LACK OF EVIDENCE FOR INTERSPECIFIC HYBRID ORIGIN IN FERAL RYE.

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Feral rye (*Secale cereale*) is an exotic invasive weed of dry land agricultural regions of the western United States. It looks like cultivated cereal rye with the exception of having a shattering seed head. Past research suggests it is hybrid-derived. We investigated the history of introduction, characterized the genetic structure, and reexamined the evidence for hybrid origin of feral rye populations across three climatically distinct regions in the western United States using fourteen isozyme and three microsatellite loci. We found no evidence of a genetic bottleneck or of strong geographic structure in feral populations, suggesting locally idiosyncratic colonization and gene flow events at each site. Populations were, however, weakly clustered as a distinct lineage relative to cultivars. Our results do not support an interspecific hybrid origin for feral rye, but do suggest that the sampled populations of feral rye share a common ancestry that may explain its weedy nature.

EFFECTS OF COMPETITION ON FITNESS IN ADVANCED-GENERATION, CROP-WILD HYBRIDS (*RAPHANISTRUM* SPP.). Lesley. G. Campbell and Allison A. Snow, Ph. D candidate and Faculty, Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, Ohio 43210-1293.

Gene flow from crops to related species may lead to mixed populations of crop-wild hybrids and wild plants. The evolutionary impact of hybrids may depend on their ability to compete with neighboring wild relatives. We compared the effect of competition on the fitness of F_3 and F_8 hybrids (*Raphanus raphanistrum* x *R. sativus*) relative to their wild parent. First, we created 3 wild and 3 F_1 hybrid radish populations in Pellston, Michigan, USA, and allowed them to evolve under semi-natural agricultural conditions for two generations. We also measured the fitness of back-crossed hybrid plants that had evolved under similar conditions for eight generations and compared them to plants from another wild population. Pure and mixed pots of wild and F_3 or F_8 hybrids were established outdoors under four density treatments. Fitness components were measured as individual seed production, pollen and ovule fertility, flower production, and biomass. All measures of fitness were sensitive to density and neighbor identity. Mean F_3 hybrid seed production was significantly lower than wild seed production at all densities, while F_3 hybrid flower production and F_3 hybrid biomass were significantly higher than those of wild plants under competitive conditions. F_8 hybrid seed production was not significantly different from wild seed production at any density and these F_8 hybrids had significantly higher flower production than the wild plants. F_3 hybrid fitness may be limited by pollen and ovule fertility: ~50% of the F_3 hybrids had reduced pollen fertility, presumably due to a heterozygous reciprocal translocation, while less than 5% of the F_8 hybrids had reduced pollen fertility. Over time, we expect that natural selection would favor plants with high pollen and ovule fertility. This study suggests that the fitness of advanced-generation hybrid radishes can exceed that of *R. raphanistrum*, but only under specific genetic and competitive conditions.

EVALUATION OF POLLEN CONFINEMENT TECHNIQUES. Raymond W. Arritt, Craig A. Clark, Mark E. Westgate, Eugene S. Takle, Brian Viner and A. Susana Goggi, Department of Agronomy, Iowa State University, Ames, IA 50011.

The expense and time required to perform field studies impose severe limits on the number of pollen confinement approaches that can be tested. We have developed a screening methodology to assess proposed confinement designs so that the most promising designs can then be evaluated in field studies. The screening methodology couples two mathematical models. The first is a hydrodynamic model that predicts airflow and turbulence expected for a hypothetical field design based on the non-hydrostatic, anelastic equations of atmospheric motion. The second is a Lagrangian-stochastic model that predicts the motions of tracer particles in turbulent flow. These tracer particles are interpreted as a sample of the pollen grains that are shed from maize plants in a source plot. The Lagrangian-stochastic model typically employs about 500,000 tracer particles.

We use the screening methodology to study the effect of porous barriers (windbreaks) on the upwind and downwind sides of an isolated maize plot. First, predicted winds and turbulence are obtained from the hydrodynamic model. These wind and turbulence fields are then used in the Lagrangian-stochastic model to track the movement of a sample of pollen grains shed from the maize canopy in the source plot. Pollen deposition is computed as the particles are transported away from their source and fall to a predefined receptor height.

An unexpected result from the coupled models is that a barrier on the downwind side of the source plot has a greater effect than a barrier on the upwind side. Specifically, sedimentation of pollen in the calm zone to the lee of the downwind barrier is more beneficial in terms of restricting fugitive pollen than is the windbreak effect of the upwind barrier. We recently completed a field experiment during the 2005 season to provide observed data for comparison to the screening methodology. If the model results are confirmed by the field results, the tested configuration can be recommended a simple and economical method for decreasing flow of pollen from GM crops to their surroundings. Such confirmation would also give confidence in the utility of the coupled numerical model as a screening tool to evaluate hypothetical pollen confinement techniques.

SENSITIVITY OF WINTER WHEAT TO FALL APPLIED POSTEMERGENCE HERBICIDES. Nader Soltani*, Christy Shropshire, Peter H. Sikkema. Research Associate, Research Technician, and Assistant Professor. Ridgetown College, University of Guelph, Ridgetown, ON, Canada, N0P 2C0.

The adoption of production practices such as no-till and the use of non-residual herbicides such as glyphosate in the preceding crop have resulted in an increase of winter annual, biennial and perennial weeds in winter wheat in Ontario. Few fall applied postemergence (POST) herbicide options are available to control these weeds. Five field trials were conducted in Ontario to evaluate the crop safety of fall POST applications of dicamba, 2,4-D amine, MCPA amine, dichlorprop/ 2,4-D ester, bromoxynil/MCPA ester and thifensulfuron-methyl/tribenuron-methyl in winter wheat. Dicamba, MCPA amine, bromoxynil/MCPA ester and thifensulfuron-methyl/tribenuron-methyl did not cause any visual injury and there was no decrease in winter wheat height or yield. The application of 2,4-D amine and dichlorprop/2,4-D ester caused minor visual injury 24 to 31 weeks after treatment. Winter wheat height was reduced as much as 8% with dichlorprop/2,4-D ester. Yield was reduced up to 9 and 14% with 2,4-D amine and dichlorprop/2,4-D ester, respectively. Based on these findings, POST applications of 2,4-D amine and dichlorprop/2,4-D ester in the fall result in unacceptable injury in winter wheat. However, fall applications of dicamba, MCPA amine, bromoxynil/MCPA ester and thifensulfuron-methyl/tribenuron-methyl possess an adequate margin of crop safety for winter wheat weed management in Ontario.

ASSESSING THE IMPACT OF GENE FLOW: EXTENSIVE RISK ASSESSMENTS DEMONSTRATE THAT GLYPHOSATE TOLERANT BENTGRASS GENE FLOW WILL HAVE NO SIGNIFICANT IMPACT. Eric K. Nelson, Douglas Cattani, Robert Harriman, Kevin Turner. The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041

Creeping bentgrass (*Agrostis stolonifera*) and its relatives have been propagated and distributed in the US by seed and vegetative means for over 200 years due to their functional value for erosion control, wildlife habitat and forage, and more recently for recreation. Glyphosate tolerant bentgrasses (GTB) have been developed for golf course use and are currently being considered for deregulation by the USDA. The *cp4 epsps* transgene used to develop GTB is the same technology incorporated in deregulated Roundup Ready™ crops including alfalfa, canola, corn, cotton and soybeans planted on over 100 million acres in the US during 2005. Potential benefits and environmental impacts of GTB deregulation are being thoroughly examined. Once deregulated, GTB could provide many benefits to seed growers, golf course superintendents, golfers, and the environment. For example, GTB will simplify weed control and will provide for a dramatic reduction in application of other herbicides and fumigants used in attempts to control *Poa annua* (annual bluegrass, AB) and other weeds. Input reductions are expected in other turf maintenance chemistries (fungicides, nematicides, insecticides, growth regulators) and water necessary to sustain AB once it dominates a bentgrass turf and the manager can no longer afford to lose the AB due to pests and environmental stresses. Risk assessment research demonstrates that GTB (event ASR368) is not significantly different from existing bentgrass in its biological and adaptive characteristics throughout its life cycle. Therefore, creeping bentgrass gene flow by seed, vegetation and pollen will not be altered from their current status. Bentgrass is seldom a target for weed control in managed or unmanaged environments except in grass seed production areas. Whereas the Roundup Pro™ formulation of glyphosate currently promises only partial control of non-transgenic bentgrass and GTB is tolerant to glyphosate, GTB will not significantly impact bentgrass occurrence or current land management programs. Herbicide tolerance is considered an ecologically neutral trait with respect to persistence. If necessary, several glyphosate alternatives for bentgrass control in both upland and riparian environments are on lists approved by federal, state and non-profit organizations and efficacy of these alternatives has been verified by field and greenhouse research. Given the history and current state of bentgrass occurrence and use in North America, the knowledge gained through risk assessment research on GTB and the potential input reduction benefits of GTB, GTB should be deregulated for use by the turfgrass industry. Gene flow in *Agrostis* is a low frequency occurrence of a low impact event and plants can be controlled if desired. GTB's will not significantly impact potential *Agrostis* gene flow or plant control practices.

RESPONSE OF WINTER WHEAT TO POSTEMERGENCE HERBICIDES APPLIED IN THE FALL. Andrew J. Chomas, James J. Kells, Lee F. Siler, and Richard W. Ward. Research Assistant, Professor, Research Assistant and Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Weed control is essential for successful winter wheat production. Winter annual weeds have increased in winter wheat, leading to increased interest in fall herbicide application as compared to the typical practice of herbicide application in the spring. Field research was conducted in 2004 and 2005 at two sites each year in Michigan to evaluate crop response to several postemergence wheat herbicides applied in the fall. Crop injury was evaluated at harvest and yields determined at all four locations. No significant injury, height reduction or yield reduction was observed with Banvel, Harmony Extra, Stinger, or Express used at typical use rates and with typical adjuvants. 2,4-D applied at either 0.5 or 1.0 lb ai/A injured wheat in three of the four sites and reduced wheat yield at one of two sites each year. Addition of non ionic surfactant to 2,4-D amine reduced wheat yield at one of four sites. Increasing 2,4-D ester rate from 0.5 to 1.0 lb ai/A reduced wheat yield at one of four sites. 2,4-D reduced plant height at both sites in 2005.

ROTATIONAL CROP RESPONSE TO FLUCARBAZONE, FLUCARBAZONE PLUS CHLORSULFURON, SULFOSULFURON, PROPOXYCARBAZONE, AND PROPOXYCARBAZONE PLUS MESOSULFURON. Dallas E. Peterson and David L. Regehr, Professors, Department of Agronomy, Kansas State University, Manhattan, KS 66506-5504.

Field experiments were conducted near Manhattan, Kansas on a Muir silt loam soil having 6.3 pH, 2.3% organic matter, and a cation exchange capacity of 18 in 2003 through 2005, and on a Reading silt loam soil having 5.8 pH, 3.2% organic matter, and a cation exchange capacity of 10.6 in 2004 through 2005 to evaluate rotational crop response to several herbicides applied to winter wheat for winter annual grass control. 'Overley' hard red winter wheat was planted into a conventional tilled seedbed on October 4, 2003 and October 8, 2004. Herbicide treatments were applied to 2-3 tiller wheat on November 13, 2003 and November 22, 2004. Herbicide treatments consisted of flucarbazone at 30, 60, and 90 g/ha; flucarbazone plus chlorsulfuron at 30 + 16, 60 + 31, and 90 + 47 g/ha; sulfosulfuron at 35 g/ha; propoxycarbazone at 45 g/ha; and propoxycarbazone plus mesosulfuron at 17 + 11 g/ha. The entire plot area was treated with glyphosate in early spring of each year to terminate winter wheat growth. 'Asgrow RX718' corn, 'Pioneer 84G50' grain sorghum, 'Asgrow 3302' sulfonylurea tolerant soybeans, 'Paymaster PM 2145RR' cotton (2004 only), 'Pioneer 63M91' sunflower, and 'Mycogen 8N429CL' (2004) or 'Triumph 650 CL' (2005) imidazolinone resistant sunflower were no-till planted and fertilized according to local recommendations on May 24, 2004 and May 31, 2005. All crops were evaluated for visual injury symptoms throughout the season. Corn, sorghum, soybean, and sunflower crops were harvested for yield at crop maturity. No visible injury symptoms were evident on any rotational crop following flucarbazone, except for minor injury on corn and conventional sunflowers at the highest application rate. Carryover injury and yield loss in corn and conventional sunflowers was severe following flucarbazone plus chlorsulfuron. Carryover injury to cotton and grain sorghum was minor, and primarily only at the higher rates of flucarbazone plus chlorsulfuron. Sulfosulfuron residues caused substantial injury and yield loss in corn, grain sorghum, and conventional sunflowers. Propoxycarbazone caused some injury and minor yield reductions in corn and conventional sunflowers, and minimal injury to grain sorghum. Crop response to propoxycarbazone plus mesosulfuron was generally less than for propoxycarbazone alone. Imidazolinone resistant sunflowers exhibited substantially less injury than conventional sunflowers to all herbicides, but injury was not always eliminated. Cotton and sulfonylurea tolerant soybeans did not exhibit visual injury symptoms or yield loss from carryover of any of the herbicides evaluated. Crop yield loss generally corresponded to visual injury from herbicide carryover, but to a lesser degree than early season ratings. Rotational crops planted 18 months after herbicide application in 2003 exhibited no visible injury symptoms or yield loss.

SURVEY OF WEEDS IN UPSTATE MISSOURI FLOODED RICE. Matthew F. Jones and Kelly A. Nelson, Research Specialist and Assistant Professor, Division of Plant Sciences, University of Missouri, Novelty, MO 63460.

Rice was produced in northern Missouri from the late 1930's to the mid-1970's. However, limited management research was available for potential rice growers in this part of the state. Research was conducted in 2005 at Novelty and Bethel to determine weed species diversity in flooded rice in northern Missouri and the impact on grain yield, and to evaluate the effects of water depth on weed species diversity. 'Cocodrie' rice was seeded at 112 kg/ha in May 2005. Weed-free plots were maintained using chemical weed control and hand-weeded as necessary. Fall panicum, barnyardgrass, giant foxtail, and common waterhemp were present in the untreated control at Novelty and Bethel, while common cocklebur was present only at Novelty. Rice grain yield was reduced 5250 kg/ha at Novelty primarily due to a high weed population; however, no effect on rice grain yield was observed at Bethel with a low population of weeds. Additionally, water depth affected weed species diversity at the two sites. Grain yield was reduced by 6080 kg/ha in the untreated control at 2.54 cm compared to a 10 cm water depth. Common waterhemp and giant foxtail dry weights were 2 and 7 kg/ha greater, respectively, with a 2.54 cm compared to a 10 cm water depth.

CONVENTIONAL AND IMIDAZOLINONE-TOLERANT SUNFLOWER RESPONSE TO METSULFURON AND CHLORSULFURON SOIL RESIDUES. Andrew R. Kniss, Stephen D. Miller, and Craig M. Alford, Assistant Research Scientist and Professor, University of Wyoming, Laramie, 82071, and Field Development Representative, DuPont Crop Protection, Lincoln, NE 68505.

Metsulfuron and chlorsulfuron are commonly used herbicides in the winter wheat – fallow cropping systems of Wyoming and the high plains. These herbicides have long soil residual and their use may prohibit a transition to extended cropping rotations that include sunflower. Imidazolinone-tolerant sunflower cultivars adapted to this region have recently become available. Field studies were carried out at Archer and Lingle, WY from 2003 to 2005 to determine whether imidazolinone-tolerant sunflower cultivars possess increased tolerance to these two sulfonyl-urea herbicides compared to conventional sunflower cultivars. Imidazolinone-tolerant cultivars showed significantly less injury than conventional cultivars when planted into metsulfuron or chlorsulfuron treated soils. When planted one year following chlorsulfuron application at 51.5 g/ha, conventional sunflowers exhibited up to 67% visual injury and yield was reduced 28% compared to the untreated control. Imidazolinone-tolerant sunflower showed up to 23% injury, but yield was unaffected by this rate of chlorsulfuron. Imidazolinone-tolerant sunflower cultivars could potentially be used to shorten the rotational restriction after use of metsulfuron or chlorsulfuron.

THE EFFECT OF AMMONIUM SULFATE AS AN ADJUVANT WITH GLYPHOSATE FOR BURNDOWN CONTROL OF ITALIAN RYEGRASS. James R. Martin and Charles H. Slack, Extension Professor and Research Specialist, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445.

Two studies were conducted to evaluate AMS as an additive for enhancing burndown control of ryegrass with different formulations of glyphosate applied in mid March or mid April.

Liquid AMS was included in the appropriate treatments in both studies at a rate of 3.7% v/v. Burndown control was evaluated periodically during the first 4 weeks after treatment.

The first study compared seven products based on the following formulations: isopropyl amine salt with 3 lb ae/gal (Clearout 41 Plus, Glyphomax Plus, Honcho); diammonium salt with 3 lb ae/gal (Touchdown IQ); isopropylamine salt with 3.73 lb ae/gal (Roundup UltraMax); potassium salt with 4.17 lb ae/gal (Touchdown Total); and potassium salt with 4.5 lb ae/gal (Roundup WeatherMAX). Glyphosate was applied in all treatments in study 1 at 0.75 lb ae/A in combination of S-metolachlor at 1.3 lb ai /A plus atrazine at 1.6 lb ai/A. The height of ryegrass averaged 3 inches on March 13 for EPP-1 (early preplant -1) and 6 inches on April 14 for EPP-2.

Ryegrass response was substantially slower when treatments were applied at EPP-1 than at EPP-2. Average control ratings across all glyphosate treatments at EPP-1 were 3, 47, and 77% compared with 47, 80, and 86% for EPP-2 treatments at 9, 16, and 24 DAT (days after treatment), respectively. The fact the average temperature for the first 24 days after application was 53^0 F for EPP-1 treatments, compared with 64^0 F for EPP-2 treatments, may have contributed to the difference in speed of response. The addition of AMS did not enhance the speed of control with the EPP-1 treatments. However, the addition of AMS to Clearout 41 Plus tank mixture applied at EPP-2 increased ryegrass control from 43 to 53% at 9 DAT, but did not enhance control of other products. AMS did not enhance ryegrass control of any glyphosate treatment when evaluated at 16 and 24 DAT.

Applying Touchdown Total plus S-metolachlor plus atrazine at EPP-1 provided 90 and 92% ryegrass control at 24 DAT, with and without AMS, respectively. The use of Roundup UltraMax at EPP-1 resulted in 77 and 83% control with and without AMS, respectively. The other glyphosate treatments at EPP-1 provided an average of 74% control at 24 DAT, regardless whether or not AMS was included.

The second study compared Roundup WeatherMAX and Clearout 41 Plus at 0.75 or 1.125 lb ae/A applied either alone or with AMS. The average height of ryegrass was 6 inches on March 15 for EPP-1 treatments and 11 inches on April 5 for EPP-2 treatments.

The cooler temperatures associated with EPP-1 treatments caused ryegrass to respond slower relative EPP-2 treatments. Roundup WeatherMAX and Clearout 41 Plus provided similar ryegrass control, however there were as few instances where differences between products occurred. When 0.75 lb ae/A was applied alone at EPP-1 timing, Roundup WeahterMAX provided 63% control at 30 DAT compared with 50% for Clearout 41 Plus. Including AMS as an additive with glyphosate at 0.75 lb ae/A, resulted in 77% control for Roundup WeahterMAX but only 53% for Clearout 41 Plus.

Increasing the glyphosate rate from 0.75 to 1.125 lb ae/A improved ryegrass control in 3 of 4 instances for EPP-1 treatments and 1 of 4 instances for EPP-2 treatments.

In summary, application timing tended to have the most impact on burndown control of ryegrass, with April applications usually providing faster and slightly better control than March applications. The different glyphosate formulations generally provided similar level of ryegrass control, yet there were a few differences in control due to formulation. AMS generally did not enhance ryegrass control, except in a few instances. Increasing the glyphosate rate from 0.75 to 1.125 lb ae/A tended to improve control, particularly when treatments were applied during early spring.

WEED MANAGEMENT STRATEGIES IN GLYPHOSATE-RESISTANT CORN. Bryan G. Young, Randy McElroy, and Ronald A. Hines, Associate Professor, Southern Illinois University, Carbondale, IL 62901, Agronomic Research Manager, Monsanto Company, Farina, IL 62838, and Research Specialist, University of Illinois, Simpson, IL 62985.

Adoption of glyphosate-resistant corn continues to increase and growers are interested in adapting the technology to their local production systems. Field research was conducted at Belleville, Farina, and Simpson, IL in 2004 and 2005 to provide additional information on the performance of weed management strategies in glyphosate-resistant corn in southern Illinois. Specifically, the objective was to determine the effect of herbicide application timing and residual herbicides on weed control and grain yield. Herbicide treatments included a single application of glyphosate at 0.84 kg ae/ha at six postemergence application timings based on weed height. Glyphosate was also applied in combination with acetochlor plus atrazine when weeds were 2 to 10 cm in height and as a sequential treatment following a preemergence application of acetochlor plus atrazine.

In three of the six site-years, weed control was greater than 90% when glyphosate was applied when weeds were 20 cm or less. Control of weeds taller than 20 cm was inconsistent with glyphosate and varied by site-year and species. Acetochlor plus atrazine applied at a full label rate followed by glyphosate provided 90% or greater weed control. Reduced rates of acetochlor plus atrazine followed by glyphosate did not provide sufficient control of ivyleaf morningglory in one site-year. In almost all instances, the use of acetochlor plus atrazine in combination with glyphosate prevented any corn yield reductions. Reliance on a single postemergence application of glyphosate did not consistently result in optimal yields. This research suggests that growers with a basic understanding of the primary weed problems in individual fields will likely be more successful in adopting glyphosate-resistant corn and specific weed management strategies.

MULTI-YEAR EVALUATIONS OF KIH-485 FOR WEED CONTROL AND CROP TOLERANCE.
James L. Moody, Douglas J. Maxwell, and Aaron G. Hager, Research Specialists and Assistant Professor, University of Illinois, Urbana, IL 61801.

KIH-485 is an experimental herbicide being developed for weed control in corn. Over a three-year period, field experiments have been conducted at three locations in Illinois to evaluate phytotoxicity, weed control, and corn yield resulting from treatments containing KIH-485. Weed species common to all experiments included giant foxtail, velvetleaf, and common lambsquarters; a treatment of *S*-metolachlor also has been common to each experiment. Weed control and crop phytotoxicity evaluations were made approximately 30 days following preemergence applications. Results obtained from six environments indicate treatments containing KIH-485 performed equal to or better than *S*-metolachlor-containing treatments on the aforementioned weed species. Crop phytotoxicity, as measured by visual assessments and crop yield, indicated KIH-485 and *S*-metolachlor both provide excellent crop safety. KIH-485 provided longer soil residual weed control and overall better control of velvetleaf than *S*-metolachlor. Soil moisture required for optimal herbicide activity appears similar for KIH-485 and *S*-metolachlor.

FIELD SANDBUR CONTROL IN IRRIGATED CORN WITH HERBICIDES. Stevan Z. Knezevic and Jon E. Scott*, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE, 68728.

Field sandbur is the most troublesome annual grassy weed in corn production in Nebraska, especially on sandy soils. A field study was initiated in 2005 at Brunswick, in the northeastern part of the state, to evaluate the performance of 10 herbicide combinations for sandbur control. Sandbur densities prior to the POST application (V-4 corn stage) ranged from 20 to 40 seedlings per meter square. Evaluation at 26 days after application of PRE treatments implied that several treatments provided fair to good (>80%) sandbur control. These included KIH-485 at 125 g ai/ha, 166 g ai/ha and 209 g ai/ha, respectively; isoxaflutole (35 g ai/ha) + flufenacet (504 g ai/ha) + atrazine (1120 g ai/ha); and S-metolachlor (1880 g ai/ha) + mesotrione (190 g ai/ha) + atrazine (700 g ai/ha). Evaluation of all treatments 27 days after application of POST treatments suggested excellent control (>90%) with only one treatment, which was: isoxaflutole (35 g ai/ha) + flufenacet (504 g ai/ha) + atrazine (1120 g ai/ha) PRE followed by foramsulfuron (38 g ai/ha) + sodium salt of diflufenzopyr (42 g ae/ha) + sodium salt of dicamba (110 g ae/ha) POST. Good control (87%) was also achieved with isoxaflutole (35 g ai/ha) + flufenacet (504 g ai/ha) PRE followed by foramsulfuron (38 g ai/ha) + sodium salt of diflufenzopyr (42 g ae/ha) + sodium salt of dicamba (110 g ae/ha) POST. Our results suggest that the PRE herbicides did not provide satisfactory sandbur control (>80%) for more than 30 days after application, compared to the excellent control (95%) with the PRE followed by POST application. KIH-485 alone performed better than the other graminicides tested, and it was similar to other tank mix and premix herbicide treatments when applied PRE. This indicates that there is a need for a combination of PRE and POST herbicides to control sandbur on sandy soils with high infestation levels. (13)

CONTROL OF GREEN FOXTAIL, YELLOW FOXTAIL, AND SHATTERCANE WITH MESOTRIONE AND ALS-INHIBITING HERBICIDES IN CORN. Christopher L. Schuster, Kassim Al-Khatib, and J. Anita Dille, Graduate Research Assistant, Professor, and Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66502.

Mesotrione is a registered soil- and foliar-applied herbicide for control of annual weeds in corn. Postemergence applications of mesotrione, however, do not provide adequate control of grasses and as a result, are often tank mixed with atrazine and/or acetolactate synthase (ALS)-inhibiting herbicides. Recent complaints have contended that control of shattercane and foxtail species is reduced when ALS-inhibiting herbicides are applied in combination with mesotrione. Field experiments were conducted near Manhattan and Rossville, KS in 2004 and 2005 to evaluate the efficacy of various ALS-inhibiting herbicides applied with mesotrione or mesotrione + atrazine on green foxtail, yellow foxtail, and shattercane. Plants were treated at 7.5 to 12.5 cm height with mesotrione (105 g ha^{-1}), mesotrione + atrazine (105 + 757 g ha^{-1}), nicosulfuron (35 g ha^{-1}), foramsulfuron (37 g ha^{-1}), nicosulfuron + rimsulfuron (26 + 13 g ha^{-1}), or a combination of mesotrione or mesotrione + atrazine with any one of the three ALS-inhibiting herbicides. Adjuvants were included in tank mixes as recommended on herbicide labels. Grass injury was visually assessed 7 and 21 days after treatment (DAT) based on a scale where 0% = no injury, and 100% = plant mortality. Treatments were combined over years due to a lack of interactions. Visual injury of green and yellow foxtail were greater than 80%, while shattercane injury was greater than 90%, when treated with nicosulfuron, foramsulfuron, or nicosulfuron + rimsulfuron. Injury of green foxtail and yellow foxtail was reduced 14 and 39%, respectively, when mesotrione was tank mixed with nicosulfuron. An application of mesotrione + foramsulfuron resulted in 59 and 51% visual injury of green foxtail at Manhattan and Rossville, respectively. Tank mixing mesotrione with nicosulfuron + rimsulfuron did not result in an antagonistic interaction when applied to yellow foxtail or shattercane at either location. The addition of mesotrione + atrazine to nicosulfuron + rimsulfuron at Manhattan, however, resulted in only 77, 70, and 78% visual injury of green foxtail, yellow foxtail, and shattercane, respectively. Similar antagonistic interactions were observed at Rossville. Mesotrione + atrazine plus nicosulfuron, foramsulfuron, or nicosulfuron + rimsulfuron consistently resulted in a greater antagonistic interaction when applied to grass species, as compared to the ALS-inhibiting herbicide applied in combination with mesotrione without atrazine.

SOIL-APPLIED MESOTRIONE IN GRAIN SORGHUM. James M. Lee, Phillip W. Stahlman, Patrick W. Geier, and John C. Frihauf, Assistant Scientist, Professor, Assistant Scientist, Kansas State University Agricultural Research Center, Hays 67601, and Biological Science Technician, USDA-ARS, Urbana, IL 61801.

Experiments were conducted near Hays, KS in 2003, 2004, and 2005 to evaluate weed control and grain sorghum tolerance to prepackaged mixtures of mesotrione&*S*-metolachlor&atrazine (1:10:3.7 ratio) and mesotrione&*S*-metolachlor (1:10 ratio) compared to *S*-metolachlor&atrazine (0.774:1 ratio). Herbicides were applied 20 days preplant (20 DPP), 10 days preplant (10 DPP), and preemergence (PRE) at 1X rates (2.77, 2.06, and 3.25 kg/ha, respectively) and 2X rates (5.33, 4.12 and 6.50 kg/ha, respectively) each time. Soil was a Crete silty clay loam soil with 1.8 ± 0.2% organic matter and pH 6.3 ± 0.2. DeKalb 'DK36' or 'DKC36-00' grain sorghum was planted no-till at 103,000 ± 2,000 seed/ha. Herbicides had no visible effect on grain sorghum in any of three experiments when applied 20 DPP, and little or no effect when applied 10 DPP in 2003 or 2004. Most 10 DPP treatments stunted grain sorghum <10% in 2005, but the effect was temporary. However, grain sorghum was injured as much as 20% in 3 of 4 experiments when mesotrione&*S*-metolachlor&atrazine or mesotrione&*S*-metolachlor were applied at 2X rates PRE. Those treatments caused occasional necrosis, reduced sorghum growth and mature plant height, delayed flowering and reduced yields as much as 45%. However, yields were seldom reduced by 1X herbicide rates. In general, mesotrione&*S*-metolachlor&atrazine and mesotrione&*S*-metolachlor controlled pigweed species, puncturevine and annual grass species as well as or better than metolachlor&atrazine, regardless of application timing.

CONTROL OF VOLUNTEER ADZUKI BEAN IN CORN AND SOYBEAN. Chris Kramer, Josh Vyn, Christy Shropshire, Nader Soltani, and Peter H. Sikkema. Undergraduate student, Research Technician, Research Technician, Research Associate, and Assistant Professor. Ridgetown College, University of Guelph, Ridgetown, ON, Canada. N0P 2C0.

There is currently little knowledge of herbicides that may provide effective control of volunteer adzuki bean in corn and soybean. Field studies were conducted in 2005 at Exeter and Ridgetown, Ontario to evaluate the performance of various pre- and post-emergence herbicides to control volunteer adzuki bean in soybean and corn. The pre-emergence application of cloransulam-methyl, linuron, metribuzin, flumetsulam, and imazethapyr did not control volunteer adzuki bean in soybean. The post-emergence application of glyphosate provided 83% control of adzuki bean, reduced adzuki bean dry weight, and increased soybean yield compared to the weedy check. The postemergence application of chlorimuron suppressed the growth of volunteer adzuki bean in conventional soybean. The post-emergence application of acifluorfen, fomesafen, bentazon, thifensulfuron, cloransulam-methyl, imazethapyr, and imazethapyr + bentazon did not have any effect on visual control, dry weight of volunteer adzuki bean, or soybean yield. Of the pre-emergence herbicide options in corn, dicamba/atrazine provided the best control and reduced adzuki bean dry weight to the level of the weed free check. None of the pre-emergence treatments had any effect on corn yield compared to the weedy check. The post-emergence application of atrazine, dicamba, dicamba/diflufenzopyr, dicamba/atrazine, 2,4-D/atrazine, bromoxynil + atrazine, prosulfuron + dicamba, primisulfuron/dicamba, mesotrione, and mesotrione + atrazine controlled volunteer adzuki bean 82-96%, reduced dry weight 90-100%, and increased corn yield 26-35% over that of the weedy check. Dicamba/atrazine was the most effective herbicide while mesotrione was the least effective herbicide option in controlling volunteer adzuki bean among the post-emergence herbicides evaluated in corn.

EFFECT OF GLYPHOSATE CONTAMINATION ON CONVENTIONAL CORN AND SOYBEAN.
Douglas J. Maxwell, Aaron G. Hager, Jeffrey A. Bunting, and Joshua T. Kunkel, Principal Research Specialist, Assistant Professor, Dept. of Crop Sciences, University of Illinois, Urbana; Seed Agronomist, Growmark Inc., Bloomington, IL; Visiting Research Specialist, Dept. of Crop Sciences, University of Illinois, Urbana, IL, 61801.

Field research was conducted at Urbana, IL in 2003 and 2004 for corn, and in 2005 for soybean to evaluate the effect of glyphosate contamination and or simulated drift on non-glyphosate-resistant corn and soybean. Non-glyphosate-resistant corn and soybean were planted in 30-inch rows and maintained weed free. Various rates of glyphosate were applied with proportional rates of ammonium sulfate. The soybean trial also included combinations of fomesafen and imazamox with glyphosate. Crop injury, height, photographs, and yield were taken. In corn, plant samples from roots and leaves were also analyzed for glyphosate content by APT Labs Inc., Wyomissing, PA. Rates applied were based on a 1X in crop application of 0.75 lb/acid equivalent (a.e.). Multiple rates were applied ranging from 0.001X to 0.2X in corn and 0.01X to 0.33X in soybean. For corn minimal injury and no yield loss occurred from glyphosate at 0.01X or less. However, glyphosate rates of 0.1X or greater resulted in significant injury and yield loss of 50% or more. Glyphosate concentration in the plant was less than 0.5 parts per million (ppm) with 0.01X rates or less, while concentrations for rates of 0.1X or greater were 0.6 ppm or higher. Yield reducing injury tended to occur on 4 to 8 inch corn plants with detectable amounts of 0.1 ppm or greater. Extracted plant concentrations less than 0.3 ppm, or more than 0.6 ppm, appear to be the threshold range between recoverable and permanent injury for 12 to 36 inch tall corn, respectively. For soybean minimal injury and no loss of yield occurred with glyphosate alone at rates of 0.1X or less, or 0.04X or less when tank-mixed with fomesafen and/or imazamox at field use rates. Season-long injury that reduced yield significantly occurred with glyphosate alone treatments at 0.167X or greater, or at 0.01X or greater when tank-mixed with fomesafen. Soybean maturity was delayed from 6 to 12 days when yield loss was significant.

WEEDSOFT: EFFECTS OF CORN ROW SPACING ON PREDICTIONS OF HERBICIDE EFFICACY ON SELECTED WEED SPECIES. Shawn M Hock*, Research Associate III, Univ. of Guam, Mangilao, GU, 96923, Stevan Z. Knezevic, Professor, Univ. of Nebraska, Concord, NE, 68728, William G. Johnson, Purdue Univ., Lafayette, IN, 47907, Christy Sprague, Ass. Professor, Michigan State Univ., East Lansing, MI, 48824.

The ability to accurately estimate herbicide efficacy is critical for any decision support system used in weed management. Recent efforts by weed scientists in the North Central Region to adopt WeedSOFT across a broad region have resulted in a number of regional research projects designed to assess and improve the predictive capability of WeedSOFT. Field studies were conducted in Nebraska, Missouri, and Illinois to evaluate herbicide efficacy predictions by a computerized weed management decision support system in two corn row spacings. After crop and weed emergence, weed densities and heights were entered into WeedSOFT to generate a list of treatments ranked by predicted crop yields, which included: highest predicted crop yield potential (number one control recommendation), a 10% yield reduction, a 20% yield reduction, a 10% yield reduction plus cultivation, and cultivation alone. These treatments were applied to corn grown in 38- and 76-cm rows. Generally, treatments applied in 38-cm rows had more accurate herbicide efficacy predictions compared to 76-cm rows. WeedSOFT provided better control predictions for broadleaf than grassy species. WeedSOFT provided excellent herbicide efficacy predictions for the most important treatment, the number one control recommendation based on highest predicted crop yield potential, which indicates a good potential for practical use of this software for herbicide recommendations.

NICOSULFURON AND THIFENSULFURON PREMIX FOR POSTEMERGENCE GRASS AND BROADLEAF WEED CONTROL IN CORN. Susan K. Rick, James D. Harbour, Larry H. Hageman and David W. Saunders, Field Development Representatives and Product Development Manager, DuPont Ag and Nutrition, Wilmington, DE 19803.

Nicosulfuron is registered for postemergence grass control in corn and marketed under the trade name Accent® herbicide. While nicosulfuron has demonstrated suppression and/or control of several broadleaf weed species, a tank mix partner is necessary for broad spectrum weed control.

Thifensulfuron-methyl is registered for postemergence broadleaf control and has been marketed under the trade name of Pinnacle® and more recently Harmony® GT in soybeans and corn. Thifensulfuron-methyl has also been marketed for broadleaf weed control in cereal crops under the Harmony™ and Affinity™ series of products. A pre-mixture of thifensulfuron-methyl and rimsulfuron has been marketed in corn as Basis® herbicide since the mid 1990's. Thifensulfuron-methyl provides suppression and/or control of various important broadleaf weed species including velvetleaf and common lambsquarters.

A pre-mixture of nicosulfuron and thifensulfuron-methyl provides the same grass control provided by nicosulfuron plus additional broadleaf weed control . A label was submitted to the EPA in August 2005 for the pre-mixture. The nicosulfuron and thifensulfuron-methyl mixture will be marketed under the trade name of Stout™ herbicide. Federal registration was received in the fall of 2005.

INFLUENCE OF FALL AND SPRING HERBICIDE APPLICATIONS ON WINTER AND SUMMER ANNUAL WEED POPULATIONS IN NO-TILL CORN. Nicholas H. Monnig and Kevin W. Bradley, Graduate Research Assistant and Assistant Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211.

Field experiments were conducted in the fall of 2004 through the summer of 2005 in central and northwest Missouri to evaluate the effects of fall and early spring herbicide applications on winter and summer annual weed populations. At each location, 1.12 kg/ha simazine plus 0.54 kg/ha 2, 4-D, 0.013 kg/ha rimsulfuron plus 0.007 kg/ha thifensulfuron plus 0.54 kg/ha 2, 4-D, and 1.12 kg/ha glyphosate plus 0.54 kg/ha 2, 4-D were applied in the fall, 45, 30, and 7 days early preplant (EPP). At both locations, control of field pennycress (*Thlaspi arvense* L.) one week after planting (WAP) was greater than 80% for all treatments except glyphosate plus 2, 4-D applied in the fall. Control of henbit (*Lamium amplexicaule* L.) 1 WAP at the central location was greater than 90% for all treatments except simazine plus 2, 4-D applied 45 and 30 days EPP. At the northwest location, all fall treatments provided 99% control of henbit 1 WAP, while all spring treatments provided less than 80% control except glyphosate plus 2, 4-D applied 45 and 30 days EPP and simazine plus 2, 4-D applied 45 days EPP. Weed control ratings to evaluate summer annual weed control conducted 5 WAP at the central location revealed poor control of Pennsylvania smartweed (*Polygonum pensylvanicum* L.) from all treatments containing glyphosate plus 2, 4-D and fall treatments of simazine plus 2, 4-D and rimsulfuron plus thifensulfuron plus 2, 4-D. However, all spring treatments of simazine plus 2, 4-D and rimsulfuron plus thifensulfuron plus 2,4-D provided greater than 80% control of Pennsylvania smartweed. Control of giant foxtail (*Setaria faberi* Herrm.) 5 WAP at both locations was less than 80% with all fall treatments and spring treatments of glyphosate plus 2, 4-D at 45 and 30 days EPP. However, at the central location all other spring treatments provided greater than 80% giant foxtail control except rimsulfuron plus thifensulfuron plus 2, 4-D applied 30 days EPP. At the northwest location, all spring treatments containing glyphosate plus 2, 4-D provided less than 80% control of giant foxtail, as did simazine plus 2, 4-D applied 45 days EPP. Poor control of common waterhemp (*Amaranthus rudis* Sauer) at the northwest location was observed with all treatments 5 WAP. Summer annual weed emergence counts were also conducted at both locations beginning 1 WAP and continuing through 5 WAP.

WIRSTEM MUHLY CONTROL IN CORN. Chris Kramer, Josh Vyn, Christy Shropshire, Nader Soltani and Peter H. Sikkema. Undergraduate student, Research Technician, Research Technician, Research Associate, and Assistant Professor. Ridgetown College, University of Guelph, Ridgetown, ON, Canada. N0P 2C0.

Field trials were conducted at three Ontario, Canada locations to study the efficacy of five sulfonylurea herbicides for the control of wirestem muhly in field corn. Experiments were arranged in a randomized block design with four replications. Treatments consisted of a weedy check, a weed-free check, and the postemergence application of rimsulfuron (15 g ai/ha), nicosulfuron (25 g ai/ha), nicosulfuron plus rimsulfuron (25 g ai/ha), foramsulfuron (70 g ai/ha), and primisulfuron (25 g ai/ha). All treatments included 141 g ai/ha of dicamba for broadleaf weed control. Rimsulfuron provided little visual control of wirestem muhly and had no effect on density, dry weight and corn yield compared to the weedy check. Nicosulfuron provided 8% visual control of wirestem muhly and reduced density 44%, dry weight 70% and increased corn yield 18% compared to the weedy check. Nicosulfuron plus rimsulfuron resulted in 2% visual control of wirestem muhly, there was no effect on wirestem muhly density but decreased dry weight 48% and increased corn yield 14%. Foramsulfuron provided 64 and 88% control of wirestem muhly at 28 and 56 DAT, respectively. Wirestem muhly density and dry weight were decreased by 59 and 69%, respectively and corn yield was increased by 14%. Primisulfuron provided little control and had no effect on density, dry weight or corn yield compared to weedy check. Based on these results, foramsulfuron applied postemergence has potential for the control of wirestem muhly in corn. However, the postemergence application of rimsulfuron, nicosulfuron, nicosulfuron plus rimsulfuron, and primisulfuron do not provide adequate control of wirestem muhly in corn.

FALL APPLICATIONS OF DUPONT BASIS® AND KARMEX® HERBICIDES FOR WINTER ANNUAL WEED CONTROL IN FIELD CORN. Kevin L. Hahn, Susan K. Rick, and David W. Saunders. DuPont Crop Protection, Wilmington, DE .

Diuron (DuPont Karmex®) was applied alone and in tank-mixtures with 2,4-D LVE and thifensulfuron + rimsulfuron (DuPont Basis®) herbicides during the fall of 2004 and early-spring of 2005. Control of winter annual weeds and early season residual control of summer annual weeds was evaluated prior to corn planting and after corn emergence.

Karmex® applied alone provided broader spectrum control of winter annual broadleaf weeds as compared to simazine applied alone with the fall application timing. When 2,4-D LVE was tank mixed with Karmex® or with simazine, burndown weed control spectrum was similar with Karmex® and simazine. Spring applied timings revealed that Karmex® applied alone provided broader spectrum burndown control of emerged winter annual weeds as compared to simazine applied alone.

Weed control evaluations made in May 2005 and June 2005 revealed that both fall and spring application timings of Karmex® and simazine provided limited residual control of many key summer annual weeds including large crabgrass, palmer amaranth, and tall waterhemp. Karmex® provided better residual weed control of tall waterhemp as compared to simazine. Simazine provided better residual control of common lambsquarters and giant foxtail as compared to Karmex®.

Tank mixing Basis® with Karmex® provided the best overall burndown control of emerged winter annual weeds and the broadest residual weed control spectrum of summer annual weeds.

FALL AND SPRING DANDELION CONTROL IN SOYBEAN. Anthony F. Dobbels and Mark M. Loux, Research Associate and Professor, The Ohio State University, Columbus, OH 43210.

Dandelion continues to be problematic for soybean producers in Ohio. Previous research has shown that fall herbicide applications can be effective for the control of dandelion. However, some growers choose to use a spring application, in order to maximize the longevity of weed control from residual herbicides. This research was conducted to determine the most effective fall and spring herbicide treatments for control of dandelion. Herbicides were applied on November 9, 2004, and April 20, 2005 in west central Ohio and on April 15, 2005 in northwest Ohio. Fall and spring treatments were followed with a postemergence (POST) application of glyphosate approximately 4 weeks after planting of glyphosate-resistant soybean. Treatments were visually evaluated for dandelion control at the time of planting in west central Ohio, several weeks after planting, at the time of POST application, and at the time of soybean harvest at both locations. Measurements at harvest included the population density of dandelion and soybean yield in all plots.

Dandelion control from all of the fall-applied treatments was sufficient to prevent soybean yield loss the following year, when followed by a postemergence glyphosate treatment. Control at the time of soybean harvest ranged from 75 to 98%, and reduction in dandelion population ranged from 73 to 95%. Fall application of chlorimuron plus tribenuron plus 2,4-D controlled 98% of dandelion at the time of soybean harvest, and reduced the population density by 95%. Similar control resulted from combinations of glyphosate plus 2,4-D with either chlorimuron plus sulfentrazone, chlorimuron plus tribenuron, or cloransulam. Glyphosate plus 2,4-D controlled 82% of the dandelion at harvest, and reduced dandelion population density by 73%. The addition of flumioxazin or imazaquin to glyphosate plus 2,4-D did not improve dandelion control when applied in the fall.

Spring treatments included glyphosate at 0.84 kg a.e and 1.23 kg a.e/ha, and glyphosate at 0.84 kg a.e./ha plus the following: cloransulam, flumioxazin, sulfentrazone, metribuzin, flumioxazin plus cloransulam, chlorimuron plus tribenuron, or chlorimuron plus thifensulfuron. These treatments were applied with and without 0.64 kg ai/ha of 2,4-D ester approximately 14 days before soybean planting. In west central Ohio, the inclusion of 2,4-D improved dandelion control in the first evaluation, 14 days after application, which occurred at the time of soybean planting. At that time, dandelion control ranged from 33 to 78% for treatments applied without 2,4-D, and from 57 to 82% for treatments applied with 2,4-D. Dandelion control at that time was also higher for treatments that included flumioxazin or sulfentrazone. The addition of 2,4-D ester did not improve control in later evaluations, and data were combined. Data were combined over sites for visual evaluations of control at 30 DAT and at the time of POST glyphosate application, due to the lack of a significant site by treatment interaction.

Almost all spring treatments provided at least 85% dandelion control 30 days after application. At the time of POST glyphosate application, the only treatments controlling at least 85% of the dandelion were combinations of glyphosate plus chlorimuron plus either tribenuron or thifensulfuron. Dandelion control in northwest Ohio at the time of soybean harvest ranged from 88 to 100%, and dandelion population densities were reduced by 65 to 100%. However, presumably due to more unfavorable environmental conditions, dandelion control in west central Ohio ranged from 48 to 83%, and dandelion population densities were reduced by only 27 to 71%. The most effective treatments in west central Ohio at the time of harvest were the following: glyphosate plus chloransulam plus flumioxazin; and glyphosate plus chlorimuron plus either tribenuron or thifensulfuron. These treatments controlled 82 to 83% of the dandelion, and reduced population densities by 66 to 71%. The only other treatment to reduce population density by more than 50% was glyphosate plus chloransulam, which controlled 73% of the dandelion at harvest. Soybean yield was similar among spring-applied treatments at both locations.

