.122 kg ae ha^{-1} and metsulfuron, but white clover frequency was also reduced with imazapic. Red clover establishment was reduced with the two highest rates of aminopyralid, metsulfuron, and plateau. Results indicate that grass establishment was not reduced the spring following fall aminopyralid applications, but enough herbicide persisted in the soil to reduce the establishment of legume forages. Future experiments are necessary to determine the amount and consistency of injury to specific legume species from aminopyralid under varying environmental conditions.

AMINOPYRALID EFFECTS ON CANADA THISTLE (*CIRSIUM ARVENSE*) AND NATIVE PLANT SPECIES IN THEODORE ROOSEVELT NATIONAL PARK, NORTH DAKOTA. Luke W. Samuel and Rodney G. Lym, Plant Sciences Department, North Dakota State University, Fargo, ND 58105.

Aminopyralid controls Canada thistle but resultant effects on plant community composition are generally unknown. A study was initiated to evaluate the effect of aminopyralid efficacy on Canada thistle and native plant species in Theodore Roosevelt National Park, ND. Thirty native and Canada thistle-infested areas were selected and aminopyralid at 120 g ae/ha was applied in September 2004 to half of each 9- by 6-m plot. Canada thistle density and foliar cover of each plant species in all sub-plots were determined prior to and 10 and 22 mo after treatment (MAT). Canada thistle density 10 MAT averaged 2 stems/m^2 compared to 31 stems/m^2 in the control and 22 MAT averaged 16 stems/m^2 compared to 42 stems/m^2 in the control. Plant community composition differed between native and Canada thistle-infested sites prior to treatment with greater richness and diversity in Canada thistle-infested plots than in native plots. Native plant richness and diversity were reduced 10 and 22 mo after treatment by aminopyralid. For example, native plant richness 10 mo after treatment averaged 12 species in non-treated compared to less than 9 species in treated sub-plots. Plant species richness and diversity were similar following aminopyralid treatment between all Canada thistle-infested sub-plots. The relative abundance (evenness) of plant species within the Canada thistle-infested sites 10 and 22 MAT increased when treated with aminopyralid compared to non-treated plots. Removal of Canada thistle resulted in a more even distribution of the remaining plant species within the plot. Plant species evenness in the native community 10 or 22 MAT was not affected by aminopyralid. Native plant evenness likely did not change because the dominant plant species within the native plots were not susceptible to aminopyralid. In summary, aminopyralid reduced Canada thistle density and did not affect plant species composition in Canada thistle-infested areas, but native plant species richness and diversity were reduced.