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FIELD PANSY (*VIOLA RAFINESQUII* GREENE) CONTROL IN NO-TILL FIELDS WITH FALL- AND SPRING-APPLIED HERBICIDES. Jason N. Miller, David L. Regehr and Dallas E. Peterson, Graduate Research Assistant, Professor and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Field pansy has become a problematic weed in no-till fields in northeast Kansas and adjacent regions. It is usually a winter annual, but can germinate in either the fall or spring. It is the only *Malanium* violet native to North America. Previous work has shown poor or erratic weed control from many spring burndown treatments. Field studies were conducted over the past three years to evaluate herbicide application timing, and herbicides with different modes of action, for effective field pansy control. Experiments were conducted on natural populations of field pansy growing in northeast Kansas no-till fields in an annual corn/soybean rotation. Ahead of corn, in 2002-03, most treatments provided excellent field pansy control. Only paraquat applied in the fall, and glyphosate applied in the spring, provided <89% control. In 2004, all treatments were spring applied. In general, control was less than 2003, with control ranging from 60% to 100%. In 2005, treatments were applied either early or late spring. All treatments provided >90% control regardless of application timing, except atrazine at 1120 g/ha for both timings, and atrazine plus flumetsulam applied late spring. Ahead of soybeans, in 2002-03, all fall-applied treatments provided >90% control, except thifensulfuron, sulfentrazone, and thifensulfuron plus sulfentrazone. The only treatments to provide >90% control in the spring of 2003, were cloransulam and cloransulam plus flumioxazin. In the 2003-04 fall applied treatments, only sulfentrazone plus chlorimuron, thifensulfuron, and thifensulfuron plus sulfentrazone provided >90% control. In the spring of 2004, only glyphosate plus thifensulfuron, glyphosate plus sulfentrazone plus chlorimuron, and glyphosate plus thifensulfuron plus sulfentrazone provided >90% control. In both soybean experiments, the spring-applied treatments generally provided lower control compared to the fall-applied. This research demonstrated that ahead of no-till corn, atrazine with appropriate tank mix partners, can control a broad spectrum of winter and spring germinating weed species, including field pansy, from both fall or spring application timings. For no-till soybean producers, the most effective strategy for field pansy control consists of fall-applied burndown treatments that have soil-residual activity.

INTERNATIONAL PERSPECTIVES OF TRANSGENIC CROPS. Kathrin Schirmacher, Christina D. DiFonzo, Karim Maredia, and James J. Kells, Graduate Student, Department of Crop and Soil Sciences, Associate Professor, Department of Entomology, Professor, Institute of International Agriculture, Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

A field site was established in 2005 as a hands-on component of several short courses organized by the Institute of International Agriculture at Michigan State University. The site consisted of demonstration plots in which different conventional crops were planted side-by-side with their transgenic counterparts. All of the participants in the courses took part in a GMO detection activity using rapid field testing methods. Plots and activities were designed to foster discussion on various topics ranging from regulatory, environmental, agronomic, and health issues. Participants came from countries worldwide and included professionals with varying levels of familiarity with transgenic crops. Participants discussed the adoption of transgenic crops in their countries.

NORTH CENTRAL WEED SCIENCE SOCIETY: THE PATH TO OUR 60TH CONFERENCE.
Jerry D. Doll, Weed Scientist Emeritus, Univ. of Wisconsin, Department of Agronomy, Madison, WI 53706.

Our 2005 meeting in Kansas City, MO marks the 60th time we have gathered as a society to ponder those plants we call weeds. The reason this is our 60th meeting while the Society is 62 years old (created in 1944 in Omaha, NE) is that in the 1960s we met biennially with the WSSA on two occasions, thus creating the two-year gap in our age and number of meetings. The biennial meetings with the WSSA were deemed unwise by the NCWCC board of directors and we have met annually ever since 1966.

The founding state members of the NCWCC were Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, Oklahoma, South Dakota and Wisconsin. Several Canadian provinces joined later and today Ontario remains as one of the 17 active state/province members of the Society. Interestingly, Colorado and Wyoming were represented at the 1944 meeting but did not become official members until 1991. Ninety-one people attended the very first meeting in Omaha. Attendance swelled to 629 in 1947 and the highest attendance ever for the Society of 841 occurred in St. Louis in 1985. Four cites have hosted the conference of the Society six times: Kansas City, Milwaukee, St. Paul and St. Louis. Missouri is the state that has hosted the most meeting: six each in Kansas City and St. Louis, which represents 20% of our conferences. We have met in Winnipeg, Canada four times.

The histories of the WSSA and the NCWSS are closely linked as the First National Weed Control Conference was held in conjunction with the 10th meeting of the North Central Weed Control Conference in 1953, interestingly also in Kansas City, MO. Three years later (1956) Weed Society of America was created. The WSA evolved into the WSSA and that society is celebrating its golden anniversary in 2006 in New York City where its first meeting was held in 1956.

Remarkably, the objectives of the Society have changed little in 60 years. A primary focus was and is “to facilitate the exchange of ideas, experience, opinions, and information.” To that end the NCWSS has a long history of publishing the proceedings of our annual gatherings (annually as volume 60 will appear in 2005). Our Research Reports were published yearly even when the Society did not meet annually in the 1960s as the 2005 Reports will be volume 62, the same as the Society’s age. Major events in the life of the North Central Weed Science Society to support the professional training of students include creating contests for written essays (1955), oral presentations (1972), summer field events (1981) and poster presentations (1984). A history of the summer contests is found in our 2004 Proceedings. The name changed from the North Central Weed Control Conference to the current name in 1988.

The history of the Society from 1944 through 1988 is summarized in the book “The North Central Weed Control Conference: Origins and Evolution” by Robert Andersen published in 1988 to commemorate the name change of our Society. This book is still available from our headquarters office. In it you will find answers to these questions: Who is considered the “Father of the NCWCC?” When did the NCWCC first meet in Canada? If 2,4-D was the “star herbicide” of the 1940s, what weed “caused” the NCWCC to come into existence? What city and state have hosted the most NCWSS annual meetings? Who was the last NCWCC president? Who was the first NCWSS president? In what years did the NCWCC meet every other year? Who was the first Honorary member of the NCWCC? Who was the first woman honored as a NCWSS Fellow?

INTEGRATED WEED MANAGEMENT: “ONE YEAR’S SEEDING... .” A NEW EXTENSION BULLETIN. Adam Davis, USDA-ARS, Urbana, IL, and Karen Renner, Christy Sprague, Larry Dyer, and Dale Mutch, Professor, Assistant Professor, Extension associate, and Extension Specialist, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

A new Extension guide, E-2931, Integrated Weed Management: “One Year’s Seeding...” was published at Michigan State University in 2005 to provide farmers, agribusiness personnel, consultants, and university teachers and researchers a resource for integrated weed management. Much of the material in the guide came from meetings that were held with a working group of organic and conventional farmers, Extension educators, and university weed scientists during the winter of 2004. During a series of four, 8-hour working sessions the group discussed integrated weed management systems that growers were already using and determined what types of information would be useful to gather from scientific literature or gleaned from individuals not directly involved with the working group. The integrated weed management guide was then written. The guide follows a similar format of two guides in the Michigan field crop series: *Michigan Field Crop Ecology and Management* and *Michigan Field Crop Pest Ecology and Management.* The authors, as well as members of the working group, felt that information on weed biology and ecology could help every farmer become a better weed manager. Each chapter covers a different aspect of weed ecology and management. Chapter content includes: weed life cyles and seedbank dynamics, soil properties and soil organic amendments and the influence on weeds, tillage impacts on weed seedbanks and perennial weeds, integrated crop and weed management including crop rotation, physical weed management, biological weed management, herbicide weed management, and prevention as a key to long term weed management. There are five appendices that include: the profiles of twelve common weeds, a summary of integrated weed management on four Michigan farms, the thoughts of how crop rotation is utilized to manage weeds on one organic farm, background information on the figures and tables that are used in the guide, and a detailed bibliography. Lastly, there is a weed management exercise that could be implemented at weed management meetings. This guide is an excellent teaching tool for university crop science and weed science classes, as well as a reference for high school agriscience teachers. The printed guide and a CD-ROM of pictures and graphs used in the guide is available from the Michigan State University Extension publication office at www.emdc.msue.msu.edu.

DEVELOPING HANDS-ON EXPERIENCES USING THE AGRONOMY LEARNING FARM. J. Anita Dille and Christopher L. Schuster, Associate Professor and Graduate Research Assistant, Department of Agronomy, Kansas State University, Manhattan, KS 66506-5501.

Agronomy students would greatly benefit from more hands-on experiential learning activities developed to test technical and diagnostic skills, improve critical thinking and problem-solving abilities, and be able to work in teams. The Agronomy Learning Farm is a new facility being made available to undergraduate students at Kansas State University, where they can develop these skills in the field. The Learning Farm encompasses 80 acres and is located within the Agronomy North Farm, a research-teaching-extension facility located three miles northwest of the Agronomy Department building. The Learning Farm is divided into a long-range plan of crop and tillage rotations, with a website acting as a resource for all field information (see address below).

Undergraduate students utilize the Learning Farm through class field trips, in-class research exercises, and undergraduate research assistantships. Crop science, soils, weed science, and soil fertility courses have made field trips to the Learning Farm and have studied how to make weed control recommendations, update soil maps, compare seed placement and establishment with different planting equipment, and develop soil nutrient recommendations. Comments by undergraduate students after a crop science field trip to the Learning Farm: “I really liked this lab. The hands-on experience allowed me to learn more. I will be able to apply this in my future.” And “Pretty interesting on how to measure % residue and never done crop scouting before so that was interesting as well. One of the best labs all year.” Examples of research projects include studying the site-specific correlations among winter annuals/biennials and soil properties, enhancing soil humus development with different crop residues, and developing soil pH titration curves. The Learning Farm provides a venue for skill development integrated throughout the four-year Agronomy curriculum and provides a resource for extension education and developmental training in the future. Continual evaluation of learning and skill development is occurring to maximize creativity, innovation, improvement, and coordination involving the Learning Farm.
(http://www.oznet.ksu.edu/agronomy/academics/undergrad/LearningFarm/welcome.asp).

EFFECT OF SEEDING RATE ON GLYPHOSATE RESISTANT ALFALFA ESTABLISHMENT. S. Ann McCordick, James J. Kells, and Richard H. Leep, Graduate Student, Professor, and Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Recommendations for alfalfa seeding rates are based on conventional varieties. The introduction of glyphosate resistant alfalfa offers a new management system for establishing alfalfa. Determining optimum seeding rates will provide forage producers with the information to maximize yield, quality, and profitability with this new technology. Field experiments were conducted in 2005 to determine the effect of weed control on forage production, forage quality and alfalfa stand establishment at varying seeding rates in glyphosate resistant alfalfa. Seeding rates of 4.5, 9.0, and 17.9 kg ha^{-1} were evaluated. Weed control methods included no herbicide, glyphosate applied once before the first harvest, and glyphosate applied once before the first harvest and then 7-10 days following each harvest. No injury was observed from glyphosate. The greatest differences in alfalfa, forage and weed yields were observed at the first and second harvests. There were no differences in forage, alfalfa or weed yields across seeding rates and weed control methods at the third and fourth harvests. Alfalfa yield increased with increasing seeding rate. Glyphosate applications increased alfalfa yield at the 9.0 and 4.5 kg ha^{-1}seeding rates. At the 17.9 kg ha^{-1} seeding rate, weed control did not affect alfalfa yield. Multiple glyphosate applications reduced weed biomass at the 4.5 kg ha^{-1}seeding rate but not at the higher seeding rates. Multiple applications of glyphsate did not increase alfalfa or total forage yield compared to a single application at any of the seeding rates. Glyphosate applications increased forage quality at the first harvest in all seeding rates. Seeding rates did not affect forage quality, regardless of weed control system. Alfalfa stand density was the highest at the 17.9 kg ha^{-1} seeding rate in the spring and fall. Alfalfa crowns thinned out significantly more at the 17.9 kg ha^{-1} seeding rate than at the lower seeding rates.

FALL APPLIED WEED MANAGEMENT SYSTEMS FOR TALL FESCUE SEED PRODUCTION.
Kelly A. Nelson, Assistant Professor, Division of Plant Sciences, University of Missouri, Novelty, MO 63460.

Fall applied weed management systems research was conducted from 2002 to 2005 to evaluate control of downy brome (*Bromus tectorum* L.) and tall fescue (*Festuca arundinacea* Schreb.) response in winter grazed and non-grazed seed production systems. All treatments except metribuzin at 0.84 kg ai/ha alone or tank mixed with oxyfluorfen at 0.14 kg ai/ha injured non-grazed tall fescue less than 10% while oxyfluofen and metribuzin applied alone or tank mixed injured grazed tall fescue 3 to 11%. Cultivation only and diuron at 1.8 kg ai/ha alone or tank mixed with oxyflurofen controlled downy brome greater than 79% in non-grazed tall fescue. Oxyflurofen plus metribuzin applied postemergence and pendimethalin at 2.2 kg ai/ha applied preemergence followed by metribuzin, oxyfluorfen plus metribuzin, diuron, or oxyfluorfen plus diuron controlled downy brome greater than 85% in grazed tall fescue. All weed management systems had forage and seed yields similar to the non-treated control.

SALTCEDAR CONTROL ON THE CIMARRON NATIONAL GRASSLAND. 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 shrub or tree found along stream banks and waterways throughout the western United States. In Kansas, saltcedar infests more than 20,000 ha and is particularly a problem along the Cimarron and Arkansas watersheds. Research was conducted in 2004 and 2005 on the Cimarron National Grassland located near Elkhart, KS. Scattered stands of multi-stemmed saltcedar were cut near ground level during the dormant season using a 10-cm rotary saw attached on the front end of a tractor. On April 13, 2004 and May 6, 2005, 100 cut-stumps were selected for herbicide treatment. Ten treatments were applied each year in a randomized block design with 10 replications. Herbicides were applied using hand-held garden sprayers. Treatments applied in 2004 were rated for percent control 3 and 6 months after treatment (MAT), and for mortality 15 MAT. Treatments applied in 2005 were rated for percent control 3 and 5 MAT with a preliminary mortality rating taken 5 MAT. Treatments in 2004 included an untreated check, triclopyr at 10, 24, and 48 g L^{-1} diesel, glyphosate at 18 g L^{-1} water, imazapyr at 23 g L^{-1} water, triclopyr + 2,4-D at 5 + 10 g L^{-1} diesel, a ready to use formulation of triclopyr at 90 g L^{-1}, glyphosate + 2,4-D at 18 + 23 g L^{-1} water, and glyphosate + imazapyr at 18 + 12 g L^{-1} water. In 2005 treatments included an untreated check, triclopyr at 48 and 120 g L^{-1} diesel, glyphosate at 90 g L^{-1} water, imazapyr at 23 g L^{-1} water, triclopyr + 2,4-D at 5 + 10 g L^{-1} diesel, a ready to use formulation of triclopyr at 90 g L^{-1}, glyphosate + 2,4-D at 36 + 46 g L^{-1} water, glyphosate + imazapyr at 36 + 24 g L^{-1} water, and imazapyr at 23 g L^{-1} diesel. All untreated trees resprouted, with resprouts up to 1.8 m tall. In 2004, all herbicides provided greater than 90% control 3 MAT except those cut-stump treatments containing glyphosate. Additional resprouting occurred between 3 and 6 MAT. All treatments containing triclopyr or imazapyr provided greater than 80% control 6 MAT. The only treatment providing 100% mortality 15 MAT was the ready to use formulation of triclopyr applied at 90 g L^{-1}. In 2005, all herbicide treatments provided at least 75% control of saltcedar 3 MAT. Apparent mortality at the end of the growing season was at least 80% for triclopyr at 48 and 120 g L^{-1} diesel, the ready to use formulation of triclopyr at 90 g L^{-1}, and imazapyr at 23 g L^{-1} in water or diesel.

METSULFURON METHYL AND CHLORSULFURON: COMBINATIONS THAT PROVIDE POSTEMERGENCE WEED CONTROL IN IMPROVED PASTURES AND RANGELAND. Michael T. Edwards, Robert N. Rupp, Eric P. Castner, James D. Harbour, C. William Kral and Lawrence S Tapia, DuPont Crop Protection, Wilimington, DE.

Metsulfuron methyl and Chlorsulfuron are combined in different products to provide residual postemergence weed control in pasture and rangeland.

Combinations of metsulfuron methyl and chlorsulfuron in a 1:1 ratio (Cimarron® X-tra) is new product offering from DuPont Crop Protection that in replicated field trials have measured grass response and weed control in improved pastures and rangeland.

Cimarron® X-tra controls the treated foliage of Canada thistle and reduces the regrowth. Cimarron® X-tra also controls these thistle species - musk, plumeless, flodman, bull, wavyleaf, yellowspine and suppresses scotch thistle. Wild garlic, wild carrot, dogfennel, narrowleaf plantain and wild rose are controlled with Cimarron® X-tra. Common milkweed was suppressed.

Ongoing clipping studies continue to have a 2 to 3-fold forage increase in grass forage when metsulfuron methyl and chlorsulfuron combinations are used.

GROWTH CHARACTERISTICS OF COMMON AND ALTERNATIVE BUFFER SPECIES DURING ESTABLISHMENT AND EARLY GROWTH. Janyce L. Woodard, Stevan Z. Knezevic, and David P. Shelton, Haskell Ag. Lab, University of Nebraska, Concord, Nebraska.

The production-oriented function of the agricultural landscape has produced unintended and undesirable environmental consequences such as non-point source (NPS) water pollution. One way in which the agricultural community addressed the NPS pollutant problem was to develop soil conservation practices using vegetative filter strips to trap and filter out NPS pollutants. Both native grasses and various alternative species can be used in conservation buffers. Field studies were conducted in northeastern Nebraska in 2002 and 2003 with the objective to evaluate the growth characteristics of 14 potential buffer species during the establishment and early growth periods. Growth analysis included determination of leaf area index (LAI), specific leaf area, partitioning coefficients, and dry matter (DM) production. Preliminary data suggested that LAIs ranged from 0.25 to 3 during the initial season of growth. At the end of the first growing season, the largest LAI for the warm season species was 2 for big bluestem (*Andropogon gerardii*). Cool season grasses such as Virginia Wildrye (*Elymus virginicus*) had a LAI of 3. The same species also produced the largest amount of DM. Once the growth characteristics are described, the species can be combined in different mixes to better meet the objectives of the buffer. (woodarj@witcc.com)

RESPONSE OF SELECTED INDIANA HORSEWEED (*CONYZA CANADENSIS*) POPULATIONS TO 2,4-D RATES.

Valerie A. Mock*, Vince M. Davis, J. Earl Creech, and William G. Johnson, Undergraduate Research Assistant, Research Associate, Graduate Research Assistant, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907-2054.

Our previous research has shown that 141 out of 450 Indiana horseweed populations screened with 1.5 lb ae/A are resistant to glyphosate. With glyphosate resistance in many horseweed populations, 2,4-D is an increasingly important herbicide for early-season, pre-plant weed control prior to corn and soybean. The objective of this experiment was to evaluate the efficacy of 2,4-D on selected Indiana horseweed populations collected in 2003. A total of 9 horseweed populations were selected, each representing a different degree of tolerance to 2,4-D from an initial 2X (1 lb ai/A) dose in a greenhouse screen. Various rates of 2,4-D were applied at 20 GPA in a compressed air cabinet sprayer when horseweed rosettes were 2 to 4 inches wide. For the 3 populations that were relatively sensitive to 2,4-D, rates of 0, 0.03, 0.06, 0.13, 0.25, 0.5, 1, and 2 lb ai/A of 2,4-D ester were used. For the six populations that were relatively tolerant, 0.13, 0.25, 0.5, 1, and 2, 4, and 6 lb ai/A of 2,4-D ester rates were used. There were differences in efficacy between selected populations; however, none of the 9 populations appear to be resistant to 2,4-D. Two populations survived rates of 0.25 lb ai/A and produced seed.

HERBICIDE DOSE-RESPONSE OF WILD OAT WITH ALTERED ACETYL-COA CARBOXYLASE GENES. Michael J. Christoffers, Shauna N. Pederson, and Aruna V. Kandikonda, Assistant Professor, Research Specialist, and Graduate Research Assistant, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Chemical inhibitors of acetyl-CoA carboxylase (ACCase) are important postemergent herbicides used for selective control of wild oat and other grass weeds. Wild oat biotypes with missense point mutations in the *Acc1;1* gene for plastidic ACCase were evaluated in a greenhouse for whole-plant resistance to ACCase inhibitors. Biotypes AI13R10, 830R34, and VIR35 have Trp_{2027} to Cys, Asp_{2078} to Gly, and Cys_{2088} to Arg substitutions, respectively, with amino acid positions corresponding to blackgrass ACCase. Dose-response was evaluated for the aryloxyphenoxypropionate (APP) ACCase-inhibiting herbicides fenoxaprop-P, clodinafop, and quizalofop; and the cyclohexanedione (CHD) herbicides sethoxydim, tralkoxydim, and clethodim. Treatment was at the two-leaf stage and analysis was based on the dry weight of above-ground tissue three weeks after treatment, with growth reduction compared to that of a susceptible wild oat biotype, KYN119.

Resistance to fenoxaprop-P was confirmed in all three wild oat biotypes including 830R34 and VIR35, but was highest in AI13R10. Resistance to clodinafop was also observed in the three biotypes with altered *Acc1;1*. Biotypes AI13R10 and VIR35 were resistant to quizalofop, while 830R34 treated with quizalofop displayed reduced growth reduction below label rate compared to susceptible KYN119. Reduced growth reduction below label rate was also observed for 830R34 and VIR35 with sethoxydim and clethodim, and all three mutant biotypes with tralkoxydim. These results are consistent with ACCase target-site alterations conferring resistance to ACCase inhibitors, and especially APPs, in AI13R10, 830R34, and VIR35.

LIMPOGRASS INVASION IN THE KISSIMMEE RIVER FLOODPLAIN. Walt Beattie, Brent A. Sellers, and Jason A. Ferrell, Biological Scientist and Assistant Professor, University of Florida-IFAS Range Cattle Research and Education Center and Department of Agronomy, and University of Florida-IFAS Department of Agronomy, Ona, FL 33865

Limpograss (*Hemarthria altissima*) is a stoloniferous tropical grass of the family Poaceae, and it is found in its native habitat along stream banks or seasonably wet soils in southern Africa. It was introduced into Florida as a promising cattle forage and four cultivars have since been released. Approximately 100,000 ha of limpograss have been planted for grazing and/or hay production in central and south Florida, including the Kissimee River floodplain.

Historically, the Kissimmee River was a meandering 166 km stretch of waterway consisting of a 1.6 to 3.2 km wide floodplain. As a result of catastrophic flooding in the 1940's and early 1950's, the state of Florida and the U.S. government funded a plan to channelize the river to prevent such wide-spread flooding events. Once the 9.1 m deep by 91 m wide channel was complete in 1972, much of the flood plain was drained and diversity of desirable plant and animal species began to decline.

The loss of species diversity and increasing environmental concerns resulted in an effort to restore the river back to its native state. This prompted nearly 20 years of research on restoration in the Kissimmee River and its floodplain, which led to back-filling 35 km of the man-made canal and restoring approximately 104 km^2 of the floodplain. Within this non-residential area, the floodplain was acquired from ranchers, with much of this area subject to seasonal flooding.

Prior to restoration of the Kissimmee River, ranchers improved pastures near the river channel by establishing limpograss. It is estimated that over 15,000 ha was planted near the channel. However, limpograss was not recorded in the Kissimee River floodplain through biological surveys prior to restoration. After restoration efforts were concluded in the pool C section of the river, limpograss invasion began to occur. It is estimated that limpograss has infested approximately 1,200 ha where a broadleaf marsh existed prior to channelization of the river. Additionally, limpograss can be found in isolated patches in a portion of the floodplain that was a bahiagrass (*Paspalum notatum*) sod farm prior to restoration.

Although limpograss is an important forage species for Florida cattlemen, it is also important that best management practices for eradication in natural areas, such as the Kissimmee River, be developed. Experiments were established at the Range Cattle Research and Education Center to determine the most effective treatment options for limpograss control. Glyphosate ($\geq$1.1 kg ae/ha) appears to be the best option as greater than 95% visual control was observed 3 months after treatment. Other herbicides such as clethodim, fluazifop, nicosulfuron and diquat provided some reduction in limpograss growth, but limpograss appeared to recover. These results will be used to develop treatments for limpograss in the Kissimmee River floodplain in an attempt to restore the native broadleaf marsh that was present prior to channelization.

COTTON INJURY AS AFFECTED BY SIMULATED DRIFT OF 2,4-D AND DICAMBA. Molly E. Marple, Douglas E. Shoup, Kassim Al-Khatib, Dallas E. Peterson, Graduate Research Assistant, Graduate Research Assistant, Professor, and Professor, Department of Agronomy, Kansas State University, Manhattan KS 66502.

A field study was conducted in 2004 and 2005 at Manhattan, Kansas to compare cotton injury and yield reduction with 2,4-D and dicamba to other hormonal-type herbicides. The herbicides evaluated were dicamba (Clarity), 2,4-D amine, 2,4-D ester, clopyralid (Stinger), picloram (Tordon), fluroxypyr (Starane), and triclopyr (Remedy); herbicide rates were 0, 1/100, 1/200, 1/300, 1/400 of the use rate. The use rates were 561, 561, 561, 280, 561, 210, and 561g ai/ha for 2,4-D amine, 2,4-D ester, dicamba, clopyralid, picloram, fluroxypyr, and triclopry, respectively. Herbicides were applied at 5 to 6 leaf stage. A separate study was conducted to determine the effect of multiple exposure of simulated 2,4-D drift from multiple exposures to cotton. 2,4-D amine was applied at 0, 1/400, 1/800, 1/1200 of the use rates. Plots were treated with 1, 2 or 3 applications of 2,4-D amine at 2 week intervals. In general, injury symptoms and yield reduction was the greatest with 2,4-D when compared to other hormonal-type herbicides. Visual injury and yield reductions were greatest with 2,4-D and picloram. Similar injury was observed from both 2,4-D amine and ester. The lowest injury was with triclopry and clopyralid, whereas dicamba and fluroxypyr injury was intermediate. In the multiple exposure study, visual injury was the greatest at the highest rate of 2,4-D applied at 2 or 3 times. However, yield loss was still evident at the 1/1200 use rate of 2,4-D regardless of application timing. Cotton is extremely susceptible to 2,4-D drift, thus the use of 2,4-D should be avoided around cotton fields by using an alternative herbicides such as clopyralid and triclopry.

DUST AFFECTS GLYPHOSATE EFFICACY ON EASTERN BLACK AND HAIRY NIGHTSHADE. Jingkai Zhou and Calvin G. Messersmith, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Glyphosate is one of the most frequently used herbicides in the world. Adsorption on soil is one important property of this herbicide, which essentially inactivates on contact glyphosate. Weeds in the field are regularly covered with dust to some extent, which may decrease glyphosate efficacy. Greenhouse experiments were conducted to evaluate the effect of dust on efficacy of glyphosate on eastern black and hairy nightshade. Glyphosate efficacy decreased when dust accumulated on leaves, and the effect was greater from clay than loam dust. Dust pH did not influence the decrease of glyphosate efficacy. The adverse effect of dust on glyphosate efficacy was more on hairy nightshade than on eastern black nightshade. Ammonium sulfate, nonionic surfactant, and silicone surfactant adjuvants partially overcame the adverse effect of dust to glyphosate for eastern black and hairy nightshade control, which was silicone surfactant > nonionic surfactant ≥ ammonium sulfate.

ALTERNATIVE MANAGEMENT FOR WINTER ANNUAL WEEDS AND IMPROVED SOIL QUALITY. Robert J. Kremer, Microbiologist, USDA-ARS, Cropping Systems & Water Quality Research Unit, Columbia, MO 65211.

The widespread adoption of glyphosate-resistant crops in no-tillage crop production systems has contributed to extensive infestations of winter annual weeds. Dense infestations of winter annual weeds may adversely affect subsequent crops in a crop rotation by lowering soil temperatures and soil water content in the spring; disrupting planting operations; serving as hosts for pests including detrimental insects and the soybean cyst nematode; and producing copious amounts of seeds that replenish the seedbank. Because glyphosate applied during the crop-growing season has no residual soil activity on winter annual weeds that establish after crop harvest, additional herbicide management strategies to control these weeds have been proposed. Establishment of cover crops into standing soybean or corn is an alternative to additional herbicide inputs, which increase production costs and impact environmental quality. In the Midwest USA, selected cover crops can be established prior to crop harvest for adequate vegetative production to suppress winter annual weed growth, provide surface residue cover, and enhance soil quality before a killing frost. The objectives of this research were to determine winter annual weed suppression and biomass production of selected cover crops overseeded into soybean or corn prior to harvest, and to determine the effects of these cover crops on selected soil quality indicators.

A soybean-corn rotation was established in spring 2001 on a Mexico silt loam (fine, smectitic, mesic, Aeric Vertic Epiaqualfs) on Sanborn Field, University of Missouri-Columbia. The existing cool-season grasses were killed with glyphosate and no-till soybean was planted; no-till corn was planted in 2002, and this crop rotation was continued throughout the study (2001-2005). A completely random design with three replicates of three treatments consisted of plots 3.1 m wide and 9.2 m long, which were planted with the rotational crop at 0.76 m row widths. Cover crop treatments were a control (weedy check), spring oat (VNS), and canola ('Victoria'). Cover crops were overseeded into soybean or corn in late-August to mid-September with a hand-crank seeder at 170 kg ha^{-1} (oat) or 100 kg ha^{-1} (canola). Cover crop and weed above-ground biomass was harvested in late November to early December (fall sampling) and in April to early May (spring sampling) by clipping all growth at the soil surface within a 0.1 m^2 quadrat. Biomass samples were separated into cover crop and weed components and dried at 105˚C for 48 h for dry weight determination. Soil samples were collected from the upper 0-8 cm in late fall and early spring. Total organic carbon (TOC) and total nitrogen contents were determined by dry combustion using a C/N analyzer. Soil microbial activity was assessed using the fluorescein diacetate (FDA) hydrolysis and dehydrogenase enzyme assays (Kremer and Li. 2003. Soil Till. Res. 72:193-202). Soil aggregate stability was determined for aggregates ≥250-µm using a wet-sieving method (Kremer and Li 2003). All data were subjected to one-way analysis of variance and, where F-values were significant and $p<0.05$, means were compared by using Fisher's protected least significance differences (LSD) test.

Common chickweed, henbit, and purple deadnettle were the predominant winter annual weeds that produced 260-450 g biomass m^2. Spring oat had the greatest cover crop biomass accumulation and suppressed weed growth by 77-94% and 75-100% in the fall and spring, respectively. Canola accumulated an average of 400 g biomass m^2 but suppressed <80% of winter annual weed growth regardless of sampling period. Spring oat was winter-killed by freezing temperatures and provided a dense mulch on the soil surface. Canola growth was suspended by winter conditions but re-grew in spring that required mowing to mulch the soil surface. Canola also often sprouted new shoots after mowing, which interfered with corn and soybean growth. For these reasons, canola was not evaluated as a cover crop after the 2003 season. Soils under 4 yr of no-tillage with spring oat as a cover crop had ~ 10% greater TOC compared to weedy check soils. The resulting increased soil organic matter levels likely contributed to improved soil structure and microbial activity, and increased carbon sequestration. The spring oat cover crop had ~ 3 times greater water-stable aggregation compared to the weedy check soils. The highest microbial activity (FDA hydrolysis and dehydrogenase) was also associated with the spring oat cover crop. Thus, the improved soil structure that developed under spring oat cover cropping provided optimum soil aeration and water availability for increased microbial activity. Corn yields under spring oat cover cropping were not different from or were higher than yields in the check plots in which winter annual weeds were controlled with glyphosate.

In summary, adoption of an overseeded, spring oat cover crop in a no-tillage system can significantly decrease winter annual weed infestations in a corn-soybean crop rotation. The advantages of spring oat seeded in late summer include the accumulation of sufficient cover crop biomass to suppress winter annual weed establishment in fall, and the vulnerability of spring oat to winter-kill that provides a mulch that maintains weed growth suppression into the spring, which eliminates the need for herbicide treatment. Further, the spring oat cover cropping system can improve soil biological activity, soil structure, and promote carbon sequestration. The results presented here support previous conclusions (Reicosky and Forcella. 1998. J. Soil Water Convervat. 53:224-229) regarding the critical role of cover crops in maintaining environmental quality at both the field and ecosystem levels.

EVALUATION OF HERBICIDES FOR ASIATIC DAYFLOWER IN SOYBEANS. Santiago M. Ulloa and Micheal DK. Owen; Research assistant and University Professor, Iowa State University, Agronomy Department, Ames, IA 50011.

Asiatic dayflower has recently become a problem for some soybean farmers in eastern Iowa. Its tolerance to glyphosate and presumed lengthy emergency period makes it difficult to control in Roundup Ready® soybean and cornfields. Field research was conducted at Vinton, IA in 2005 to evaluate herbicides for Asiatic dayflower control in soybean fields. Also different times of application were evaluated. Five Pre (Metribuzin, S-Metoalachlor, KIH-485, Flufenacet and Flumioxazin) and five Post herbicides (Carfentrazone, Lactofen, Flumiclorac, Cloransulam and Glyphosate) were applied at the highest rate on label. Herbicide treatments were applied in two different locations to plots arranged in randomized complete block design with three replications. All Post herbicides applications included label recommended additives. Post herbicides were applied at 21 and 42 days after planting. Visual evaluations were conducted 3 and 6 weeks after application.
Pre herbicides provide better control than Post herbicides reducing Asiatic dayflower population. The greatest control occurred with Metribuzin in both places. The response of this Asiatic dayflower to post-emergent herbicides was not satisfactory and there were not important differences between days of application. However an early application of Cloransulam provided some control. More investigations are necessary in order to find consistent control strategies.

SOYBEAN AND POPCORN TOLERANCE TO KIH-485. Michael D. White, Thomas T. Bauman, and Chad D. Dyer, Research Associate, Professor, and Graduate Student, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN, 47907.

Field trials were conducted at the Purdue Agronomy Center for Research and Education in 2004 and 2005 to determine crop response and yield from soybean and popcorn plots treated at planting with KIH-485. Plots were maintained weed free through lay-by with cultivation and hand weeding.

Soybean: KIH-485 and s-metolachlor were tested at the labeled and twice the labeled rate at planting. No differences in crop injury or crop yield were observed between the two herbicides and the glyphosate standard.

Popcorn: Two popcorn hybrids (AP416 and P621) were tested. KIH-485, s-metolachlor, and acetochlor were applied at the labeled and twice the labeled rate at planting. No differences in crop injury or crop yield were observed between the three herbicides.

VOLUNTEER GLYPHOSATE-TOLERANT CORN CONTROL IN GLYPHOSATE-TOLERANT SOYBEAN. Nader Soltani*, Christy Shropshire, Peter H. Sikkema. Research Associate, Research Technician, and Assistant Professor. Ridgetown College, University of Guelph, Ridgetown, ON, Canada, N0P 2C0.

Glyphosate-tolerant volunteer corn has become a problem when glyphosate-tolerant soybean follows glyphosate-tolerant corn in a crop rotation. A total of four field trials were conducted at Exeter, Ontario over a two year period (2003 and 2004) to evaluate the control of glyphosate-tolerant volunteer corn in glyphosate-tolerant soybean. Treatments consisted of postemergence applications of glyphosate alone (control) and in tank-mix with three rates of clethodim, fenoxaprop-p-ethyl, fluazifop-p-butyl, quizalofop-p-ethyl or sethoxydim. Glyphosate tank mixed with clethodim, fenoxaprop-p-ethyl, fluazifop-p-butyl, quizalofop-p-ethyl and sethoxydim did not injure the soybean. Volunteer corn control was improved as the rate of clethodim, fenoxaprop-p-ethyl, fluazifop-p-butyl and sethoxydim increased. However, sethoxydim did not provide control of glyphosate-tolerant volunteer corn equivalent to the other herbicides evaluated. There was no rate response with quizalofop-p-ethyl. Glyphosate-tolerant volunteer corn density and dry weight were reduced with clethodim, fenoxaprop-p-ethyl, fluazifop-p-butyl, quizalofop-p-ethyl and sethoxydim. Soybean yields reflected the level of glyphosate-tolerant volunteer corn control achieved. Based on these results, the recommended rate of clethodim, fenoxaprop-p-ethyl, fluazifop-p-butyl or quizalofop-p-ethyl tank mixed with glyphosate can be used to effectively control glyphosate-tolerant volunteer corn in glyphosate-tolerant soybean under Ontario growing conditions.

EFFECT OF PREEMERGENCE HERBICIDES ON THE CRITICAL PERIOD IN GLYPHOSATE RESISTANT CORN AND SOYBEAN. Guillermo D. Arce and Bob Hartzler, Graduate Research Assistant and Professor, Iowa State University, Ames, 50011.

Research was conducted at three Iowa locations in 2005 to determine whether preemergence herbicides provide greater flexibility for postemergence glyphosate applications in glyphosate resistant corn and soybean. In soybean, alachlor was applied at 1.1 or 2.2 kg/ha, whereas in corn a combination of acetochlor and atrazine at 0.7 + 0.3 or 1.4 + 0.6 kg/ha was used. An untreated control was included in the experiments. Glyphosate (0.84 kg/ha) was applied at the V2, V4 or V6 crop stage, with an untreated control. V2 and V4 treatments were also sprayed at V6 to eliminate late-emerging weeds.

The preemergence treatments reduced weed densities (pooled across the three post timings) between 60 and 80% depending on crop, rate and location compared to no preemergence herbicide. Reductions in weed biomass by the preemergence herbicides were similar to weed density reductions in corn, but were smaller and more variable in soybean. The high rate of acetochlor + atrazine reduced weed biomass by approximately 90%, whereas 2.2 kg/ha alachlor reduced weed biomass by only 50 to 60% in soybean. The smaller reductions in weed biomass in soybean versus corn were due to the narrow spectrum of control provided by alachlor compared to acetochlor + atrazine. The high rate of alachlor provided excellent control of foxtail species and waterhemp (>90% reduction in density), but had little or no affect on common ragweed, velvetleaf and common cocklebur. The greater variability in weed biomass in soybean was due to the patchy distribution of the large-seeded weed species that escaped effects of alachlor.

Yield responses to the treatments were inconsistent, possibly due to moderate weed infestations at all locations. A significant interaction between pre and post treatments occurred at two of the three soybean experiments and one of two corn experiments. At these experiments, the lowest yields in the V6 postemergence timing occurred in the no preemergence herbicide treatment. These locations had significantly more weed biomass in the preemergence control treatment than in the low or high preemergence treatment. Soybean yield response to full-season weed competition was determined by adjusting yield to the ‘weed-free’ treatment (high pre/V2 post) at the three soybean experiments. Regression analysis indicated a linear response in yield to end-of-season weed biomass in the postemergence control treatments (Relative yield (%) = 1.0126 – 0.0006x; R^2 = 0.71; where x = g weed biomass m^{-2}.)

CONTROL OF PROBLEM WEEDS IN ROUNDUP-READY SOYBEANS WITH SOIL APPLIED HERBICIDES AND GLYPHOSATE TANK-MIXES. Stevan Z. Knezevic and Robert N. Klein, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Despite the fact that glyphosate controls many plant species, there are many broadleaf species found in Nebraska's cropping systems that are tolerant to the label rates of this herbicide, including: ivyleaf morningglory, wild buckwheat, Venice mallow, yellow sweetclover, field bindweed, waterhemp, kochia, Russian thistle and volunteer Roundup-Ready corn. Two studies are being conducted in 2004 (and 2005) at Concord and North Platte to evaluate performance of: six PRE herbicides (study 1); and glyphosate applied POST at the label rate tank-mixed with half label rate of major POST herbicides (study 2) for control of problem weeds in soybean. At 45 DAT, sulfentrazone+chlorimuron, metribuzin, imazethapyr+pendimethalin, and imazaquin applied to the soil at the label rate provided > 85% control of most weed species. Sulfentrazone +chlorimuron, and imazethapyr+pendimtelhalin were the only herbicides that provide > 80% PRE control of ivyleaf moningglory. At 21 DAT most POST treatments of glyphosate tank-mixes provided > 80% control of most studied species that were up to 10cm tall except ivyleaf morningglory. As the height of weeds increased the level of control decreased. Tank mixes of glyphosate with half rate of lactofen, imazethapyr, fomesafen, imazaquin or acifluorfen provided >70% control of all species that were 10-20 cm tall except sweet clover and ivyleaf morningglory. Most weeds that were 30-40 cm tall had >70% control by glyphosate tank-mix with lactofen, fomesafen or acifluorfen (sknezevic2@unl.edu).

COMMON WATERHEMP CONTROL IN SOYBEAN WITH METOLACHLOR PLUS FOMESAFEN OR METRIBUZIN. Michael Duff, Kassim Al-Khatib, and Dallas E. Peterson, Graduate Research Assistant, Professor, and Professor, Department of Agronomy, Kansas State University, Manhattan KS 66502.

Common waterhemp is a troublesome weed throughout the Midwestern states. Control of common waterhemp in conventional soybean has become difficult, especially where acetolactate synthase (ALS)-inhibitor herbicides and/or protoporphyrinogen oxidase (protox)-inhibitor herbicide resistance has developed. Early research at Kansas State University, however, has indicated that a tank mix of metolachlor plus fomesafen could potentially control ALS- and Protox-resistant waterhemp. Field experiments were conducted near Sabetha and Manhattan, KS in 2005 to determine the efficacy of metolachlor tank mixed with fomesafen on waterhemp in soybean. Preemergence treatments included metolachlor + fomesafen at 0.91 + 0.22, 1.21 + 0.28, 1.52 + 0.36, and 1.82 + 0.43 kg ha^{-1} and metolachlor + metribuzin at 0.55 + 0.14 kg ha^{-1}. These treatments were applied alone or followed by a postemergence glyphosate application at 0.88 kg ha^{-1}. Postemergence glyphosate alone at 0.88 kg ha^{-1} was also included for comparison. Visual injury ratings were determined 2, 4, and 8 weeks after treatment (WAT) on a scale of 0% = no injury, and 100% = mortality. Metolachlor + fomesafen, regardless of the rate, gave complete waterhemp control at 2 WAT and greater than 95% waterhemp control by 8 WAT at Sabetha. Metolachlor + fomesafen at the Manhattan location had control greater than 88% at 2 WAT and greater than 60% at 8 WAT, respectively. Metolachlor + metribuzin controlled 91 and 59% of waterhemp 8 WAT at Sabetha and Manhattan, respectively. Applying a single postemergent application of glyphosate after metolachlor + fomesafen or metolachlor + metribuzin resulted in greater than 95% control of waterhemp 8 WAT regardless of location. Season-long control of waterhemp can be achieved with metolachlor + fomesafen at 1.52 + 0.36 kg ha^{-1} with or without a postemergent application of glyphosate.

SPATIAL AND TEMPORAL DISTRIBUTION OF STALK BORING INSECTS IN INDIANA AND MICHIGAN GIANT RAGWEED. Eric J. Ott, William G. Johnson, Corey K. Gerber, Dana B. Harder, and Christy L. Sprague, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology Purdue University, West Lafayette, IN 47907-2054, Entomologist, Department of Agronomy Purdue University, West Lafayette, IN 47907-2054, Graduate Research Assistant, Assistant Professor, Department of Crop and Soil Sciences Michigan State University. East Lansing, MI 48824.

Our previous research has shown that stalk boring insects can reduce glyphosate efficacy on large giant ragweed. Previous field surveys of stalk boring insects have only accounted for the presence of insects and not their spatial and temporal distribution in giant ragweed plants. Four regions in Indiana (northwest, northeast, central, and southwest) and three regions in Michigan (central, southeast, and southwest) were selected for a field survey. Survey timings included June 2005, August 2004 and 2005, and September 2005. Five soybean fields with giant ragweed present were chosen within each region. Ten giant ragweed plants were collected from each site at each timing. Plants were examined for the presence or absence of stalk boring insects. If an insect was found, the insect was collected in a vial with isopropyl alcohol to preserve for later identification. Insects were then identified to the family level. Cerambycidae insects were frequently found in September in Indiana and Michigan. Curculionidae insects were frequently found in August in Indiana. Noctuidae insects were primarily found in June throughout Indiana, and northern Indiana in August. Tortricidae insects were found in primarily in southern Michigan and northern Indiana, and a majority of the insects collected were from the September survey timing. Languriidae and Pyralidae insects were also found, but not in large numbers.

TANK MIXES OF CHLORIMURON-ETHYL WITH LINURON, METRIBUZIN, THIFENSULFURON-METHYL, SULFENTRAZONE, OR FLUMIOXAZIN EVALUATED FOR SPRING WEED CONTROL IN SOYBEAN PRODUCTION. Marsha J. Martin, Helen A. Flanigan, AND SUSAN K. RICK. Field Development, Dupont Ag and Nutrition, E. I. DuPont De Nemours and Co. Inc.,Wilmington, DE 19898

Both historical and experimental mixes of chlorimuron-ethyl(CE) with linuron, metribuzin, thifensulfuron-methyl, tribenuron-methyl, sulfentrazone and flumioxazin were tested at 25 locations to determine which was the best combination treatment for broad-spectrum weed control in US soybean production.

Chlorimuron-ethyl was tested with metribuzin at both 10.7% CE + 64.3% metribuzin (Canopy DF) and 6.5% CE + 68.5% metribuzin (Preview DF). Chlorimuron-ethyl was tested with linuron at 3.1% CE + 56.9% linuron (Lorox Plus), with thifensulfuron-methyl at 21.5% CE + 6.9% thifensulfuron-methyl (Synchrony XP), and with tribenuron-methyl at 22.7% CE + 6.8% tribenuron-methyl (Canopy EX). Chlorimuron-ethyl was tested with sulfentrazone at 9.4% CE + 46.9% sulfentrazone (Canopy XL) and with 1 ozai/acre flumioxazin. Chlorimuron-ethyl rates were matched to 0.24 - 0.25 or 0.42 - 0.43 ozai/acre for the low and high rate mixes, respectively.

With CE kept as a constant, differences in weed control from the mixing partners were as follows. Sustained common chickweed control was seen with tribenuron methyl and the highest rates of metribuzin or linuron. Higher rates of linuron, metribuzin or flumioxazin improved common ragweed control while higher rates of linuron, metribuzin, sulfentrazone or flumioxazin improved lambsquarters and giant foxtail residual control. Deadnettle burndown was best with metribuzin, sulfentrazone or flumioxazin. Residual eastern black nightshade control was best with higher linuron rates or sulfentrazone or flumioxazin. Sulfentrazone and flumioxazin gave the best residual palmer amaranth and waterhemp control.

CONTROL OF GLYPHOSATE RESISTANT VOLUNTEER CORN WITH CLETHODIM. Thomas T. Bauman, Michael D. White, and Chad D. Dyer, Professor, Research Associate, and Graduate Student, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN, 47907.

Volunteer corn can be effectively controlled with glyphosate when glyphosate resistant soybeans are grown after non-glyphosate resistant corn. The adoption of glyphosate tolerant corn is projected to increase in Indiana. Volunteer corn could become a problem in glyphosate resistant soybeans if they are grown the year after glyphosate resistant corn.

Field trials were conducted in 2002 through 2005 at the Purdue Agronomy Center for Research and Education to evaluate clethodim as a tank mix partners with glyphosate for its effectiveness in controlling volunteer glyphosate resistant corn in glyphosate resistant soybeans.

Rate, adjuvant, and glyphosate formulation all had an impact on the effectiveness of clethodim to control volunteer glyphosate resistant corn.

A 2-YEAR SUMMARY OF COHORT EMERGENCE IN NARROW ROW SOYBEAN. Edward M. Costigan, Thomas J. Ross and Christy L. Sprague, Undergraduate Students and Assistant Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Research was conducted at East Lansing, MI in 2004 and 2005 to examine the interference potential of a multi-species weed community that emerged after soybean growth stages VE, VC, V1 and V3. Plots were planted with glyphosate-resistant soybean (Asgrow 2107) at 494 000 seeds ha^{-1} in 19-cm rows spacing in a conventionally-tilled field. Treatments included plots that were weed-free and four cohort emergence timings that were kept weed-free until soybean growth stages VE (untreated), VC, V1, and V3 with glyphosate applications. The glyphosate rate was 0.84 kg a.e./ha for all applications. Quadrats were established in each plot two weeks after final glyphosate application. At peak weed biomass, weed density, height, biomass, and seed production were recorded. In 2004, weeds emerging with the crop produced a biomass of 461 g m^{-2} and reduced soybean yield by 58%. Weeds emerging after the glyphosate application at the VC soybean stage produced a biomass of 93 g m^{-2} and reduced soybean yield by 13%. Weeds emerging after the glyphosate application to V1 soybean produced a biomass of 21 g m^{-2} and reduced soybean yield by 11%. Weeds that emerged after the glyphosate application at the V3 soybean stage did not survive throughout the season and did not reduce soybean yield compared with the weed-free control. In 2005, weeds emerging with the crop produced a biomass of 212 g m^{-2} and reduced soybean yield by 41%. Weeds that emerged after the glyphosate application to VC soybean produced a biomass of 128 g m^{-2} but did not significantly affect soybean yields compared with the weed-free control. There was no weed emergence after the glyphosate application to V1 and V3 soybean, therefore yields were not reduced. The time of late-season weed interference varied between the two years; differences in precipitation appear to be the contributing factor for these differences.

BENEFITS FROM A FALL APPLICATION OF CHLORIMURON-ETHYL PLUS TRIBENURON-METHYL PREMIX. Helen A. Flanigan, Kevin L. Hahn and Martin W. Park, Field Development Representatives and Technical Sales Agronomist, Dupont Ag and Nutrition, E. I. DuPont de Nemours and Co. Inc., Wilmington, DE 19898.

University and Dupont researchers have conducted field trials to study the efficacy of various fall applied programs. Tests with chlorimuron-ethyl plus tribenuron-methyl premix (Canopy EX) have shown good to excellent broad spectrum burndown of winter annual weeds including common chickweed, cressleaf groundsel, deadnettle, henbit and mustards and perennial weeds including dandelion and wild garlic. Chlorimuron-ethyl plus tribenuron-methyl also provided residual control of many winter and summer annual weeds and seedling perennial weeds. With the burndown and residual control provided by this premix, soils dry faster, warm quicker and the grower has a clean seedbed at the time of planting.

FALL AND SPRING DEVELOPMENT OF SOYBEAN CYST NEMATODE ON WINTER ANNUAL WEEDS IN THE EASTERN CORN BELT. J. Earl Creech, William G. Johnson, Bryan G. Young, Jared S. Webb, Jason P. Bond, Mark M. Menke, and S. Kent Harrison, Graduate Research Assistant and Associate Professor, Purdue University, West Lafayette, IN 47907, Associate Professor, Graduate Research Assistant, and Assistant Professor, Southern Illinois University, Carbondale, IL 62901, Graduate Research Assistant and Professor, the Ohio State University, Columbus, OH 43210.

Certain winter annual weeds have been confirmed as alternative hosts to soybean cyst nematode (SCN) in the greenhouse. However, SCN development is known to cease at temperatures below 10ºC. Thus, the potential interaction between winter weeds and SCN in the field is limited to a short period of time in the fall and the spring when both the nematode and the weeds are present and active. SCN reproduction on purple deadnettle was recently confirmed at one site in southern Indiana. The objective of this research was to determine the distribution of SCN development and reproduction on winter annual weeds in the North Central region. To address this objective, surveys were conducted in Illinois, Indiana, and Ohio. Three sampling sites were chosen in each state to represent a range of environmental conditions. Sampling occurred in both mid-December 2004 and 1 May 2005. Four purple deadnettle or henbit plants were removed from 5 locations within each field and transported to the laboratory where SCN juvenile, cyst, and egg counts were performed. Fall SCN reproduction occurred at all sites in fall 2004 but was generally higher at the southern field sites. Reproduction of SCN in the spring was more limited than the fall but juvenile presence within the root was higher. Thus, SCN reproduction in the eastern Corn Belt appears to be widespread and SCN management programs in fields with high populations of henbit or purple deadnettle should include a winter weed management component. In addition, delaying burndown of winter annual weeds until mid-May or later could allow spring-hatching SCN juveniles sufficient time to complete a life-cycle and further enhance the effect these weeds have on an SCN population.

NICOSULFURON USE ON SWEET CORN. Mick F. Holm and Larry H. Hageman, Field Research and Development and Field Station Manager, DuPont Crop Protection, Wilmington, DE 19805.

For a number of years, nicosulfuron has been utilized for weed control in certain processing sweet corn hybrids. DuPont conducts evaluations of the tolerance of sweet corn hybrids to nicosulfuron on an annual basis and maintains a list of recommended sweet corn hybrids for use with nicosulfuron. This list is updated each year as new hybrids enter the market and tolerance data is generated.

In 2005, field research was conducted at Rochelle Illinois to determine the tolerance of nicosulfuron on 22 sweet corn hybrids. Nicosulfuron was applied postemergence at 0.5 ozai, 1.0 ozai. and 2.0 ozai. in combination with crop oil concentrate and AMS. Phytotoxicity ratings were made at 7, 14 and 28 days after application. A treatment of nicosulfuon at 0.5 ozai. plus mesotrione at 1.5 ozai. was also included in the study. Sweet corn hybrids that exhibited adequate tolerance over two years will be added to the 2006 recommended list.

EFFECTS OF BROMOXYNIL AND OXYFLUORFEN RATE AND SPRAY VOLUME IN ONION. Carrie E Schumacher, Harlene Hatterman-Valenti, Graduate Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051. Paul Hendrickson, Irrigation Specialist, Carrington Research Extension Center, Carrington, ND 58421.

Field research was conducted at Absaraka, Carrington, and Oakes, ND, in 2005 to determine the effect of bromoxynil and oxyfluorfen rate and spray volume on early postemergence weed control in onion (*Allium cepa* L.). Bromoxynil and oxyfluorfen are two postemergence herbicides commonly used in onion. Increased spray volume is used to improve crop safety for both of these herbicides. Onion must be in the two-leaf stage before herbicide application, but at this stage, many weeds are already beyond the effective stage of control. Onion variety ‘Teton’ pelleted seed was planted on May 3 using a Stanhay four double-row planter unit, with 10 cm paired rows and 35 cm between main rows. To evaluate the effect of spray volume on efficacy, two rates of each herbicide (bromoxynil at 80 and 340 g ai/ha and oxyfluorfen at 30 and 110 g ai/ha) were applied at 90, 230 and 470 L/ha using a CO_2-pressurized backpack sprayer. Treatments were applied to the middle two rows of each 2- by 6-m plot when onions were at the first true leaf stage (June 9). Results only from the Carrington site are presented due to time restraints. Lower volumes of 90 and 230 L/ha exhibited better weed control than 470 L/ha throughout the season. Weed species present in the experiment were common lambsquarters (*Chenopodium album* L.) and redroot pigweed (*Amaranthus retroflexus* L.). One week after treatment the low rate had twice as many weeds present than the high rate for both species. Onion injury was visible one week after treatment. Oxyfluorfen had twice as much injury as bromoxynil and the high rate also caused twice as much injury as the low rate. Onion height did vary throughout the season, but was not significant three weeks after treatment. Plant stand was unaffected by herbicide, rate or volume. Herbicide, rate and volume did not affect total yield that ranged from 54 t/ha (bromoxynil 80 g ai/ha at 470 L/ha) to 75 t/ha (bromoxynil 340 g ai/ha at 230 L/ha). All treatments yielded significantly better than the untreated control (7 t/ha), but not as great as the hand-weeded check (95 t/ha).

PREEMERGENCE WEED CONTROL IN ONION. Collin Auwarter, Carrie E. Schumacher, Harlene Hatterman-Valenti, Research Specialist, Graduate Assistant, Assistant Professor Department of Plant Sciences, North Dakota State University, Fargo, ND 58105-5051. Paul Hendrickson, Irrigation Specialist, Carrington Research Extension Center, Carrington, ND 58421.

Field research was conducted at Absaraka, Carrington, and Oaks, ND, in 2005 to identify the efficacy of preemergence herbicides bromoxynil, DCPA, dimethenamid-P, and pendimethalin applied for early season-weed control. Weed control and crop injury were evaluated for each herbicide. Onion variety 'Teton' pelleted seed was planted on May 3 using a Stanhay four double-row planter unit, with 10 cm paired rows and 35 cm between main rows. Herbicide treatments were applied with a CO_2-presurized backpack sprayer to 2 m wide by 6 m long plots at a volume of 190 L/ha with a pressure of 0.06 kPa. DCPA, pendimethalin, and dimethanamid-p were applied directly after planting at 3 rates. DCPA had rates of 2950, 5890, 11,800 g ai/ha, Pendimethalin had 530, 1070, and 2130 g ai/ha and dimethanamid-p had 420, 840, and 1680 g ai/ha. Bromoxynil was applied 10 DAP, May 13, at 180, 350, and 700 g ai/ha. Also, glyphosate rate at 772 g ai/ha was applied 10 DAP along with pendimethalin at 1070 g ai/ha and in another treatment with pendimethalin at 1070 g ai/ha applied at the one-leaf stage, June 9. At 4 WAT all herbicides had adequate weed control of common lambsquarters (*Chenopodium album* L.) and redroot pidweed (*Amaranthus retroflexus* L.). Pendimethalin plus glyphosate 10 DAP had 97.5% control 4 WAT and bromozynil applied 10 DAP had 87% control. High rates for all herbicides had 96% control and low rates average had 84% control 4 WAT. Plots were virtually weed free all season long. Average onion height for the high rate was 73.8 cm while low and medium rates had a 76.0 cm average height. Weedy check had a 70.4 cm average height and hand weeded check height was 75.0 cm. DCPA had the highest stand numbers while dimethanamid-P and penimethalin at one leaf stage plus glyphosate 10 DAP had the lowest stand numbers with 13 plants/2 m of row. Herbicide and rate interaction had a significant effect on large grade yield and total yield. Glyphosate 10 DAP followed by pendamethalin applied at the one-leaf stage had a yield of 68.7 t/ha, while pendimethalin plus glyphosate 10 DAP had a yield of 88.0 t/ha. All treatment yields were significantly better than weedy check (13.7 t/ha), while hand weeded yield was 82.2 t/ha.

EFFECT OF HALOSULFURON, GRASS HERBICIDES, AND ADJUVANTS ON CUCURBITA SPECIES INJURY AND GRASS CONTROL. Kate J. Kammler, S. Alan Walters, and Bryan G. Young. Graduate Research Assistant and Associate Professors, Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Halosulfuron is the only postemergence herbicide registered for control of broadleaf weeds in pumpkins. Growers often need post-emergent control for both grass and broadleaf weed species which requires a tank-mixture of halosulfuron with sethoxydim or clethodim. The label for halosulfuron does not allow for the use of oil-based adjuvants due to concerns of excessive pumpkin injury and potential yield loss. However, the use of oil-based adjuvants is required for applications of sethoxydim and clethodim. Two greenhouse experiments were conducted during the winters of 2004 and 2005: 1) evaluation of various adjuvants with halosulfuron to assess pumpkin cultivar injury, and 2) determination of tank-mix compatibility of halosulfuron applied with sethoxydim or clethodim with nonionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO), and a surfactant/oil blend for control of giant foxtail, smooth crabgrass, and large crabgrass.

The application of halosulfuron injured all pumpkin cultivars by 7 DAT ranging from 13 to 21%. Only slight differences in injury were observed between cultivars. The least amount of growth reduction (5% or less) was observed for *C. pepo* ‘Howden,’ *C. pepo* ‘Appalachian,’ and *C. moschata* ‘Libby’s Select’ at 21 DAT. The specific adjuvant used with halosulfuron did not influence the level of pumpkin injury or dry weight.

The addition of halosulfuron to clethodim antagonized control of giant foxtail by 15% when applied with only COC. Tank-mixing halosulfuron with sethoxydim antagonized control of giant foxtail when applied with NIS and smooth crabgrass when applied with COC. Combining halosulfuron with either sethoxydim or clethodim was antagonistic for control of large crabgrass when applied with NIS or COC. Control of large crabgrass was reduced by up to 41% with these herbicide combinations. No antagonism was observed for any herbicide tank-mixture or weed species combination when MSO was used.

RESPONSE OF SUGARBEET VARIETIES TO *S*-METOLACHLOR AND DIMETHENAMID-P APPLICATIONS. Scott L. Bollman and Christy L. Sprague, Graduate Research Assistant and Assistant Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Previous research has shown a differential response of sugarbeet varieties to herbicides. Injury may reduce sugarbeet population, leaf area, yield, and sucrose content. Field trials were conducted at St. Charles, MI in 2004 and 2005 and at East Lansing, MI in 2005. This research evaluated the response of eight sugarbeet varieties to preemergence (PRE), 2-leaf, and 4-leaf applications of *s*-metolachlor and dimethenamid-P applied at 1.4 kg ha^{-1} and at 0.84 kg ha^{-1}, respectively. Sugarbeet injury (visual) and leaf area were recorded 14 days after the 4-leaf application. Sugarbeet canopy was recorded weekly starting 14 days after 4-leaf application until maximum canopy was achieved. Sugarbeets were harvested for yield at the end of the season. Sugarbeet varieties differed in their response to herbicides and application timings. All herbicide treatments resulted in at least 10% sugarbeet injury. PRE and 2-leaf applications of dimethenamid-P resulted in the greatest crop injury and these applications were significantly greater than *s*-metolachlor applications at these timings. Sugarbeet injury from PRE *s*-metolachlor applications ranged from 9 to 25% compared with 24 to 35% injury from PRE applications of dimethenamid-P across all varieties. All herbicide treatments reduced sugarbeet leaf area at least 18%, but the greatest reduction in leaf area was from PRE applications of dimethenamid-P. Sugarbeet canopy development differed between herbicides and application timings during the first 13 weeks of the growing season. Although certain sugarbeet varieties tended to be more sensitive to *s*-metolachlor and dimethenamid-P applications than other varieties, application timing affected the relative order of tolerance. All herbicide applications significantly reduced sugarbeet yield and recoverable white sugar compared with untreated control.

EVALUATION OF KIH-485 POTENTIAL FOR WEED CONTROL IN VEGETABLE CROPS.
David E. Hillger, Kevin D. Gibson and Stephen C. Weller, Graduate Research Assistant, Assistant Professor, and Professor, Purdue University, West Lafayette, IN 47907.

KIH-485 is an experimental herbicide being developed by the Kumiai Chemical Industry Co. Ltd., for use in corn and possibly soybeans, cotton, and sunflower. KIH-485's mode of action is currently being investigated; however early indications are that it is most effective as a preemergence grass control herbicide for several annual broadleaf species. This research was designed to determine if KIH-485 had acceptable crop safety in a variety of vegetable crops. Greenhouse evaluations were conducted to screen vegetables exhibiting tolerance for further evaluation in field trials. Species selected for field studies were tomato, pepper, snap bean, watermelon, muskmelon and pumpkin. The species were transplanted or seeded into the field and were treated with a post-plant/transplant application of KIH-485 at three concentrations (209, 105, and 52 g ai ha $^{-1}$). Crop injury from treatments was visually rated and compared to untreated and standard treatment controls within each species. KIH-485 at all rates caused significant crop death or stunting and severe necrosis on tomatoes and snap bean within the first three weeks after planting/transplant. Although, pepper stand was not reduced, severe chlorosis was observed and yields were reduced. Muskmelon, pumpkin and watermelon had no significant injury or yield loss from application of KIH-485 at any rate. These results suggest that KIH-485 has acceptable crop safety for use in muskmelon, pumpkins and watermelon, however, additional research is needed to determine the most effective KIH-485 use rates for weed control and whether it has potential in other vegetable crops not tested.

THE RESPONSE OF SEEDLING CONIFERS TO FLUMIOXAZIN. Michael W. Marshall, Bernard H. Zandstra, and Richard J. Robertson, Research Associate, Assistant Professor, and Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824, and Crop Science Department, North Carolina State University, Raleigh, NC 27695.

Weed competition, especially for light, hinders growth and development of the transplanted seedling conifers. Current recommendations for liner beds include preemergence application of oryzalin plus isoxaben followed by hand-weeding. In addition to herbicide cost, hand-weeding increases the labor cost for the nursery. Flumioxazin is a newly introduced herbicide labeled for field grown conifers; however, seedling conifers tolerance to flumioxazin is not known. Research studies were conducted at cooperator sites in 2005 near West Olive in west-central Michigan to compare response of seedling conifers to various rates of flumioxazin compared to oryzalin plus isoxaben and evaluate weed control as affected by different rates of flumioxazin. Herbicide treatments included flumioxazin applied at 0.12, 0.18, 0.24, and 0.36 kg ha^{-1}, oryzalin plus isoxaben applied at 2.8 plus 0.94 kg ha^{-1}, and an untreated control. Experimental design consisted of a randomized complete block with 4 replications with individual plot sizes of 1.8 by 1.8 m. Seedling conifers were transplanted at 5 cm spacing on 10 cm rows into individual liner beds on May 24, 2005. The following conifer species (1-year-old) were transplanted: Eastern red cedar (*Juniperus virginiana* L.), balsam fir [*Abies balsamea* (L.) Mill.], and concolor fir [*Abies concolor* (Gordon & Glend.) Lindl. *ex* Hildebr.]. Herbicides treatments were sprayed on May 26, 2005 with the heights of eastern red cedar, balsam fir, and concolor fir at 7.6 to 10, 2.5 to 5, and 7.6 to 10 cm in height, respectively. Conifer heights and injury ratings were collected 8 and 16 weeks after treatment (WAT), respectively. Large crabgrass (*Digitaria sanguinalis* L.) percent control ratings were evaluated 12 WAT. Conifer height and injury and weed control data were analyzed using ANOVA and means separated at the P = 0.05 level. No differences were observed between heights among the flumioxazin and oryzalin plus isoxaben treated eastern red cedar, balsam fir, and concolor fir. Very little (less than 1%) conifer injury was observed 12 WAT across the flumioxazin treatments; however, significant injury was observed with the oryzalin plus isoxaben treatment in balsam and concolor firs. All herbicide treatments provided greater than 83% control of large crabgrass at 12 WAT. Data indicated that flumioxazin provided season long control of large crabgrass without significant injury or growth reduction to the seedling conifers.

TOLERANCE TO SELECTED HERBICIDES AND WEED CONTROL IN ORNAMENTALS. Robert E. Uhlig* and Bernard H. Zandstra, Graduate Research Assistant and Extension Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824.

Field studies were conducted at the Horticulture Research and Teaching Center located near East Lansing, Michigan in 2003 and 2004 to evaluate herbicide response and weed control in field grown Japanese barberry (*Berberis thunbergii*) var. ‘Burgundy Carousel’, redosier dogwood (*Cornus stolonifera*) var. ‘Alleman’s Compact’, winged euonymus (*Euonymous alatus*) var. ‘Chicago Fire’, panicle hydrangea (*Hydrangea paniculata*) var. ‘Kyushu’, holly (*Ilex* x *meserveae*) var. ‘Blue Prince’, white spruce (*Picea glauca)* var. ‘Dwarf Alberta’, Japanese spirea (*Spiraea japonica*) var. ‘Fire Light’, preston lilac (*Syringa x prestoniae*) var. ‘Donald Wyman’, anlojap yew (*Taxus* x *media*) var. ‘Browni’, and white cedar (*Thuja occidentalis*) var. ‘Holmstrup’. Terbacil (1.12 kg ai/ha), imazapic (0.07 kg ai/ha), imazaquin (0.42 kg ai/ha), halosulfuron (0.035 kg ai/ha), flumioxazin granular (0.28 kg ai/ha), isoxaben (1.12 kg ai/ha) plus trifluralin (0.84 kg ai/ha) were applied over the top of the plants on July 14, 2003. An untreated control was included as a check. Weed control and crop injury were evaluated at 2 and 6 weeks after treatments (WAT) on a scale of 1 to 10, meaning 1 = no weed control or no crop injury, and 10 = complete weed control or crop death. In November, plant height and width were measured. Plant size index was calculated according to the following formula: height + width/2. Experimental design for crop injury and size index was split block with the main plot and subplot being treatment and species, respectively. Experimental design for weed control was a randomized complete block. Crop injury, size index, and weed control data were analyzed using ANOVA and means were separated at P = 0.05.

Woody ornamentals holly, white spruce, anlojap yew, and white cedar were not injured by any of the treatments at 6 WAT, but terbacil caused the most injury on the remaining species evaluated at 2 and 6 WAT. Imazaquin, imazapic, and halosulfuron injured Japanese barberry, redosier dogwood, and panicle hydrangea, except halosulfuron which was safe to panicle hydrangea in both years. Flumioxazin and isoxaben plus trifluralin were the safest treatments. Plant size index did not differ among treatments except for redosier dogwood, in which imazaquin and imazapic treatments stunted plant growth compared to the control.

Terbacil, imazaquin, and flumioxazin provided excellent control in all weeds rated at 6 WAT. Imazaquin control of common lambsquarters was poor in 2003, but flumioxazin controlled common groundsel and common chickweed 7.8 and 6.3, respectively. Imazapic weed control was excellent in all weed species except for common lambsquarter and common groundsel. Halosulfuron did not provide consistent weed control. Isoxaben plus trifluralin was among the best treatments for control of redroot pigweed, common lambquarters, common chickweed, and curly dock in 2004.

A trade-off between weed control and crop injury was observed. However, flumioxazin and isoxaben plus trifluralin were the safest treatments on the ornamental species evaluated with relatively good weed control.

MESOTRIONE AND CLOMAZONE EFFECTS ON PEPPERMINT AND SPEARMINT GROWTH AND YIELD. Mary S. Gumz and Stephen C. Weller, Graduate Research Assistant and Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907.

Mesotrione and clomazone have been shown to control *Amaranthus* species and white cockle, respectively, in Midwest peppermint and spearmint production while causing minimal crop injury. In the field trials described, the objective was to determine optimal rates of mesotrione and clomazone which minimized crop injury while achieving acceptable crop oil yield.

Mesotrione was applied preemergence at rates of 70, 105, and 210 g a.i./ha alone and at 70 g a.i./ha in combination with either 840 g a.i./ ha clomazone or 83 g a.i./ha flumioxazin and postemergence at rates at rates of 70 and 105 g a.i./ha alone or at 70 g a.i./ha combined with 225 g a.i./ha terbacil (plus 1% v/v COC and 1kg/100L AMS). Clomazone was applied preemergence at 840 g a.i./ha. All treatments were compared to a standard treatment of 900 g a.i./ha terbacil applied preemergence. Preemergence treatments were made prior to crop emergence in peppermint and to emerged but dormant spearmint. Postemergence treatments were made to 30cm tall spearmint and 15cm tall peppermint.

Peppermint had greater tolerance to all preemergence treatments than spearmint while spearmint had greater tolerance to all postemergence treatments than peppermint. In spearmint, mesotrione preemergence at 70 g a.i./ha caused 10% injury 28DAT compared to 25% and 75% for 105 and 210 g a.i./ha respectively and 25% for 840 g a.i./ha clomazone. By 74 DAT, spearmint had recovered from all early season injury. In peppermint, only clomazone and 210 g a.i./ha mesotrione resulted in injury (<5%) 28 DAT, and the crop had complete recovery by 57 DAT. Postemergence applications of 70 and 105 g a.i./ha mesotrione and 70g a.i./ha mesotrione combined with 225 g a.i./ha terbacil resulted 5, 7, and 7% injury, respectively in spearmint 14 DAT and resulted in 8, 21, and 10% injury, respectively, in peppermint. Despite differences in injury symptoms, no treatment significantly reduced yield compared to the terbacil control. Management implications of results indicate the industry standard of terbacil is adequate for use in mint weed control situations where *Amaranthus* species or white cockle are not present. However, if white cockle is present, clomazone can be used without significant yield loss, and in the future, if mesotrione becomes registered for mint, it could offer additional weed management options for control of *Amaranthus* species.

EFFICACY OF GLYPHOSATE APPLIED ALONE OR IN COMBINATION WITH CARFENTRAZONE-ETHYL ON FOUR ANNUAL WEED SPECIES. Steven R. King, Assistant Professor, Montana State University, Southern Agricultural Research Center, Huntley, MT 59037.

An experiment was performed in 2005 to evaluate the efficacy of glyphosate applied alone or in combination with carfentrazone-ethyl for the control of common lambsquarters (*Chenopodium album*), common sunflower (*Helianthus annuus*), kochia (*Kochia scoparia*), and wild buckwheat (*Polygonum convolvulus*). Glyphosate treatments were applied at three rates (0.34, 0.69, and 1.38 lb ai/A), with or without 0.007 lb ai/A carfentrazone-ethyl, and at two different weed sizes (1 and 4 inch). Additional treatments of 0.007 lb ai/A of carfentrazone-ethyl alone and 0.75 lb ai/A of paraquat alone were also evaluated. Herbicide treatments were arranged factorially in a randomized complete block design and replicated four times. The main effects of glyphosate rate, the addition of carfentrazone-ethyl, and weed size were all determined to be significant for the control of common lambsquarters (CHEAL), common sunflower (HELAN), and kochia (KCHSC). The main effects of glyphosate rate and the addition carfentrazone-ethyl were determined to be significant for the control of wild buckwheat (POLCO). Control of 1 inch tall CHEAL increased from 41 to 76%, 45 to 76%, and 48 to 81% when 0.007 lb ai/A of carfentrazone-ethyl was added to 0.34, 0.69 and 1.38 lb ai/A of glyphosate, respectively. No increase in the control of 4 inch tall CHEAL was observed when 0.007 lb ai/A of carfentrazone-ethyl was added to any rate of glyphosate. No difference between the control of 1 and 4 inch tall CHEAL occurred within an individual glyphosate rate due to the addition of carfentrazone-ethyl. A significant interaction of glyphosate rate by weed size was observed for CHEAL control, where CHEAL was not affected by glyphosate rate when applied to 1 inch tall CHEAL. However, CHEAL control increased from 66% with 0.34 lb ai/A of glyphosate to 86 and 91% with 0.69 and 1.38 lb ai/A of glyphosate, respectively, when applied to 4 inch tall CHEAL. Control of 1 inch tall HELAN increased from 43 to 79%, 43 to 81%, and 48 to 89% due to the addition of when 0.007 lb ai/A of carfentrazone-ethyl to 0.34, 0.69 and 1.38 lb ai/A of glyphosate, respectively. No difference in control of 4 inch tall HELAN occurred when carfentrazone-ethyl was added to any rate of glyphosate. Control of 1 inch tall KCHSC and POLCO also increased due to the addition of carfentrazone-ethyl to the three glyphosate rates. No difference was observed in the control of 4 inch tall KCHSC or POLCO due to the addition of carfentrazone-ethyl to any glyphosate rate. Results indicate that the addition of 0.007 lb ai/A carfentrazone-ethyl to 0.34, 0.76 and 1.38 lb ai/A of glyphosate may increase the level of control of 1 inch tall CHEAL, HELAN, KCHSC, and POLCO. The addition of carfentrazone-ethyl to glyphosate treatments applied to 4" taller weeds did not increase the level of control to that provided by glyphosate alone.

AN AFLP APPROACH TO INVESTIGATE SEX DETERMINATION IN WATERHEMP. Dean S. Volenberg and Patrick J. Tranel, Postdoctoral Research Associate and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

There are several molecular techniques which generate molecular markers. Certain molecular techniques have advantages over others depending on the research question being addressed. The amplified length polymorphism (AFLP) technique generates large numbers of molecular markers and provides a rapid method for scanning the genomes of different individuals for sequence variation. The AFLP technique can be used to quantify genetic variation, assist in marker assisted breeding programs, and identify sex specific markers in plant species which are sexually dimorphic.

Waterhemp is a weed species which exhibits sexual dimorphism. Historical (1930s) genetic work involving crosses between waterhemp and monoecious amaranth species suggested that males are the heterogametic sex. In other words, males have an XY chromosome pair, whereas females have an XX chromosome pair. However, sex chromosomes in waterhemp have never been distinguished from the autosomes. The objective of this study was to evaluate DNA from female and male waterhemp plants using AFLP technique to identify female- or male-specific molecular markers.

A dioecious waterhemp accession was tested for polymorphisms between full-sib-male and -female plants using the AFLP technique. Equal amounts of DNA from five female or male plants were bulked. Eighteen primer combinations were tested, and two of these primer combinations yielded a male-specific molecular marker. The experiment was repeated on DNA from individual male and female plants to verify sex specificity of the molecular marker.

AFLP band patterns in waterhemp showed a high level of variation between individuals, which were unrelated to sex. The eighteen primer combinations were scored to quantify the level of polymorphism in waterhemp. In total, 1928 bands were polymorphic out of 3079 bands scored, producing an average band polymorphism of 62.6%.

AFLP technique in waterhemp generated very low level (0.06% of total scorable bands) of male specific markers. The primer combinations of M*se*I-CTA/E*co*RI-AGC and M*se*I-CTA/E*co*RI-ACA each generated one male specific band of approximately 202 and 252 bp, respectively. These bands were present in all male plants, but absent from all female plants tested. The eighteen primer combinations failed to yield a female-specific molecular marker.

Future research will:1) evaluate other unique primer combinations, 2) clone and sequence male-specific bands(s), and 3) design primers to amplify male-specific molecular markers.

MICROBIAL INTERACTIONS WITH WEED SEEDS. Joanne C. Chee-Sanford[1], Adam S. Davis[2], Martin M. Williams II[2], Lynn M. Connors[3], Teresa J. Holman[3], and Gerald K. Sims[1], [1]Research Microbiologist, [2]Research Ecologist, and [3]Biological Science Technician, USDA-ARS, Invasive Weed Management Unit, Urbana, IL 61801.

Buried seed reserves in soil (seed banks) are a major source of future plant emergence. Seed production from many annual weed species is high and the longevity of seed banks suggests existing mechanisms of seed protection against natural decay processes. This environment also offers opportunities for numerous seed-microbe interactions, with potential importance to plant and microbial community development. Studies conducted earlier demonstrated seeds of velvetleaf (*Abutilon theophrasti*) were subject to extensive decay mediated by soil microorganisms, in contrast to other species like giant ragweed (*Ambrosia trifida*), Pennsylvania smartweed (*Polygonum pensylvanicum*), jimsonweed (*Datura stramonium*), and woolly cupgrass (*Eriochloa villosa*). We investigated the hypothesis that if accessed, seeds provide significant nutritional resources for soil microbial populations with focus on velvetleaf seed as a model. Microbial community analysis using terminal restriction fragment length polymorphisms (TRFLP) and rDNA clone libraries, along with cultivation and microscopic examination, were used to characterize microbial species and community assemblages associated with seeds following exposure to soil microorganisms. Multidimensional scaling analysis of TRFLP profiles indicate bacterial assemblages generally differed between weed seeds of different species, and particularly with velvetleaf seed, the associated populations differed in accordance with the origin of the soil inoculum. While TRFLP analysis did not indicate a specific community composition associated with seed type, the dominant presence of several bacterial sequences in clone libraries derived from individual seeds did indicate closely related species were present on replicate seeds exposed to the same soil inoculum. This suggests certain species within complex soil microbial communities may likely be found in seed associations, but weed seeds may support overall associations with a wide range of soil bacteria. Most of the dominant bacteria identified in association with decaying velvetleaf seed were native soil species, such as members found within the phyla *Bacteroidetes* and *Proteobacteria*. In contrast to bacteria, species belonging to the major fungal phylum *Ascomycota* were present, regardless of soil origin indicating specific relationships between certain species of seeds and soil-borne fungi may occur. Microscopic examination indicated densely populated surfaces of seeds following incubation where seeds provided the major source of carbon nutrition for microbial growth. The results suggest seeds can provide a selective environment for microbial associations, and leads to further investigation on whether these relationships are common in natural soil environments. The results further suggest that native soil microbial populations are active in association with seeds, and identifying the species and factors that influence these associations in natural soil, will determine whether these relationships can be manipulated or exploited for use in seed bank depletion.

WEED SEED MORTALITY IN SOILS WITH CONTRASTING AGRICULTURAL MANAGEMENT HISTORIES. Adam S. Davis*, Kathleen I. Anderson, Steven G. Hallett, Karen A. Renner, Ecologist, USDA-ARS Invasive Weed Management Unit, Urbana, IL 61801; Research Technician and Assistant Professor, Purdue University, West Lafayette, IN 47907; Professor, Michigan State University, East Lansing, MI 48824.

It has been proposed that cropping systems can be managed to promote the development of soil microbial communities that accelerate weed seed mortality. We examined soil fungal and bacterial communities, soil C:N ratio, soil particle size fractions, and weed seed mortality in soil from five fields with over 10 years of contrasting agricultural management histories. Seed mortality of giant foxtail and velvetleaf were greatest in soil from the conventionally managed systems and lowest in soil from a compost-amended corn-corn-soybean-wheat rotation. Principal components analysis of soil microbial communities showed distinct differences in the fungal and bacterial profiles among the study soils, with the first two principal components explaining over 50% of the variation in the study soils. The first principal component of the 18S rDNA PCR-DGGE analysis of fungal community composition showed a strong negative correlation with both giant foxtail (-0.52, $P < 0.05$) and velvetleaf (-0.57, $P < 0.01$) seed mortality, as did ordination with non-metric multidimensional scaling (NMS) [giant foxtail (-0.54, $P < 0.01$) and velvetleaf (-0.60, $P < 0.01$)], suggesting that seeds of the two species were affected similarly by changes in the soil fungal community. For giant foxtail, weed seed mortality was also positively correlated ($r = 0.48$, $P < 0.05$) with the first NMS axis of the bacterial 16S rDNA analysis. None of the other measured soil properties were significantly correlated with weed seed mortality. These results demonstrate that soil management history, microbial community composition and weed seed mortality are linked. More work is needed to identify components of the fungal and bacterial communities that are active in seed degradation, and to develop conservation biocontrol recommendations for these species.

HOST SPECIFICITY OF *Microsphaeropsis amaranthi* AND *Phomopsis amaranthicola*, BIOHERBICIDE CANDIDATES FOR *Amaranthus* SPECIES. Loretta Ortiz-Ribbing and Martin M. Williams II, Research Associate and Ecologist, USDA-ARS, Invasive Weed Management Research Unit, Urbana, IL 61801.

Weeds of the *Amaranthus* genus have variable susceptibility to two indigenous fungal organisms, *Microsphaeropsis amaranthi* and *Phomopsis amaranthicola.* In an effort to explain host specific responses, *M. amaranthi* and *P. amaranthicola* conidial germination and germ tube length were quantified on the leaf surfaces of seven *Amaranthus* species at 21° and 28° C. Weeds included common waterhemp, Palmer amaranth, Powell amaranth, redroot pigweed, spiny amaranth, smooth pigweed, and tumble pigweed. Host-specific responses were greater for *P. amaranthicola* than *M. amaranthi*, as evidenced by weed species effects on conidial germination and germ tube elongation. Conidia of *M. amaranthi* had higher germination and germ tube elongation than *P. amaranthicola*. Assuming disease severity of host plants increases with conidia germination and germ tube elongation, these results are largely consistent with seedling biomass reduction and mortality reported for these weed species in previous work. However conidial germination and germ tube elongation are only two processes of disease expression; the ability of the fungal organism to penetrate and infect leaf tissue warrants further study.

VALIDATION OF WEEDSOFT CROP-YIELD LOSS PREDICTIONS FOR COHORTS OF MIXED-SPECIES WEED COMMUNITIES. Mark R. Jeschke and David E. Stoltenberg, Graduate Research Assistant and Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706; J. Anita Dille, Assistant Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506; Gregg A. Johnson, Associate Professor, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108; George O. Kegode, Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105; Stevan Z. Knezevic and Shawn M. Hock, Associate Professor and Graduate Research Assistant, Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE 68583; and Christy L. Sprague, Assistant Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

WeedSOFT is a decision support system that brings together a wealth of information on weed biology and management efficacy to improve weed management decision-making. An essential part of maintaining WeedSOFT as a state-of-the-art weed management tool is validation and improvement of the crop-yield loss model. Research was conducted in corn and soybean at several sites in the north central region in 2004 and 2005 to determine crop-yield loss associated with four cohorts of multi-species weed communities for validation of WeedSOFT. Crop-yield loss observed in these experiments was compared to yield loss predicted by WeedSOFT to determine the accuracy of predictions across a wide range of weed emergence times relative to the crop.

Separate experiments were conducted for corn and soybean. The experimental design was a randomized complete block with four or more replications of four weed cohorts and a weed-free treatment. Weed cohorts were established relative to crop growth stage: weeds that emerged at the same time as the crop (cohort 1) and at the V2 (cohort 2), V4 (cohort 3), and V6 (cohort 4) growth stages in corn, and at the VC (cohort 2), V1 (cohort 3), and V3 (cohort 4) stages in soybean. Glyphosate was applied to maintain a weed-free environment before targeted weed emergence times. Each experiment included a season-long weed-free treatment. Common lambsquarters, giant ragweed, velvetleaf, redroot pigweed, tall waterhemp, woolly cupgrass, giant foxtail, barnyardgrass, yellow foxtail, and large crabgrass were selected as target species at the outset of the experiment, and research sites were chosen based on the presence of at least two of these species. Corn was planted at 79,000 seeds ha^{-1} in rows spaced 76-cm apart and soybean was planted at 494,000 seeds ha^{-1} in rows spaced 19-cm apart. Plot size was 3.0 m by 9.1 m. Weed community data were collected from two 25 cm by 76 cm quadrats in each plot. Crop-yield loss predicted by WeedSOFT was based on weed density 2 wk following cohort establishment. Crop yield in the weed-free treatment was used as the weed-free yield for WeedSOFT predictions.

Weed communities across research sites consisted largely of grass species and moderately competitive broadleaf species. Crop-yield loss due to weed interference occurred only for cohorts 1 and 2, with yield loss up to 85% and 100% in soybean and corn, respectively. Crop-yield loss occurred in four of six soybean site-years, and in all corn site-years for cohort 1, and in one soybean and one corn site-year for cohort 2. WeedSOFT typically over-predicted yield loss in both corn and soybean, with substantial yield loss predicted in many cases where no yield loss occurred. Yield loss was greatly over-estimated for cohort 2, with an average over-prediction of 31% in corn and 35% in soybean. The greatest over-predictions of yield loss were associated with weed communities composed largely of grasses, indicating that WeedSOFT over-estimated the competitiveness of these species at later emergence times. Substantial under-prediction of crop-yield loss occurred only when observed corn-yield loss exceeded the upper limit for corn-yield loss (60%) in the WeedSOFT model.

INFLUENCE OF HERBICIDE APPLICATION TIMING ON GIANT RAGWEED CONTROL AND INSECT INFESTATION. Dawn E. Nordby and Kelly A. Cook, IPM Extension Specialists, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Previous research has examined some potential associations between various insect and weed species. However, few studies have addressed how members of the stem-boring guild of insects may influence various aspects of weed management. A better understanding of such a relationship would increase the knowledge of the spectrum of insect and weed species that may be involved and potentially help minimize this interaction. In many parts of Illinois, lack of giant ragweed control following a postemergence herbicide application has been attributed to the presence of common stalk borer (*Papaipema nebris*) in the stem of the plant. The primary objective of this study was to determine which herbicide application strategies are effective at minimizing insect-weed-herbicide interactions in the future.

Three field experiments were conducted in glyphosate-resistant soybean during 2003 and 2004 at the Northern Illinois Agronomy Research Center at Dekalb, IL. Treatments consisted of seven herbicide application timings including early post, post, late post, preemergence followed by post, preemergence followed by late post, early post followed by late post, and a non-treated control. The preemergence treatment consisted of chloransulam-methyl at 0.036 kg/ha, while postemergence treatments consisted of glyphosate at 0.84 kg/ha. Treatments were evaluated for giant ragweed control 14 DAT. Additionally, twenty giant ragweed plants were harvested from each plot prior to the post application and 14 DAT to determine the degree of common stalk borer infestation manifested by tunneling in stem tissue. Giant ragweed stem diameter and height also were recorded at these times.

Herbicide application timing affected the number of plants with stalk borer tunneling and the number of stalk borers in the plants. An early post treatment was the most effective in reducing the occurrence of stalk borers and tunneling. Common stalk borer was present in the greatest density in giant ragweed plants collected from the preemergence only and late postemergence only herbicide treatments. The presence of common stalk borer in giant ragweed appeared to be positively correlated to giant ragweed stem diameter.

CANADA THISTLE MANAGEMENT IN ORGANIC FIELD CROPS. Matthew M. Harbur, Research Specialist, University of Minnesota Southwest Research and Outreach Center, 23669 130th Street Lamberton MN 56073. Donald L. Wyse and Craig C. Sheaffer, Professors, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108. Deborah L. Allan, Professor, Department of Soil, Water and Climate, University of Minnesota, St. Paul, MN 55108.

Canada thistle is a problematic weed for certified organic producers, who lack systemic herbicides with which to directly attack the weed's vast root system. In the absence of herbicides, systemic, multiple-year strategies are needed to deplete subterranean carbohydrate reserves. In yesteryears, alfalfa was an effective control for Canada thistle; during production of that crop, Canada thistle was repeatedly mowed, thereby reducing its reserves. Three or more years of alfalfa production are required to significantly reduce Canada thistle populations, however, and many producers are unable to sell or feed that crop.

The purpose of the following research was to evaluate several two-year organic cropping systems for their potential to suppress Canada thistle by mimicking the timing of Canada thistle disturbance found in alfalfa systems – while hastening the depletion of Canada thistle populations or producing profitable conventional or alternative crops. Cropping systems included in this study included various components, ranging from repeated tillage to alternative crops to corn and soybean:

Trt	Year 1	Year 2
1.	Field cultivation every 21 d from May-Sept.	Soybean planted in late May.
2.	Field cultivation every 21 d from May-Sept.	Field cultivation every 21 d.
3.	Field cultivation every 21 d from May-Sept.	Soybean planted in late May.
4.	Field cultivation every 21 d from May-Sept.	Field cultivation every 21 d.
5.	Buckwheat planted in mid-June.	Soybean planted in late May.
6.	Buckwheat planted in mid-June.	Buckwheat planted in mid-June.
7.	Pearl millet planted in mid-June.	Soybean planted in late May..
8.	Pearl millet planted in mid-June.	Pearl millet planted in mid-June.
9.	Sunn hemp planted in mid-June.	Soybean planted in late May.
10.	Sunn hemp planted in mid-June.	Sunn hemp planted in mid-June.
11.	Field pea grown until June, buckwheat planted in mid-June.	Soybean planted in late May.
12.	Field pea grown until June, buckwheat planted in mid-June.	Buckwheat planted in mid-June.
13.	Corn planted in mid-May.	Soybean planted in late May.

In the third year, systems were rotated into wheat and alfalfa production to determine the potential of these systems to facilitate alfalfa establishment and enhance alfalfa suppression of Canada thistle during the following year. Two experiments were conducted, beginning in 2003 and 2004.

At the end of the second year of both experiments, treatment effects were highly significant. Systems which included repeated tillage during the first year had the fewest Canada thistle. We had hypothesized that delaying tillage until Canada thistle reached bud stage (mid-June in Minnesota) would maximize the depletion of carbohydrate reserves and hasten the decline of Canada thistle populations. No difference, however, was observed between systems in which tillage was begun in mid-May and those in which it was delayed until mid-June.

Among systems that were cropped during the first year, there was no overall advantage to the smother crops compared to corn by the end of the second year of each experiment. Within the systems that included smother crops during the first year, however, the systems that produced the pea - buckwheat double crop had fewer thistles in the first experiment than those that were sole-cropped. Systems that followed smother crops in the first year with soybean during the second year had fewer Canada thistle at the end of the second season than systems in which smother crops were grown in both years.

At the end of the third year (first experiment only), Canada thistle population density was still least in systems that were repeatedly tilled during the first year. Systems that were produced smother crops during the first year had fewer Canada thistles than the system that was cropped with corn. Among smother crops, however, the advantages of growing field pea in the first year or soybean in the second year had disappeared.

To date, repeated tillage has been the most effective alternative to alfalfa for controlling Canada thistle in organic systems, however, not an alternative that is expected to increase farm income. Among continuous crop systems, smother crops or soybean may allow the production of a crop while also reducing Canada thistle population density. Control of Canada thistle with smother crops may vary widely, however, with differences in smother crop performance among growing seasons.

PERSISTENCE OF A GLYPHOSATE-RESISTANT HORSEWEED (CONYZA CANADENSIS) SEEDBANK UNDER VARIOUS WEED MANAGEMENT SYSTEMS. Vince M. Davis*, William G. Johnson, and Kevin D. Gibson, Research Associate, Associate Professor, and Assistant Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

No-tillage practices and glyphosate resistant soybeans are utilized on 60% and 81% of Indiana soybean production acres, respectively. Horseweed is an increasingly common and problematic soybean weed due to frequent occurrence of biotypes resistant to glyphosate. Over-wintering horseweed rosettes are vulnerable to tillage; however, other management strategies to protect no-tillage soybean production practices need to be determined. The objective of this study was to evaluate crop rotation, cover crops, glyphosate verses residual herbicide programs, and fall verses spring herbicide application timings on a glyphosate resistant horseweed seed bank. The goal is to evaluate these management strategies by there potential to change the dynamics of the soil seed bank composition in a mixed susceptible and resistant horseweed population. This study was established in a no-tillage field following a 2003 glyphosate resistant soybean crop that contained a moderate infestation of glyphosate resistant horseweed (1 plant yd^{-2}). This experiment is a split-plot design with crop rotation (soybean-corn-soybean or continuous-soybean) as the main plots and management systems as sub plots. Management systems are evaluated by monitoring in-field horseweed density and by counting viable horseweed seeds in the soil seed bank. Soil for seed bank evaluations is collected in the fall (post seed rain), spring, and late summer (pre seed rain). Seed bank density is determined in a greenhouse grow-out procedure. The average viable horseweed seed density in the starting soil seed bank for the trial was 11 viable seeds per lb of dry soil. By spring 2004, following fall herbicide applications, differences in viable horseweed seeds ranged from 32 viable seeds for fall applied glyphosate to 3 viable seeds per lb of dry soil for treatments that included a residual herbicide application. However, by the end of the summer (pre seed rain), there were no differences in seed bank density with an average of 5 viable seeds per lb of dry soil for all management strategies. In conclusion, the first year results indicate that less than half of viable horseweed seeds remain in the soil seed bank just prior to new seed inputs for all management strategies employed.

EVALUATION OF MUSTARD GERMPLASM AS GREEN MANURES. Christopher Gittings and John B. Masiunas, Undergraduate Research Associate and Associate Professor, Univ. of Illinois, 1201 West Gregory Dr., Urbana, IL 61801.

Crucifer green manures have potential as biofumigants to suppress weeds emerging with crops. The primary mechanism for weed suppression by crucifer residues is the hydrolysis by myrosinase (thioglucoside glucohydrolase, EC 3.2.3.1) of glucosinolates to D-glucose, sulfates and a number of active allelochemicals such as isothiocyanates, nitriles, thiocyanates. In crucifer tissues, myrosinase is normally segregated from glucosinolates but when cells are damaged, myrosinase is released. Crucifers differ in their glucosinolate profile with more than a hundred thirty glucosinolates varying in their side chains and weed suppression existing. Crucifer genotypes with higher concentrations of glucosinolates or exposure to environmental stress (i.e. drought, high temperatures, insect feeding) that elevates levels of glucosinolates may result in better weed suppression. The objectives of our research were to identify accessions that have the best germination and growth under Midwestern U.S. conditions and to determine the alleopathic activity of their water extracts. We hypothesize that the best accessions for further development are those with good emergence, large biomass, and suppessive water extracts. Accessions were obtained from the crucifer germplasm collection in Ames, IA and commercial seed companies (Seeds of Change, High Performance Seeds, Siegers Seeds, Rispens Seeds, Harvest Moon Seeds, Southern Exposure Seeds, and Native Seeds). We evaluated: 22 accessions in *B. juncea*, 10 accessions in *Brassica napus*, 3 accessions in *B. rapa*, 3 accessions in *B. nigra*, 3 accessions in *Sinapis arvensis*, 2 accessions in *Camelina sativa*, 2 accessions in *Eruca sativa*, and 1 accession in each of the following species *Biscutella lustianica*, *B. frutescens, B. sempervirens, Brassica barrelieri*, *B. campestris, B. kaber, B. oxyrrhini*, *B. tournefortii*, *Enarthrocarpus arcuatus*, *Eruca pinnatifida*, *Erysimum cheiranthoides, Sinapis alba*, and *Sinapis flexuosa*. On August 22, mini-plots (.09 m^2) were established in Champaign in a randomized complete block design with 5 replications. The number of plants and dry mass were determined six weeks later. The accessions in *Camelina sativa*, *Biscutella lustianica*, *B. frutescens*, and *Erysimum cheiranthoides* did not emerge in any replication. The accessions with the greatest biomass/ plant were *Brassica juncea* ‘Florida Broadleaf’, *Brassica napas* var. *napus* ‘Ames 26655’ and *Brassica napas* ‘PI 305280’. The accessions also differed in the allelopathic activity of their water extracts against cress and annual ryegrass in a Petri dish bioassay. Our results indicate that promising accessions exist which merit further evaluation in field studies.

CORN AND PALMER AMARANTH INTERACTIONS WITH NITROGEN RATES IN DRYLAND AND IRRIGATED ENVIRONMENTS. Ella K. Ruf*, J. Anita Dille, and Dwain M. Rule, Graduate Research Assistant, Associate Professor of Agronomy, and Graduate Research Assistant, Kansas State University, Department of Agronomy, Manhattan, KS 66502.

A field experiment was conducted near Manhattan, KS during the summer of 2005 to evaluate the growth and uptake of nitrogen (N) in corn and Palmer amaranth (PA) when grown alone and in competition with each other in two moisture environments. The objective was to determine the influence of increasing PA density on corn in two environments of furrow irrigation or dryland conditions and with varying the applied nitrogen rates. Within each moisture environment, N rates of 0, 112, and 224 kg ha^{-1} were applied to selected plots. DKC 60-19 RR corn was planted at a seeding rate of 76,600 seeds ha^{-1} and PA was over seeded into each plot. Plots were hand thinned to desired PA densities of 0, 1, 4, and 8 plants m^{-1} row corn, or corn was removed to establish monoculture PA treatments with 2 plants m^{-1} row. One destructive harvest of 2 plants of each species per plot was taken around tasselling. Plant height and leaf number or growth stage of each species was recorded to compare the growth of each species at that time. Plants were then brought to the lab, processed and separated into stem, reproductive tissues and leaves, from which leaf area (LA) was measured. Samples were then dried and weighed before the leaf and stem tissue were ground separately and analyzed for total N content. Tasselling occurred over time beginning on 7/15/2005 with 224 kg N ha^{-1} irrigated corn through 7/15/2005 for 0 kg N ha^{-1}. Corn height and LA differences by moisture environment were observed with taller leafier corn in 224 kg ha^{-1} as compared to 0 kg ha^{-1} in both dryland and irrigated. Within an environment across all N rates, corn LA and dry weights of corn leaf and stem tissue decreased as PA density increased. The intended goal is to optimize N and water input and gain a better understanding of the interaction between corn and PA in different environments.

BIOLOGY AND MANAGEMENT OF CRESSLEAF GROUNDSEL. Jeremy T. Lake and Aaron G. Hager, Graduate Research Assistant and Assistant Professor, Department of Crop Science, University of Illinois, Urbana, IL 61801.

The number of fall applied and preplant herbicide programs for control of winter annual weeds has increased along with the number of acres in conservation tillage. In central and southern Illinois, along with many other surrounding states, cressleaf groundsel, also known as butterweed, has become a prominent weed species in no-till systems. Little information is known about the biology and management of cressleaf groundsel. Field studies were conducted in the fall of 2004 and spring of 2005 to observe biological characteristics associated with cressleaf groundsel. Studies were also carried out to determine possible herbicide management strategies for control of cressleaf groundsel. These studies were established on four cooperator fields in Douglas, Fayette, Piatt, and Vermillion counties. Biological characteristics that were observed included: periodicity of emergence, rosette diameter prior to overwintering, winter survival, spring rosette diameter continuation, and time to bolting and flowering. Herbicides evaluated for possible cressleaf groundsel control consisted of: 2,4-D, dicamba, glyphosate, clomazone, paraquat, flumioxazin, quinclorac, chlorimuron, tribenuron, mesotrione, atrazine, imazaquin, simazine, and pendimethalin. These herbicides were applied and evaluated for both fall and spring control of cressleaf groundsel. Visual ratings were taken 103 days after treatment (DAT) of the fall applied and 21 DAT of the spring applied treatments. Visual ratings demonstrated that a fall application of 2,4-D, glyphosate, imazethapyr + glyphosate, paraquat, glyphosate + 2,4-D, flumioxazin, chlorimuron + tribenuron, imazaquin + 2,4-D, simazine + paraquat, or pendimethalin + glyphosate + 2,4-D provided the greatest control among all treatments. Evaluations of spring-applied treatments indicated that glyphosate, glyphosate + 2,4-D, chlorimuron + tribenuron, or simazine + paraquat provided the greatest.

SEEDLING EMERGENCE OF ROW CROPS AND WEEDS ACROSS FIVE TILLAGE SYSTEMS.
Dean Peterson, Kurt Spokas, Frank Forcella, Don Reicosky, and Chris Wente, Agricultural Science Technician, Soil Scientist, Research Agronomist, Soil Scientist, and Agricultural Science Technician, USDA-ARS Soils Lab, 803 Iowa Avenue, Morris, MN 56267.

Adoption of reduced tillage in the north central region of the United States has lagged behind adoption rates in other regions. One reason for this lag is that if soils in the north central region are not tilled, they remain cold and wet in spring, which delays access to fields and, thereby, delays planting and increases probabilities of low crop yields. New equipment and residue management systems may help alleviate these problems. However, effects of these new systems on weed and crop emergence rates and densities are not known well. Consequently, we examined the above variables for three row crops (corn, soybean, and sunflower), five tillage systems (moldboard plow, MP; chisel plow; deep strip till, STd; shallow strip till; and no-till, NT), and (for weeds) three micro-sites (crop row, interrow with wheel tracks, and interrow without wheel tracks) during 2004 and 2005 in a loam soil in Minnesota. Primary weeds were green foxtail, common lambsquarters, and wild mustard. Foxtail tolerated all tillage systems, preferred rows in reduced tillage systems, and emerged faster in plowed soils. Lambsquarters preferred plowed soils, tolerated reduced tillage systems, and emerged slightly faster in MP. Mustard was entirely restricted to plowed soils, especially MP. Sunflower performed consistently well in STd and inconsistently elsewhere. Soybean was relatively insensitive to tillage and performed consistently well in reduced tillage. Corn was sensitive to NT but, otherwise, was not affected by tillage. All crops tended to emerge faster as tillage intensity increased, and emergence in STd often was similar to that in plowed soils (except corn in 2004). Overall, MP remains unique among the tested management systems, but a system like STd may be an acceptable alternative in terms of crop stand and rate of crop emergence. Delayed emergence of some weeds in STd may require use of PRE + POST or split POST herbicide strategies. Fortunately, STd is inhospitable to other weeds, like wild mustard.

INTRODUCTION TO GENE FLOW AND INTROGRESSION BIOLOGY. C. Neal Stewart, Jr., Racheff Chair of Excellence in Plant Molecular Genetics, Department of Plant Sciences, University of Tennessee, Knoxville, TN 37996.

Hybridization (crosses between plant types) and introgression (stable gene integration from one plant type to another) are generally referred to as "gene flow", typically with reference to a recipient plant type and gene(s) of interest. Gene flow is of practical concern in crop breeding, weed evolution, or transgene movement from crops to weeds. While gene flow is a natural process, the desire for transgene containment has elevated plant hybridization and introgression biology to an unprecedented level: both scientifically and politically. While gene flow might pertain to seed movement with regards to volunteer plants or type "contamination", most research has been performed on assessing gene flow via pollen movement, with transgenes being important and convenient markers to assay. Transgenic introgression and linkage effects (Stewart et al. 2003) might be most pertinent topic with regards to introgression biology for this meeting and will be the focus of this presentation. In short, transgenes cannot be treated as "magic islands" within genomes. Rather, they are subject to evolutionary forces common to the tens-of-thousands of genes within each genome with regards to all natural processes, including introgression.

Reference

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THE POPULATION GENETICS OF MOVING GENES: IMPLICATIONS FOR THE RECEIVING POPULATION. Norman C. Ellstrand, Professor of Genetics, University of California, Riverside, CA 92521-0124.

Evolution depends on the interplay of four evolutionary forces: mutation, selection, drift, and gene flow. The potential importance of gene flow is often unappreciated. In plants, rates of pollen and seed immigration are often so large as to counteract the effects of genetic drift, moderate levels of local selection, and opposing mutation. Gene flow in plants can play a creative evolutionary role as well, for example, by augmenting local diversity and by working in concert with natural selection to spread advantageous alleles. Whether immigrant alleles will persist and spread varies with several factors, including (i) the fitness effects of the alleles in question, (ii) whether those alleles are tightly linked to alleles with strong fitness effects, (iii) the reproductive system of the organisms involved, and (iv) whether gene flow occurs once or is recurrent. For the weed scientist, gene flow can be a challenge if immigrant alleles make weeds more difficult to control, or gene flow can be a tool if immigrant alleles make weeds easier to control.

IMPLICATIONS OF GENE FLOW ON THE SEED PRODUCTION INDUSTRY. Barry Martin, Director of Seed Technology, Monsanto Company, St. Louis, MO, 63167.

Gene flow in seed production may arise from two possible sources, pollen flow and seed mixture. Pollen flow into a seed crop may come from indigenous relatives of the crop such as Brassica Rapa pollen movement into Canola or from commercial varieties of the same species such as is common in hybrid maize production where pollen movement of the commercial maize is a significant issue. Pollen flow out of the seed crop can happen, however, measures taken to mitigate pollen flow into the crop are equally effective in reducing pollen flow out of the seed crop into commercial crops or indigenous species. Seed mixtures can occur during several steps of breeder, foundation and commercial seed production if care is not taken in cleaning out equipment. The results of such mixtures are varietal and/or trait mixtures which have adverse financial consequences. This impact has resulted in many companies using structured quality management programs such as ISO 9001-2000 to minimize these problems.

Preventing gene flow into seed crops has always been an objective of the seed industry and historically quality assurance programs have used physical examination of seed, grow outs of the seed and biochemical tests such as isozymes to assure customers of purity. **The advent of biotechnology products has made measurement of unwanted gene flow more complex, requiring sophisticated molecular technology and** has resulted in purity standards that are 100 – 600 fold more rigorous than those which were common 10 years ago for some markets. To continue to support seed trade new methods have been developed to test seed such as; ELISA, element, construct, gene and event specific PCR, pooled testing techniques and improved statistical techniques such as SeedCalc to estimate risk of shipping seed which buyers or regulatory officials will find unmarketable.

THE IMPORTANCE OF UNDERSTANDING BIOGEOGRAPHY AND REPRODUCTIVE BIOLOGY OF SEXUALLY COMPATIBLE SPECIES. Baltazar M. Baltazar[1], Jose de Jesus Sanchez G.[2], and John B. Schoper[3]; [1]Pioneer Hi-Bred International, Inc., Nayarit. Mexico; [2]Universidad de Guadalajara, Las Agujas, Mpio. de Zapopan, Jalisco, México; [3]Pioneer Sementes Ltda., Brasilia – DF, BRAZIL.

Mexico is the center of origin and hosts the greatest diversity of the genus *Zea*. This diversity has developed over millennia as a result of domestication and further selection by farmers including natural hybridization of landraces of maize and teocintes in areas where they grow sympatrically. Understanding the origins and extent of maize genetic diversity is critical to ensure food and fiber for current and future generations.

Pioneer Hi-Bred International, in collaboration with Mexican institutions, established a research program in Mexico to measure gene flow in the genus *Zea* as a component of genetic diversity. Our research has shown that maize landraces and hybrids exchange genes freely. Landraces have thereby acquired new alleles for yield, biotic and abiotic stresses. We have also found that the most gene-flow in the teocinte-maize system is from teocinte (*Zea mays* subesp. *mexicana*) to maize, rather than from maize to teocinte. Parameters used to measure genetic compatibility and gene flow were: pollen size and longevity, silk size and longevity, isolation distance, floral synchrony and pollen and atmospheric water potential.

The purpose of this presentation is to share our research results on gene flow in the genus *Zea* that we have obtained in Mexico. Our studies are continuing. Our ultimate goal will be to provide a better understanding of the consequences of gene flow in maize's center of origin and to develop additional data on genetic biodiversity of Mexican maize landraces.

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UNDERSTANDING GENE FLOW AND INTROGRESSION CONSEQUENCES FOR BIOTECH CROP RISK ASSESSMENT. Thomas E. Nickson, Ecological Technology Center, Monsanto Company, St. Louis, MO, 63141.

Advances in recombinant DNA technology have enabled the development of crops with traits that would have been difficult to solely using traditional breeding techniques. Today, biotechnology-derived crops, widely known as genetically modified (GM), have been planted commercially by over 7 million farmers in 18 countries on approximately 1 billion acres. Prior to commercial planting, each product is rigorously assessed for its potential risks compared to conventional (non-GM) counterpart using a science-based, stepwise approach grounded in the principles of risk assessment (Risk = f(hazard + likelihood)). Based on guidance developed by internationally recognized bodies, risk assessment considers the nature of the trait, the nature of the crop, the nature of the likely receiving environment and interactions among these. Prior to initiating any experimental work, the planning phase examines possible hazards as well as pathways and exposure scenarios in light of the factors noted above. Gene flow is a key aspect that must be closely examined as it represents a pathway by which a potential hazard associated with a GM trait could be realized in the environment. Potential exchange of genes to non-GM plants directly through pollen or as a consequence of movement of seed and plant parts must be carefully considered. Two important questions are asked at the outset of the risk assessment concerning gene flow: (1) is it likely that the introduced trait will change the pollination biology of the crop such that rates of gene flow will increase or decrease; and (2) what are the potential consequences associated with movement of the trait from the GM plant to a non-GM plant? This presentation describes an approach that has been developed based on a combination of published, scientifically sound guidance and over 12 years experience in assessing GM crops. The essential elements of the approach include: assessment planning, plant/crop characterization, hazard identification, hazard assessment, likelihood/exposure assessment and risk characterization. When there is reasonable certainty for a risk, possible risk management options would be proposed to mitigate or manage the potential risk. The objective of using such a rigorous approach is to develop a good understanding of gene flow including the potential for introgression of the GM trait into non-GM plants and the environmental consequences associated with spread of a GM trait beyond its intended application within agricultural fields. Assessing GM crops in this manner should ensure that their benefits outweigh their negative impacts on the environment.

FURTHER INVESTIGATIONS INTO THE UTILITY OF MESOTRIONE IN MINOR CROPS. Venance H. Lengkeek and Michael D. Johnson, Research and Development Scientist and Technical Brand Manager, Syngenta Crop Protection, Greensboro, NC 27419.

Field studies were initiated in 2004 to evaluate mesotrione potential for use in selected minor crops. Crops identified from those studies were: asparagus, blueberry, cranberry, lingonberry, raspberry, flax, grasses grown for seed, millets, mints, okra, sorghum, and sugarcane. The purpose of 2005 trials was to further evaluate the level of crop tolerance to mesotrione under field conditions to these selected crops; and to establish mesotrione use rates, timings, and application methods. The rates and application methods tested varied by individual crop. Data from 2005 confirm the potential for mesotrione labelling on asparagus, the small fruit group (blueberry, lingonberry), cranberry, flax, grasses grown for seed (fine and tall fescue, Kentucky bluegrass, perennial ryegrass, ryegrass, orchard grass, and canary grass), millets (proso and pearle), mints (spearmint and peppermint), okra, sorghum and sugarcane. The results of these studies will be presented.

WEED CONTROL IN SORGHUM WITH MESOTRIONE. Whitney R. Kumm*, Alex R. Martin, and Fred W. Roeth, and David L. Regehr, Graduate Research Assistant, Professor, Professor, and Professor, Department of Agronomy University of Nebraska, Lincoln, NE 68583 and Department of Agronomy Kansas State University, Manhattan, KS 66506.

Three studies were conducted to evaluate mesotrione for weed control in sorghum. One study was conducted at Kansas State University comparing different mesotrione combinations. Two studies were conducted in Nebraska, one in Lincoln, and one at the South Central Agricultural Laboratory in Clay Center. These two studies measured weed control and crop damage with different mesotrione products and rates with the focus on sorghum tolerance to mesotrione.

In the Kansas study, the sorghum was evaluated at heights of 10 ”, 18 ”, and 34 ” for crop injury. Some initial damage was observed, but by 34 ” height the mesotrione treated plots had recovered.

In Nebraska, the sorghum was evaluated 2, 3, and 5 weeks after planting. Once again, there was some initial damage but the plants showed no symptoms by the fifth week. After recovery from the initial symptoms, the crop produced a full yield.

ASSESSMENT OF TRANSGENIC HERBICIDE AND INSECT RESISTANCE TRAITS IN MICHIGAN CORN. Kathrin Schirmacher, James J. Kells, and Christina D. DiFonzo, Graduate Student, and Professor, Department of Crop and Soil Sciences, Associate Professor, Department of Entomology, Michigan State University, East Lansing, MI 48824-1325.

Multiple resistance in stacked trait corn hybrids is becoming more prevalent and will be aggressively marketed in the near future. Field research was conducted in Michigan in 2004 and 2005 to determine the consistency of conventional and transgenic strategies for control of insects and weeds under a range of Michigan conditions. Field trials were conducted at four locations in both years. Locations with different pest infestations were chosen to determine if the resistance traits are justified under a range of infestation levels. Near-isogenic corn hybrid lines were used throughout the experiment to minimize agronomic differences between the hybrids. In 2004, two corn hybrids were used: 1) a hybrid containing the glyphosate-resistant trait (RR) and 2) a hybrid with the same base genetics which contains resistance to corn rootworm (CRW) in addition to RR (CRW/RR). During the 2004 growing season, a three-way stacked hybrid containing resistance to European corn borer (ECB) along with CRW/RR was approved for commercial production in the US. In 2005, we utilized near-isogenic hybrid lines containing RR/ECB and CRW/RR/ECB. All corn hybrids were planted in rows 0.76 m apart at a seeding rate of 74,000 seed ha^{-1}. Plots were four rows wide by 10.7 m long. The experimental design was a randomized complete block with four replications and 24 treatments. Treatments consisted of combinations of weed and corn rootworm management strategies. The weed management strategies involved preemergence (PRE) and postemergence (POST) (sequential and total POST) herbicide application and herbicide selections based on scouting. Corn rootworm management strategies included resistance in the hybrid, conventional soil-applied insecticides, and seed treatments.

Three corn plants were dug from each plot in late July to assess corn rootworm damage. Roots were rated on the new Iowa node-injury scale ranging from 0 (no damage) to 3 (highly damaged). Visual weed control evaluations were taken throughout the growing season and three permanent quadrats (0.76 m x 1 m) were established in the center row of each plot. Weed densities and weed biomass were determined from weeds present in the quadrats. Corn grain yield was obtained by mechanically harvesting the middle two rows of each plot.

DETERMINATION OF THE SOIL PERSISTENCE OF KIH-485, ACETOCHLOR, DIMETHENAMID, AND *S*-METOLACHLOR USING THREE GRASS SPECIES. Chad D. Dyer*, Thomas T. Bauman, and Michael D. White, Graduate Student, Professor of Weed Science, Administrative Professional, Purdue University, West Lafayette, IN 47906.

Field research was conducted at the Agronomy Center for Research and Education in West Lafayette, IN on a Chalmers silt loam soil in 2004 and 2005 to determine the soil persistence of KIH-485, acetochlor, dimethenamid, and *S*-metolachlor using barnyardgrass, green foxtail, and wild oat. 10wks after application it was determined that KIH-485 applied at 2.98oz ai/ac was providing 69%, 80%, and 95% control of green foxtail, wild oat, and barnyardgrass, respectively. Acetochlor applied at 1.75lb ai/ac was providing 0%, 3%, and 46% control of green foxtail, wild oat, and barnyardgrass, respectively, 10 wks after application. Dimethenamid applied at 0.94lb ai/ac provided 10%, 8%, and 24% control of green foxtail, wild oat, and barnyardgrass, respectively, 10wks after application. *S*-metolachlor applied at 1.52lb ai/ac provided 10%, 0%, and 55% control of green foxtail, wild oat, and barnyardgrass, respectively, 10wks after application.

COMPARISONS OF KIH-485 AND S-METOLACHLOR FOR WEED CONTROL IN CORN.

Randall S. Currie and David L. Regehr, Associate Professor, Kansas State University, SW Research-Extension Center, Garden City, KS 67846, and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

The chemistry of KIH-485 has not been released at this time. From more than 25 research reports and abstracts published by the North Central Weed Science Society in 2003 and 2004, one can infer that--contingent on many factors, such as manufacturing cost--it could be marketed in the future as a grass weed control compound competitive with several chloracetamide herbicides. Although work to date is far from conclusive, several researchers have reported that this compound provides superior control of a different spectrum of broadleaf weeds than is controlled by current chloracetamide herbicides. Although some of these studies measure control of *Amaranthus Spp.*, none of these reports discuss *Palmer amaranth* control. Therefore, it is the objective of this work to compare *Palmer amaranth*, *digitaria sanguinalis,* and *Sorghum bicolor* control provided by KIH-485 or S-metolachlor, with and without atrazine.

On a Ulysses silt loam near Garden City, Kansas, Palmer amaranth, yellow foxtail, crabgrass, sunflower, barnyard grass, and Rox orange sorghum (to simulate shatter cane)were seeded at 700,000; 344,124; 9,800,000; 40,000; 817,000; and 119,000 seeds/acre, respectively, into clean tilled fields before corn was planted. All weeds except Rox orange sorghum were planted with a carrier mixture of cracked corn at a rate of 40 lb/acre by using a 14-foot Great Plains Drill with tubes removed to allow weed seed to be dropped on the soil surface. Rox orange sorghum was drilled separately, with every third hole set at 1 inch deep, at 2 inches deep, or with the tube pulled for seed to be dropped on the soil surface. Weed seed was planted in 10-inch rows. This procedure was repeated at a second location in 2005. Triton 9461 HX LL corn was planted May 16, 2004, 1.5 inches deep in 30-inch rows at a rate of 36,000 seeds/acre with a John Deere Max Emerge II 6-row planter. Dekalb DK-6019 RR corn was similarly planted on May 16, 2005, at 34,200 seeds/acre. On a Reading silt loam near Manhattan, Asgrow RS 718 RR was planted on April 13, 2004, at 24,500 seeds/acre and a depth of 2 inches. A garden seeder was used to plant crabgrass and Rox orange sorghum. Palmer amaranth populations were naturally high and were not supplemented. KIH-485 at rates from 2.37 to 4.74 oz ai/a were compared with 20.3 oz ai/acre S-metolachor.

Early-season crabgrass control was similar at all locations. When corn reached the 8-leaf stage, only the high rates of KIH-485 out-performed S-metolachlor. At the 3- to 6-leaf stage and at the 8-leaf stage, KIH-485 provided better control of Rox orange sorghum than S-metolachlor and its tank mixes did. At comparable rates, S-metolachlor and KIH-485 provided similar control of Palmer amaranth at all rating dates. But only good control was achieved at 2 of 3 locations. At Garden City in 2005, early-season control ranged from 44 to 75% and, by the time corn had reached the 8-leaf stage, control had declined to 44 to 55%. All treatments increased corn yield over yield of the untreated plots. No statistically significant differences in yield were measured in 2004. In 2005, KIH-485 increased yield more than S-metolachlor treatment did. We speculate that the leaf surface lost to hail just before tassel, and the somewhat more persistent control provided by the higher rates of KIH-485, were responsible for this yield boost.

EVIDENCE FOR THE DEGRADATION OF KIH-485. Peter J. Porpiglia and Osamu Watanabe, Vice President and Manager of Research and Development, Kumiai America, White Plains, NY; and Yoshihiro Yamaji and Hisashi Honda, Chief Researcher and Researcher, Kumiai Chemical Industry Co., Ltd., Tokyo, Japan.

KIH-485 is under development for broad use as a pre-emergence herbicide. The development focus for KIH-485 has been in corn and soybeans in the United States. After several years of extensive testing in replicated field trials, observations of KIH-485 activity on sensitive weeds indicate this product will provide full-season weed control under a range of environmental conditions. Up to this point there has been limited quantitative information on residual activity and half-life under field conditions primarily due to the early stage of development of KIH-485. However, field bioassays for two years have shown the residual activity of KIH-485 to be equal to or slightly greater than metolachlor at typical use rates under specific testing environments. In these trials, metolachlor tended to show longer residual activity than either dimethanamid or acetochlor, but the differences were not always significant. In 2005, two additional trials were conducted where soils were treated with KIH-485 and then sampled at various times and depths. Treated soil samples were analyzed using Gas Chromatography with Mass Spectral Detection (GC/MS). The analytical phase of these trials generally confirms field observations on residual activity while providing a better understanding of degradation of KIH-485 under natural conditions.

KIH-485, FLUFENACET, AND ACETOCHLOR EFFICACY AND CROP RESPONSE IN GRAIN SORGHUM. Patrick W. Geier, Phillip W. Stahlman, and David L. Regehr, Assistant Scientist and Professor, Kansas State University Agricultural Research Center, Hays, KS 67601, and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Field trials near Hays and Manhattan, KS in 2005 determined the effects of KIH-485, flufenacet, acetochlor, and *S*-metolachlor on weed control and crop response in grain sorghum. Each herbicide was applied preemergence at the 1X and 2X rates based on soil type and included atrazine at 1.1 kg/ha as a tankmix partner. Atrazine at 1.1 kg/ha was included as a standard comparison, as was a weed-free check. Precipitation differences between the two locations greatly influenced herbicide activation and results during these experiments. The Hays location received 6.3 cm of rainfall within 14 days of herbicide application; at Manhattan, only 0.9 cm of precipitation fell during the same time interval. Consequently, better herbicide performance occurred at Hays, whereas dry weather throughout the season affected results at Manhattan.

At Hays, puncturevine control did not differ regardless of rate with *S*-metolachlor, KIH-485, or acetochlor (73 to 83%) at 80 days after treatment (DAT); flufenacet at 0.63 or 1.27 kg/ha provided only 48 to 55% puncturevine control. Most herbicides controlled devil's-claw and green foxtail 95% or more at 80 DAT, with the exception of atrazine at 1.1 kg/ha (85%). KIH-485 at 0.17 or 0.33 kg/ha and flufenacet at 0.63 or 1.27 kg/ha controlled prairie cupgrass 93 to 100%. *S*-metolachlor at 1.4 or 2.8 kg/ha or acetochlor at 2.2 or 4.5 kg/ha provided 76 to 85% prairie cupgrass control. Regardless of herbicide or species, increasing herbicide rate to 2X did not improve weed control compared to the 1X rate. At Manhattan, large crabgrass control ranged from 48 to 87% but did not differ between treatments. Dry conditions resulted in less than 20% shattercane control, regardless of herbicide.

At Hays, flufenacet at 1X and 2X rates reduced sorghum plant density 41 and 69% respectively, compared to atrazine alone. No other herbicide affected sorghum density. Sorghum was stunted 25 to 53% by flufenacet at the 1X and 2X rates when evaluated 26 DAT. KIH-485 at the 2X rate and acetochlor at either rate caused 11 to 24% sorghum stunting on the same date. By 80 DAT, sorghum stunting was only visible with either rate of flufenacet (10 to 24%). Sorghum was not visibly injured at Manhattan, and yields were not determined because of drought. Sorghum yields at Hays ranged from 4770 to 5890 kg/ha but did not differ between any herbicide treatment or the weed-free check.

WEED CONTROL IN GLYPHOSATE-RESISTANT CORN WITH FALL-APPLIED HERBICIDES. Ronald F. Krausz and Bryan G. Young, Researcher and Associate Professor, Department of Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Glyphosate-resistant corn and fall-applications of herbicides are becoming more popular with corn growers in the southern corn belt. Therefore, the objective of this research was to evaluate the effectiveness of fall-applied herbicides on weed control in glyphosate-resistant corn production. Fall-applied glyphosate provided 95 to 100% control of henbit, common chickweed, smallflower buttercup, and wild garlic by April 1. However, fall-applied glyphosate alone provided no control of giant ragweed by late- April. The addition of simazine with glyphosate in the fall increased control of giant ragweed by 42 to 92%. Winter annual weed competition in the nontreated plots controlled giant ragweed 80% by late-April. Three glyphosate applications (fall, 14 days before planting, postemergence) were required to obtain 100% control of summer annual weeds where no glyphosate was applied preemergence. Two glyphosate applications (preemergence and postemergence) provided 100% control of summer annual weeds where glyphosate was applied preemergence with or without a residual herbicide.

RIMSULFURON BASED WEED CONTROL PROGRAMS IN GLYPHOSATE TOLERANT CORN. Craig M. Alford*, J. Leslie Lloyd, and David W. Saunders. Field Development Representatives and Product Development Manager, DuPont Crop Protection, Lincoln, NE 68505 and Des Moines, IA 50009.

Studies were conducted in 2005 comparing herbicide systems in glyphosate tolerant corn (Zea mays L.). Rimsulfuron was applied pre-emergence, as a setup for glyphosate in a two pass program or in combination with glyphosate in a one pass weed control program. Studies were placed in replicated small-plot trials with university, private contractor and DuPont investigators across the United States. Key weeds included giant foxtail, yellow foxtail, green foxtail, common lambsquarters, velvetleaf, common waterhemp and common ragweed. The addition of rimsulfuron to glyphosate improved control of several grass and broadleaf weed species compared to glyphosate applied alone. Rimsulfuron based pre-emergence treatments provided similar levels of weed control to current commercial standards.

UPDATE ON THE EFFECT OF IMAZETHAPYR AND IMAZAPYR ON POLLINATION OF IMIDAZOLINONE TOLERANT CORN. James H. Herbek, James R. Martin, and Jonathan D. Green, Extension Professors, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445.

The ongoing objective of this multi-year research project has been to determine if postemergence applications of the premix imazethapyr at 0.672 oz ai/A plus imazapyr at 0.224 oz ai/A to imidazolinone tolerant (IT) corn hybrids are linked to the ear damage occasionally observed in commercial production fields. Symptoms of abnormal ears ranged from twisted rows to scattered kernels and barren cobs.

Mounting evidence from small plot studies during the last few years indicated that the pollination process of Pioneer 34B28 hybrid was affected when this premix was applied as a broadcast spray beyond the normal recommended time to corn plants in the V8 to V9 growth stage. However, corn ear injury in the treated plots was minimal to non-existent in these trials. It was believed that the close proximity of all plots allowed pollen to drift from plants in non-treated check plots to the silks of plants in nearby treated plots; therefore, overriding any herbicide injury to corn tassels.

In order to limit the risk of pollen contamination in the 2005 study, treated and non-treated plot areas were isolated at least 600 feet from one another. The premix was applied to Pioneer 34B28 corn when plants averaged V8 growth stage at a plant height of 32 inches. This occurred at approximately 6 1/2 weeks after corn emergence. Anther emergence and silk development were monitored daily from June 27 through July 8, 2005. Data were collected from flagged areas of each plot consisting of ten consecutive plants occurring in each of the two center rows of the treated and non-treated plots. These same plants were also evaluated for ear deformity at corn harvest.

Results of the 2005 study indicated the amount of emerged anthers on the main axis of the tassels was less than 1% for the treated plants compared with 100% for the non-treated plants. The average length of ear silks on the treated corn plants was 65% longer than those for the non-treated corn which was an early indication that the herbicide premix might have limited pollination.

Unlike previous studies, ears from the treated plots in 2005 had noticeably fewer kernels than those from the non-treated plots, and resembled the injury occasionally observed in commercially treated fields. The grain yields from the treated areas averaged 14.1 bu/A compared with 167.6 bu/A for the non-treated areas.

Results of this multi year research project indicate that applying the premix of imazethapyr plus imazapyr to Pioneer 34B28 at V8 to V9 growth stage did not cause visible plant injury during or shortly after application, but did limit anther emergence / development. This resulted in poor pollination and low grain yield when very limited viable pollen was available from the tassels of nearby healthy plants.

WEED CONTROL WITH AE 0172747 IN CORN. John Hinz, John Wollam and Jayla Allen, Field Development Representative, Regional Research Manager and Product Development Manager, Bayer CropScience, Story City, IA 50248, Kansas City, MO 64120, and Research Triangle Park, NC 27709.

AE 0172747 is a new postemergence corn HPPD-inhibiting herbicide from Bayer CropScience. The proposed use rate is 92 grams of the active ingredient per ha. AE 0172474 is very safe to corn. Only, 1% phytotoxicity was observed at 3 times the use rate. AE 0172747 is safer to the crop than mesotrione at use rates. AE 0172747 has comparable weed control to mesotrione for Abutilon theophrasti, Amaranthus retroflexus, Ameranthus rudius, Chenopodium album, Ambrosia elatior, Ambrosia trifida, Polygenum pennsyvanicum, Xanthium strumarium and Digitaria sanguinalis. AE 0172747 had superior weed control compared to mesotrione for Echinochloa crus-galli, Pennisetum glaucum, Setaria faberi and Sorghum vulgare. The label for AE 0172747 has been submitted and registration is expected in 2008.

SWEETCORN AND POPCORN TOLERANCE TO AE 0172747. Mike Edenfield and Jayla Allen. Bayer CropScience, Research Triangle Park, NC 27709.

AE 0172747 is a 4-HPPD inhibitor that provides post-emergence control of annual broadleaf and grass weeds in field corn, sweet corn, and popcorn. Sweet corn and popcorn hybrids have been shown to vary in their sensitivity to herbicides. Therefore, field studies were conducted from 2002-2005 to determine the impact of AE 0172747 applications at 1X and 3X rates on crop tolerance with sweet corn and popcorn hybrids. AE 0172747 proved to have excellent crop safety on a number of sweet corn and popcorn hybrids.

EVALUATION OF INSECTICIDE INTERACTION WITH AE 0172747. Jerry Hora, John Wollam and Jayla Allen, Field Development Representative, Regional Manager and Product Development Manager, Bayer CropScience, 2 TW Alexander Drive, Research Triangle Park, NC 27709.

Interaction and resultant corn injury has been observed between various classes of herbicides and insecticides. Trials were therefore conducted to determine two factors, (1) does any interaction exist when AE 0172747 herbicide is applied postemergence to corn treated with soil insecticides or seed treatments, or (2) does any interaction occur when AE 0172747 herbicide is tankmixed with foliar insecticides and applied postemergence to corn. Most postemergence applications were made to V3 corn. 2X rates of herbicides and insecticides were used to simulate an overlap situation.

Results showed AE 0172747 did not interact with soil insecticides or seed treatments and maintained safety to corn in all cases. In contrast, the herbicides mesotrione and nicosulfuron exhibited strong to light interaction with soil insecticides in the same trials with corn injury.

AE 0172747 generally did not interact with foliar insecticides when tankmixed and maintained safety to corn. A small interaction between AE 0172747 and chlorpyrifos was noted in Iowa at 2X rates on a sensitive hybrid. Mesotrione exhibited a strong interaction with several foliar insecticides with serious corn injury in these same trials. AE 0172747 appeared safe even when tankmixed with foliar insecticides and applied over soil insecticides.

The AE 0172747 formulation contains the safener isoxadifen. This safener appears responsible for maintaining corn safety with AE 0172747 and preventing insecticide interaction. The added safety that formulated AE 0172747 herbicide exhibits with both foliar and soil insecticides compared to other postemergence herbicides will be a benefit to the corn grower.

TOPRAMEZONE: A NEW ACTIVE FOR POSTEMERGENCE WEED CONTROL IN CORN.
Richard M. Porter, Paul D. Vaculin, John E. Orr, John A. Immaraju and William B. O'Neal, AMVAC Chemical Corporation, Newport Beach, CA 92660.

Topramezone is a novel 4-HPPD inhibitor herbicide for postemergence weed control in corn (*Zea mays* L.). AMVAC Chemical Corporation has licensed from BASF AG exclusive rights for this usage in North America. Topramezone is effective against the major broadleaf weed species, and also active against several grass weed species common to U.S. and Canadian corn production. This compound is formulated as a 2.8 lb ai/gal suspension concentrate (SC). Topramezone has been field tested for several years in numerous industry and university research programs. These trials have demonstrated that topramezone at rates of 0.011 to 0.016 lb ai/A, applied with recommended spray additives such as methylated seed oil and a nitrogen fertilizer source, provides excellent weed control coupled with exceptional tolerance to all types of corn. Topramezone will be used as a sequential application to preemergence soil applied treatments or in a total postemergence program in mixtures with other herbicides. Topramezone was reviewed as part of a Joint Review with the U.S. Environmental Protection Agency and the Canadian Pest Management Regulatory Agency. The agencies concluded that the use of topramezone and its end use product in accordance with the label does not pose an unacceptable risk of harm to man or the environment. The crop tolerances of topramezone and EPA registration for uses in field corn, seed corn, sweet corn and popcorn were received in August 2005. Topramezone will be marketed under the brand name Impact herbicide in the U.S. and Canada, and will be launched and available for commercial use during the 2006 corn season.

GRAMOXONE INTEON® INNOVATIVE FORMULATION TECHNOLOGY. Stott Howard, Scott Cully and Chuck Foresman, Syngenta Crop Protection, West Des Moines, IA 50266.

Paraquat products have been successfully used in agriculture for over 40 years. When compared to most crop protection products, it has a favorable and modern toxicological profile; however, paraquat can be fatal if the undiluted product is swallowed. Syngenta scientists have been studying the oral toxicity of paraquat for a number of years and have developed Gramoxone Inteon®, a major advancement in product stewardship and reduced risk. Gramoxone Inteon contains a gelling agent that is activated or triggered at the pH of stomach acid. Once formed, the gel minimizes and slows dispersion and passage of paraquat into the small intestines, thus allowing more time for productive emesis as caused by the emetic in the Gramoxone Inteon formulation. Toxicological data has demonstrated that the Inteon technology results in a greater than 10-fold reduction in toxicity of the undiluted product. Clearly, this is technology that will improve the sustainability of important agricultural products such as paraquat.

The Inteon technology does not influence the excellent performance standards set by Syngenta's paraquat containing products. Gramoxone Inteon, a soluble liquid (SL) that contains 2 lb ai/gallon (240g/l) paraquat, will continue to provide unique benefits to growers and the environment with contributions to: soil conservation, water quality, yield protection, farming efficiency, and control of herbicide resistant weeds. In trials from 2005, Gramoxone Inteon soybean weed control programs outperformed glyphosate-based programs by providing more complete control of Conyza canadensis. In addition, Gramoxone Inteon applied alone, with 2,4-D, or in combination with a residual partner such as Boundary provided an excellent foundation weed control program in no-till soybeans. This excellent efficacy, coupled with consistent performance, excellent tank mix versatility, broad utility, and now improved human safety position Gramoxone Inteon for an excellent future.

AMINOPYRALID: A NEW NON-RESTRICTED USE HERBICIDE FOR RANGELAND AND PASTURE VEGETATION MANAGEMENT. Robert A. Masters, Patrick L. Burch, Jamie M. Breuninger, Vanelle F. Carrithers, Mary B. Halstvedt, John J. Jachetta, William N. Kline, Donald D. Hare, Adrian A. Chemello, John L. Troth, and Rodney D. Schultz, Dow AgroSciences, LLC, Indianapolis, IN 46268.

Aminopyralid is a recently discovered herbicide being developed by Dow AgroSciences for rangeland and pasture vegetation management systems. Other anticipated use-sites for this herbicide include Conservation Reserve Program acres, non-cropland, and natural areas. Aminopyralid is a pyridine carboxylic acid that is formulated as a 240 g acid equivalent (ae)/liter product and has an auxinic mode of action. Aminopyralid has very low acute and chronic toxicity (practically nontoxic) to mammals, birds, fish, and aquatic invertebrates, with no evidence of teratogenicity, mutagenicity, carcinogenicity, or adverse endocrine or reproductive effects. Aminopyralid is only slightly toxic to algae and aquatic vascular plants and substantially below EPA's levels of concern for adverse effects on these organisms. Aminopyralid has a very favorable environmental fate because of rapid degradation in soil ($t_{1/2}$ = 34 d) and photolysis in aquatic habitats ($t_{1/2}$ = 0.6 d) with CO_2 and NH_3 as the only metabolites. Aminopyralid provides preemergence and postemergence control of many broadleaf noxious and invasive plants with little to no injury to most rangeland and pasture grasses. Aminopyralid is effective at rates between 52.5 and 120 g ae/ha, which is about 1/4 to 1/20 of the use rates for currently registered rangeland and pasture herbicides including, 2,4-D, picloram, clopyralid, triclopyr, and dicamba. Undesirable plants in the *Acroptilon*, *Ambrosia*, *Carduus*, *Centaurea*, *Cirsium*, *Croton*, *Solanum*, and *Vernonia* genera are among those controlled by aminopyralid. In the Great Plains, mid-West, and mid-Atlantic USA, research continues to determine the role of aminopyralid in facilitating forage legume establishment during pasture renovation programs.

CONTROL OF MUSK THISTLE AND OTHER BIENNIAL THISTLES WITH AMINOPYRALID. Robert A. Masters, Patrick L. Burch, Vanelle F. Carrithers, and Mary B. Halstvedt., Product Technology Specialists, Dow AgroSciences, LLC, Indianapolis, IN 46268

Experiments at multiple rangeland and pasture sites across the USA were conducted to determine the response of musk thistle and other biennial thistles to aminopyralid, a new herbicide active ingredient being introduced by Dow AgroSciences for use on rangeland, pastures, and non-cropland. Aminopyralid was applied to musk thistle plants at varying growth stages from fall rosette to spring rosette, bolting, and late bolt to early bloom. Efficacy of aminopyralid at 53, 70, 88, and 105 g ae/ha applied alone or with 2,4-D was evaluated. Results were compared to herbicides commonly recommended for musk thistle control including picloram, dicamba, 2, 4-D, and metsulfuron. Aminopyralid applied to musk thistle rosettes in the fall or spring at 53 g/ha or higher provided excellent control of musk thistle rosettes and was similar to the results with picloram at 140 g/ha and dicamba at 1120 g/ha. In addition, aminopyralid and picloram control of musk thistle seedling emergence in the spring and summer, at least 90 day after treatment, was superior to that observed with dicamba. Aminopyralid at 53 g/ha provide excellent control applied of musk thistle that was bolted at time of application. The level of bolted musk thistle control with aminopyralid was similar to the control with picloram at 140 g/ha + 2,4-D at 560 g/ha and better than control obtained with dicamba at 280 g/ha + 2,4-D at 804 g/ha or 2,4-D at 1120 g/ha alone. Aminopyralid at 70 g ha or aminopyralid at 53 g/ha + 2,4-D at 560 g/ha controlled musk thistle treated at the late bolt to early bloom stages of growth as well as picloram at 140 g/ha + 2,4-D at 1120 g/ha or metsulfuron at 11 g ai/ha + 2,4-D at 1120 g/ha. As with musk thistle, treatment of other biennial thistles (plumeless thistle and bull thistle) at the rosette growth stage in the spring with aminopyralid at 53 g/ha provided excellent control. In these experiments, introduced cool-season forage grasses (smooth bromegrass, timothy, orchardgrass, tall fescue, and Kentucky bluegrass) and native perennial grasses (prairie junegrass, big bluestem, little bluestem, and sideoats grama) where not injured by aminopyralid, regardless of rate applied. Aminopyralid at 53 g/ha provided excellent control of musk thistle, plumeless thistle, and bull thistle rosettes emerged at time of application and controlled emergence of thistle seedlings after application.

RANGELAND WEED CONTROL IN KANSAS USING AMINOPYRALID. Walter H. Fick, Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Aminopyralid, a product of Dow AgroSciences, was labeled for control of susceptible broadleaf weeds on rangeland and permanent grass pastures in August 2005. The objective of this study was to compare the efficacy of aminopyralid with other commonly used herbicides for the control of western ragweed and western ironweed. Thirteen treatments were applied on June 30, 2003 on a clay upland ecological site near Manhattan, KS. Herbicides were applied in 187 L ha^{-1} spray volume using a CO_2-powered backpack sprayer. Individual plots were about 2 by 8 m with treatments replicated in four blocks. Treatments were evaluated for control 1 and 12 months after treatment (MAT). Aminopyralid was applied alone at 35, 52.5, 70, and 87.5 g ha^{-1} and in combination with 0.8 kg ha^{-1} 2,4-D amine. Other treatments included 2,4-D amine at 1.1 kg ha^{-1}, dicamba + 2,4-D at 0.28 + 0.8 and 0.56 + 1.1 kg ha^{-1}, and picloram + 2,4-D at 0.14 + 1.1 kg ha^{-1}. Defoliation of western ironweed 1 MAT was less than 50% with all treatments whereas western ragweed defoliation was greater than 70% with all treatments. The addition of 2,4-D to aminopyralid enhanced western ragweed control, but did not improve western ironweed defoliation 1 MAT. Picloram + 2,4-D at 0.14 + 1.1 kg ha^{-1} provided 95% control of western ironweed 12 MAT. Aminopyralid + 2,4-D at 87.5 g + 0.8 kg ha^{-1} provided 87% control of western ironweed 12 MAT. All treatments except 2,4-D amine at 1.1 kg ha^{-1} provided greater than 80% control of western ragweed 12 MAT. Aminopyralid used alone or in combination with 2,4-D can be expected to provide control of western ragweed and western ironweed equivalent to that provided by other commonly used herbicides on rangeland.

INFLUENCE OF SELECTED HERBICIDE TREATMENTS ON IRONWEED CONTROL, FORAGE YEILD, AND FORAGE QUALITY IN TALL FESCUE PASTURES. Kevin W. Bradley* and Robert L. Kallenbach, Assistant and Associate Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211.

Field experiments were conducted to evaluate the effect of various herbicides and herbicide combinations on tall ironweed (*Vernonia altissima* Nutt.) control, total forage yield, and forage quality in tall fescue pastures. In separate experiments, 2, 4-D, 2, 4-D plus dicamba, 2, 4-D plus picloram, clopyralid plus 2, 4-D, and metsulfuron plus 2, 4-D plus dicamba were applied at various rates to tall ironweed that was 20 cm in height on May 19 in 2004 and on May 27 in 2005. In 2004, greater than 80% visual control of tall ironweed was observed with all treatments except metsulfuron plus 2, 4-D plus dicamba 2 months after treatment. However, all herbicide treatments except clopyralid plus 2, 4-D at 0.1 plus 0.56 kg/ha provided similar and moderate reductions in tall ironweed stem numbers one year after treatment (YAT). These treatments provided from 40 to 73% fewer tall ironweed stems compared to the untreated control 1 YAT. Total forage (fescue plus tall ironweed) was harvested from the middle 1.25 by 6 meters of each plot approximately 2 MAT in both trials and analyzed for acid detergent fiber (ADF), neutral detergent fiber (NDF), and protein content in response to each treatment. In both years, all herbicide treatments reduced total forage yield compared to the untreated control. This occurred as a result of the reduction in tall ironweed content in herbicide-treated compared to untreated plots. Few differences in ADF, NDF, or protein content were observed between herbicide-treated and untreated forage samples, and none of the observed differences suggested improved forage quality in treated compared to untreated plots. For example, ADF content of forage from herbicide-treated plots ranged from 33 to 34.4% while that of untreated plots was 33%. These results suggest that tall ironweed infestations may not necessarily reduce forage quantity or quality of tall fescue pastures, but may occur in these environments due to the poor palatability of this weed compared to other desirable species.

WEED MANAGEMENT PRACTICES DURING ESTABLISHMENT AND EARLY GROWTH OF CONSERVATION BUFFER SPECIES. Janyce L. Woodard, Stevan Z. Knezevic, and David P. Shelton, Haskell Ag. Lab, University of Nebraska, Concord, Nebraska.

The successful establishment of a conservation buffer can be severely compromised by weeds and their ability to colonize newly opened sites. A field study was initiated in 2003 in northeastern Nebraska to evaluate 13 chemical and non-chemical weed control methods in a newly seeded conservation buffer grass mixture of big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). The pure live seed rates were 18.48 kg/ha for big bluestem and indiangrass and 2.24 kg/ha for switchgrass. In general, weed control with non-chemical methods was not satisfactory compared to herbicide treatments. For example, mowing and planting an oat (*Avena sativa*) cover crop provided less than 50% weed control compared to 60%-95 % control with various herbicides. Excellent weed control (>90%) at 60 days after PRE application was achieved with: imazapic at 0.053 kg ae/ha and 0.105 kg ae/ha; imazethapyr at 0.053 kg ae/ha; and a POST application of 2,4-D LVE at 0.538 kg ae/ha. Most herbicides did not cause injury to the buffer grass species. (woodarj@witcc.com)

GLYPHOSATE RESISTANT ALFALFA ESTABLISHMENT SYSTEMS. S. Ann McCordick, James J. Kells and Richard H. Leep, Graduate Student, Professor, and Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Glyphosate resistant alfalfa offers new weed control options for alfalfa establishment. Field studies were conducted in 2004 and 2005 in East Lansing, MI to determine the effect of establishment method and weed control method on forage production, forage quality and alfalfa stand establishment. Seeding methods included clear seeding and companion seeding with oats. Herbicide treatments included glyphosate, imazamox or imazamox + clethodim, and no herbicide. Glyphosate injury was minimal, short-lived and no longer evident at the first harvest in 2004. No glyphosate injury was observed in 2005. Weed control with glyphosate was more consistent than imazamox or imazamox + clethodim. In 2004, total seasonal forage yield was the highest where no herbicide was applied in the oat companion crop and was reduced where a herbicide was applied in both establishment systems. In 2005, seeding method or weed control method did not affect total seasonal forage production. Glyphosate resistant alfalfa established by clear seeding methods yielded the highest alfalfa dry matter in both years. Imazamox injury at the first harvest reduced alfalfa yield in the clear seeded system in both years. When no herbicide was applied, alfalfa yield was higher in the clear seeded system. The oat companion crop suppressed alfalfa yield significantly in both years. Alfalfa established with an oat companion crop had a lower weed biomass than the clear seeded system where no herbicide was applied in both years. In 2004, forage quality in the first harvest was reduced where an oat companion crop was used. In 2005, forage quality was lower where a herbicide was not applied in both establishment systems. At the final harvest of the establishment year, forage quality was similar where a herbicide had been applied. Alfalfa plant density in the fall of the establishment year was not affected by establishment method or weed control method in either year. Weed biomass was reduced in the year following establishment where a herbicide was applied in the 2004 establishment year. However, there were no significant differences in alfalfa yield, forage quality and alfalfa stand density observed in the year after establishment.

PERENNIAL VINE CONTROL WITH TRICLOPYR AND HERBICIDE MIXTURES.

R.J. Richardson, Assistant Professor, North Carolina State Univ., Raleigh, NC 27695; B.H. Zandstra, and R. H. Uhlig, Professor and Graduate Research Assistant, Michigan State Univ., East Lansing, MI 48824.

In 2003 through 2005 near Greenville, MI, field studies were conducted to evaluate perennial vine control in Fraser fir (*Abies fraseri*) Christmas trees. Twelve treatments were applied as directed sprays in late summer of each year. Tree injury and weed control were visually rated on a 0 to 100% scale. Virginia creeper (*Parthenocissus quinquefolia*) and wild grape (*Vitis* spp.) were present in the 2003 trial, while both weeds plus poison ivy (*Toxicodendron radicans*) were present in 2004. In the 2003 trial, tree injury at 1 month after treatment (MAT) was greatest with triclopyr (1.5 lb ae/A) plus halosulfuron (0.032 lb ai/A), triclopyr plus 2,4-D (1 lb ai/A), and triclopyr plus clopyralid (0.25 lb ai/A) at 12 to 16%. Injury in 2004 was greatest with 2,4-D, triclopyr plus halosulfuron, and triclopyr plus 2,4-D at 5 to 9%. Injury symptoms were predominantly needle necrosis or abscission with no observed long-term effects. Virginia creeper control in the 2003 trial at both 1 and 11 MAT was highest with herbicide mixtures containing triclopyr at 92 to 100%. Wild grape control at both ratings was greatest with triclopyr alone or in mixture at 93 to 100%, although 2,4-D was equivalent at 11 MAT with 83% control. In the 2004 trial at one MAT, Virginia creeper control was high with all triclopyr treatments, 2,4-D, and mesotrione (0.092 lb ai/A) plus hexazinone (0.5 lb ai/A) at 93 to 100%. Wild grape control was greatest with all triclopyr treatments, glyphosate (0.75 lb ae/A), hexazinone, and mesotrione plus hexazinone at 90 to 100%. Poison ivy control was greatest with all treatments containing triclopyr and mesotrione plus hexazinone at 92 to 95%. At 11 MAT, injury was 6% or less with all treatments. Virginia creeper control exceeded 97% with 2,4-D, and all treatments containing triclopyr. Wild grape and poison ivy control was similar with these treatments, although hexazinone did control both species and glyphosate controlled poison ivy.

RATIOS OF SULFOMETURON-METHYL AND HEXAZINONE EVALUATED FOR CROP RESPONSE AND WEED CONTROL IN EASTERN CHRISTMAS TREE PRODUCTION. Marsha J. Martin, Donald D. Ganske, Mick F. Holm and Ronnie G. Turner, Field Development and Product Development Manager, DuPont Ag and Nutrition, E. I. DuPont De Nemours and Co., Wilmington, DE 19898.

New ratios of sulfometuron-methyl and hexazinone were evaluated for use in eastern Christmas tree production. Both 1:20 and 1:15 ratios of sulfometuron-methyl and hexazinone were compared to the currently registered, water-dispersible, granular-blended product of 6.5% sulfometuron-methyl and 68.6% hexazinone (Westar™). Tests were conducted in the states of CT, MI, NY, OH and PA.

The two ratios were both tested at 0.375, 0.563 and 0.75 ozai/acre sulfometuron-methyl. The 1:15 ratio had 5.63, 8.4 and 11.25 ozai/acre hexazinone respectively, and the 1:20 ratio had 7.5, 11.25 and 15 ozai/acre hexazinone respectively. The comparision Westar™ rates of 6.01, 7.51, and 9.01 ozai/acre, which have 0.52, 0.65, and 0.78 ozai/acre sulfometuron-methyl, were chosen to best match the sulfometuron-methyl rates of the ratios.

Crop safety results showed that Westar™ and the two experimental ratios of sulfometuron-methyl and hexazinone gave similar results on crop safety. In 5 tests on Fraser Fir, 2 tests each on Douglas Fir, Colorado Blue Spruce, and Eastern White PIne, and 1 test on Scotch Pine, there were no significant differences between treatments, and crop injury was low, 3% or less on Fraser Fir.

Efficacy results were as follows. The treatment with the lowest amount of hexazinone (5.5 ozai/acre) still gave 97% control of marestail and 99% control of common ragweed. For 90% or greater control of dandelion, ca. 7 ozai/acre hexazinone was required. For season-long quackgrass control and late-season crabgrass control greater than 85%, 0.563 oz ai/acre sulfometuron-methyl was required. On marestail, quackgrass, dandelion, and crabgrass, all sulfometuron-methyl and hexazinone treatments performed significantly better than 4 oz ai/acre flumioxazin.

USING HIGH-RESOLUTION AERIAL MULTISPECTRAL IMAGERY FOR EARLY-SEASON WEED DETECTION IN CORN. Richard D. Dirks*, Jon-Joe Q. Armstrong, Kevin D. Gibson, Research Associate, Graduate Research Assistant, and Assistant Professor, Purdue University, West Lafayette, IN 47907.

High-resolution images (7.62 cm pixels) in red, green, blue and near-infrared wavelengths can be obtained with a recently developed remotely-controlled unmanned aerial vehicle. Plots to evaluate the value of these multispectral images for detection of early-season weeds at economic thresholds in corn were established at two Purdue University research farm locations in May 2005 (ACRE and TPAC). Plots measured 5-m x 5-m and were arranged in a complete randomized block design with eight replicates at each location for a total of 32 plots at each site. Glyphosate resistant corn was planted in 0.76m rows at 64,250 seeds ha^{-1}. At one week after planting (WAP) common lambsquarters seedlings were transplanted at four densities: 0, 1, 2, and 4 weeds m^{-1}. Imagery was obtained three, four and five WAP and analyzed using the unsupervised ISODATA clustering algorithm in MultiSpec©. Accuracy increased as crop and weeds increased in size. At 5 WAP (V8 corn, 43 cm tall weeds), all weed densities were significantly different from the weed-free plots, according to ANOVA followed by LSD. Although the corn was within the range for labeled herbicide application at 5 WAP, weeds were larger than recommended for optimal control. This is the first study we have conducted using this new technology and believe this imaging method has merit for obtaining economical high resolution images for early-season weed maps.

CLASSIFICATION OF EARLY-SEASON MULTISPECTRAL IMAGES FOR LOW-DENSITY WEED DETECTION IN CORN. Jon-Joseph Q. Armstrong, Richard D. Dirks, and Kevin D. Gibson, Graduate Research Assistant, Research Associate, and Assistant Professor, Purdue University, West Lafayette, IN 47907.

Detection of early season weeds at low densities is critical to developing prescription maps for site-specific herbicide application. The objective of this study was to evaluate aerial multispectral remote sensing for detection of weeds in corn. Field plots were established at two sites (ACRE, TPAC) in summer 2005 in a complete randomized block design with eight blocks. One week after planting, common lambsquarters seedlings were transplanted into the plots at four densities (0, 1, 2, 4 weeds m^{-2}). Aerial multispectral images were taken at 3 and 5 weeks after planting. MultiSpec, a remote sensing software package, was used for image classification and images were trained and tested for classification into one of three classes (bare ground, crop, weed). Classified pixels in the final thematic images were counted for each plot and treatments were analyzed with ANOVA. Corn and common lambsquarters could not be reliably detected and differentiated in the 3 WAP image at either site. Differences among treatments were detected at 5 WAP at ACRE ($p=0.1$) and TPAC ($p<0.01$). At both sites, plots containing 4 weeds m^{-2} had significantly more weedy pixels than plots containing no weeds. While at 5 WAP the common lambsquarters plants were slightly beyond the recommended height for glyphosate application, the images could be used for rescue treatments. These results indicate the need for higher spatial and spectral resolution to reliably detect weeds early in the season.

APPLICATION FACTORS ALTER SPRAY QUALITY AND GLYPHOSATE EFFICACY ON TWO AMARANTHUS SPECIES. Sean D. Nettleton and Bryan G. Young, Graduate Research Assistant and Associate Professor, Southern Illinois University, Carbondale, IL 62901.

Inconsistent common waterhemp control with glyphosate has been observed in commercial applications. The extent of variable weed control attributed to the various application methods used by applicators is unknown. Two field research studies were conducted at Ina and Carbondale, IL in 2005 to determine the influence of application method on control of two *Amaranthus* species. The first study investigated the interaction of four carrier volumes and four application travel speeds with two spray nozzle types to determine the effects on glyphosate efficacy. At both locations, common waterhemp and Palmer amaranth control was greatest at 28 days after treatment (DAT) with XR Teejet nozzles at 47 L/ha and decreased as carrier volume increased, although spray coverage was greatest at 187 L/ha. This suggests that the concentration of glyphosate in the spray solution may be more important than spray coverage for control of both species. Control of common waterhemp at 28 DAT fluctuated by up to 33% for all carrier volume and travel speed combinations at both locations with AI nozzles at 28 DAT. Travel speed did influence the trends observed for common waterhemp control at different carrier volumes, however these differences were not consistent across locations.

The second study was designed to determine if application method would influence the time of day affect for glyphosate applications. Glyphosate was applied at two carrier volumes and with two nozzle types at three times of day. Control of common waterhemp and Palmer amaranth at 14 DAT was lower when glyphosate was applied in 47 L/ha of carrier at 7:00am compared with 1:00pm. The reduction in glyphosate efficacy at 7:00am was not observed when applied in 187 L/ha. However, control of Palmer amaranth at 28 DAT was reduced at the 7:00pm application with XR nozzles at 187 L/ha. Logically, spray coverage and droplet density were greatest with applications at 187 L/ha. At Ina, 28 DAT, increased spray coverage may have allowed for improved control of common waterhemp and Palmer amaranth with XR and AI nozzles for the 7:00am applications, whereas common waterhemp control was possibly not influenced by spray coverage with XR nozzles at the 1:00pm applications. This suggests that spray quality is less important with applications during the middle of the day.

NOVEL ADJUVANT SYSTEMS. Gregory K. Dahl, Joe V. Gednalske and Eric Spandl, Research Coordinator, Manager of Product Development and Agronomist, Agriliance LLC, St. Paul, MN 55164.

Oil based adjuvant systems have been developed that provide convenience, performance and desirable functions for herbicide applicators.

A recently recognized category of adjuvants is called high surfactant oil concentrates. High surfactant oil concentrates are emulsifiable oil based products that contain 25 to 50 percent surfactant by weight in a minimum of 50% oil by weight.

Separate field studies were conducted with nicosulfuron, nicosulfuron plus rimsulfuron, foramsulfuron, imazamox, clethodim, mesotrione, and other herbicides applied at reduced rates with oil type adjuvants. High surfactant oil concentrates were compared to crop oil concentrates, containing 17% emulsifier and 83% paraffinic oil, and methylated seed oils. Crop oil concentrates and methylated seed oils were applied at labeled rates. High surfactant oil concentrates were applied at one-half of the rate of the crop oil concentrates and methylated seed oils.

Weed control was evaluated visually. Weed control with herbicides applied with high surfactant oil concentrate adjuvants was similar to herbicides applied with crop oil concentrate. Herbicides applied with methylated seed oil provided weed control greater than or equal to that of herbicides applied with either high surfactant oil concentrates or crop oil concentrates.

Field studies were conducted to evaluate the influence of adjuvants on control of glyphosate tolerant volunteer corn with glyphosate plus reduced rates of clethodim. Treatments included the herbicides alone and the herbicides with ammonium sulfate, nonionic surfactant plus ammonium sulfate, crop oil concentrate plus ammonium sulfate, high surfactant oil concentrate plus ammonium sulfate and methylated seed oil with ammonium sulfate.

Treatments that contained an oil adjuvant system provided greater control of the glyphosate tolerant volunteer corn than treatments without oil adjuvants. Some treatments that contained oil adjuvants provided less broadleaf weed control than treatments that did not contain oils. The high surfactant oil concentrate plus ammonium sulfate adjuvant system provided the best balance of glyphosate tolerant volunteer corn and broadleaf weed control of the adjuvant systems tested.

A modified vegetable oil plus emulsifier system has been developed that has increased canopy penetration, retention and reduced spray drift. The product has been compatible with most nozzle types and has performed well in ground and aerial applications.

Field studies were conducted in windy conditions to determine the influence of the modified vegetable oil plus emulsifier on herbicide spray particle drift onto susceptible plants. Visual evaluations were made of the amount of herbicide injury and the distance herbicide injury symptoms were observed downwind from the treated area. Treatments of herbicide plus the modified vegetable oil plus emulsifier adjuvant had less herbicide injury downwind of the treated area than treatments with out the adjuvant. The modified vegetable oil plus emulsifier adjuvant reduced the distance downwind that herbicide injury symptoms were observed compared to where the herbicide was used without the modified oil adjuvant.

The modified vegetable oil adjuvant reduced the percentage of fine droplets with most nozzle types without significantly increasing the percentage of very coarse droplets. This adjuvant has been used satisfactorily with nozzles that are incompatible with polymer type drift control adjuvants.

THE EFFECT OF A NEW VENTURI NOZZLE ON POSTEMERGENCE WEED CONTROL. Robert E. Wolf and Dallas E. Peterson, Associate Professor and Extension Specialist, Biological and Agricultural Engineering, and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

This study was planned to measure herbicide efficacy comparing a new venturi type nozzle and three other nozzles, all designed to reduce drift while maintaining adequate efficacy. The experiment included comparisons of a chamber style nozzle, the turbo flat-fan from Spraying Systems (TT); a venturi style, the AirMix from Greenleaf (AM); the Ultra LoDrift from Hypro (ULD), also a venturi style; and the new design, a turbo-venturi combination, the turbo flat-fan induction also from Spraying Systems (TTI). The TTI is the chamber style turbo flat-fan incorporating a venturi system for added drift control. Orifice size and operating pressure for each nozzle treatment were selected to deliver a spray volume of 94 L/ha at 9.6 km/h while maintaining a similar droplet size. Droplet sizing charts based on ASAE S-572 (*Spray Nozzle Classification by Droplet Spectra*) were used and a medium droplet spectra was chosen. To achieve 94 L/ha and a medium droplet spectra, the TT11002 and AM11002 were used at 276 kPa and the ULD120015 and the TTI110015 were used at 483 kPa. The applications were made with a tractor-mounted 3-point sprayer equipped with a 4-nozzle boom. Nozzles were spaced at 51 cm and located 51 cm above the target. Glyphosate at 0.17 kg ae/ha and paraquat at 0.25 kg ai/ha were used to compare efficacy on common velvetleaf, common sunflower, sorghum, and corn. Sublethal herbicide rates were used to accentuate efficacy differences. AMS at 5% v/v was added to the glyphosate treatments and NIS at 0.25% v/v was added to the paraquat treatments. The experiment had a randomized complete block design in a split plot arrangement with herbicide as the main plot and spray tip by pressure as the subplot. Treatments were replicated three times. Efficacy ratings for 27 days after treatment (DAT) are reported.

Efficacy ratings show that very few significant differences and interactions were found among herbicide and nozzle variables. At 27 DAT species control varied between glyphosate and paraquat as would be expected. Glyphosate provided better control for corn and sorghum compared to paraquat and was similar to slightly less than paraquat for sunflower control. Paraquat had significantly better control for the velvetleaf treatments (LSD=10). With glyphosate, the TTI was significantly better than the AM for velvetleaf control (LSD=6). No other glyphosate and nozzle comparisons were significantly different across all species. With paraquat, the ULD had significantly better control than both the AM and the TTI for velvetleaf control (LSD=6). Also with paraquat, the ULD was significantly better for sorghum control than the TTI (LSD=5), but the TTI was significantly better than both the ULD and AM with corn control (LSD=6).

There were no significant differences among nozzle treatments when compared across the paraquat and glyphosate for all species. Sunflower control was best in the nozzle comparisons with velvetleaf somewhat lower. The corn and sorghum treatments were lower with sorghum slightly better than corn.

As evidenced in this study, only a few significant differences were found among treatments. Difference between paraqaut and glyphosate were expected. Since there are no significant differences in control among nozzle types across all species applicators would be advised that using the new TTI at a higher pressure (483 kPa) should provide sufficient efficacy. However, when analyzing each chemical and nozzle treatment independently, reduced control may result when using the TTI with paraquat for velvetleaf control. With glyphosate the TTI was better for velvetleaf control.

SPRAY PARTICLE SIZES AND GLYPHOSATE EFFICACY. Robert N. Klein, Alex R. Martin, Fred W. Roeth and Brady F. Kappler. Professors and Associate Extension Educator, University of Nebraska, North Platte, NE 69101 and Lincoln, NE 68583.

Field research was conducted at several sites across Nebraska in 2004 and 2005 to determine the effect of particle sizes on the efficacy of glyphosate (Roundup WeatherMax). The nozzles and pressures where chosen based on the particle size distribution obtained from each using a Sympatec Helos particle analyzer with the rate of glyphosate used in the research. The nozzles tips used in the study were XRC11003, XRC11004, TT11003, TF2, AIC110025 used at pressures delivering 1.06 L/min.

Three glyphosate rates were used for the field trials: 0.65 kg ae/ha, 0.32 kg ae/ha, and 0.16 kg ae/ha. Ammonium sulfate at 2% m/m was included in each treatment, and treatments were applied at 93.54 L ha^{-1}. Table 1 lists the spray particle sizes with the various pressures and glyphosate rates used in the research. Weeds planted: field corn, common oil sunflower, ivyleaf morningglory, common lambsquarter and velvetleaf. Only small differences in efficacy were observed. Therefore, one should make nozzle tip and pressure selection when applying glyphosate with ammonium sulfate based on particle size that is least prone to drift.

Table 1. Spray particle sizes with Air Induction, Turbo Flood, Turbo TeeJet, and Extended Range nozzle tips with three rates of Roundup WeatherMax and 2% ammonium sulfate.

Nozzle	Pressure (Bars)	Roundup Rate* (liters)	% < 210	% > 730	VMD	Classification
AI 110025	3.45	None	6	24	571	VC (VC)
AI 110025	3.45	.4	5	19	536	VC
AI 110025	3.45	.8	7	12	498	VC
AI 110025	3.45	1.6	20	4	404	C
TF 2	1.38	None	7	28	574	VC (XC)
TF 2	1.38	.4	7	30	578	VC
TF 2	1.38	.8	9	24	536	VC
TF 2	1.38	1.6	13	13	472	VC
TT 11003	2.41	None	16	5	400	VC (VC)
TT 11003	2.41	.4	18	4	381	C
TT 11003	2.41	.8	19	3	367	C
TT 11003	2.41	1.6	22	3	346	C
XR 11004	1.38	None	22	0	327	C (C)
XR 11004	1.38	.4	29	0	293	M
XR 11004	1.38	.8	31	0	285	M
XR 11004	1.38	1.6	31	0	289	M
XR 11003	2.41	None	41	0	237	F (F)
XR 11003	2.41	.4	48	0	217	F
XR 11003	2.41	.8	51	0	206	F
XR 11003	2.41	1.6	53	0	201	F

* Roundup WeatherMAX (.4= .22 kg ae/ha; .8= .43 kg ae/ha; 1.6= .87 kg ae/ha)
In 93.54 L ha^{-1} and 2% ammonium sulfate F= Fine VC= Very Course
( ) – Spraying Systems Co. Classification M= Medium XC=

Extremely Course	
	C= Course

INVASIVE PLANTS OF THE UPPER MIDWEST. Kelly Kearns, Bureau of Endangered Resources, Wisconsin Department of Natural Resources.

This session and Tim Smith's will cover the range of those invasive plants that are currently widespread in the Midwest and those that are likely to become problematic in the near future. A brief introduction will delineate some differences and similarities between ag weeds and invasive plants and touch on the economic impacts of invasives. This session will then cover the most widespread invasive plants in the upper Midwest with a focus on identification, origin, habitat preferences, means of spread and potential for ecosystem and economic damage. Potential problem species in the future will also be covered. Plan to attend both sessions as we will be splitting the plants up between the two talks.

INVASIVE PLANTS OF THE LOWER MIDWEST. Tim Smith, Missouri Department of Conservation.

A brief introduction will consider the scope of the invasive plant problem and the economic impacts of invasion. Most of the presentation will be a species-by- species look at some of the most widespread invasive plants in the lower Midwest with a focus on their origin, method of invasion, habitat preferences and potential for ecosystem damage. Potential problem species in the future will be considered. A Missouri Department of Conservation policy on exotic plants will be provided.

INVASIVE PLANTS: WORKING WITH THE HORTICULTURE INDUSTRY ON ADOPTING VOLUNTARY CODES OF CONDUCT. Valerie Vartanian, The Nature Conservancy.

Wildland weeds are a major threat to biodiversity and human endeavors. Current Federal regulation does not address invasive plant introductions, and State regulations are minimal in controlling invasive plant movement. Regulation alone cannot protect wildlands from invasive plants. In order to effectively control the introduction of invasive plant species through venues such as gardens and landscaping, the horticulture industry is teaming up with the environmental community to adopt and implement a voluntary set of industry-created rules known as the Voluntary Codes of Conduct. The Nature Conservancy and the Missouri Botanical Garden are supporting these efforts by inviting businesses throughout the country to test implement the codes and participate in a survey that will provide information on the effectiveness of this voluntary method. Ultimately, the long-term benefit will be the reduction of harmful exotic plants invading wildlands through gardens and landscaping. This, along with other preventative or early detection and rapid response measures will go a long way towards reducing the pressure on wildland management budgets as well as preserving native species, habitats, and ecosystems.

MIDWEST INVASIVE PLANT NETWORK: A COLLABORATIVE APPROACH TO REDUCING THE THREAT OF INVASIVE PLANTS AT A REGIONAL SCALE. Kate Howe, Midwest Invasive Plant Network.

Despite the abundance of problematic invasive plants in the Midwestern United States, the issue of invasive plants has received relatively little attention in this region. The lack of awareness of invasive species issues in the Midwest is largely a result of the lack of organization and coordination among groups and individuals working on issues related to exotic plant invasion in the region. The Midwest Invasive Plant Network (MIPN), composed of individuals and organizations dedicated to addressing the threat of invasive plants in the Midwest, was formed in order to more effectively address the problem of invasive plants at a regional scale. MIPN is working to facilitate collaboration and information-sharing and help to energize local projects going on throughout the Midwest. MIPN is working on a variety of projects through its four project committees: Education, Early Detection & Monitoring, Green Industry, and Research.

BIOTECHNOLOGY AND BIODIVERSITY INTERFACE COMPETITIVE GRANT PROGRAM.
Hector Quemada and Karen Hokanson, BBI Program Director and BBI Program Assistant, Program for Biosafety Systems, Department of Biological Sciences, Western Michigan University, Kalamazoo, MI, 49008.

The Biotechnology and Biodiversity Interface (BBI) Competitive Grant Program provides funding for research to address the impacts of agricultural biotechnology, particularly transgenic organism, on natural biodiversity in developing countries. BBI grants will support research that 1) provides information needed to assess the potential effects of agricultural biotechnology products on wild biodiversity, or on managing identified risks, in the context of agriculture and wild ecosystems in developing countries; 2) focuses on the express needs of developing countries; 3) assists developing country regulatory bodies in making science-based decisions; and 4) builds capacity among developing countries to conduct this type of research. The program encourages collaboration between scientists in developing and developed countries. The program provides funding for research on topics that include the consequences of gene flow between crop plants and wild relatives, non-target organism effects, post-commercialization monitoring, and insect resistance management, as these relate to potential impacts on wild biodiversity. After two rounds of funding (2004 and 2005), research is being conducted on crops that include brassicas, corn, cowpea, eggplant, rice, and sorghum, and in countries that include Burkina Faso, Ethiopia, India, Indonesia, Kenya, Mali, the Philippines, and Tanzania. The geographic focus of the program is currently on countries in Africa and Asia. The range of funding is typically between $150,000 and $350,000 for research of three or four years in duration. The BBI Program is a component of the Program for Biosafety Systems (PBS), with financial support from the US Agency for International Development (USAID).

BIOGEOGRAPHY OF BENTGRASSES (AGROSTIS) IN CONNECTICUT. Carol Auer, Associate Professor, Department of Plant Science, University of Connecticut, Storrs, CT 06269.

The biogeography of bentgrasses had no practical significance until the recent concerns about gene flow from genetically-modified (GM) herbicide-tolerant *Agrostis stolonifera* (creeping bentgrass). Therefore, it is not surprising that there is no comprehensive source of information about the distribution of these grasses in the United States.

A recent Federal Register notice asked for floristic assessments to understand the prevalence of *Agrostis* and its sexually compatible relatives. This study performed a rapid assessment of bentgrass species in Connecticut, a New England state with many urban/suburban areas and golf courses. The assessment of bentgrass species (*Agrostis* and related genera) used two approaches: 1) examination of approximately 600 herbarium specimens in the University of Connecticut Herbarium (Storrs, Connecticut) and the Yale Herbarium (New Haven, Connecticut), and 2) summer field studies in the northeastern region of Connecticut on public lands (e.g. roadsides, public golf courses, land trust conservation areas and town parks).

The study revealed that Connecticut has nine bentgrass species with three species considered to be native to the state. Of the nine species in the flora, six bentgrass species have the potential to hybridize with *A. stolonifera*. There is gap in knowledge about gene flow for three species, including two native bentgrasses (*A. perennans and A. hyemalis*). The study demonstrated that three native *Agrostis* species are widely distributed, with *A. perennans* (upland bentgrass) the most common native bentgrass based on herbarium accessions (present in 45% of the towns in the state) and frequent identification in roadside flora. If herbicide-tolerant creeping bentgrass is used in Connecticut, there is potential for gene flow into some populations of native and introduced bentgrasses at a frequency that cannot be accurately predicted.

A second important conclusion is that *A. gigantea* (redtop bentgrass) is a common introduced species and it can be found in some Connecticut wetlands. Gene flow is possible between *A. stolonifera* and *A. gigantea*, suggesting that herbicide-tolerant *A. gigantea* populations could develop in wetlands. Field studies in wetlands in the Connecticut River Valley revealed that *A. gigantea* and the invasive plant purple loosestrife can occur in the same site. In theory, if glyphosate herbicide were sprayed to kill the purple loosestrife, a population of herbicide-tolerant *A. gigantea* could survive and spread by rhizomes and seeds. Herbicide-tolerant *A. gigantea* could compete with desirable wetland plants and decrease future weed management options because there are very few herbicides labeled for wetlands. Therefore, it is possible that herbicide-tolerant bentgrass populations in Connecticut could impact land management in ways that are difficult to predict or quantify at this time.

DETECTING GENE FLOW FROM IMIDAZOLINONE-RESISTANT WHEAT TO CONVENTIONAL WHEAT VARIETIES. Todd A. Gaines, Christopher Preston, Patrick F. Byrne, Scott J. Nissen, Dale L. Shaner, W. Brien Henry and Philip H. Westra, Graduate Student, Visiting Scientist, Associate Professor, Professor, USDA-ARS Scientist, USDA-ARS Scientist, and Professor, Colorado State University, Fort Collins, CO 80523.

Detecting rare events efficiently, such as gene flow between crop fields or between species, requires both the testing of a large number of individuals and a simple, but robust selection system. These factors make herbicide resistance an obvious marker to use. However, one of the constraints of finding rare events is the number of individuals that can be screened efficiently. For example, events occurring at low frequency require many thousands of individuals to be tested. In such cases, an efficient screen needs to be developed. In this work, gene flow between imazamox-resistant and imazamox-susceptible wheat crops was examined. In order to determine the most effective method for detecting imazamox resistance within samples; a comparison was made among three screening methods using a selected group of samples. A field evaluation used replicated field plots with a total sample size of approximately 10,000 individuals. A greenhouse method involved planting approximately 800 seeds by hand in flats, spraying at the two to three leaf stage, clipping, and evaluating re-growth. A germination method involved soaking approximately 5,000 seeds in herbicide solution for 24 hours, planting at high density in greenhouse flats, and spraying to eliminate false positives. Simply as a result of the number of individuals screened, the field evaluation method allowed detection of gene flow at the lowest levels. However, the seed soaking method required the least amount of time, space and labor.

POLLEN-MEDIATED GENE FLOW AMONG WINTER WHEAT CULTIVARS AND FROM WHEAT TO JOINTED GOATGRASS IN THE PACIFIC NORTHWEST. Bradley D. Hanson[1], Carol A. Mallory-Smith[2*], Robert S. Zemetra[3], Donald C. Thill[3], and Bahman Shafii[3], [1]Research Agronomist, USDA-ARS, Parlier, CA 93648; [2] Professor, Oregon State University, Corvallis, OR 97331; and [3] Professor, University of Idaho, Moscow, ID 83844.

The introduction and commercialization of novel genetically modified (GM) and non-GM crop genotypes has raised concerns about the ecological and economic consequences of unintended gene flow among populations. Field experiments were conducted in Idaho, Oregon, and Washington from 2000 to 2003 to determine the frequency and distance of pollen-mediated gene flow among winter wheat cultivars and from wheat to jointed goatgrass using a Nelder wheel design. Outcrossing among wheat cultivars occurred at all five locations with a maximum distance of 42.1 m from the pollen source although only 2.4% of all wheat samples had any hybrid seed. While the maximum contamination in any wheat sample was 0.45%, most had less than 0.1% hybrid seed. Gene flow from imidazolinone-resistant wheat to jointed goatgrass occurred at two of three locations with a maximum distance of 40.2 m. Altogether, 20 imazamox-resistant F1 hybrids were identified and the maximum amount of resistant seeds in a sample was 0.52%. Wheat pollinated both other wheat cultivars and jointed goatgrass at low, but potentially significant amounts in all but one of eight site-years as far as 42.1 m from the pollen source. The biological and economical significance of pollen-mediated gene flow observed in these experiments will depend upon grain purity requirements and the selective advantage of the trait of interest to jointed goatgrass.

POTENTIAL OF CROP-TO-WILD GENE FLOW IN SORGHUM IN ETHIOPIA AND NIGER: A GEOGRAPHIC SURVEY. Tesfaye Tesso, Issoufou Kapran, Cécile Grenier, Gebisa Ejeta, Allison A. Snow, Jeffrey F. Pedersen, Gurling Bothman, David B. Marx, and Patricia M. Sweeney, EARO/MARC, Melkassa, Ethiopia; INRAN, Niamey Niger; Purdue Univ., West Lafayette, IN 47907; Ohio State Univ. Columbus, OH 43210; USDA, Univ. of Nebraska Lincoln, NE 68583; and ARC-Roodeplaat Pretoria, South Africa.

Cultivated sorghum is known to hybridize readily with its wild relatives. Surveys to determine the prevalence of wild and weedy sorghums in major sorghum growing areas were conducted in Niger and in Ethiopia. Data collected included date, location name, sorghum cultivar type/name, type of stand, presence of wild or weedy sorghum, incidence of wild or weedy sorghum within or near the field, habitat, synchrony of flowering, and tillering habit. These data demonstrate extensive overlap of distribution and flowering times of wild and cultivated sorghums. Considerable variability in weedy sorghum species was noted. Weedy sorghums were not identified by species, but were grouped into three distinct types based on morphology.

MOLECULAR CONFIRMATION OF EVOLUTION OF CROP MIMICRY BY INTROGRESSION FROM MAIZE TO TEOSINTE. Lesley Blancas, Dulce Maria Arias, Ariel Alvarez Morales, and Norman C. Ellstrand, Postdoctoral Scholar, UCR Department of Botany and Plant Sciences, Riverside CA 92521, Director and Professor of Molecular Systematics, CEAMISH, UAEM, Morelos, Mexico, Professor of Molecular Genetics, CINVESTAV, Irapuato, Mexico, and Professor of Genetics and Director, UCR Department of Botany and Plant Sciences and Biotechnology Impacts Center, Riverside CA 92521.

The hybrid zone interface, where two genetically distinct populations overlap, is a natural hot spot for both the assortment of genes and the generation of new recombinant alleles. However, hybrid zones between crop and wild species are seldom studied thoroughly enough to address evolution at the genomic level. For example, one question that remains elusive is the introgression and evolutionary fate of crop genes in natural populations. Populations of wild crop relatives closely associated with their domesticated relative acquire introgressed genes that mimic the crop form and allow them to evade removal in agricultural fields. Our study examines the evolution of a domesticated gene in maize-teosinte hybrid zones in Mexico, and molecular evidence for crop mimicry.

GENE FLOW FROM DETASSELED MAIZE IN A REGULATED PRODUCTION SYSTEM. Gene Stevens, Michael Horak, Sharon Berberich, and Mark Halsey; University of Missouri, Portageville, MO; Monsanto Co., St. Louis, MO; Chlorogen, Inc., St. Louis, MO; and Donald Danforth Plant Science Center, St. Louis, MO. (121)

Genetically modified maize produced for regulated products such as pharmaceutical or industrial proteins will require methods to confine transgenic pollen. In one production system, nontransgenic maize would be used to pollinate detasseled transgenic inbred plants. Resulting hybrid kernels would be used for protein extraction or seed increase. The effect of different female inbred detasseling efficiency levels on gene flow was tested at three locations in Southeast Missouri in 2000 and 2001. Pollen sources were yellow inbred isolines representing transgenic females planted in alternating rows with white inbred maize representing non-transgenic males. During detasseling, female plants were intentionally missed at rates of 0, 730, 1460 and 7300 tassels ha^{-1}. Each detasseling treatment was matched with a maize isoline and traceable marker. White hybrid trap plots were planted on three dates at 200 m and 300 m from pollen sources. Dates that maximized silking synchronization with yellow isoline tasseling were selected for sampling. Gene flow was detected by counting yellow kernels in white maize plots. When no tassels were removed from an isoline, the highest recorded gene flow was 0.03% at the 200 m and 0.02% at the 300 m isolation distances. At greater detasseling levels, gene flow decreased. Gene flow was 0.0013% or less when 730 tassels ha^{-1} remained. When complete detasseling was intended, one positive kernel with a tracer gene was detected at 200 m, and none was detected at 300 m. For effective control of regulated transgenes in pollen by detasseling, complete and timely tassel removal will be necessary.

ALLOZYME VARIATION AND POPULATION GENETIC STRUCTURE OF NEW WORLD AND OLD WORLD POPULATIONS OF JOHNSONGRASS, *SORGHUM HALEPENSE*, Paul E. Arriola and Lesley Blancas, Department of Biology, Elmhurst College, 190 Prospect Ave., Elmhurst, IL 60126-3296 and Department of Botany and Plant Sciences, University of California, Riverside, Riverside, CA 92521-0124

It has been suggested that analysis of genetic variation and the population genetic structure of widespread weedy plant groups can provide insight into their evolutionary dynamics and reasons for success. Allozyme diversity in johnsongrass, *Sorghum halepense*, one of the World's most noxious and successful weed species, is surveyed over 46 populations and accessions collected from North America, Central America, northern Africa, India and the Near East. The relative genetic diversity of johnsongrass was low when compared to plants which share many of the same life history characters, with the mean fraction of polymorphic loci in the populations and accessions surveyed at about 23%. The allozyme variation existing in johnsongrass was evaluated using *F*-statistics and *Structure* and was determined to be partitioned within and among populations, but some patterns were apparent. New World populations of johnsongrass tend to have higher genetic identities with other New World populations than with Old World populations. We present evidence that evolutionary and genetic factors which could be affecting the genetic variation and population structure include founder events, polyploidy, genetic drift, and perhaps most significantly gene flow from crop relatives.

EFFECTS OF VIRUS-RESISTANT TRANSGENIC SQUASH ON POLLINATOR BEHAVIOR.

Holly R. Prendeville and Diana Pilson, University of Nebraska-Lincoln, Lincoln, NE 68588-0118

One ecological risk associated with the use of transgenic crops is gene flow from transgenic crops to wild relatives. To assess the potential for gene flow from crop to wild plants we compared pollinator behavior on conventional and virus-resistant transgenic squash. We performed two common garden experiments in which we planted seven varieties of conventional squash and seven varieties of transgenic squash. In the first experiment, in 2004, squash was planted in mid-May and the primary pollinators were honeybees (*Apis mellifera*). Honeybees visited conventional squash flowers more frequently than transgenic squash flowers, which may have been because corolla width was significantly larger on these varieties. In the second experiment, in 2005, squash was planted in late June and the primary pollinators were squash bees (*Xenoglossa* and *Peponapis*). In contrast to honeybees, squash bees visited transgenic squash more frequently and spent more time in transgenic squash flowers than on conventional flowers. However, in this year corolla length was greater in transgenic flowers. Thus, in both years the primary pollinators preferentially visited plants with larger flowers. We also measured several other floral traits (nectar sugar concentration, nectar volume, and other components of floral morphology), but these did not vary between conventional and transgenic varieties of commercial squash in either year, and therefore cannot explain differences in pollinator visitation. Although we found differences in visitation rate to conventional and transgenic squash flowers these differences were not consistent across years. If differences in pollinator visitation rates lead to differences in siring success, then our results suggest that gene flow from transgenic squash into wild populations will vary over time.

BIOGEOGRAPHIC SURVEY OF FERAL ALFALFA POPULATIONS IN THE U.S. DURING 2001 AND 2002 AS A COMPONENT OF AN ECOLOGICAL RISK ASSESSMENT OF ROUNDUP READY® ALFALFA. Daniel L. Kendrick, Todd A. Pester, Michael J. Horak, Glennon J. Rogan, Thomas E. Nickson, Monsanto Company, St. Louis, MO 63167.

Prior to the commercialization of Roundup Ready® alfalfa (*Medicago sativa* L.), an ecological risk assessment was conducted. As part of the risk assessment, the potential for and consequences of the transfer of the glyphosate-tolerance trait to feral alfalfa were evaluated. A biogeographic survey was conducted in 2001 and 2002 on feral alfalfa populations within five major U.S. alfalfa production states to assess the potential for gene flow from cultivated alfalfa to feral alfalfa. A total of 940 roadside sites were surveyed (500 m^2 per site). At approximately 23% of the sites, feral populations were located within 2000 m of cultivated alfalfa. On average, observed feral populations occupied < 3% of the area surveyed. The proximity of feral populations to cultivated alfalfa suggests that there is the potential for gene flow to occur between these populations. In forage production systems, gene flow from cultivated alfalfa is minimized by continual harvest of the forage at early bloom. Gene flow in seed production regions can be significantly reduced by isolation management practices. The consequences of gene flow from cultivated Roundup Ready alfalfa to feral alfalfa would likely have little environmental impact in terms of increased pest potential because (a) plant phenotypic evaluations concluded that the introduction of the glyphosate-tolerance trait does not increase the fitness of alfalfa, (b) feral alfalfa is not typically targeted for weed control in unmanaged areas or on roadsides, and (c) glyphosate plays a limited role in the control of feral alfalfa because other herbicides are available that provide better control.

ASSESSING GM X WILD RICE HYBRID FITNESS. Wesley J. Leverich, and Anbreen Bashir, Professor of Biology, Graduate Student, St. Louis University, St. Louis, MO 63103 and Barbara A. Schaal, Spencer T. Olin Professor, Department of Biology, Washington University, St. Louis, MO 63130.

As part of a broader collaborative study to measure and assess the effects of possible gene flow between cultivated rice and its wild progenitor (*Oryza rufipogon*), we have been studying the relative fitnesses of genetically modified rice cultivars, the wild ancestor of cultivated rice, *O. rufipogon*, and their F1 hybrids. The GM rice lines in our studies contain a LEA (late embryogenesis abundant) protein, HVA1 with a strong constitutive promoter, rice act 1(Actin 1). These lines, from David Ho's lab, exhibit increased tolerance to water-deficit stress. In earlier studies, we estimated relative fitnesses of 4 GM rice lines, *O. rufipogon*, and 4 F1 hybrid lines. The study reported here examines the relative response to water-deficit stress challenge in these same lines. Beginning on the tenth day following planting, water was withheld for 5 day; after two days of watering, water was again withheld for 5 days. Plants were then maintained with normal amounts of water for the remainder of the study. Fitness responses to the water stress treatment were assessed by measuring number of leaves, number of tillers, day of first flowering, number of panicles, reproductive biomass, final plant height, and total plant biomass. We assessed the variation between unstressed and water-deficit stressed treatment, in addition to the differences between GM lines, wild rice, and F1 lines. Under non-stress and water deficit stress conditions, all groups were similar in emergence and survival. Under non-stress conditions, hybrids flowered later and had greater final biomass. In the stress study, hybrids flowered later and produced more panicles, but the GM cultivars produce more seeds, just as they did under non-stress conditions. *O. rufipogon* final biomass was greater than either GM or hybrids under water deficit stress.

CONFIRMATION OF HYBRIDIZATION BETWEEN RICE AND PHENOTYPICALLY DISTINCT RED RICE TYPES IN ARKANSAS RICE FIELDS. David R. Gealy, Leopoldo Estorninos Jr., Charles E. Wilson, and Hesham Agrama, Plant Physiologist, United States Department of Agriculture-Agricultural Research Service, Dale Bumpers National Rice Research Center, Stuttgart, AR 72160, and Post Doctoral Associate, Extension Rice Specialist, and Post Doctoral Associate, University of Arkansas Rice Research and Extension Center, Stuttgart, AR 72160.

This review details several key findings from rice-red rice outcrossing evaluations in research plots and in grower fields in Arkansas from 2000 to 2005. Observations from research plots, controlled crosses, and grower fields have provided us with several easily discernable phenotypic traits (e.g. leaf pubescence, stem and leaf coloration, days to flowering, awn length) that can be very useful in establishing the general biotype of the red rice parent involved in the original cross with rice. For instance blackhull awned red rice types crossed with commercial long grain rice typically produce hybrids (first generation cross) with purple colored lower stems (basal leaf sheaths), and/or pink awns, and normal flowering patterns, while hybrids derived from strawhull awnless red rice types produce hybrids with normal green stems, no awns, and extremely delayed flowering periods. In combination with these and other phenotypic traits (e.g. seed pericarp color, seed shape, leaf pubescence, plant height, culm growth angle), SSR DNA fingerprinting and subsequent mathematical analyses can be used to infer population structure and the probable parentage of unknown crosses.

Evaluation of reciprocal outcrossing between pairs of rice cultivars (both herbicide-resistant and non-resistant) and red rice biotypes, chosen for their overlapping flowering periods in order to optimize outcrossing, has revealed substantial year-to-year and cultivar-biotype variations at Stuttgart, AR. Outcrossing estimates (based on phenotypic traits only) from adjacent rice and red rice rows have ranged from as high as 0.79% in 2004 in a ‘Kaybonnet’ rice / #8 awned blackhull red rice plot with red rice as the pollen donor to as low as 0.006% in 2001 in a StgS awnless strawhull red rice / ‘CL121’ imidazolinone-resistant rice plot with rice as the pollen donor. The greatest outcrossing between imidazolinone-resistant rice and red rice was 0.54% in a ‘CL161’ rice / #8 awned blackhull red rice plot in 2004 with red rice serving as the pollen donor. Outcrossing was usually much greater when red rice, instead of rice, served as the pollen donor. When this advantage for red rice as a pollen donor is very large, the future infestation levels of red rice hybrid derivatives in the affected rice fields will be minimized because most of the hybrid seeds formed on rice panicles (from red rice pollen) are harvested and removed from the field along with the rice seed (most hybrid seeds formed on red rice panicles shatter to the ground and remain in the field). Conversely, the harvested rice seed will be much more contaminated with red rice hybrid seeds under these conditions, and thus, much less valuable for milling and more risky for replanting.

POLLEN-MEDIATED GENE FLOW IN CANOLA. Eric W. Rosenbaum, Michael J. Horak, Todd A. Pester, and Thomas E. Nickson, Plant Ecologist, Plant Ecology Lead, Regulatory Affairs Manager, and Ecological Technology Center Lead, Monsanto Company, St. Louis, MO 63167.

Information on pollen-mediated gene flow (PMGF) in canola is useful for managing trait purity in commercial production. A multi-year, multi-site study was conducted to estimate the frequency and distance of PMGF in commercial-scale fields in 1999-2002. Each field site consisted of glyphosate tolerant canola being produced adjacent to conventional canola. Seed collected along transects in the conventional field were assayed to detect the glyphosate tolerance trait, thus indicating gene flow. Low levels of PMGF from glyphosate tolerant canola to conventional canola were detected at all sites. PMGF levels along the 10 m transect averaged 0.99, 0.75, 1.2, and 1.49% in 1999, 2000, 2001, and 2002, respectively. PMGF levels decreased exponentially with greater distance from the source field and, at 400 m, averaged 0.21, 0.14, 0.11, and 0.20% each year. These results from commercial-scale production fields are consistent with published information for canola and show that pollen-mediated gene flow can be managed to acceptable levels by using an appropriate isolation distance.

POLLEN-MEDIATED GENE FLOW IN CALIFORNIA COTTON DEPENDS ON POLLINATOR ACTIVITY. Allen Van Deynze, Frederick J. Sundstrom, and Kent Bradford; Seed Biotechnology Center, University of California, Davis; and California Crop Improvement Association, University of California. One Shields Avenue, University of California, Davis, CA, 95616.

Many cotton (*Gossypium hirsutum*) pollination studies have been carried out in the southern U.S., but no data exist for California. In this study, we measured pollen-mediated gene flow (PGF) in four directions over two years from herbicide-resistant source plots in upland cotton in the California cotton growing region and in a region with high pollinator activity. In addition, samples were taken from fields of conventional varieties at varying distances from fields planted with herbicide-resistant varieties to assess PGF under commercial production conditions. A seedling herbicide bioassay confirmed by DNA tests was used to measure PGF. PGF was independent of direction from the source plot and declined exponentially with increasing distance from 7.65% at 0.3 m to less than 1% beyond 9 m when there was high pollinator activity (Figure 1). In the absence of high pollinator (honeybee) populations, PGF was less than 1% beyond 1 m. Pollen flow in commercial fields was consistent with the experimental plot data, with only 0.04% PGF detected at 1625 m. This study confirms that PGF decreases exponentially with distance in cotton grown under California conditions and is low in the absence of pollinators, although sporadic occurrence of PGF can be detected up to 1625 m (1 mile) (Figure 2).

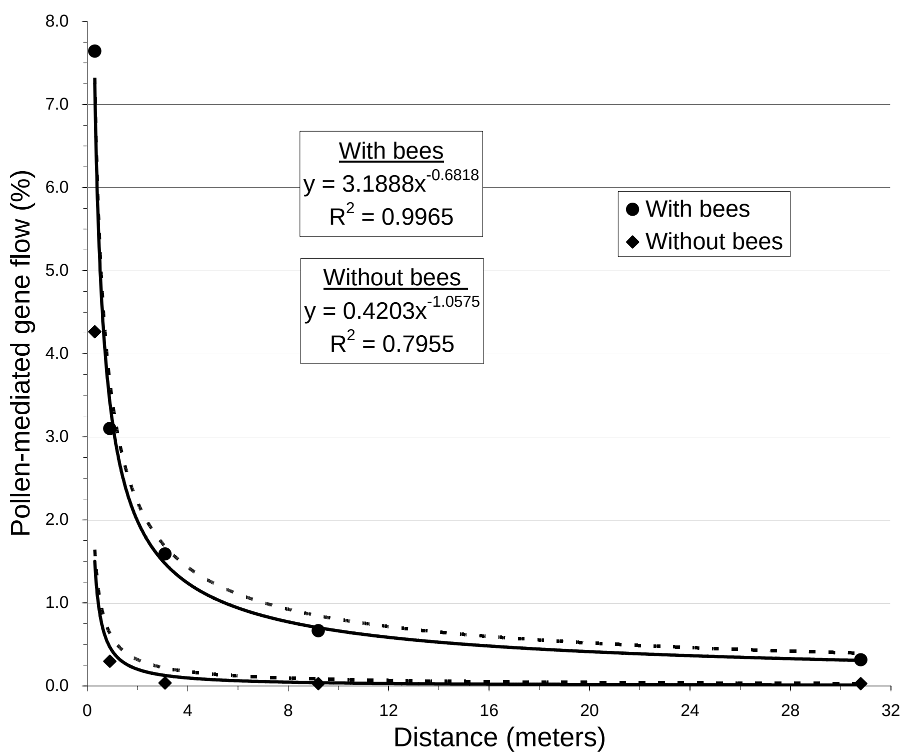

Figure 1. Pollen-mediated gene flow (PGF) in California with (Kearney, circles) and without (Shafter, triangles) the addition of honeybees. Each datapoint represents PGF detected from 16,000 seeds sampled in four directions from a source plot in two growing seasons. Solid lines represent the best fit curve for the two datasets. Broken lines represent 95% upper confidence limit.

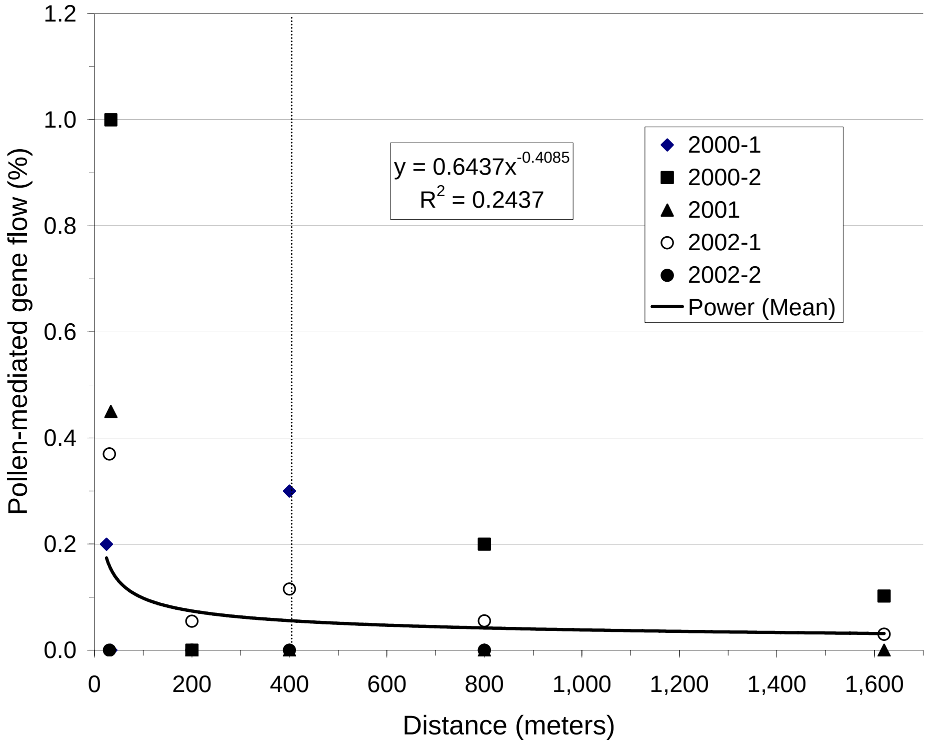

Figure 2. Pollen-mediated gene flow (PGF) in California collected from neighboring fields separated by open space in five different locations in three years. PGF was calculated based on samples (2000 seeds each) collected at the closest edge of solid-seeded commercial fields (25-34 m), 200, 400, 800 and 1625 m from herbicide-resistant (BXN or Roundup Ready) cotton. Solid line is the best-fit regression curve. Broken vertical line represents the current isolation distance for foundation seed of 400 m.

ASSESSMENT OF THE POTENTIAL FOR GENE FLOW BETWEEN TRANSGENIC COTTON AND THE ENDEMIC HAWAIIAN COTTON. John M. Pleasants and Jonathan F. Wendel, Adjunct Assistant Professor and Professor, Ecology, Evolution and Organismic Biology Department, Iowa State University, Ames, IA 50011

We investigated the potential for gene flow via pollen dispersal between transgenic varieties of commercial cotton (*Gossypium hirsutum* and *G. barbadense*) and the Hawaiian endemic cotton species *G. tomentosum*. Because these species are inter-fertile and because artificial crosses lead to viable progeny, interspecific gene flow is possible when: 1) there is spatial proximity between *G. tomentosum* populations and transgenic cotton fields; 2) there is overlap in flowering between *G. tomentosum* populations and transgenic cotton plantings; and 3) there is overlap in pollinators between *G. tomentosum* populations and transgenic cotton. A previous report in the literature documented hybrid populations, substantiating the possibility of gene flow.

1) Evidence in the literature indicates that *G. tomentosum* is present on all of the main Hawaiian Islands except Hawaii and Kauai. Populations of *G. tomentosum* are located on the drier, leeward coastal plains of the islands at low elevations. These are also the parts of the islands that are used for agriculture. The locations of all natural populations of *G. tomentosum* are not known so an evaluation of proximity to plantings of transgenic cotton would have to be made on a case-by-case basis.

2) We monitored flowering phenology for *G. tomentosum* over 2003-4. There was a distinct flowering period that began around the end of January and peaked in April and May. In 2004, when there was a higher than normal precipitation during the wet season, the flowering period extended into August. Thus, any transgenic cotton that was blooming between January and August could potentially overlap temporally with *G. tomentosum*.

3) We observed both honeybees and carpenter bees visiting and pollinating *G. tomentosum* flowers. These same pollinators are known to be pollinators of commercial cotton. Therefore, there is complete overlap in pollinator fauna. In addition, these pollinators are long-distance foragers; honeybees may forage up to 6 miles from their nest. Consequently, to reduce the chances of interspecific pollen transfer to near zero, transgenic cotton fields would have to be placed more than 6 miles from a *G. tomentosum* population.

LANDSCAPE-LEVEL GENE FLOW FROM CLEARFIELD WINTER WHEAT TO CONVENTIONAL WHEAT OVER THREE YEARS. Philip Westra*, Pat Byrne, Todd Gaines, Scott Nissen, Dale Shaner, Brien Henry, and Christopher Preston; Professor, Professor, MS Graduate Student, Professor, ARS Scientist, ARS Scientist, and Professor. Colorado State University and USDA/ARS, Fort Collins, CO 80523.

Pollen-mediated gene flow among crop cultivars and from crops to compatible relatives is an important issue for crops with regulated markets and with traits that may impact non-target organisms. The objectives of this project are to evaluate landscape-level crop-to-crop and crop-to-weed gene flow in wheat using commercially available varieties. Gene flow was estimated using pollen drift from 'Above,' a non-transgenic, imazamox-resistant winter wheat cultivar to susceptible wheat and jointed goatgrass. Wheat and jointed goatgrass samples were collected in eastern Colorado in 2003, 2004, and 2005. Additionally, a Nelder wheel plot was sampled in 2004 to estimate gene flow to two wheat varieties and jointed goatgrass. Wheat sub samples from commercial fields were screened for resistance by treating with 44 g/ha imazamox in field plots. Jointed goatgrass and Nelder wheel samples were screened in the greenhouse. In both the field and greenhouse, hybrids were identified by an injured (tillering) phenotype and were confirmed with a PCR-based marker. Two wheat varieties (Jagger and Prairie Red) were found to have significantly (α=0.05) higher cross-pollination rates in 2003 at one to fifteen feet from Above than the nine other varieties sampled, at 2.7 percent and 1.1 percent. Cross-pollination rates of 0.01 percent to 0.5 percent were observed at the farthest sample distance of 120 feet in 2003. The average cross-pollination rate for jointed goatgrass collected within the Above plot at the Nelder wheel was 0.18%. No cross-pollination was detected in five field jointed goatgrass samples in 2003and five in 2004; one sample from 2004 had cross-pollination of 1.6 percent. Hybridization rates between wheat and jointed goatgrass were low in this study and gene flow did not occur over distance. Cross-pollination in wheat declines rapidly with increasing distance from the pollen source. Samples collected in 2005 are growing in the field test site and will be sprayed in the spring of 2006 with imazamox to complete the third year of testing on this project. Jointed goatgrass collected in 2005 is currently being screened in the greenhouse. The data from this research provide an excellent validation of the empirical model for pollen-mediated gene flow in wheat published in Crop Science by Gustafson et. al in May, 2005.

USING TIME AND DISTANCE ISOLATION FACTORS FOR CONFINEMENT OF POLLEN-MEDIATED GENE FLOW IN MAIZE. Mark E. Halsey, Donald Danforth Plant Science Center, St. Louis, MO 63132; Kirk M. Remund, Philip J. Eppard, Monsanto Company, St. Louis, MO 63167; Christopher A. Davis, Monsanto Company, Coalinga, CA 93210; Mick Qualls, Qualls Ag Labs, Ephrata, WA 98823; Sharon A. Berberich, Chlorogen, St. Louis, MO 63141.

Studies were conducted in California (CA) and Washington (WA) to evaluate the relationship of distance and temporal separation for isolation of maize from pollen-mediated gene flow (PMGF). Kernel color was used to detect outcrossing from source plots to receptor plots planted at distances up to 750 m and planting intervals of up to three weeks from the pollen source. Increasing temporal separation reduced the distance required to achieve genetic isolation. Outcrossing was <0.01% at 500 m when source and receptors flowered at the same time, whereas this level of confinement was achieved at 62 m when two weeks of temporal separation (335 gdu) was used. No outcrossing was detected at 750 m and two weeks of temporal separation. Levels of outcrossing were less in WA, perhaps due to the less persistent wind patterns observed there. Wind variability was such in WA that the presentation of wind data in ‘wind roses’ was not helpful in determining the direction of predominant gene flow, and more detailed presentation was required. PMGF may be expressed as dispersal curves or gradients, which may be helpful in analyzing diverse environmental influences. The comparison of gene flow gradients may be useful in evaluating production locations and establishing reproductive isolation standards for maize with novel genetic traits.

EVALUATION OF TEMPORAL ISOLATION ON FREQUENCY AND DISTANCE OF POLLEN-MEDIATED GENE FLOW IN CORN MEASURED AT TWO INTERFIELD SPACINGS. Eric W. Rosenbaum, Michael J. Horak, Todd A. Pester, Kirk M. Remund, and Thomas E. Nickson, Plant Ecologist, Plant Ecology Lead, Regulatory Affairs Manager, Statistician, and Ecological Technology Center Lead, Monsanto Company, St. Louis, MO 63167.

A two-year study at two sites was initiated in 2001 to determine the effects of temporal and spatial isolation on pollen-mediated gene flow in corn. At each site, a 16-acre source plot of yellow corn was centered in a 40-acre field of white corn. Trap plots were established in the white corn to the north, south, east, and west of the source plot. Temporal isolation was tested by varying the planting date of the trap plots -10, 0, or +10 days relative to the planting of the source plot. Spatial isolation was tested by incorporating 15 and 60 ft. fallow borders on each side of the source block. Ears were collected from each trap plot at various distances out to 230 ft. from the source plot and kernels were sorted by color. Yellow kernels indicated gene flow from yellow corn. Minimal differences were observed due to the early or late planting dates. The 60 ft. fallow border reduced gene flow along the edge of the trap plots when compared to the 15 ft. border. As expected, gene flow decreased with greater distance from the source plot and was correlated with wind direction. Gene flow levels were significantly reduced at sampling points 10 ft. into the trap plots, indicating the effectiveness of border rows in filtering foreign pollen.

MODELING GENETICALLY-MODIFIED MAIZE GRAIN PRODUCTION PRACTICES TO ACHIEVE EU LABELING THRESHOLDS. David I Gustafson, Ivo O. Brants, Michael J. Horak, Kirk M. Remund, Eric W. Rosenbaum, and John K. Soteres, Senior Fellow and Research Scientists, Monsanto Company, 800 North Lindbergh Blvd, St. Louis, MO 63167.

An empirical approach is given for specifying co-existence requirements for genetically-modified (GM) maize production, in order to ensure compliance with the 0.9% labeling threshold for food and feed in the European Union. A total of 56 individual datasets were considered in which pollen-mediated gene flow (PMGF) was measured within maize receptor fields at a series of distances from source fields having a marker trait not present in the receptor. The field data for each trial were assessed to determine three characteristic results from each experiment: (1) the precise distance at which gene flow fell below 0.9%; (2) the first 5 m harvester pass that would yield gene flow below 0.9%; and (3) the number of 5 m passes that would need to be harvested separately in order to maintain blended average gene flow below 0.9% for a 100 m wide field (corresponding to a square, 1 ha receptor field, or approximately one truck load of grain). In addition, an empirical model is presented that fits the observed decrease of gene flow with distance. The model was parameterized to provide both reasonable worst case and expected case predictions of gene flow for various combinations of isolation distance, use of non-GM border rows in the GM field and/or separately harvested border rows in the receptor field. Based on the data assessed, the model is used to show that the effect of scale is minimal for source fields of surface area 4 ha and greater. Combinations of isolation distance and border rows of 20 m or more are predicted to result in gene flow of less than 0.9%, as a blended average for receptor fields 1 ha or larger. Lesser requirements are necessary when the source field is much smaller than the receptor, and an extension to the model is provided in order to estimate such effects.

INFLUENCE OF NITROGEN FERTILIZER ON GIANT RAGWEED INTERFERENCE IN CORN.

Eric J. Ott and William G. Johnson, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology Purdue University, West Lafayette, IN 47907-2054.

Environmental concerns regarding the use of nitrogen fertilizer and soil-applied herbicides such as atrazine, and the adoption of glyphosate-resistance corn hybrids will likely cause changes in the dynamics of weed interference in corn. Giant ragweed (GRW) is a highly competitive weed that commonly infests crop production fields in the Midwest. GRW has the ability to emerge throughout the early growing season making it difficult to control with just a single herbicide application. Previous research evaluating the influence of N application timings and giant ragweed removal timings in corn has not been published. A field experiment was conducted at the Purdue University Agronomy Center for Research and Education. Treatments were established in a split plot design with four replications. Three nitrogen treatments (180 lbs/ac before planting (BPLT), 180 lbs/ac side dressed (SIDE), and 90 lbs/ac BPLT + 90 lbs/ac SIDE (SPLIT), assigned to the main plots and three GRW removal timings (weed free, 40-cm, and season long) were assigned to the subplots. GRW plants were allowed to emerge with the corn, and GRW density was established at 0.5 plants/10 ft^2 14 days after GRW emergence maintained until the appropriate removal timing. Weed free plots were maintained throughout the growing season by hand weeding at biweekly intervals. Corn was then harvested for grain and yields were then converted to 15.5% grain moisture.

Post emergent N fertilizer did enhance corn and GRW growth in the early part of the growing season, and GRW accumulated more nitrogen on a per plant basis than did corn. When GRW was allowed to interfere with corn for the entire growing season, it was able to accumulate 72-to 135-lbs N/ac. Higher corn yields were observed in the SIDE and SPLIT N fertility regimes than in the BPLT when GRW interference periods were pooled together. GRW at a density of 0.5 plants/10 ft^2t can be controlled up to 16 inches tall without yield loss.

CORN AND PALMER AMARANTH INTERACTIONS IN DRYLAND AND IRRIGATED ENVIRONMENTS. Dwain M. Rule and J. Anita Dille, Graduate Research Assistant and Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506-5501.

Palmer amaranth is a competitive weed in corn fields in the Great Plains of the United States. A field experiment was conducted in 2005 at the Department of Agronomy Ashland Bottoms Research Farm, near Manhattan, KS. The objective of the experiment was to monitor corn and Palmer amaranth competition under two soil moisture environments. The experiment was established on Eudora silt loam soil consisting of coarse-silty, mixed, superactive, mesic Fluventic Hapludoll with characteristics of 2.0 % organic matter, 28 % sand, 56 % silt, and 16 % clay. The field had crop nutrients applied according to the Kansas State Soil Fertility Recommendation Guidelines, except for nitrogen, which was applied at 224 kg N ha^{-1}. The previous crop was soybean, and field preparations included field cultivation and pre-plant furrowed rows. Corn hybrid 'DKC60-19RR' was planted at 76,600 seeds ha^{-1} on May 6, with a 0.76 cm row spacing. Palmer amaranth was seeded by hand in a 12 cm band over the corn rows and hand thinned to treatment weed densities. The experiment was a split-plot design with the whole plot treatments dryland and well watered furrow irrigation. Within each soil moisture environment (whole-plot treatment), four sub-plot treatments were established including monoculture corn, monoculture Palmer amaranth at 1 plant m^{-1} of row, and two mixtures of crop and Palmer amaranth with 1 and 4 weeds m^{-1} of row. Treatments were replicated four times and arranged in a randomized complete block. Each treatment plot was four corn rows wide and 17 m long to allow for eleven destructive plant harvests (20, 26, 31, 35, 40, 45, 49, 55, 60 and 130 days after planting), final corn yield, and yield components to be measured. Soil water content and soil temperature were measured using Campbell Scientific, Inc. CS605 TDR probes and CS 107 probes, respectively. The probes were placed within a subset of plots to determine soil water content at 15 and 30 cm depth between corn and Palmer amaranth plants and beside monoculture corn and Palmer amaranth plants. Palmer amaranth began to interfere with corn growth reducing plant biomass at 49 days after planting in both environments. Palmer amaranth height, leaf area, and plant biomass were reduced with corn interference. Treatment soil water content level varied based on plant water usage and plant canopy. Soil water content decreased as Palmer amaranth density increased with corn, but soil water content levels were higher in monoculture Palmer amaranth in both environments due to no corn competition. The results of this study seem to mechanistically explain the competition for water between corn and Palmer amaranth. The information collected from this experiment will be used to improve crop-weed competition models and ultimately, optimized weed management decisions in diverse environments.

INFLUENCE OF APPLICATION TIMING ON CONTROL OF STAR-OF-BETHLEHEM. Jennifer A. Hagerman, Bryan G. Young, and John E. Preece, Graduate Research Assistant, Associate Professor, and Professor, Southern Illinois University, Carbondale, IL 62901.

Star-of-Bethlehem is a bulbous perennial weed that has become increasingly problematic in certain no-till agricultural sites during spring field operations and early crop establishment. Seed production by star-of-Bethlehem is thought to be rare in the United States, making bulb management crucial for control. Star-of-Bethlehem emerges in late fall to early winter and appears to initiate bulblet growth prior to the blooming period which begins in early to mid-April. The greatest susceptibility of star-of-Bethlehem to selected herbicides can be determined by targeting various physiological stages of bulb development, prior to flowering.

Field research was conducted at Marion, IL in 2004 and Murphysboro, IL in 2005 to evaluate the efficacy of paraquat, glyphosate, flumioxazin, and combinations of paraquat + flumioxazin and glyphosate + flumioxazin for control of star-of-Bethlehem at three preplant application timings staggered by three-week intervals starting in early-March. Foliar control was evaluated 21 days after treatment (21 DAT) and one year after treatment (1 YAT). In general, foliar control of star-of-Bethlehem 21 DAT increased as application timing was delayed. For instance, control increased from 47 to 99% when paraquat was applied in early-March versus the mid-April application in 2004. Paraquat, flumioxazin and the tank mixtures provided similar control of star-of-Bethlehem 21 DAT, within each application timing. Glyphosate applied alone was the least effective treatment 21 DAT, with 15% or less star-of-Bethlehem control, regardless of application timing or year. At Marion, the greatest control of star-of-Bethlehem (96%) at 1 YAT was from the mid-March application of treatments containing paraquat. For the mid-April timing, control with flumioxazin was 45% or less 1 YAT, compared with 99% control observed 21 DAT, indicating that the efficacy of flumioxazin on star-of-Bethlehem is not sustained for long-term management. Control of star-of-Bethlehem from glyphosate was 30% or less, 1 YAT. Total bulb density was reduced by 99% with paraquat and paraquat + flumioxazin 1 YAT for the mid-March application timing. Glyphosate alone reduced total bulb density by 44% or less 1 YAT and increased total bulb density by 143% at the early March application timing, with most of the increase occurring in medium (0.5 to 1.0 cm) and large (> 1.0 cm) sized bulbs. Flumioxazin reduced total bulb density by 27% or less 1 YAT, regardless of application timing. Thus, paraquat applied in mid-March provided the greatest efficacy for both short- and long-term management of star-of-Bethlehem.

ASSESSMENT OF THE SUSTAINABILITY OF GLYPHOSATE RESISTANT CROPPING SYSTEMS – AN ALTERNATIVE APPROACH. Andrew M. Westhoven, William G. Johnson, Mark M. Loux, and Jeff M. Stachler, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology Purdue University, West Lafayette, IN 47907, Professor, Extension Program Specialist, Department of Horticulture and Crop Science The Ohio State University, Columbus, OH 43210.

Soybean production practices place heavy reliance on glyphosate for weed management. Our field surveys have shown that glyphosate resistant horseweed is widespread in Indiana. In fields where we have found glyphosate resistant horseweed, we have documented other weeds which have escaped treatment with glyphosate and entered this information into a database. In an attempt to evaluate the sustainability of glyphosate cropping systems, we will attempt to learn if the presence of glyphosate resistant horseweed can be used as an indicator species for other weeds with enhanced glyphosate tolerance. The database, which is comprised of 2003 field survey information, was queried for escaped weeds, specifically giant ragweed (GRW) and common lambsquarters (CLQ). In the fall of 2005, GRW and CLQ seed samples were collected and will eventually be screened for tolerance to glyphosate.

Results from database queries led us to sample primarily the SE region of Indiana. This area had the highest incidence of horseweed, GRW, and CLQ escapes in 2003. In the fall of 2005, we investigated 73 sites in 28 counties, and collected seed samples from 27 fields in 17 counties. A total of 229 GRW and 173 CLQ samples were collected. Since horseweed is being used as an indicator species, it’s presence was recorded in the 2005 sampling process. All fields sampled contained horseweed with approximately 70 percent of the sites visited documented as containing resistant populations in the 2003 survey. From the 2003 survey database, horseweed, GRW, and CLQ were present in approximately 33 percent of the sites visited in 2005.

RISKS OF WEED SPECTRUM SHIFTS AND HERBICIDE RESISTANCE IN IRRIGATED ROUNDUP READY CROPPING SYSTEMS - A WESTERN NEBRASKA PERSPECTIVE AFTER 8 YEARS.

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Experiments were conducted at three irrigated locations: Scottsbluff, NE, Fort Collins, CO, and Torrington, WY from 1998 through 2995 to determine if glyphosate use patterns in glyphosate tolerant cropping systems influenced weed control by placing selection pressure on weed species, altered weed population dynamics, or lead to the development of glyphosate-resistant weeds. Experiments were designed as a two factorial split plot set in a randomized complete block design with our replications. Main plots were either continuous glyphosate tolerant corn or a rotation of glyphosate tolerant corn, sugarbeet, corn, sugarbeet, wheat, corn, sugarbeet, and corn. Sub-plots were glyphosate at 0.4 kg/ha applied postemergence twice each spring, glyphosate at 0.8 k/ha applied postemergence twice each spring, a rotation of glyphosate at 0.8 kg/ha applied postemergence twice each spring followed the next year by a non-glyphosate treatment, or a non-glyphosate treatment each year. The seed bank was examined each year before crop planting. Weed density was measured before herbicide treatment, 2 wk after the last postemergence treatment, and at crop harvest when crop yields were also determined. After 6 yr of study the weed population at Scottsbluff declined and shifted from kochia and wild proso millet dominated population to a predominately common lambsquarters population. Common lambsquarters seed and plant populations increased to a greater extent in areas treated with the half rate of glyphosate. For the first time in 2003, the increase in weed density in the half rate glyphosate treatment resulted in a 42% decrease in corn seed yield. In reaction to the increase in common lambsquarters, each of the glyphosate sub-plots was split and half of the plot received acetochlor plus atrazine preemergence. The addition of a preemergence herbicide to postemergence glyphosate provided 91 and 98% common lambsquarters control in the half and full rate glyphosate treatments, respectively. After 8 yr of study, the weed population in the non-glyphosate treatment shifted to kochia. Two weed management strategies; glyphosate at 0.8 kg/ha twice each year, alternating glyphosate at 0.8 kg/ha twice each year with a non-glyphosate treatment, and non-glyphosate treatment were both equally effective in reducing weed density.

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WEED RESISTANCE MANAGEMENT: STEWARDSHIP APPROACHES. Michelle R. Starke, Harvey L. Glick, and Greg A. Elmore, Product Stewardship Manager, Director of Scientific Affairs, and Soybean Technical Manager, Monsanto Company, St. Louis, MO 63167.

Product stewardship is a fundamental component of responsible customer service in every business. Glyphosate weed resistance management is a critical element of glyphosate herbicide stewardship, and is important to Monsanto both for customer satisfaction and to sustain the utility of the product. One of the first cases of a glyphosate resistant weed in the U.S. was a horseweed (*Conyza canadensis* (L.) Cronq.) biotype in the year 2000. Monsanto has implemented several management and mitigation strategies to help farmers control glyphosate resistant horseweed. These strategies include continuing education of growers, as well as extensive internal and external research on this weed species. Now, some five years later, we have the ability to take a retrospective look at the occurrence of this resistant weed, and the management and mitigation strategies put in place for it.

SWEET CORN CULTIVAR INFLUENCES BIOLOGICALLY EFFECTIVE HERBICIDE DOSE.
Martin M. Williams II[1], Rick A. Boydston[2], and John C. Frihauf[1], Ecologist, Research Agronomist, and Biological Science Technician, USDA-ARS, [1]Invasive Weed Management Research Unit, Urbana, IL 61801 and [2]Vegetable and Forage Crop Research Unit, Prosser, WA 99350.

Competitive crop cultivars are considered a component of integrated weed management systems; however specific knowledge of interactions among crop cultivars and other management tactics, such as biologically effective herbicide dose, is limited. Observed variation in crop tolerance and weed suppressive ability among sweet corn cultivars, coupled with the need for new approaches to manage annual grasses, provided incentive to quantify the effect of sweet corn hybrid on efficacy of sublethal sethoxydim doses and crop yield stability. A split plot design was established in Urbana, IL and Prosser, WA where main plot treatments were one of two sethoxydim-tolerant *sugary-1* sweet corn cultivars, also seeded with wild proso millet. Subplot treatments were doses of sethoxydim ranging from 0 to 100 g ai/ha applied at 3-4 leaf wild proso millet. Cultivar ‘GH6631’ grew taller, produced a denser canopy, and yielded more than ‘GH6333’. As a result, weed suppressive ability was higher in ‘GH6631’ than ‘GH6333’. At the time of crop harvest, wild proso millet shoot biomass was least in ‘GH6631’ for doses up to 25 g ai/ha of sethoxydim, where higher doses provided complete weed control regardless of crop cultivar. Functional relationships between crop yield and sethoxydim dose revealed ‘GH6631’ yielded 35 to 50% better than ‘GH6333’ at sublethal herbicide doses. Although sethoxydim is not currently registered for broadcast use on sethoxydim-tolerant sweet corn hybrids, this study demonstrates that efficacy of sublethal herbicide dose is improved when integrated with competitive crop cultivars.

ASSOCIATION BETWEEN WEED SEEDBANK SIZE, FARM CHARACTERISTICS AND IPM-RELATED FARMER BEHAVIOR. Edward C. Luschei and Clarissa M. Hammond, Assistant Professor and Graduate Student, Department of Agronomy, 1575 Linden Drive, Madison, WI 53706.

Pest science personnel generally recognize the benefits of integrated pest management (IPM), but in order to effectively target extension efforts and engage in research that addresses the real-world constraints of farmers, it is essential to gauge farmer behaviors and attitudes. To accomplish this goal, a corn pest management survey was sent to Wisconsin farmers in 2002. Our objectives were (1) to report benchmark pest management data and (2) to examine correlations between total farm size and type (cash-grain or dairy) and management behaviors. A total of 213 farmers were surveyed about the characteristics of their operations, weed, insect and disease pest management practices, use of crop consultants, interactions with their local agrichemical dealer and their attitudes regarding pest management decision-making. The responses between cash-grain and dairy farmers were compared and further categorized on the basis of farm size. The overall rate of IPM adoption, as reflected by a behavioral index calculated from survey responses, was moderate (overall mean index score of 10.4 of a maximum of 24). Large cash-grain farmers indicated rotating crops, rotating herbicide families and using a broadcast herbicide application more often in their weed management program than their small dairy farmers. Generally, both the cash-grain and large-size categories were related to considerations of the level of control, price, carryover potential, weed resistance management, environmental safety, and risk to the applicator when selecting herbicides than other operational categories. Cash grain operations had a (significant) higher mean IPM index score than dairy operations (11.1 compared to 9.2). Larger farms tended to involve management that was more integrated (i.e. had higher index scores) than smaller counterparts. The mean index scores for each progressively larger size class were 8.9, 10.6, 11.0, and 11.5 units. Our results provide a benchmark for future comparisons of IPM adoption rates in Wisconsin and highlight the association between IPM research/extension and farmer management behavior.

SEEDCHASER: TILLAGE MODEL FOR VERTICAL WEED SEED DISTRIBUTION.
Kurt Spokas, Frank Forcella, Dean Peterson, Dave Archer, and Don Reicosky, Soil Scientist, USDA-ARS, North Central Soil Conservation Research Lab, Morris, MN 56267.

Knowledge of the vertical distribution of surface residues, chemicals, or seeds following tillage operations is of paramount importance to a wide variety of soil research areas. This presentation describes a 1-D empirical vertical soil tillage particle distribution model with 1 cm grid spacing. Prior models have only examined the impact of a limited list of implements and used coarser vertical spacings. The model predicts the vertical distribution of weed seeds following a user selectable sequence of tillage cycles. Results of this model are particularly suited for weed seedling emergence modeling. However, the model can be easily adapted to any surface broadcasted and/or incorporated agrochemical. The present model can handle up to 9 passes with user selected sequence of implements. This developed model consolidates the results from previous literature models along with new data on conservation tillage and planting implements into a prediction tool that would have applications both in weed science, as well as other soil research areas. This model was developed in JAVA and is publicly available via the internet.

USING SPECTRAL VEGETATION INDICES FOR WEED DETECTION IN MINT. Mary S. Gumz and Stephen C. Weller, Graduate Research Assistant and Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN.

Peppermint and spearmint are grown as high value essential oil crops in the Midwestern U.S. (IN, MI, and WI) and the Pacific Northwest (OR, WA, MT, and ID). U.S. mint production must become more cost effective in order to compete with foreign produced mint oils and synthetic flavorings. Remote sensing-based site-specific weed management offers great potential to decrease weed control expense, the number one input cost in mint production, by simplifying weed detection and producing site specific weed maps for precision herbicide application. Our research objective was to develop a method of spectrally differentiating mint and weeds in remotely sensed images. Although supervised classification and discriminant analysis of hyperspectral reflectance data (296 to 1094 nm) can identify mint and weeds with >90% accuracy, these methods require extensive ground referencing or more expensive hyperspectral imagery. Spectral vegetation indices (SVIs) can be used to identify mint and weeds based on ratios of reflectance at two to three wavelengths. In our approach, reflectance levels were measured from experimental field plots of peppermint, native spearmint, giant foxtail, white cockle, tall waterhemp, Powell amaranth, common lambsquarter, and velvetleaf. Discriminant analysis identified potential wavelengths for use in developing spectral vegetation indices (SVIs) for discriminating between weeds and mint. SVIs based on simple ratios and normalized differences of reflectance values in the near infrared and green portions of the spectra accurately differentiated between peppermint, spearmint, and weed species. In addition, white cockle, Powell amaranth, common lambsquarter, and velvetleaf could be differentiated from each other. The development of these SVIs and the identification of specific wavelengths for weed identification in crops, as a result of this research, will allow calibration of multispectral sensors to wavelengths most useful for weed identification in developing site specific weed management programs for mint.

NATURAL HYBRIDIZATION BETWEEN GIANT AND COMMON RAGWEED. Dean S. Volenberg, A. Lane Rayburn, Danman Zheng, and Patrick J. Tranel, Postdoctoral Research Associate, Associate Professor, Graduate Research Assistant, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Hybrids between common (pollen receptor) and giant (pollen donor) ragweed have been reported to occur under field conditions. However, hybrids between giant (pollen receptor) and common (pollen donor) ragweed have not been reported to occur, except for being produced in controlled crosses and through the use of in vitro embryo rescue. Here we report on the interspecific hybridization between giant and common ragweed under field conditions.

A field study was conducted to determine the pollen dispersal characteristics of giant ragweed. Plants of a biotype resistant to acetolactate synthase (ALS)-inhibiting herbicides were surrounded by plants of a sensitive biotype in concentric circles having radii of 5, 10, 20, 40, and 60 m. Progeny obtained from herbicide-sensitive plants were screened for resistance to an ALS inhibitor to establish pollen dispersal from resistant plants. The majority of giant ragweed pollen was dispersed within 5 m and pollen dispersal declined rapidly as the distance increased. The mean percentages of herbicide resistant progeny –which presumably received pollen from the resistant plants-were 31, 11, 8, 4, and 5% at 5, 10, 20, 40, and 60 m, respectively. Pollen was uniformly dispersed in all directions, except for the true west direction in which herbicide-resistant progeny were <5% at all distances. Some of the progeny plants displayed peculiar leaf morphology which resembled that of common ragweed. These plants as well as representative plants of giant and common ragweed, were further investigated using flow cytometry (DNA content), root squashes (chromosome counts), and pollen viability (in vitro germination). Results of flow cytometry suggested that these peculiar plants are hybrids between giant and common ragweed. The DNA content of the hybrids was 3.03 pg, whereas the DNA content of giant and common ragweed was 3.94 and 2.36 pg, respectively. Chromosome counts revealed that the hybrid plants contained on average 30 chromosomes (range 29 to 31), whereas giant and common ragweed contained 24 (range 23 to 24) and 36 (range 35 to 36) chromosomes, respectively. Pollen germination tests demonstrated a mean germination rate of 26% for giant ragweed, compared to rates of 5 and <1% for common ragweed and the hybrid, respectively. Hybrid ragweed pollen grains varied in size, whereas the pollen grains of giant and common ragweed were uniform in size. Hybrid ragweed plants crossed to either common or giant ragweed plants produced seeds, however in most seeds examined thus far, embryos have aborted. Future studies will examine seeds produced in reciprocal crosses.

INFLUENCE OF RAGWEED BORER ON GLYPHOSATE EFFICACY IN COMMON RAGWEED**.**
Justin M. Pollard* and Reid J. Smeda, Graduate Research Assistant and Associate Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211; Brent A. Sellers, Assistant Professor, Range Cattle Research and Education Center and Department of Agronomy, University of Florida-IFAS, Ona, FL 33865.

In 2004, a population of common ragweed was identified resistant to glyphosate in Missouri. Initial investigations revealed that several plants surviving glyphosate were infested with a stem-boring insect, commonly known as ragweed borer (*Epiblema strenuana*, Walker). Field experiments were initiated to evaluate whether or not the ragweed borer influenced common ragweed response to glyphosate. Two sites were evaluated in 2004 and 2005, with one site containing the confirmed glyphosate-resistant common ragweed population, and a second site containing a known glyphosate-susceptible population. The experimental design was a split-block, with blocks treated with either 0 or 0.028 kg ai/ha lambda-cyhalothrin. Sub-plot treatments included 0, 0.84 (1X) or 2.52 (3X) kg ae/ha glyphosate on either 12 or 24 cm common ragweed. Lambda-cyhalothrin was applied bi-weekly from early spring until 6 weeks after glyphosate application to minimize ragweed borer infestation. At least four replications were utilized at each site-year and as many as 10 common ragweed plants were flagged in each plot following herbicide application. Flagged common ragweed plants were harvested at ground level six weeks after treatment and dissected following harvest to evaluate ragweed borer infestation; plant dry weight was measured following 3 days at 35 C. Biomass data were converted to percent reduction in dry weight compared to the untreated control prior to ANOVA. Overall, there were no differences in percent reduction of common ragweed biomass between the insecticide treated block (ITB) and the non-insecticide treated block (NITB) at either site in both years. For susceptible common ragweed, percent biomass reduction varied only in response to plant height at treatment, with reductions of 99 and 98% for 12 cm glyphosate treated plants and 86 and 89% for 24 cm glyphosate treated plants in 2004 and 2005, respectively. For glyphosate-resistant common ragweed, percent biomass reduction varied with both plant height and glyphosate rate. In 2004, 12 cm treated plants were reduced 87 and 97% for 1X and 3X glyphosate rates, respectively, while 24 cm treated plants were reduced 64 and 89% for 1X and 3X rates, respectively. Percent ragweed borer infestation of the herbicide treated glyphosate-resistant common ragweed was 22 and 60% for the ITB and NITB, respectively, and plant survival was >80%. In 2005, percent biomass reduction for 12 cm treated plants was 75 and 90% for 1X and 3X glyphosate rates, respectively and plants treated at 24 cm exhibited 79 and 85% reductions for 1X and 3X rates, respectively. Percent ragweed borer infestation of the herbicide treated glyphosate-resistant common ragweed was 28 and 39% for the ITB and NITB, respectively, with both blocks exhibiting 72% survival. These outcomes provide evidence that response to glyphosate for the glyphosate-resistant common ragweed is influenced by glyphosate rate and the timing of applications; ragweed borer is not a significant factor influencing plant response.

COMPARISON OF IMAZETHAPYR AND IMAZAMOX AS EITHER PRIMARY OR SALVAGE HERBICIDES IN IMIDAZOLINONE-RESISTANT RICE. James W. Heiser, J. Andrew Kendig, Chad L. Smith, and Paula M. Ezell, Graduate Research Assistant, Extension Associate Professor, Research Specialist, Senior Research Laboratory Technician, Division of Plant Sciences, University of Missouri Delta Research and Extension Center, Portageville, Mo. 63873, Reid J. Smeda, Associate Professor, Division of Plant Sciences, University of Missouri-Columbia, Columbia, Mo. 65211

Imazethapyr is currently used in imidazolinone-resistant (IR) rice (*Oryza sativa*) as the primary herbicide for the selective control of red rice (*Oryza sativa*) (a weedy biotype of commercial rice) and several other weeds. Unfortunately, red rice can hybridize with IR rice and acquire herbicide resistance. Current recommendations are for sequential, early postemergence imazethapyr applications. However, if there is a herbicide failure, labeling prohibits additional imazethapyr applications. Complete control of red rice is needed to minimize the possibility of selecting herbicide resistant plants. Currently, imazamox has a special local need (24c) registration for a clean-up or salvage application. Imazethapyr and imazamox have several similarities. However, current thought is that imazethapyr should be used for routine, early postemergence (“primary”) application, and imazamox should be reserved for “salvage” situations.

A factorial arrangement of four primary treatments, four salvage treatments, and two herbicide scenarios were tested in 2003 and 2004 at the University of Missouri Delta Research and Extension Center Lee Farm. The primary treatments were: 1) Preemergence (PRE) only; 2) mid-postemergence only (MPOST) 4-5 leaf rice; 3) PRE followed by (fb) MPOST; and 4) Early postemergence (EPOST) 2-3 leaf rice fb MPOST. Treatments 1 and 2 were intended to result in a salvage situation while the latter two programs were label recommendations. Salvage treatments were applied at: 1) approximately 3 days preflood; 2) approximately 7 days postflood; 3) preflood fb postflood; and 4) no salvage treatment. To compare the two herbicides, imazethapyr was used as the primary herbicide fb imazamox as the salvage, or imazamox was used as the primary fb imazethapyr as the salvage.

Imazethapyr and imazamox were applied at 0.07 kg/ha and 0.044 kg/ha respectively. Postemergence treatments were applied with 0.25% V/V nonionic surfactant (NIS), and a blanket application of aciflourfen + NIS was made at the 4-5 leaf stage to control legume weeds. Treatments were applied using CO_2-back-pack spray equipment, 8002 flat-fan spray nozzles, and an application volume of 187 l/ha at approximately 160 kPa pressure. Standard rice production practices were followed. Plots were 2.25 by 4 m and the experimental design was a randomized complete block with four replications. Data were subjected to an analysis of variance with years considered a random factor and means were separated using a Fisher’s protected LSD at the 5% significance level.

Without a salvage application, PRE only treatments resulted in less than 50% red rice control. Mid-POST only treatments resulted in less than 60% red rice control. Early-POST fb MPOST treatments resulted in 88% or better red rice control, while PRE fb MPOST treatments resulted in less than 85% control. Imazethapyr resulted in better control than imazamox in all primary alone treatments excluding PRE only. No treatment which did not include a salvage application resulted in greater than 90% red rice control. Imazethapyr PRE fb imazamox at all salvage timings resulted in greater than 90% red rice control. All PRE-only and MPOST-only treatments benefited from a salvage application; however, EPOST fb MPOST treatments were not statistically improved by a salvage application. When imazamox was applied PRE fb MPOST, control increased from 67% to 95, 96, and 98% when a salvage application of imazethapyr was applied at the preflood, postflood and both salvage timings respectively. Two salvage applications of imazamox following imazethapyr PRE fb MPOST improved control 16% while single applications at either preflood or postflood only increased control 14 and 12% respectively. While these two salvage treatments did not statistically improve weed control, numerical improvements in red rice control may be important due to the need to prevent outcrossing. These results indicate that current recommendations of two pre-planned EPOST fb MPOST applications of imazethapyr, and imazamox as a salvage clean up (when needed) are appropriate. Imazamox generally did not provide as much control as imazethapyr when used as the primary herbicide at currently recommended timings. These data suggest that imazamox should not replace imazethapyr as the primary herbicide in imidazolinone-resistant rice.

INFLUENCE OF WINTER ANNUAL WEED CONTROL ON SUMMER ANNUAL WEED EMERGENCE. Jared S. Webb*, Bryan G. Young, William G. Johnson, and J. Earl Creech, Graduate Assistant and Associate Professor, Southern Illinois University, Carbondale, IL 62901, Assistant Professor and Research Assistant, Purdue University, West Lafayette, IN 47907.

Winter annual weeds have become a greater management concern in corn-soybean rotations throughout the southern Corn Belt. Increased adoption of no-till production, reduced use of residual herbicides, and recent mild winter seasons have all been cited as possible contributors to the problem. Fall applications of herbicides have been utilized to improve management of these winter annual weeds. However, field observations have suggested that removal of winter annual weeds may alter spring emergence patterns of important summer annual weed species. Giant ragweed and common waterhemp are two of the most problematic weeds in Illinois (IL) and Indiana (IN) crop production fields. Therefore, the objectives of this research were to determine the influence of winter annual weed removal timing on giant ragweed and common waterhemp emergence and subsequent control in soybean. Research was conducted in IL and IN in 2004 with four winter annual weed removal strategies: 1) no control of winter annuals in the fall or spring, 2) control of winter annuals in both the fall and spring, 3) control of winter annuals in the fall but not the spring, and 4) control of winter annuals in the spring but not the fall. Winter annual weeds were removed with glyphosate at 840g ae/ha.

Winter annual weed removal strategy did not affect initial emergence of giant ragweed at two of three locations. However, at one location in IL, giant ragweed emergence was greater when winter annual weeds were controlled in the fall only compared with removal strategies that used spring removal. At two of the three locations, giant ragweed biomass was greater when winter annual weeds were controlled in the fall only. At both locations in IL, control of giant ragweed with glyphosate at 18 days after planting was lower with the fall only removal strategy. There was no difference in initial emergence of common waterhemp or biomass due to winter annual weed removal strategy at any location. However, at one location, controlling winter annual weeds in the fall and spring resulted in greater common waterhemp densities compared with winter annual weed control in the fall only.

GROWTH AND DEVELOPMENT OF CUT-LEAVED TEASEL. Diego J. Bentivegna and Reid J. Smeda. Graduate Research Assistant and Associate Professor, Division of Plant Science. University of Missouri. Columbia, MO. 65211.

Cut-leaved teasel (*Dipsacus laciniatus* L.) is a biennial plant that was introduced into the US for use in the textile industry and has become a significant problem weed. It was declared a noxious weed in MO in 2000. Even though it is a not a significant problem in agronomic crops, it is important along roadsides, cemeteries and other undisturbed areas. The objective of this research was to determine characteristics of growth and resource location from emergence to seedset for teasel. Field research was conducted from 2004 to 2005 at two locations in central Missouri. Seeds of teasel were germinated in the greenhouse and seedlings with the first set of true leaves were transplanted into polypropylene pots in early April, 2004. At bi-monthly to monthly intervals, ten plants were harvested at each location. Variables measured for each plant included: dry weight of leaves, stems, capitulums, taproot, and secondary roots; length and diameter of the taproot, and total leaf area. The absolute growth rate (GRA) was calculated as the difference of dry weight between two successive samples divide by the time elapse between them. The relative growth rate (GRR) was calculated using the follow equation $R = (\text{Ln } W_1 - \text{Ln } W_0) / t_1 - t_{0.}$ Teasel biomass reached a peak at the end of the first season and at seed production during the second year. The maximum GRA of above ground growth (2.2 to 4.9 g./day) was in August to September, 2004 and in May to June, 2005 (2.4 to 4.8 g./day). The total amount of above ground biomass per plant for 2004 was almost half that attained in 2005. The largest GRR values were measured during the first 7 months (0.1 to 0.15) following seedling establishment. During the same period, the GRR for roots was also maximum (0.10 to 0.12) compared to the remainder at the plant's life cycle. Plants formed a rosette during the first year; hence leaves were the primary contributor to above ground biomass in 2004. However, in 2005, stems and seedheads comprised >75% of the primary plant biomass. Maximum total leaf area was similar in both years; however, leaves were larger and fewer in number in 2004 compared to 2005. For root growth, length, diameter, and dry weight of the taproot increased considerably in 2004, but remained relatively constant from late fall to senescence of the plants. Maximum resource storage in the taproot was October to November of 2004. Little accumulation of root biomass in 2005 suggests that photosynthetic activity by leaves was put into reproductive growth. Teasel exhibited an aggressive growth habit following establishment that exclude or reduced competitiveness of other species. In the first year, the development of a large rosette and taproot provided a competitive advantage over other species, especially in late fall and early spring. In the second year of growth, plant resources were used to optimize reproduction prior to plant senescence

GLYPHOSATE DOSE RESPONSE CURVES AND SELECTIVITY FOR CONTROL OF PROBLEM WEEDS IN ROUNDUP-READY SOYBEAN. Stevan Z. Knezevic and Robert N. Klein, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828 and West Central Station, University of Nebraska, North Platte.

Widespread and repeated use of glyphosate is likely a reason for a shift in weed species across many Nebraska fields from those easily controlled by glyphosate to those more tolerant to this herbicide. Current problem weeds include: ivyleaf morningglory, wild buckwheat, Venice mallow, yellow sweetclover, field bindweed, waterhemp, kochia, and Russian thistle. Objective of this field study was to describe a dose response curve based on three application times and seven glyphosate rates for control of problem weeds, at two university of Nebraska research stations (Concord and North Platte). Glyphosate rates were arranged in stepwise increments from 1/5X to 4X of the label rate (1X-rate). Preliminary data suggested that most weeds up to 10cm tall were controlled well with the label rate of glyphosate (1X rate) except morning glory and sweet clover. Taller weeds required from 1.5-4X rate. About 1.5-2X rate was needed to control 10-20 cm tall wild buckwheat, Venice mallow, velvetleaf, waterhemp, sweet clover, ivyleaf mornigglory and bindweed. About 3-4X rate was needed to control 30-40 cm tall ivyleaf morningglory and sweetclover. A tank-mix of glyphosate with other herbicides will be needed to control such species (sknezevic2@unl.edu).

CONTROL OF KEY WEEDS IN GLYPHOSATE TOLERANT SOYBEAN. Greg A. Elmore, Glen P. Murphy and William B. Parker, Soybean Technical Manager, Technology Development Representative – Kentucky and Technical Development Representative – Missouri, Monsanto Company, St. Louis, MO 63167.

Field trials were conducted at several locations in 2005 to determine the effect of including a pre-plant residual herbicide on control of common waterhemp, Palmer amaranth and common lambsquarters in glyphosate tolerant soybeans. All treatments received a burndown application of glyphosate and 2,4-D prior to planting. Alachlor was included as a treatment in common waterhemp and Palmer amaranth trials while pendamethalin was included as a treatment in common lambsquarters trials. Flumioxazin was included in trials for all three weed species. Weed counts were taken at the post-emergence application timing (when weeds were approximately three inches tall) with a 0.5 meter square quadrat. Three counts were taken in each plot between the two center soybean rows of a four row plot. Weed control was rated on a 0 to 100% scale at the post-emergence application timing and again approximately two weeks after the post-emergence application. Inclusion of alachlor applied pre-emergence reduced amaranthus species (waterhemp and Palmer amaranth) present at post-emergence glyphosate application timing by 28 to 97 percent compared to the glyphosate only treatment, depending upon location. Flumioxazin reduced amaranthus species present at post-emergence glyphosate application timing by 87 to 100%. Weed stand counts at post-emergence glyphosate application timing showed that common lambsquarters populations were reduced by 30 to 75% by pendimethalin applied pre-emergence and 30 to 100% by flumioxazin applied pre-emergence.

FACTORS AFFECTING COMMON LAMBSQUARTERS CONTROL WITH GLYPHOSATE. Dana B. Harder, Christy L. Sprague, Karen A. Renner, and Christina D. DiFonzo, Graduate Research Assistant, Assistant Professor, and Professor, Department of Crop and Soil Sciences, and Associate Professor, Department of Entomology, Agriculture, and Natural Resources, Michigan State University, East Lansing, MI 48824.

Common lambsquarters control with glyphosate in Michigan has been variable. In 2003, beet petiole borers (*Cosmobaris americana*) were found tunneling throughout the vascular tissue of common lambsquarters plants that survived glyphosate application. Field and greenhouse studies were established to: 1) evaluate the effect of glyphosate rate, application timing, and insect larval tunneling on common lambsquarters control, and 2) determine if there were differences in susceptibility of seven different common lambsquarters populations collected in Michigan to glyphosate. Field studies were established on May 6 and June 4 in 2004 and May 4 in 2005. In 2004, the experiment was a 3x4 factorial; the first factor was application timing (10-, 25-, and 46-cm tall common lambsquarters), and the second factor was glyphosate rate (0, 0.63, 0.84, and 1.7 kg ae/ha). In 2005, an additional factor consisting of no insecticide compared to bi-weekly applications of the insecticide lambda-cyhalothrin was added to comprise a 3x4x2 factorial arrangement. Common lambsquarters plants were examined for insect tunneling prior to each glyphosate application and visual control was recorded 28 DAT. In 2004, there was no insect tunneling present in common lambsquarters prior to the 10- or 25- cm application timings in the May planting. However, insect larval tunneling was present in 40% of common lambsquarters plants prior to the 46-cm application timing. Common lambsquarters control was significantly less at this application timing compared with the other two application timings. Insect tunneling was present in 40 to 70% of common lambsquarters plants prior to glyphosate applications for the June planting; however, common lambsquarters control was greater than 83% and was similar between the medium and high glyphosate rates across application timing. In 2005, insect larval tunneling was present prior to the 25- and 46-cm application timings. The insect identified tunneling in common lambsquarters was a fly larva, order Diptera, family Agromyzidae. Bi-weekly applications of lambda-cyhalothrin significantly reduced the number of plants infested with insect larvae prior to glyphosate application. However, there were no differences in common lambsquarters control between plants treated or not treated with the insecticide. Common lambsquarters control was greater than 92% for all treatment timings with all rates of glyphosate. In greenhouse studies, common lambsquarters biotypes from Eaton, Gratiot, Ingham, Montcalm, Saginaw, and Shiawassee Counties and a control population from F&J Seeds were treated with glyphosate at rates of 0, 0.21, 0.42, 0.84, 1.7, 3.4, and 6.7 kg ae/ha when plants were 8- to 10-cm tall. Three of the seven populations had significantly higher GR_{50} values compared with the F&J biotype. However, there was no difference in GR_{75} values among the biotypes. In conclusion, insect larval tunneling had no effect on common lambsquarters control. Glyphosate rate and application timing had the greatest effect on control. Furthermore, common lambsquarters populations can vary in tolerance to glyphosate, particularly at reduced rates.

DOCUMENTING THE EXTENT OF GLYPHOSATE-RESISTANT COMMON RAGWEED.

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In a long-term soybean production system in central Missouri, continuous use of glyphosate for weed management has selected an herbicide-resistant population of common ragweed. The extent of resistance to glyphosate from both a population and geographical perspective is not known. A unique morphological characteristic of plants in the resistant population is that the majority of plants exhibit a very short growth habit, even in the absence of glyphosate. In September 2004, seed from 338 individual common ragweed plants (sample point) was harvested over a 180 ha area, and a hand-held global positioning satellite instrument was used to document the location of each plant. Plants were chosen at random throughout the infested area, along field edges, and in nearby areas (roadsides, field edges of adjacent areas, etc.). Seed dormancy was broken by placing seeds in moist sand at 4 C for 75 days. All seeds from each sample were then placed in two polypropylene flats containing a professional potting mix. Seed from a common ragweed population known to be glyphosate-resistant (JRW) and glyphosate-susceptible (BRAD) were also sown and used for confirmation of resistance or susceptibility for sampled plants. Emerging seedlings were thinned at random to a final population of up to 20 plants per flat. At 20 cm in height, seedlings were treated with 1.68 kg ae/ha of glyphosate and individual plants mapped according to growth morphology: stunted (S), intermediate (I), and normal (N).

Three weeks following treatment, each plant was visually evaluated for damage and the number of plants denoted with 0 to 89% (resistant) and 90 to 100% (susceptible) injury. Of all samples collected, seed from 245 sample points emerged. For the BRAD plants (350 plants assessed), 96.6, 3.4, and 0% were categorized as N, I, and S, respectively. Mean injury to BRAD plants was 94.7%. For JRW plants (479 plants assessed), 12.1, 25.3, and 62.6% were categorized as N, I, and S, respectively. Mean injury to JRW plants was 18.9%. Of the 245 sample points evaluated, 86.4% contained plants that exhibited 0 to 89% injury. Most of the glyphosate-resistant plants appear concentrated in a 20 hectare area, but resistant plants had spread along a roadside at least 60 meters from the infested field. For areas with suspected glyphosate-resistant weed populations, sampling areas potentially infested can clarify the extent of resistance.

TOLERANCE OF DRY BEANS TO KIH-485. Peter H. Sikkema*, Nader Soltani, and Christy Shropshire. Assistant Professor, Research Associate, and Research Technician, Ridgetown College, University of Guelph. Ridgetown, ON N0P 2C0.

There is little information on the sensitivity of dry beans to KIH-485. Tolerance of eight market classes of dry beans (black, brown, cranberry, kidney, otebo, pinto, white, and yellow eye beans) to the preemergence (PRE) application of KIH-485 at 209 and 418 g/ha was studied at two locations, Exeter (2004 and 2005) and Ridgetown (2004) in Ontario. The eight market classes differed in their response to KIH-485. Generally, the small seeded market classes (black, otebo, pinto and white) were more sensitive to KIH-485 than the large seed market classes (brown, cranberry, kidney and yellow eye). The PRE application of KIH-485 at Ridgetown resulted in 67, 40, 33, 39, 59, 55, 65 and 44% visual crop injury 14 days after emergence (DAE) in black, brown, cranberry, kidney, otebo, pinto, white and yellow eye beans, respectively. Dry bean height 28 DAE at Ridgetown was 32, 22 and 17 cm and at Exeter (2004) was 24, 24 and 22 cm with the application of KIH-485 at 0, 209 and 418 g/ha, respectively. At Exeter in 2005, there was only a decrease in the height of brown and white beans. Bean dry weight 42 DAE at Ridgetown was 117, 90 and 63 g and at Exeter (2005) was 166, 156 and 142 g with the application of KIH-485 at 0, 209 and 418 g/ha, respectively. The maturity of black, otebo and pinto beans was delayed with the application of KIH-485 at Ridgetown. Dry bean yield at Ridgetown was 3.21, 2.84 and 2.33 T/ha and at Exeter (2004) was 3.00, 2.85 and 2.67 T/ha with the application of KIH-485 at 0, 209 and 418 g/ha, respectively. Based on these preliminary studies, the application of KIH-485 causes unacceptable visual crop injury and yield loss in dry beans.

IMPACT OF WINTER WEED MANAGEMENT AND CROP ROTATION ON WINTER ANNUAL WEEDS AND SCN. William G. Johnson and J. Earl Creech, Associate Professor and Graduate Research Assistant, Purdue University, West Lafayette, IN 47907.

Soybean cyst nematode (SCN) is a threat to profitable soybean production in Indiana and throughout the soybean growing regions of the U.S. Research has shown that a number of winter annual weed species can serve as alternative hosts for SCN. However, the importance of winter weed management in managing SCN has not been documented. The objective of this research was to evaluate the value of winter annual weed management on SCN population densities, winter annual weed populations, and soybean profitability. Long-term field experiments were established in fall 2003 at the Agronomy Center for Research and Education (ACRE) in West Lafayette, IN and at the Southwest Purdue Agricultural Center (SWPAC) in Vincennes, IN. The winter annual weed management regimes included (1) no control of winter annuals in the fall or spring, (2) control of winter annuals in both the fall and spring, (3) control of winter annuals in the fall but not the spring, (4) control of winter annual weeds in the spring but not the fall, (5) Italian ryegrass (*Lolium multiflorum*) cover crop, and (6) winter wheat (*Triticum aestivum*) cover crop. The SWPAC site has high weed and SCN pressure while the ACRE site has low weed and SCN pressure. The only significant treatment difference between the winter weed treatments on SCN population density after 1 year was the annual ryegrass cover crop at SWPAC where SCN was reduced from 5,940 to 3,480 eggs/100 cc soil. After 1 year, total winter annual weed seed in the soil seedbank was significantly lower in treatments where winter weed management tactics were utilized than the treatment were weeds were allowed to grow uninhibited. No significant soybean yield differences due to winter weed treatments were detected in 2004.

INFLUENCE OF FALL AND SPRING HERBICIDE APPLICATIONS ON WINTER AND SUMMER ANNUAL WEED POPULATIONS IN NO-TILL SOYBEAN. Nicholas H. Monnig and Kevin W. Bradley, Graduate Research Assistant and Assistant Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211.

Field experiments were conducted in the fall of 2004 through the summer of 2005 in central and northeast Missouri to evaluate the effects of fall and early spring herbicide applications on winter and summer annual weed populations. At each location, 0.023 kg/ha chlorimuron plus 0.12 kg/ha sulfentrazone plus 0.54 kg/ha 2, 4-D, 0.035 kg/ha chlorimuron plus 0.01 kg/ha tribenuron plus 0.54 kg/ha 2, 4-D, and 1.12 kg/ha glyphosate plus 0.54 kg/ha 2, 4-D were applied in the fall, 60, 30, and 7 days early preplant (EPP). At both locations, control of purslane speedwell (*Veronica peregrine* L.) at planting was greater than 80% with all herbicide treatments except glyphosate plus 2, 4-D in the fall. Glyphosate plus 2, 4-D applied 60 days EPP also provided significantly lower control of purslane speedwell at planting than the remaining treatments at the northeast location. Control of annual fleabane [Erigeron annuus (L.) Pers.] at the central location was greater than 93% with all treatments except those applied 7 day EPP. At this timing, all three herbicide treatments provided less than 77% annual fleabane control. At the northeast location, control of corn buttercup (*Ranunculus arvensis* L.) was greater than 80% with all treatments except chlorimuron plus tribenuron plus 2, 4-D applied 7 days EPP. Weed control ratings to evaluate summer annual weed control conducted four weeks after planting (WAP) at the central location revealed poor control of common waterhemp (*Amaranthus rudis* Sauer) with glyphosate plus 2, 4-D in the fall, 60, 30, and 7 days EPP, and also with chlorimuron plus tribenuron plus 2, 4-D in the fall, 60, and 30 days EPP. However, chlorimuron plus sulfentrazone plus 2, 4-D applied in the fall provided 68% control of common waterhemp 4 WAP, which was significantly better than either of the remaining fall herbicide treatments. All three spring applications of chlorimuron plus sulfentrazone plus 2, 4-D provided greater than 90% control of common waterhemp 4 WAP. Weed control ratings 4 WAP at this location correlated with emergence patterns of common waterhemp in response to each treatment. At the northeast location, control of giant foxtail (*Setaria faberi* Herrm.) was greater than 80% with all treatments except chlorimuron plus sulfentrazone plus 2, 4-D in the fall, and glyphosate plus 2, 4-D in the fall, 60, and 30 days EPP.

SOYBEAN CYST NEMATODE DEVELOPMENT ON PURPLE DEADNETTLE UNDER SELECTED WINTER TEMPERATURE REGIMES. J. Earl Creech, Andreas Westphal, and William G. Johnson, Graduate Research Assistant, Assistant Professor, and Associate Professor, Purdue University, West Lafayette, IN 47907.

Some soybean cyst nematode (SCN) juveniles have been documented to infect purple deadnettle roots too late to reach maturity in the fall. However, the fate of these juveniles is unknown. These purple deadnettle plants could be serving as a trap-crop for SCN if freezing winter temperatures kill the juveniles. On the other hand, if SCN enters a diapause as soil temps drop, growth and maturation could resume in the spring as soon as soil temperatures permit. The objective of this research was to assess the ability of SCN to survive cold temperatures then complete a lifecycle when favorable temperatures return. Purple deadnettle was planted in SCN infested soil and placed in a 20°C growth chamber for 20 days to allow SCN to penetrate and establish a feeding site inside the root. After the infection period, pots were transferred to 20, 15, 10, 5, and 0°C growth chambers where they were maintained for 10 or 20 days. Pots were then returned to the original 20°C growth chamber for 0 or 20 days of post-treatment growth. Plant and nematode development was measured following the completion of each post-treatment growth period. The experiment was arranged as a randomized complete block with 5 replications and was repeated twice. Nematode reproduction and purple deadnettle growth were reduced by cold temperature regimes. However, SCN development and cyst production was able to proceed to completion once pots were returned to a favorable temperature level. Thus, weed management programs that disrupt the purple deadnettle lifecycle in either the late fall or early spring may be necessary to prevent over-wintering SCN to reproduce in the spring.

DETERMINING THE DOSE DEPENDENCY OF SYNERGISM BETWEEN MESOTRIONE AND ATRAZINE. Josie A. Hugie, Dean E. Riechers, and Patrick J. Tranel, Graduate Research Assistant, Associate Professor and Associate Professor, University of Illinois, Urbana, IL 61801.

Previous research has demonstrated that mesotrione and atrazine can interact synergistically to enhance postemergence activity on broadleaf weeds. However, preliminary data have suggested that the synergism is inconsistent as herbicide doses vary. In order to better understand this apparent dose-dependency, mesotrione dose-response curves were generated where a range of mesotrione doses were applied with and without an approximate GR_{50} dose of atrazine – a dose in which 50% biomass is reduced. Doses of mesotrione ranged from 0.316 to 316 g/Ha mesotrione, and the dose of atrazine was held constant at 140 g/Ha. These mesotrione doses (with and without atrazine) were applied to four biotypes of *Amaranthus* spp., including triazine-susceptible and site-of-action based triazine-resistant biotypes of both tall waterhemp (*Amaranthus tuberculatus*) and redroot pigweed (*Amaranthus retroflexus*). Due to model constraints in Colby's equation, calculations of synergism are restricted to a range of certain growth response doses where values of expected injury must remain below biologically achievable injury levels. Analysis of aboveground biomass harvested 14 days after treatment suggested that one specific ratio between mesotrione and atrazine provided the most consistent synergistic interaction in herbicide sensitive waterhemp and redroot pigweed. Synergism was occasionally observed at several ratios surrounding the most synergistic treatment. Furthermore, in the triazine-resistant waterhemp and redroot pigweed, atrazine shifts the dose-response curve of mesotrione such that less mesotrione is necessary to reach a certain level of plant injury. This observation suggests that atrazine is contributing some activity in these triazine-resistant *Amaranthus* spp. Further studies involving fluorescence measurements and metabolite analysis will supplement and more thoroughly characterize the impact of atrazine, in the presence of mesotrione, in these triazine-resistant *Amaranthus* spp.

BUILDING A GLYPHOSATE FORMULATION FOR HARD WATER. Donald Penner, Jan Michael, Michigan State University, East Lansing, MI 48824-1325 and William G. Brown, Adjuvants Plus, Kingsville, Ontario, Canada N9Y2S5.

Maximum efficacy of glyphosate requires an activator adjuvant to enhance penetration of the glyphosate and a water conditioner to counter the cations found in hard water. The challenge is to combine the various components into a single product. Liquid formulations have the advantage that they can be pumped or poured. Dry formulations cost less to ship, reduce container deposit costs, and reduce worker exposure. Using a soluble bag within a bag can reduce registration costs. This study evaluated dry surfactants containing urea clathrates plus dry diammonium sulfate as the adjuvant components with dry glyphosate acid to form an all dry formulation to test on velvetleaf and common lambsquarters in the greenhouse. The urea clathrate, ATPLUS UCL 1007, was more effective than ATPLUS UCL S-10 or AL-3265. Weed control obtained with the dry formulation of glyphosate acid, ATPLUS UCL 1007, and diammonium sulfate was similar to that obtained with popular commercial liquid glyphosate products plus 2% diammonium sulfate under both greenhouse and field conditions. The results indicate that dry glyphosate formulated products can be as effective as liquid products and have the advantage of containing a water conditioner within the product.

THE AUXIN-REGULATED GENE *GH3* SPECIFICALLY DETECTS PLANT GROWTH REGULATOR HERBICIDE INJURY IN SOYBEANS. Kevin B. Kelley and Dean E. Riechers, Graduate Research Assistant and Associate Professor, University of Illinois, Urbana, IL 61801.

The expression of a candidate auxin-responsive gene was evaluated for developing a diagnostic assay for plant growth regulator (PGR) herbicide injury in soybean leaves. Expression of *GH3*, a primary auxin-responsive gene, was evaluated in response to dicamba and clopyralid at the RNA and protein levels, and proteomic analyses evaluated global expression profiles of proteins in response to dicamba. Expression of *GH3* was also analyzed in response to heat, drought, and salt stress, and infection by *Soybean mosaic virus* (SMV) and *Bean pod mottle virus* (BPMV), to determine the specificity of *GH3* expression as a diagnostic marker for PGR herbicide injury. At the RNA level, *GH3* was strongly induced by dicamba and clopyralid within 8 hours after application. Expression peaked 1 to 3 days after treatment (DAT) in response to 10% and 1% of a labeled dose of dicamba and clopyralid, with higher expression levels detected at higher herbicide rates. At the protein level, GH3 expression was also strongly induced at 1, 2 and 3 DAT by 10% versus 1% of a labeled dose of dicamba and clopyralid. Heat, drought, and salt stress, and infection with SMV or BPMV had no effect on *GH3* expression at either the RNA or protein levels. Proteomic analysis identified three proteins that were upregulated in response to dicamba. Two were induced for less than 7 DAT, and a third was identified as a general stress-response enzyme (superoxide dismutase) that is likely not specific to PGR herbicide injury. Expression of *GH3* was highly induced by PGR herbicides at the RNA and protein levels, and was not affected by abiotic stresses or viral infection, indicating that *GH3* expression has excellent potential for use in a diagnostic assay specific for PGR herbicide injury.

INHERITANCE OF PROTOX RESISTANCE IN COMMON WATERHEMP. Douglas E. Shoup, Kassim Al-Khatib, and Peter Kulakow, Graduate Research Assistant, Professor, and Research Assistant Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Common waterhemp resistance to protoporphyrinogen oxidase (protox)-inhibiting herbicides was first reported in northeast Kansas in 2001. The objectives of this research were to determine the inheritance of the protox-resistance trait. Resistant (R) and susceptible (S) common waterhemp were inbred using sib-mating for three generations in the greenhouse. After the third generation, R and S plants were crossed in a male and female reciprocal manner creating 57 F1 lines. A proportion of the F1 progeny were screened for resistance and the remaining progeny were used to create F2 and backcross lines. Over 500 F1 progeny were treated with 105 g ha^{-1} of lactofen when plants reached the 15 to 18 cm height. Visual injury ratings were determined at 14 days after treatment and based on a scale of 0 = no injury and 100 = mortality. A plant was considered to be R when visible injury was less than 50%. The remaining progeny from the F1 were either crossed to a sibling or back crossed to an S parent. Approximately 400 backcross progeny and 1440 F2 progeny were screened and rated for protox-resistance as described above. Approximately 93 and 92% of F1 progeny from R female × S male and S female × R male crosses, respectively, were scored as being resistant. There was no evidence of reciprocal differences in F1 or segregating generations indicating the resistance is dominant and contained in the nucleus. F2 progenies from individual crosses and pooled data supported a 3:1 genetic ratio using a Chi-squared goodness-of-fit test. In addition, backcross progenies supported a 1:1 ratio. These results indicate resistance to protox-inhibiting herbicides is determined by a single dominant nuclear gene.

MECHANISM OF RESISTANCE TO PPO-INHIBITING HERBICIDES IN WATERHEMP. Patrick J. Tranel, William L. Patzoldt, and Aaron G. Hager, Associate Professor, Postdoctoral Research Assistant, and Assistant Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Genes encoding protoporphyrinogen oxidase (PPO) were identified in waterhemp biotypes resistant (R) and sensitive (S) to PPO-inhibiting herbicides, and evaluated to determine if they accounted for the resistance phenotype. Using reverse transcriptase polymerase chain reactions (RT-PCRs), three cDNA clones with high sequence similarities to known PPO genes were isolated from waterhemp. One of the PPO genes, designated *PPX1*, was isolated from both the R and S biotypes and was most similar to genes encoding plastid-targeted PPOs. A second PPO gene, designated *PPX2S*, was isolated by RT-PCR only from the S biotype, and was most similar to genes encoding mitochondria-targeted PPOs. Southern blot analysis also indicated that *PPX2S* was present in the S but not the R biotype. The third PPO gene, *PPX2L*, which was isolated from both R and S biotypes, was nearly identical to *PPX2S*, with the exception that it contained a 90-basepair extension at the 5' end. Presumably, the 5' extension can result in dual targeting – via the presence of a second in-frame translation initiation codon – of the encoded PPO to plastids and mitochondria.

Several sequence polymorphisms between the R and S biotypes were identified in both *PPX1* and *PPX2L*. Molecular markers were developed and used to determine whether the allele found in the resistant plant for either of these genes co-segregated with the resistance phenotype in a backcross population. The *PPX2L* marker, but not the *PPX1* marker, was significantly correlated with resistance, indicating that the *PPX2L* allele was responsible for resistance. Sequencing of additional *PPX2L* alleles from other R and S plants allowed us to identify a single amino acid that was consistently different between R and S plants. Specifically, *PPX2L* from R compared with S plants encoded a protein lacking a glycine amino acid at position 210, which is predicted to be proximal to the herbicide-binding site of the enzyme.

Confirmation that the Gly_{210} deletion was the molecular basis for resistance to PPO-inhibiting herbicides was obtained using a transgenic approach. PPO enzymes that differed only in the presence/absence of Gly_{210} were expressed in a PPO mutant strain of *E. coli*. Both enzymes were able to complement the mutant *E. coli*; however, *E. coli* expressing the minus-Gly_{210} PPO grew in 10-fold or higher concentrations of lactofen compared with *E. coli* expressing the plus-Gly_{210} PPO. This is the first elucidation of the molecular basis for evolved resistance to PPO-inhibiting herbicides.

RESISTANCE TO ALS INHIBITORS IN FOXTAIL SPECIES. Danman Zheng, Dean S. Volenberg, Aaron G. Hager, and Patrick J. Tranel, Graduate Research Assistant, Postdoctoral Research Associate, Assistant Professor and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

The foxtails (*Setaria spp.*) are among the world's most successful colonizing weeds. Green foxtail, giant foxtail, and yellow foxtail biotypes from the North Central states have been reported to have evolved resistance to certain acetolactate synthase (ALS)-inhibiting herbicides. However, there is currently inadequate knowledge of these foxtail biotypes' mechanisms of resistance. Our objectives were to: 1) characterize resistance to imidazolinone (IMI) and sulfonylurea (SU) herbicides at the whole-plant and enzyme levels, 2) identify the molecular mechanism(s) of resistance and, 3) quantify the genome size and *ALS* gene copy number in the foxtail species.

ALS-resistant green and yellow foxtail biotypes were from Wisconsin (WI) and Minnesota (MN), respectively. Three ALS-resistant giant foxtail biotypes were obtained, one each from WI, MN and Illinois (IL). An ALS susceptible biotype of each foxtail species was obtained from each respective state.

Whole-plant dose-response experiments were conducted on three- to four leaf-stage foxtail plants. Compared to susceptible plants, the ALS herbicide resistant green foxtail plants were 9 and >411-fold resistant to nicosulfuron and imazamox, respectively. ALS herbicide resistant giant foxtail plants from WI were >3,600 and >600-fold resistant to nicosulfuron and imazamox, respectively. Similarly, ALS herbicide resistant giant foxtail plants from MN were >3,600 and >600-fold resistant to nicosulfuron and imazamox, respectively. In contrast, ALS herbicide resistant giant foxtail plants from IL were 1.6 and 81.2-fold resistant to nicosulfuron and imazamox, respectively. The ALS herbicide resistant yellow foxtail was 1.6 and 178-fold resistant to nicosulfuron and imazamox, respectively. Results of in vitro ALS enzyme activity assays corresponded with whole-plant dose-responses; however, the resistance ratio (resistant I_{50} / susceptible I_{50}) was an order of magnitude lower compared to the whole plant resistance ratio. Results from the in vitro ALS activity assays indicated that altered target sites were responsible for herbicide resistance in these foxtail biotypes.

Regions of the ALS gene were sequenced to determine what mutations were responsible for resistance. Specific primers were designed based on green foxtail *ALS* cDNA sequence and were used to amplify region A and B from each foxtail biotype. Sequence data showed that a polymorphism at position 653 correlated with the IMI-resistant phenotype in green and yellow foxtail, and in the giant foxtail biotype from IL. A leucine-for-tryptophan substitution at position 574 (L574W) of ALS was the mechanism of herbicide resistance in the giant foxtail biotypes from MN and WI.

Southern blot analysis indicated that green foxtail has one copy of *ALS*, however, both giant and yellow foxtail have two copies of *ALS*. Consistent with this, chromosome counts indicated that green foxtail is diploid (2X=18) whereas giant and yellow foxtail are tetraploid (4X=36).

PREEMERGENCE WEED CONTROL OPTIONS IN IRRIGATED POTATO. Harlene M Hatterman-Valenti* and Collin P Auwarter, Assistant Professor, and Research Specialist, Plant Sciences Department, NorthDakota State University,Fargo, Fargo, ND 58105.

A field trial was initiated during 2004 at the Northern Plains Potato Growers Association Irrigated Research site near Tappen, ND to evaluate season-long weed management options for irrigated Russet Burbank. Several herbicides have recently been registered for use on potato, which almost doubled the weed management options for growers. Russet Burbank 2 oz seed pieces were planted May 2 and hilled June 5. Herbicides were applied immediately following hilling to the middle two of four row plots with a CO2 pressurized sprayer equipped with 8002 flat fan nozzles with a spray volume of 20 GPA and a pressure of 30 psi. Green foxtail, redroot pigweed, common lambsquarters, and black nightshade seed were broadcast prior to hilling to increase weed pressure and species uniformity. Crop injury and efficacy evaluations on June 17 indicated that flumioxazin at 0.047 lb ai/A alone and in combination with other herbicides caused more injury than treatments with dimethenamid-P, EPTC, metoloachlor, metribuzin, pendimethalin, s-metolachlor, or sulfentrazone. Green foxtail control was greater than 85% for all treatments except EPTC at 4.38 lb ai/A + sulfentrazone at 0.047 lb ai/A. Similarly, all treatments provided greater than 90% redroot pigweed control except pedimethalin at 1.42 lb ai/A and all treatments provided greater than 90% common lambsquarters control except EPTC at 4.38 lb ai/A, dimethenamid-P at 0.98 lb ai/A, and s-metolachlor at 0.95 lb ai/A. By July 7 little potato injury was observed with any of the treatments while weed control evaluations were similar to those of June 17. On August 23 excellent green foxtail and redroot pigweed control was obtained by most of the herbicide treatments. Common lambsquarters control decreased below 85% for most of the herbicides applied alone with the exceptions of pendimethalin at 1.42 lb ai/A and flumioxazin at 0.047 lb ai/A.

Yield results indicated that the greatest total yield of 490 cwt/A occurred with EPTC + metribuzin followed by EPTC (4.38+0.5, 4.38 lb ai/A). Total yields were greater than 400 bags for all treatments except flumioxazin at 0.047 lb ai/A, dimethenamid-P at 0.7 lb ai/A, EPTC + flumioxazin (4.38+0.047 lb ai/A). The percentage of tubers at least 6 oz was greater than 70% when V-10142 or pendimethalin were applied at either 0.27 and 1.42 lb ai/A, respectively whereas the lowest percentage of tuber 6 oz or more occurred with flumioxazin at 0.047 lb ai/A. Yield results suggest that even though plants visually outgrew the initial injury with flumioxazin, the injury may have reduced the yield. French fry quality data and tuber sugar analysis will be conducted in the future to assess processing quality. Growers appear to have several weed management options for season-long control in irrigated potato.

EFFECT OF SIMULATED GLYPHOSATE DRIFT ON SEED POTATO. Harlene M Hatterman-Valenti*,Collin P Auwarter, and Paul G Mayland, Assistant Professor, and Research Specialists, Plant Sciences Department, North Dakota State University, Fargo, Fargo, ND 58105.

A field trial was initiated during 2004 at a NDSU Agriculture Experiment Station dryland site near Prosper, ND to evaluate the effect of simulated drift from glyphosate to Russet Burbank and Red Lasoda seed potato during early the early senescence stage. Glyphosate was applied at rates one-third, one-sixth, one-twelfth, one-twenty-fourth, and one-forty-eight the use rate for spring wheat desiccation on September 10, 2004 with a CO2 pressurized sprayer equipped with 8002 flat fan nozzles with a spray volume of 30 GPA and a pressure of 40 psi. The amount of AMS added to the spray solution was also reduced accordingly. Following harvest, samples from each plot were placed into cold storage until the following March. A subsample from each plot was slowly warmed to initiate sprout formation and the visual evaluation of bud break. The remaining samples were cut into 2 oz pieces with at least two eyes to each piece; dusted with a seed piece treatment, and stored at 65º F with approximately 90% RH until planted. Plots consisted of two 10 ft rows at 36 inch row spacing with a border row on each side and three spacer plants between plots. The trial was arranged as a randomized complete block with four replications. Extension recommendations were used for cultural practices. Plots were desiccated on September 5 and 12, and harvested September 21. Tubers were hand graded into the various categories shortly after harvest.

Results indicated that glyphosate at 0.0625 lb ae/A or more inhibited tuber bud break by 75% or more compared to untreated. In the field, injury was observed as delayed emergence and in several instances, no plants emerged. Total yield for Red Lasoda was 311 cwt/A for the untreated which was significantly greater than glyphosate treatments of 0.25, 0.125, and 0.0625 lb ae/A. Yield from marketable tubers (> 4 oz) were similar indicating that the injury suppressed tuber initiation and bulking. Russet Burbank total yield was considerably less at 210 cwt/A for the untreated. Both the untreated and glyphosate at 0.0156 lb ae/A had significantly greater total yields compared to glyphosate treatments of 0.25, 0.125, and 0.0625 lb ae/A. Results for marketable tubers mimic those for total yield. The trial will be repeated in 2006.

KOCHIA AND COMMON LAMBSQUARTERS CONTROL IN SUGARBEET. Alan G. Dexter and John L. Luecke, Professor and Research Specialist, Plant Sciences Department, North Dakota State University and University of Minnesota, Fargo, ND 58105.

Sugarbeet growers in Minnesota and eastern North Dakota were asked on a survey to identify their worst weed in sugarbeet in 2003. Kochia was named worst weed by 46% and common lambsquarters by 18% of the respondents.

Eighteen herbicide treatments were applied to sugarbeet at seven locations in western Minnesota and eastern North Dakota in 2004 with the objective of measuring kochia and common lambsquarters control from the treatments.

Desmedipham & phenmedipham & ethofumesate at 0.08 lb/A plus triflusulfuron at 0.004 lb/A plus clopyralid at 0.03 lb/A plus clethodim at 0.03 lb/A plus methylated seed oil adjuvant at 1.5% v/v was the postemergence micro-rate treatment applied three or four times at a seven-day interval. Desmedipham & phenmedipham & ethofumesate at 0.25 (time 1)/0.33 (time 2)/0.5 (time 3) lb/A plus triflusulfuron at 0.008 lb/A plus clopyralid at 0.06 lb/A plus clethodim at 0.047 lb/A was the postemergence conventional-rate treatment applied three times without adjuvant at a seven-day interval. When the conventional-rate was applied four times, the rate of desmedipham & phenmedipham & ethofumesate was 0.25 (time 1) followed by 0.33 (time 2 through 4) lb/A: the clethodim rate was 0.03 lb/A and the other rates remained the same.

All treatments gave 98% or greater control of common lambsquarters at five of the six locations where common lambsquarters was present. However, at Morris, Minnesota, a separation among treatments was observed. The micro-rate applied three times gave only 72% control of common lambsquarters and four applications gave 79% control. Adding extra ethofumesate at 0.09 lb/A to each of four micro-rate applications gave 99% common lambsquarters control. The conventional-rate applied three or four times gave 99 to 100% control. Metamitron at 1.5 lb/A plus the micro-rate applied four times gave 100% control of common lambsquarters but sugarbeet injury also was increased from 8% with the micro-rate alone to 23% with the micro-rate plus metamitron.

Kochia control was evaluated at two locations in 2004. Nearly all plants were resistant to ALS-inhibitor herbicides. The micro-rate applied three times gave only 26% kochia control and four applications gave 48% control. The conventional-rate applied three times gave 73% kochia control and four applications gave 76% control. Preemergence ethofumesate at 3.0 lb/A followed by four micro-rate applications gave 72% kochia control. The best observed kochia control was from preemergence ethofumesate at 3.0 lb/A followed by four conventional-rate applications which gave 94% control. However, the cost of this treatment would be $270 per acre broadcast. Metamitron at 1.5 lb/A plus the micro-rate applied four times gave 85% kochia control compared to 48% from the micro-rate alone.

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RESPONSE OF SUGARBEET VARIETIES TO HERBICIDES. Aaron L. Carlson, Alan G. Dexter, and John L. Luecke, Graduate Research Assistant, Professor, and Research Specialist, Plant Sciences Department, North Dakota State University and University of Minnesota, Fargo, ND 58105.

Sugarbeet varieties have been shown to differ in their susceptibility to postemergence herbicides. Seeding rhizomania-resistant varieties and extending years between sugarbeet crops are the only methods to manage the sugarbeet root disease rhizomania. Rhizomania was first detected in sugarbeet growing regions of North Dakota and Minnesota in the mid 1990s. Respondents to an annual survey of sugarbeet growers in Minnesota and eastern North Dakota indicated that about 12 % of their acreage was affected by rhizomania in 2004 but the affected acreage is increasing each year. Concerns have been raised about the susceptibility of rhizomania-resistant varieties to registered sugarbeet herbicides.

Experiments were carried out in 2004 and 2005 in western Minnesota and eastern North Dakota to determine if varieties with resistance to rhizomania differ in susceptibility to registered sugarbeet herbicides compared to varieties without this resistance. Eight sugarbeet varieties were evaluated. Six varieties were considered rhizomania resistant and two varieties were conventional (non rhizomania-resistant). Three postemergence (POST) herbicide regimes consisting of micro-rate herbicides applied either three or six times or conventional-rate herbicides applied four times at seven-day intervals. The micro-rate consisted of desmedipham & phenmedipham at 0.09 kg/ha plus triflusulfuron at 0.0045 kg/ha plus clopyralid at 0.034 kg/ha plus clethodim at 0.034 kg/ha plus methylated seed oil adjuvant at 1.5% v/v. The conventional-rate consisted of desmedipham & phenmedipham at 0.28 (time 1)/0.37 (time 2 & 3)/0.56 (time 4) kg/ha plus triflusulfuron at 0.009 kg/ha plus clopyralid at 0.067 kg/ha plus clethodim at 0.053 kg/ha.

Herbicide by variety interactions were not significant for any of the analyzed factors. However, varietal differences were observed. When averaged across all herbicide regimes, the rhizomania-resistant variety ‘Van der Have H46519’ showed the greatest injury ranging from 8 to 18 % at three of four locations. At the fourth location, treated sugarbeet of all varieties failed to exhibit injury and were not included in the analysis of injury. At one location rhizomania-resistant varieties tended to show greater sugarbeet injury than conventional varieties; although only one resistant variety, Van der Have H46519, showed significantly greater injury. At a second location, rhizomania-resistant varieties tended to show less injury than conventional varieties although only one resistant variety, ‘Van der Have H46177’, showed significantly less injury. When averaged across all varieties, the micro-rate applied six times gave 6 to 8 % sugarbeet injury at all locations. This was the least injury of the three POST herbicide regimes at two locations but the greatest injury at one location. Van der Have H46519 gave the largest root yield when averaged across all herbicide regimes at all locations. At three of four locations, root yields were similar for four of the rhizomania-resistant varieties and the two conventional varieties. Five of six rhizomania-resistant varieties gave significantly larger root yields than conventional varieties at the fourth location. This suggests that rhizomania may have been present at this location even though symptoms were not visible. When averaged across all herbicide regimes, conventional varieties had higher sugar content compared to rhizomania-resistant varieties at all locations. Van der Have H46519 gave the highest extractable sucrose per hectare when averaged across all herbicide regimes at all locations. When averaged across all locations and varieties, sugarbeet treated with three applications of the micro-rate yielded significantly higher extractable sucrose per hectare than those treated with six applications of the micro-rate or four applications of the conventional-rate. Sugarbeet treated with six applications of the micro-rate or four applications of the conventional rate gave similar extractable sucrose per hectare.

HERBICIDES AS ALTERNATIVES TO METHYL-BROMIDE FOR WEED CONTROL IN DAYLILY, AJUGA, and PERWINKLE. Daniel A. Little[1]*, Robert J. Richardson[2], and Bernard H. Zandstra[1], [1]Department of Horticulture, Michigan State Univ., East Lansing, MI, [2]Crop Science Department, North Carolina State Univ., Raleigh, NC.

The methyl-bromide (MeBr) phaseout has reduced the ability of ornamental growers to adequately control weeds. In 2004 and 2005, field and greenhouse studies were conducted to evaluate herbicides as alternatives to MeBr in nursery production. A standard control treatment of MeBr/chloropicrin (67:33) was applied at a rate of 392 kg/ha. The herbicides tested were granular flumioxazin (.28 kg ai/ha), granular oxadiazon (2.24 kg/ha), isoxaben (1.12 kg/ha), isoxaben plus dithiopyr (.28 kg/ha), isoxaben plus metolachlor (1.68 kg/ha), isoxaben plus oryzalin (3.36 kg/ha), dithiopyr (.28 kg/ha), metolachlor plus mesotrione (.28 kg/ha), metolachlor, granular pendimethlin (1.4 kg/ha) plus oxadiazon and an untreated control. Weeds present included large crabgrass, redroot pigweed, common ragweed, common lambsquarters and others. Crop injury and weed control were visually rated on a 0-100% scale, with 0% equal to no crop injury or no weed control and 100% equal to complete crop or weed death. The granular treatments and treatments containing metolachlor caused the most visible injury to the Ajugas, with injury up to 68% in the field and 83% in the greenhouse. In one field, the treatments of oxadiazon, flumioxazin, isoxaben plus metolachlor and metolachlor significantly reduced plant size of Ajuga compared to MeBr treatment, and in the other field all treatments reduced plant size. Some blade twisting was seen on daylilies with treatments containing metolachlor, oxadiazon and flumioxazin, but no reduction in plant growth was observed. Visual injury was rarely seen in Periwinkle, usually less than 10%, but seven treatments showed a decrease in plant size in the 2005 field. Many treatments had 80% or better control over a range of the weeds observed with flumioxazin and treatments containing metolachlor having the most promise. No treatment tested provided broadspectrum weed control and crop safety equivalent to MeBr.

INFLUENCE OF HALOSLFURON, GRASS HERBICIDES, AND ADJUVANTS ON JACK-O-LANTERN INJURY, YIELD, AND WEED CONTROL. Kate J. Kammler, S. Alan Walters, and Bryan G. Young. Graduate Research Assistant and Associate Professors, Plant, Soil and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Pumpkin production can be a successful economic endeavor, but weed control is a major issue that growers must address due to the limited herbicide options available for weed control. Many of the current registered herbicides have problems due to their potential crop injury, high cost, and inadequate weed control. Field studies were conducted in 2004 and 2005 to evaluate halosulfuron with the grass herbicides sethoxydim and clethodim, and various adjuvants in tank-mixtures in an attempt to identify better management practices for weed control in pumpkins. Treatments were evaluated for crop injury, weed control, and pumpkin yields.

Following the applications of the tank-mixed herbicides and adjuvants, pumpkin plant injury at 28 days after treatment (DAT) was 14% with halosulfuron alone, 20% with halosulfuron + sethoxydim, 16% with halosulfuron + clethodim compared with less than 8% injury for the grass herbicides applied alone. The addition of oil-based adjuvants to halosulfuron did not increase pumpkin injury compared with using a nonionic surfactant. Redroot pigweed control was reduced from 86% with halosulfuron alone to 66% with halosulfuron + sethoxydim and 42% with halosulfuron + clethodim. In these instances, the application of the grass herbicides effectively removed the grass competition and may have allowed for more growth or emergence of pigweed. The addition of halosulfuron to sethoxydim did not antagonize control of smooth crabgrass, regardless of adjuvant. The addition of halosulfuron to clethodim reduced control of smooth crabgrass from 87% for clethodim applied alone to 73% for the tank-mixture when applied with nonionic surfactant. However, applying halosulfuron + clethodim with a crop oil concentrate or an oil/surfactant blend did not result in any antagonism of smooth crabgrass control compared with clethodim applied alone with the respective adjuvants. No herbicide treatments provided similar pumpkin yields to the handweeded control. The yield of any treatments that utilized postemergence herbicides was at least 50% less than the handweeded. The low yields were possibly related to a combination of pumpkin injury from the herbicide applications and from insufficient weed control. Therefore, improvements in pumpkin weed management are still necessary for growers to realize maximum yields and profit.

EFFECT OF HERBICIDE-FUNGICIDE TANK-MIX COMBINATIONS ON WEED CONTROL AND TOMATO TOLERANCE. Darren E. Robinson and Allan S. Hamill, 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 from 2002 2004 to compare the effect of herbicide-fungicide tank mixtures on weed control, tomato visual injury, and tomato yield. In each trial, one half of each plot was kept weed-free by handweeding to test for visual injury and tomato 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 tomato yield. Treatments included rimsulfuron (15 and 30 g a.i. ha^{-1}), thifensulfuron (6 and 12 g a.i. ha^{-1}), metribuzin (150 and 300 g a.i. ha^{-1}), rimsulfuron+metribuzin (15+150 and 30+300 g a.i. ha^{-1}), or thifensulfuron+metribuzin (6+150 and 12+300 g a.i. ha^{-1}) alone or with either chlorothalonil (1600 g a.i. ha^{-1}) or chlorothalonil+copper (1600+2200 g a.i. ha^{-1}). Untreated weed-free and weedy checks were included for comparison. In one of the study years, visual injury was observed at 7 days after treatment (DAT) in the rimsulfuron+metribuzin and thifensulfuron+metribuzin treatments, but by 28 DAT the plants had outgrown the injury. The addition of chlorothalonil or chlorothalonil+copper did not increase visual injury, and did not reduce tomato yield in the weed-free portion of the trial. The addition of chlorothalonil did not reduce weed control in any of the treatments. However, the addition of chlorothalonil+copper reduced control of velvetleaf (*Abutilon theophrasti* Medic.) control in the thifensulfuron and rimsulfuron+metribuzin treatments, and common lamb’s-quarters (*Chenopodium album* L.) control in the thifensulfuron treatment. These reductions in weed control corresponded to a yield reduction in the thifensulfuron and rimsulfuron+metribuzin treatments when chlorothalonil+copper were added to the herbicide treatments.

CROP TOLERANCE OF TOMATOES, SNAP BEANS AND CUCUMBERS TO SANDEA AND TARGA. David E. Hillger, Kevin D. Gibson and Stephen C. Weller, Graduate Research Assistant, Assistant Professor, and Professor, Purdue University, West Lafayette, IN 47907.

Weed control remains a major pest control challenge in U.S. vegetable production. Effective management systems must include a balanced program of scouting, cultural, mechanical, and chemical weed control techniques. Sandea (halosulfuron-methyl), an ALS enzyme inhibiting herbicide, is effective on many large-seeded broadleaf and sedge weeds. When applied preemergence and postemergence, it controls common cocklebur, corn spurry, galinsoga, smartweed spp., wild mustard, nutsedge spp., pigweed spp., ragweed spp., common sunflower, and velvetleaf. Halosulfuron-methyl has been registered for several years for use in field corn and turf, and has recently been approved for use as a preemergence and postemergence herbicide for many vegetables including: tomatoes, cucumbers, cucurbits, snap beans, asparagus, dry beans, sweet corn, and for application between rows in gourd, eggplant, tomatillo, and pepper. Targa, (quizalofop-P-ethyl) is an ACCase enzyme inhibitor that controls annual and perennial grasses in canola, crambe, cotton, dry beans, dry and succulent peas, lentils, mint (spearmint and peppermint), snap beans, soybeans, sugar beets, and non-crop areas. In these experiments, Sandea was applied in tomatoes, snap beans, and cucumbers and provided excellent pigweed, velvetleaf, and lambsquarters control when applied preemergence. Good postemergence control of pigweed, velvetleaf, and morningglory spp. was obtained and there was only a temporary yellowing (3-5 days) of the growing regions. Sandea did not control grass weeds with either the preemergence or postemergence application. In a vegetable field where grass weeds are present, an herbicide is needed to supplement Sandea for control of those species. Targa provided excellent annual grass control with no observed crop injury in tomatoes and snap beans when applied postemergence in combination with a preemergence application of Sandea. Targa offers additional flexibility for excellent postemergence grass control without a measurable yield loss and can compliment broadleaf herbicides for broader spectrum weed control.

WEED MANAGEMENT SYSTEMS IN TOMATO PRODUCTION. David E. Hillger, Stephen C. Weller, Elizabeth Maynard, and Kevin D. Gibson, Graduate Research Assistant, Assistant Professor, and Professor, Purdue University, West Lafayette, IN 47907.

Although weed communities respond to the cumulative effect of farm management systems, the influence of management practices at a system level are rarely studied in weed science. On-farm visits and detailed grower surveys were used to objectively classify 66 Indiana tomato fields into management systems. Fields were chosen to represent a mix of fresh market and processing fields that used herbicides or were organically managed. Multivariate statistical analyses identified five distinct management systems where differences existed in practices involving hours spent hand-weeding, whether the farmer used plastic mulch or irrigation, type of row spacing and whether tomatoes were staked. Fields were sampled during the 2003 and 2004 season for weeds and relationships between weed communities and the management systems examined. Conventional and organic fresh market systems had greater weed densities and more diversity of weed species than conventional processing farms. However, organic fresh market fields were not weedier than conventional fresh market. Although some weed species were common to all systems, each management system had problematic weed species that were related to management practices unique to that system. For example, barnyardgrass, goosegrass, and yellow nutsedge were strongly associated with the organic fresh market system. However, eastern black nightshade was common in all conventional systems but not present in the organic system. The association of weed species with particular systems suggests that species become well-adapted to specific weed management practices in a particular system. Further research on rotational schemes and past weed management practices are planned to further delineate weed management practices on species abundance.

SWEET CORN HYBRID TOLERANCE TO MESOTRIONE, NICOSULFURON, AND FORAMSULFURON. Joseph D. Bollman, Chris M. Boerboom, Don W. Morishita, Mark J. VanGessel, Robin R. Bellinder, Grant L. Jordan, and Wayne Cooley, Graduate Research Assistant, Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706, Professor, University of Idaho, Twin Falls, ID 83303, Professor, University of Delaware, Georgetown, DE 19947, Professor, Cornell University, Ithaca, NY, 14852, Researcher, A.C.D.S. Research, North Rose, NY, 14516, Extension Agent, Colorado State University, Delta, CO 81416.

A limited number of herbicides are labeled for postemergence application in sweet corn. Nicosulfuron and mesotrione are labeled and foramsulfuron is being developed for sweet corn, but each can injure sweet corn depending hybrid tolerance and environmental conditions at the time of application. A field study was conducted in 2005 to determine sweet corn hybrid tolerance to nicosulfuron, foramsulfuron, and mesotrione at twice labeled rates. The experimental design was split plot arrangement with eight replications where each replication was at a separate site. Sites were located in Idaho (2), Colorado (1), Wisconsin (3), Delaware (1), and New York (1). The main plot in the study was herbicide treatment and the subplot was sweet corn hybrid. One hundred fourteen hybrids were evaluated and included four endosperm types, normal, sugary enhanced, shrunken 2, and synergistic. The hybrids were planted in six ranges with 6-m long single-row plots in a non-randomized strip plot arrangement. The sweet corn that was planted in the alternate ranges served as a non-treated control to evaluate crop injury. The hybrids were randomized in the strip plots among each of the locations. Herbicide treatments were 70 g ai/ha nicosulfuron plus 1% v/v crop oil concentrate and 2.2 kg/ha ammonium sulfate, 74 g ai/ha foramsulfuron plus 1.8 L/ha methylated seed oil and 2.2 kg/ha ammonium sulfate, and 210 g/ha mesotrione plus 1% v/v crop oil concentrate. Treatments were applied at the V3 crop growth stage. Nicosulfuron and foramsulfuron were evaluated for percent stunting while mesotrione was evaluated for percent chlorosis at 7 and 14 days after treatment (DAT). A preemergence herbicide treatment was applied to the entire experiment to prevent early season weed competition.

Stunting from nicosulfuron ranged from 1 to 59% at 7 DAT and from 0 to 97% at 14 DAT. At 7 DAT, 23 hybrids had stunting greater than 10% compared with 18 hybrids at 14 DAT. Individual hybrid stunting varied among locations by as much as 60% at 7 DAT. Stunting from foramsulfuron ranged from 3 to 57% at 7 DAT and from 1 to 99% at 14 DAT. At 7 DAT, 48 hybrids had stunting greater than 10% compared with 16 hybrids at 14 DAT. Individual hybrid stunting varied among locations as much as 100% at 7 DAT. Chlorosis from mesotrione ranged from 1 to 32% at 7 DAT and from 0 to 21% at 14 DAT. At 7 DAT, 9 hybrids had chlorosis greater than 10% compared to 4 hybrids at 14 DAT. Individual hybrid chlorosis varied among locations as much as 70% at 7 DAT. For all three herbicides and at both dates, 'Merit' was the most sensitive hybrid followed by 'EX 08705770'.

A strong correlation existed between nicosulfuron and foramsulfuron injury with a R^2- value of 0.76. Crop injury typically was greater with foramsulfuron than with nicosulfuron. A strong correlation between nicosulfuron and mesotrione injury also existed with a R^2 - value of 0.67. All endosperm types were susceptible to injury from each herbicide, which suggests that the tolerance of sweet corn hybrids should be evaluated regardless of endosperm type.

Foramsulfuron caused greater than 10% injury to four hybrids at the three western sites while nicosulfuron and mesotrione did not injure any hybrid at this level. The four eastern sites had 43, 74, and 24 hybrids with over 10% injury from nicosulfuron, foramsulfuron, and mesotrione respectively. The environmental condition that increased the amount of crop injury likely was the higher relative humidity at the eastern locations.

THE BIOLOGY AND MANAGEMENT OF *SERICEA LESPEDEZA.* Bill Scott, Kansas State Weed Specialist.

Sericea lespedeza (*Lespedeza cuneata*) was introduced into the United States in 1896 as a potential forage crop in the southeastern US. Widespread planting for wildlife benefit and erosion control began in the 1940's. The invasive qualities of sericea lespedeza were recognized in Kansas in 1987 and it was added to the Kansas Noxious Weed Law as a county option noxious weed. In 2000 the Kansas Legislature moved sericea lespedeza to the state wide noxious weed list and listed it in the Kansas Seed Law as a prohibited noxious weed. Herbicide controls exist and when combined with mechanical and grazing options, offer the producer effective management choices. The Multi-State Sericea Lespedeza Work Group, formed in 2000, continues as a means for public agencies and private landowners to share information.

CANADA THISTLE: AREN'T WE THERE YET? Jerry D. Doll, Weed Scientist Emeritus, Univ. of Wisconsin, Department of Agronomy, Madison, WI 53706.

Canada thistle is an amazing plant. While not native to North America, it is found in all but eight of the US states(including Alaska) and in all the Canadian provinces. Thus it has long been the target of control efforts in North America by any and all means and is a legally declared noxious weed in more states (26) and provinces than probably any other plant species. Yet Canada thistle persists as an important weed. We know much regarding Canada thistle’s growth, development, biotypes, carbohydrate physiology, morphology, reproduction and more, and yet it seems the weed is smarter than we. A complete review of the importance, biology and management of Canada thistle as of 25 years ago is found in the Proceedings of the 1981 North Central Weed Control Conference (Vol. 36, pages 152 to 182; copies available from the NCWSS headquarters).

Canada thistle is less abundant in cropped land today than in recent memory. The adoption of no tillage systems coupled with glyphosate resistant crops has resulted near eradication of Canada thistle on many farms. A three-step program is recommended to control this and other perennial broadleaf weeds in glyphosate resistant varieties/hybrids: 1) use a no tillage system; 2) apply a reduced rate of a soil-active herbicide in preemergence to suppress annual weeds for 3 to 4 weeks; 3) apply glyphosate to Canada thistle when plants reach the early flowering stage or are 24 inches tall, whichever occurs first. Using these practices for 2 to 3 years will significantly reduce Canada thistle abundance.

While great strides have been made in cropping systems, the same is not true for pastures, roadsides, CRP fields and other non-disturbed sites. Part of the reason is that soil disturbance and interference from a highly competitive crop are absent in these habitats. Even though we have very effective herbicides to apply in areas where grass is desired (pastures and roadsides for example), it is rare that one would claim eradication of Canada thistle in these sites. Mowing Canada thistle in grassy areas reduces seed production but rarely achieves long term reductions in abundance or area infested because the frequency of mowing is usually once a year which has minimal impact on long-term survival.

Canada thistle hosts several diseases. One of these, *Pseudomonas syringae pv. tagetis* (PST), occurs naturally and is noted by the chlorotic leaves and stems (caused by a toxin, tagetitoxin, produced by the bacteria which prevents chloroplast biogenesis) on the upper regions of some plants. Efforts to enhance the severity and percentage of infection usually have been unsuccessful in achieving disease levels that would cause plants to die. Perhaps combining the impact of PST with that of rust or phoma, which also attacks Canada thistle, would be more effective. This hypothesis needs testing.

The impact of animals on Canada thistle infestations is unclear. In some pastures, graziers observe a decline in Canada thistle abundance; others report that Canada thistle responds as well or better to improved pasture management practices than the forage species. Do some animal species have more impact on Canada thistle than others? Is there a particular sequence of mowing and grazing events that is more detrimental to Canada thistle than others? Are the timing and frequency of grazing related to thistle abundance? How do soil moisture levels and temperatures relate to thistle survival under grazing and mowing regimes? Could the presence of plant diseases in Canada thistle add to its demise in grazing environments? Little is known about any of these questions.

New herbicides continue to be tested for Canada thistle control. The additive diflufenzopyr synergizes dicamba, so that much less dicamba is needed when applied in combination with it. Unfortunately, this seldom results in Canada thistle control as effective as that obtained with the more expensive option, clopyralid. Research to evaluate the effectiveness of diflufenzopyr with lower rates of clopyralid to achieve the same control as conventional use rates is promising. An even more promising and economical herbicide is aminopyralid. This newly developed and registered herbicide (received EPA approval in August 2005) is chemically related to clopyralid, but is at least four times more active molecule for molecule. It will be available for use in pastures, rangeland, CRP sites and non-crop areas such as roadsides in 2006. Long term field evaluations are needed to determine its impact on Canada thistle over time. The approval of glyphosate resistant alfalfa (also in 2005) gives another option to manage Canada thistle infestations in pastures. Producers could plant glyphosate resistant alfalfa, graze the site as appropriate, and hopefully achieve the same level of thistle control observed in glyphosate resistant soybean and corn systems. If and when Canada thistle is eradicated, other forage species could be reintroduced into the site as desired.

A weed that has survived control and management strategies for centuries will most likely continue to persist on the landscape. Sustained efforts to prevent, detect, contain, and control infestations are needed. Perhaps the NCWSS will someday have a symposium on “former noxious weeds” that would include Canada thistle. Until then, on-going attention to this and other invasive species should not wane. Perhaps one day we will indeed say, “Yes, we have arrived at our destination. The trip is over.”

THE BIOLGY AND MANAGEMENT OF GARLIC MUSTARD. David Borneman, Natural Area Preservation Manager, Ann Arbor, MI.

Garlic mustard (*Alliaria petiolata*) is a biennial herb introduced from Europe in the mid-19th century for food and medicinal purposes. In the central and eastern part of the US and adjacent Canada, it has proven highly invasive, especially in moist woodlands where it displaces native wildflowers. Garlic mustard spreads only by seeds, which are dispersed mainly by water, people, or on the fur or feet of animals. For small infestations, hand-pulling every year until the seedbank is depleted can be an effective strategy. But this quickly becomes impractical as populations grow. Burning and cutting have been tried with mixed results. Others have found effective control with various herbicides including glyphosate, triclorpyr, and 2,4-D. For many frustrated land managers, hope lies in four weevils (*Ceutorhynchus* sp.) being developed as biocontrol agents. This talk will address the natural history of garlic mustard, the pros and cons of various control strategies, and an update on biocontrol efforts.

ASIAN BUSH HONEYSUCKLES: THEIR HISTORY, BIOLOGY, ECOLOGY AND CONTROL. Ron Rathfon, Purdue University.

Asian bush honeysuckles (*Lonicera maackii, L. morrowii, and L. tartarica*) have proved extremely invasive in eastern hardwood forests. In addition to displacing native forest ground flora and associated fauna, these understory shrubs pose a threat to forest regeneration. Effective control strategies need to be developed to incorporate into routine silvicultural prescriptions for affected stands. The history of the Asian bush honeysuckles' introduction and spread in North America, their biology and ecology, as well as control options will be presented.

USING A NET FITNESS APPROACH TO ASSESS INTROGRESSION POTENTIAL: MODELS MEET DATA. Arthur E. Weis* and Amanda Dick; Univ. of California, Irvine.92697.

Risk assessment models rely on realistic estimates of key parameters. In the case of introgression of tansgenes out of crops and into wild relatives, the key parameters include the reproductive fitness of crop, relative and their various hybrid generations. Experiments to measure fitness can be prospective or retrospective. In prospective experiments a single generation of the appropriate genetic constructs are raised for a single generation; reproductive output is then quantified as the number of pollen produced or seeds set. These estimates may give an accurate picture of how a transgene will increase or decrease in frequency, but not inevitably so. Actual hybridization and introgression rates will not only be influenced by the number of gametes made or offspring produced, but also by the competitive ability of the gametes in fertilization and by the timing of gamete production. We implemented a net-fitness approach to asses male fitness (fertilization success) and temporal assortative mating. This retrospective method relies on a two-generation study design. Genotype frequencies are determined in both the parental and offspring generations. Maximum likelihood methods are then used to find the most probable values for fitness components and for the levels of assortative mating. The two generation structure in effect allows natural selection to run for a single generation, and thus the estimates are the "pudding" in which the proof lies. A simple example using rapid cycling *Brassica* as a model system for the method will be presented, as well as a discussion of problems in its application.

BIOINFORMATICS FOR ASSESSMENT OF REPRODUCTIVE COMPATIBILITY BETWEEN CROPS AND THEIR RELATIVES. Richard G. FitzJohn, Aaron D. Wilton, Tristan T. Armstrong and Linda E. Newstrom, Researchers, Landcare Research, Lincoln 8152, New Zealand.

Risk assessments of transgenic plants often rely on analyses of existing bodies of data; as the quantity of available data continues to expand, a major challenge is bringing information together in a format that can be conveniently updated and then reanalysed in future. Data may come in a variety of formats, and may be reported with varying levels of detail and accuracy. Moreover, depending on the required analysis, different pools of data may be appropriate to use.

We have designed an attributes database to address these challenges. Our primary design principles were that information should be entered with the least modification possible, and that information be clearly linked to its source. In particular, information is captured in a way that is entirely separate from its analysis and presentation, allowing for completely alternative use of the data in the future. Central to our database is an entity management system, which allows differentiation of taxon names at any taxonomic rank, common name and/or cultivar. In comparison with conventional databases, variables are easy to add, ordered hierarchically, and associated with metadata to facilitate information organisation.

We have applied our database to collecting and analysing published information on hybridisation between crops and their relatives, focusing on *Brassica* and allied genera. We distinguished between experimental hybridisation (manual cross-pollination), spontaneous hybridisation (unassisted pollination), and studies using *in vitro* methods (e.g. embryo rescue), and between different generations (F_1, F_2 and BC_1). In total, we databased 322 papers documenting hybridisation among species in *Brassica* and allied genera, covering 216 species combinations. We have also applied our approach to eight other crop groups, the largest of which was onion and related crops in *Allium* (34 papers). Because data from hybridisation experiments are reported in a wide variety of formats, substantial effort was required to standardise them. To deal with this, we developed a framework for extracting, analysing and presenting hybridisation data. Such transformations are required to present complex data regardless of method of storage, but our approach makes these transformations explicit.

A key advantage of our approach is that by retaining as much information as possible, decisions that affect the quantity of data available can be made at analysis rather than collection, and be based on the needs of the analysis. This increases transparency and repeatability of analyses, and allows future analyses to use alternative transformations. Using a database approach increases the ease of reusing data, and with more data available in this form some of the international duplication of effort in assembling and updating information could be avoided.

IMPORTANCE OF USING DIVERSE GERMPLASM AND MULTIPLE CONDITIONS TO UNDERSTAND THE EVOLUTIONARY CONSEQUENCES OF CROP-WILD GENE FLOW. Kristin L. Mercer[1], Ruth G. Shaw[2], and Donald L. Wyse[2], [1]Postdoctoral Research Fellow, Ohio State University, Columbus, Ohio 43210; [2]Professor, University of Minnesota, St. Paul, MN 55108.

Due to neutral or adaptive genetic divergence of populations within a species, plant populations can be differentiated in their phenotypes. Divergent environmental conditions and GxE interactions can further alter the phenotypic expression of plant characteristics, including fitness. In each crop-wild gene flow scenario, different wild populations and crop lines hybridize and the resulting hybrids may be found in different environmental conditions. These factors affect fitness and could shape the relative fitness of hybrid and wild individuals, resulting in variable amounts of crop gene introgression across hybrid zones. In our research in sunflower, the use of nine wild populations, three crop lines, and four environments helped to elucidate environmental conditions where crop gene introgression may be more likely for certain genotypes by investigating relative fitness. This perspective is essential to understanding the range of evolutionary outcomes of crop-wild gene flow, including understanding where crop gene introgression may be more or less problematic. Although there are experimental design and resource concerns regarding the use of numerous genotypes and multiple environmental conditions, if studies investigating the biosafety risks of transgenic crops do not integrate this complexity, the resulting policy will be made using erroneously simplistic data. For policy to more closely reflect biological complexity, it must emphasize the quantitative range of possible gene flow outcomes, not only a qualitative description of risk determined from a narrow pool of genotypes and environments.

GENE FLOW FROM GLYPHOSATE RESISTANT CREEPING BENTGRASS FIELDS: MIGRATION VS. MITIGATION. Carol Mallory-Smith, Maria Zapiola, Claudia Campbell, and Marvin Butler, Professor, Graduate Student, Faculty Research Assistant, and Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331.

The Oregon Department of Agriculture approved a 4500 ha control area for the production of transgenic creeping bentgrass *(Agrostis stolinifera* L.). In 2002, 160 ha in Central Oregon were seeded to Roundup Ready® (glyphosate resistant) creeping bentgrass. The transgenic creeping bentgrass was a regulated article at the time of seeding and has not yet been deregulated. From the time of planting, growers were required to monitor for and remove any escaped plants or compatible relatives within 275 m of the fields. However in 2003, a wind storm after the crop was swathed, but before threshing, moved seed beyond the 275 meters from at least one of the production fields. A mitigation program to remove all glyphosate resistant plants was initiated. Glyphosate resistant plants were either dug and removed or treated with herbicides. The production fields were removed before flowering and seed set in 2004. In the spring and summer of 2005, Oregon State University personnel surveyed the water ways in the control area for glyphosate resistant plants, either creeping bentgrass or hybrids between creeping bentgrass and compatible relatives. Seed also was collected from the plants for further testing. Even after an intense mitigation program, transgenic glyphosate resistant plants are widespread throughout the control area.

A DECADE OF INTROGRESSION: CROP ALLELES IN EXPERIMENTAL POPULATIONS OF WILD RADISH (*RAPHANUS RAPHANISTRUM*). Allison A. Snow[1], Theresa M. Culley[2], Lesley G. Campbell[1], Norman C. Ellstrand[3], Kristen L. Uthus[1], and Subray Hegde[3], Professor, Professor, Graduate Student, Professor, Research Associate, and Research Associate, [1]Ohio State University, Columbus, OH 43210; [2]University of Cincinnati, Cincinnati, OH 45221; [3]University of California at Riverside, Riverside, CA 92521.

Many cultivated species hybridize naturally with wild relatives, but little is known about the extent to which crop alleles can persist in wild populations, especially when F_1 hybrid progeny have reduced fitness. This process has important implications for understanding whether weedy populations can benefit from an influx of crop alleles, including fitness-enhancing transgenes. Wild radish (*Raphanus raphanistrum*) is a cosmopolitan, self-incompatible weed that is known to hybridize with cultivated radish (*R. sativus*) where these taxa co-occcur.

We found that three crop-specific alleles persisted for at least a decade in crop-wild hybrid populations in Pellston, Michigan, USA. Four populations were established in 1996 using a 1:1 ratio of wild plants and F_1 crop-wild hybrids. The sites were tilled each spring, and flowers, pollen, and/or seeds were sampled each summer through 2005. Initially, F_1 hybrids had reduced fitness relative to wild genotypes, but the populations quickly regained wild-type fecundity by losing a reciprocal translocation and other deleterious crop genes. Initial frequencies of the three crop-specific alleles were 0.25 in each population. Recombination and natural selection allowed the populations to absorb the two crop-specific allozyme markers at relatively high frequencies in all populations. In the F_8 generation, for example, frequencies of crop-specific alleles averaged 0.26 for PGM and 0.14 for GPI. In contrast, frequencies of the crop-specific white petal allele (a dominant Mendelian trait) were only ~0.02-0.08 during the past five years.

Overall, frequencies of crop-specific alleles varied considerably among locations, years, and loci. This study provides a clear example of how easily certain crop alleles can become established in weed populations, while others remain rare or may even disappear.

UNDERSTANDING GENE FLOW BETWEEN CANOLA CROPS IN THE AUSTRALIAN ENVIRONMENT. Christopher Preston and Jeanine Baker, Senior Lecturer and Postdoctoral Fellow, CRC for Australian Weed Management and School of Agriculture & Wine, University of Adelaide, PMB 1, Glen Osmond SA 5064 Australia.

Gene flow between crops has been an often-voiced concern of those groups opposed to the introduction of genetically engineered canola (*Brassica napus* L.) into Australia. In order to address such concerns an extensive survey was conducted in 2000 using Clearfield canola resistant to the imidazolinone herbicides. This survey determined that the levels of gene flow that could be detected were small and sporadic. The average data generated in the survey was used to build a model that considered the potential impact of having different frequencies of genetically engineered crops in the environment. However, such models tend to average the effects. Where sporadic events occur, a higher than anticipated level of gene flow could occur. Therefore, we set up an experiment to examine the behaviour of honeybees near canola crops. A section of crop, and bees, was sprayed with fluorescent paint. Bees were collected from the adjacent field and examined for traces of fluorescent paint. When crops were in full flower, less than 7% of bees in the unsprayed crop contained fluorescent paint. However, once flowering had started to decline, more fluorescent bees were detected outside the sprayed area and some up to 2 km away. A second experiment was established where bees were followed once they had alighted on a specific plant. Bees could then be observed to visit plants nearby. The distribution of plants visited was a normal distribution with more than 66% of visits within 5 m of the target plant. Together these observations suggest that bees are faithful to a nectar source and unlikely to spread large amounts of canola pollen from one field to another. The exception is when flowering starts to decline. Secondly, a bee entering a field will visit a number of flowers in a close area. This could lead to hotspots of gene flow within canola crops.

RISK ASSESSMENT OF THE TRANSFER OF IMAZETHAPYR HERBICIDE TOLERANCE FROM CLEARFIELD RICE TO RED RICE (*Oryza sativa*). Weiqiang Zhang[1], Steven D. Linscombe[2], Eric Webster[1], Siyuan Tan[3], and James H. Oard[1], Graduate Student, Professor, Professor, Senior Scientist, Professor, respectively, [1]Department of Agronomy and Environmental Management, 104 Sturgis Hall, LSU Agricultural Center, Louisiana State University, Baton Rouge, LA 70803, [2]Rice Research Station, 1373 Caffey Road, Rayne , LA 70578, [3]BASF Corporation. 26 Davis Drive, Research Triangle Park, NC 27709.

Hybridization between Clearfield rice and weedy red rice would have a direct impact on management and long-term strategies of imazethapyr technology for rice weed control. The objective of this research was to determine rates and agronomic consequences for outcrossing between Clearfield rice and red rice. Red rice populations showed extensive variation for plant height, panicle length, tillers/plant, seeds/plant, seed set and grain weight. Outcrossing was detected from all Clearfield rice cultivars (‘CL121’, ‘CL141’, ‘CL161’, and ‘CLXL8’) to red rice and was confirmed by phenotypic and DNA marker analyses. An overall outcrossing frequency of 0.17 % was observed in 2002 red rice samples with a range from 0 % to 0.46 %. Tolerance of 2002 red rice samples to imazethapyr corresponded to levels of acetohydroxyacid synthase (AHAS) activity. A majority (94 %) of the progeny from the 2002 samples segregated 3 resistant:1 susceptible for tolerance to imazethapyr, indicating that a single dominant gene from Clearfield rice was associated with tolerance in the hybrid material. The remaining samples did not segregate for tolerance, suggesting that spontaneous mutations for tolerance were present in this material before or after crossing with Clearfield rice. A four-fold increase in outcrossing frequency of 0.68 % was observed in 2003 red rice samples with the highest outcrossing frequency for a single location at 3.2 %. Results from this study indicate that outcrossing between Clearfield and red rice will occur rapidly at rates that warrant early-season field scouting and a crop rotation scheme to prolong usefulness of the Clearfield technology.

GENE FLOW IN ALFALFA (*MEDICAGO SATIVA* L.) WHEN HONEY BEES (*APIS MELLIFERA* L.) ARE USED AS POLLINATORS. Larry R. Teuber[1], Allen Van Deynze[1], Shannon Mueller[2], Ken L. Taggard[1], Larry K. Gibbs[1], Mark McCaslin[3], Sharie Fitzpatrick[3], and Glenn Rogan[4]. [1]Department of Plant Sciences University of California, Davis, CA 95616; [2]University of California Cooperative Extension, Fresno, CA; [3]Forage Genetics International, West Salem, Wisconsin; and [4]Monsanto, St Louis, MO.

Honey bees (*Apis mellifera* L.) are essential to alfalfa (*Medicago sativa* L.) seed production in California. It is well known that honey bees will forage up to several miles from their hive. A range finding study was conducted to determine the extent of potential gene flow between alfalfa cultivars within the foraging range of honey bees. The study was conducted as a federally regulated study using the roundup resistance (RR) trait as a marker source. This source was located 6.2 miles from any commercial alfalfa seed production. Trap plots were located at regular intervals to both the East and West of the source plot starting 900 feet to a distance of 2.5 miles. A very low frequency of gene flow could be detected at 2.5 miles. In this study, gene flow was less than 0.5 % at a distance of one mile. The RR trait has now been completely deregulated and a larger study has been funded and will be conduced in the San Joaquin Valley of California starting in 2006. This study will look at both bridged and unbridged gene flow out to distances of 5 miles. A second study will examine the potential for gene flow from forage producing fields into adjacent seed production fields. From each of these studies we expect to be able to examine honey bee pollinator behavior and devised potential strategies for monitoring and minimizing gene flow during seed production.

POPULATION EFFECTS OF GENE FLOW FROM TRANSGENIC SUNFLOWER TO WILD *HELIANTHUS ANNUUS*. Diana Pilson, Helen M. Alexander, and Allison A. Snow; University of Nebraska, Lincoln, NE 68588; University of Kansas, Lawrence, KS 66045; and Ohio State University, Columbus, OH 43210. (187)

Although many studies have examined the probability that trangenes will move into wild populations, far fewer have evaluated the potential ecological consequences of such gene flow. In a long-term study we have been evaluating the effect of increased seed production (as would occur if a Bt transgene for lepidopteran resistance moved into wild populations) on the size and persistence of wild sunflower populations. In wild sunflower, *Helianthus annuus*, population size (and seed production) in one year is positively correlated with population size in the following year at our Nebraska field site but not at our Kansas field site. This result indicates that at least some sunflower populations are seed limited. Now we show that in Nebraska this effect persists, through the survival of dormant seeds in the seed bank, for at least five years. In 2000 and 2001 we initiated experimental populations that dispersed between 2000 and 20,000 seeds in the year of establishment, but that were prevented from dispersing additional seeds in the following years. In populations initiated in 2000 population size in 2001, 2002, 2003, 2004 and 2005 were all positively correlated with seed dispersal in 2000. In the 2001 populations, which dispersed fewer seeds, there was almost no germination in 2002 (due to a severe drought), but population size in 2003, 2004, and 2005 were each positively correlated with seed dispersal in 2001. Thus, the dynamics of local sunflower populations are controlled by seed production, and this effect persists for several years. Because sunflower requires a recent disturbance to germinate, our results suggest that the larger-scale dynamics of sunflower are a complex function of disturbance pattern, environmental conditions, and population size (and seed production) in (at least) the previous five years. Although long survival in the seedbank is common, this study is the first to document such long-lasting effects of the seedbank on the dynamics of a wild plant population. Our results suggest that if a Bt transgene were to become established in wild *Helianthus annuus*, local populations could be larger and that this effect could persist (in the seedbank) for at least several years.

ACETOHYDROXYACID SYNTHASE (AHAS) GENES AND HERBICIDE TOLERANCE IN SUNFLOWER: A REVIEW AND CONSIDERATIONS FOR GENE FLOW. Mark L. Dahmer, Siyuan Tan, and Richard R. Evans, BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709-3528

AHAS is a critical enzyme for the biosynthesis of branched chain amino acids in plants. Common sunflower (*Helianthus annuus*) has three AHAS genes: AHAS1, AHAS2, and AHAS3. AHAS is the target enzyme for AHAS-inhibiting herbicides such as imidazolinones and sulfonylureas. AHAS resistance occurs widely in weedy common (*H. annuus*) and prairie (*H. petiolaris*) sunflowers and has been reported in several surveys in Colorado, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. Two resistant AHAS gene variants have been introduced from wild *H. annuus* populations to domesticated sunflower lines for developing herbicide tolerant sunflower. One of the variants had a point mutation at codon 205 (in reference to *Arabidopsis thaliana*) of AHAS1 gene with a codon substitution from GCG to GTG and an amino acid substitution from alanine to valine of the encoded AHAS protein. The A205V AHAS1 gene mutation confers a high tolerance to imidazolinone herbicides. It has been used to develop imidazolinone-tolerant (CLEARFIELD®) sunflower. The other AHAS gene variant had a point mutation at codon 197 of AHAS1 gene with a codon substitution from CCC to CTC and an amino acid substitution from proline to leucine of the encoded AHAS protein. The P197L AHAS1 mutation confers a high tolerance to several sulfonylurea herbicides and has been also introduced into domesticated sunflower lines. Besides the resistant mutants originated from the wild common sunflower, a sulfonylurea-tolerant sunflower line named M7 has also been created by using induced mutagenesis and artificial selection. The A205V AHAS1 gene was reported to be able to flow from a domesticated sunflower to wild common and prairie sunflowers, but the outcrossing decreased quickly with the increase of distance from pollen source. The resistant hybrids were found to be able to backcross with wild common or prairie sunflower parent. In the absence of imidazolinone herbicides, the resistant gene does not reduce or increase the competitive ability of either common or prairie sunflower. To prevent development of resistance in wild sunflower from either outcrossing or spontaneous mutation, growers are strongly encouraged to rotate CLEARFIELD® sunflower with other crops and to mix and rotate herbicides with a different mode of action. If CLEARFIELD® sunflower is planted, growers should spray the field with an imidazolinone herbicide at label rate. Growers should also employ other weed management practices that can control resistant weeds such as physical control. Effective control of weedy sunflower adjacent to CLEARFIELD® sunflower field and control of CLEARFIELD®sunflower volunteers in the following season are also good measures to minimize gene flow.

SENSITIVITY OF WEEDS AND VEGETABLE CROPS TO WATER SOLUBLE EXTRACTS OF HAIRY VETCH (*Vicia villosa*) AND COWPEA (*Vigna unguiculata*). Erin C. Hill and Mathieu Ngouajio, Graduate Student and Assistant Professor, Michigan State University, East Lansing, MI 48824.

Hairy vetch (*Vicia villosa* Roth) and cowpea (*Vigna unguiculata* (L.) Walp) are two leguminous cover crops that have been shown to affect the growth of vegetable crops and weeds both *in situ* and under laboratory conditions. Some studies have implied that water soluble allelochemicals from the residues may be responsible for the observed growth inhibition. A laboratory experiment, using a completely randomized design, was conducted to study the effects of water-soluble extracts of hairy vetch and cowpea on the germination and radicle elongation of six weed species and seven vegetable crops. Lyophilized water extracts of hairy vetch and cowpea were dissolved in distilled water to create seven concentrations: 0.00, 0.25, 0.50, 1.00, 2.00, 4.00, and 8.00 $g \cdot L^{-1}$. Each treatment had 4 replicates and the full experiment was repeated. Overall, seed germination was not affected by extracts of either cover crop. However, radicle growth of all species tested (except common milkweed exposed to cowpea extract) was impacted by the cover crop extracts. Low concentrations of the hairy vetch extract stimulated the radicle growth of carrot, pepper, barnyardgrass, common milkweed, and velvetleaf. Similarly, low concentrations of cowpea stimulated the growth of corn, barnyardgrass, and velvetleaf. Species sensitivity to the hairy vetch extract, as determined by the IC_{50} (concentration required to produce 50% radicle inhibition) values, fell from most sensitive to least in the following order: common chickweed > redroot pigweed> barnyardgrass 1 > carrot 1 > wild carrot > corn > carrot 2 > lettuce > common milkweed > tomato > onion > barnyardgrass 2 > velvetleaf > pepper > cucumber. For cowpea the order was as follows: common chickweed > redroot pigweed > corn > tomato > lettuce > wild carrot > pepper > carrot > cucumber > onion> barnyardgrass and velvetleaf. This research found that at low rates, the water-soluble extracts of hairy vetch and cowpea are stimulatory to some vegetable and weed species. However, at higher concentrations all species were negatively affected, a situation that is beneficial for weed control, but not for vegetable stand establishment. Future research should aim to identify, isolate, and test the affects of the responsible allelochemicals in hairy vetch and cowpea.

SUMMER ANNUAL COVER CROPS FOR WEED SUPPRESSION IN ORGANIC CROPPING SYSTEMS. Abram Bicksler and John B. Masiunas, Graduate Research Assistant and Associate Professor, Univ. of Illinois, 1201 West Gregory Dr., Urbana, IL 61801.

Canada thistle [*Cirsium arvense* (L.) Scop.] is an increasing problem in organic cropping systems. Canada thistle causes extensive crop yield losses through competition and, perhaps, allelopathy. The prickly mature foliage reduces productivity by increasing harvest difficulty and deterring livestock from grazing. Cover crops may suppress Canada thistle in organic cropping systems. The suppressive ability of cover crops on Canada thistle relates to their capacity to occupy ecological niches otherwise available for weed development. This occurs through cover crops sequestrating soil nutrients, releasing allelochemicals, and modifying the soil microenvironment. Buckwheat (*Fagopyrum* spp.), is commonly used as a green manure by sustainable and organic farmers. Buckwheat quickly germinates, rapidly establishes a canopy, and shades out weeds. Buckwheat plants also contain the allelochemicals, fagomime, 4-piperidone, 2-piperidine methanol, gallic acid, and (+)-catechin. Sudangrass fits into a summer niche when Canada thistle growth is poor. Sudangrass is a C_4 species that is best able to use resources in a warm, high-light environment and produces tremendous amounts of biomass. Sudangrass rapidly closes canopy, reaching heights of 3 m and immobilizes nutrients, making it more competitive than Canada thistle. Sudangrass contains the allelochemicals sorgoleone and dhurrinase. Cowpea has shown promise as a weed-suppressive cover crop in the California desert. Our objective was to evaluate the summer annual cover crops, buckwheat, cowpea and sudangrass for their ability to suppress Canada thistle. The study was conducted in a certified organic field at the Cruse Tract Irrigated Vegetable Research Farm in Champaign and the Blue Moon Organic Farm in Urbana. The study was a randomized complete block design with three (Blue Moon) or four (Cruse Tract) replications. The treatments were ‘Sweetleaf II’ sudangrass (NC+ Organic), ‘Papago’ cowpea (Seeds of Change), and common buckwheat (Fizzle Flat Farm). At the Cruse Tract we also included ‘Black Africa’ sorghum (Seeds of Change). The sudangrass and cowpea were drilled June 7 at Champaign and June 21 at Urbana. Buckwheat does not tolerate the heat of summer, thus it was planted later, when night temperatures started to cool, on July 20 (Champaign) and August 11 (Urbana). The seeding rates were 50, 67, and 100 kg/ha for sudangrass (and sorghum), cowpea, and buckwheat, respectively. Cover crop and weed counts and biomass were determined at approximately two-week intervals. The biomass data was used to create growth curves for the cover crops. The cowpea did not suppress Canada thistle or annual weeds (primarily redroot pigweed and common purslane) and was susceptible to bean leaf beetle feeding. The sudangrass (and sorghum) produced plants up to 3.5 m tall and when combined with mowing was very suppressive of Canada thistle and annual weeds. Buckwheat was also very suppressive of Canada thistle and annual weeds even though its foliage did not reach more than 90 cm. Buckwheat was difficult to manage in organic farming systems because it remained green until the first hard freeze in November and produced hard seed. Data on Canada thistle regrowth will be collected in the spring. Sudangrass when combined with other practices appears to have promise for suppressing Canada thistle in organic cropping systems.

LONG-TERM EFFECTS OF SEEDBANK MANAGEMENT ON YIELDS IN VEGETABLE CROPS. David E. Hillger, Kevin D. Gibson and Stephen C. Weller, Graduate Research Assistant, Assistant Professor, and Professor, Purdue University, West Lafayette, IN 47907.

Controlling the amount of weed seed returning to the seedbank is a major component of an integrated weed management system. Field plots were established in 2000 that investigated the weed communities of three different soil management practices (rye cover, stale seedbed and conventional tillage) with two different weed seed management levels (critical threshold and zero seed threshold) within a two crop rotation (soybean and tomato) system. Radish, leaf lettuce, and succulent pea were planted into tilled strips within each treatment and allowed to grow without any additional weed control practices for the duration of the experiment (43 days for radish, 56 days for lettuce and 65 days for peas. Weed density in the plots and yields were collected for each crop and analyzed. The level of weed seed management previously practiced significantly influenced yield for all three crops. Yields for radish, leaf lettuce and pea were 29%, 31% and 39% higher, respectively, in the zero seed threshold treatments than in the critical period threshold plots regardless of soil management effect. In the case of pea, yields were 69% higher following a previous year soybean crop than a tomato crop. Radish and lettuce did not differ based on the previous year's crop. Our results provide strong evidence that successful management of the weed seed production and soil seedbank can drastically reduce weed pressure in the follow year's crop which in this case allowed early season vegetable production with no need for supplemental weed management.

FLUMIOXAZIN FOR POSTEMERGENCE WEED CONTROL IN ONION. Bernard H. Zandstra and Michael G. Particka, Professor and Research Assistant, Michigan State University, East Lansing, MI 48824.

Onions are very sensitive to herbicide injury. Moderate stunting or foliar burn from herbicides may result in yield reduction. Onions also are very susceptible to weed competition. Herbicide-tolerant weed species tend to predominate where onions are grown continuously. New herbicide registrations are needed to broaden the weed control spectrum.

Flumioxazin was recently registered for onion. It gives good control of several broadleaves, including common lambsquarters, eastern black nightshade, ladysthumb, redroot pigweed, and spotted spurge. In previous research, flumioxazin caused onion injury under some conditions. Experiments were conducted to determine rate, timing, and tank mix combinations for safe and effective use of flumioxazin on onion.

Flumioxazin was applied to onion pre- or postemergence alone or in tank mixes in 2005. Onions were evaluated for visual injury and yield. Experiments were conducted at three locations on muck soil in Michigan. Flumioxazin at 0.016 lb ai/a plus pendimethalin 3.8 ACS at 2 lb/a preemergence and again at the 2 leaf stage (LS) and 4-5 LS caused no crop injury and gave excellent yield. The same rate of flumioxazin plus pendimethalin 3.3 EC at 2 lb/a at the same growth stages resulted in significant crop injury and yield reduction. Flumioxazin at 0.032 lb/a applied in tank mixes with dimethenamid-P at 0.98 lb/a at the 2 or 4-5 LS caused yield reduction. Flumioxazin applied alone between applications of dimethenamid-P at 0.98 lb/a and pendimethalin 3.3 EC at 2 lb/a alone at the 2 and 4-5 LS, respectively, did not reduce yield.

Flumioxazin at 0.032 lb/a applied at the 2 and 4-5 LS in tank mixes with oxyfluorfen 2 EC or oxyfluorfen 4 SC at 0.031 or 0.063 lb/a did not reduce yield. The same combinations plus clethodim at 0.125 lb/a plus 0.5% nonionic surfactant (NIS) caused yield reduction. When flumioxazin at 0.032 lb/a was applied between the two applications of oxyfluorfen at 0.063 lb/a plus clethodim at 0.125 lb/a plus NIS, there was no yield reduction. The tank mix of pendimethalin 3.3 EC at 2 lb/a plus oxyfluorfen 2 EC at 0.063 lb/a plus clethodim at 0.125 lb/a plus NIS plus flumioxazin at 0.032 lb/a resulted in almost total yield reduction. A combination of pendimethalin 3.8 ACS at 2 lb/a plus oxyfluorfen 4 SC at 0.063 lb/a plus clethodim at 0.125 lb/a plus NIS plus flumioxazin at 0.032 lb/a resulted in only slight yield reduction.

Flumioxazin will be a valuable herbicide in onion production to control several tough broadleaf weeds. It should be applied alone or in combinations with water-based formulations of pendimethalin and oxyfluorfen to avoid crop injury.

HALOSULFURON FOR WEED CONTROL IN SNAP BEANS. Abram Bicksler and John B. Masiunas, Graduate Research Assistant and Associate Professor, Univ. of Illinois, 1201 West Gregory Dr., Urbana, IL 61801.

Halosulfuron is registered for PRE or POST application in snap beans. Application rates range from 19 to 38 g/ha. Halosulfuron applied PRE will control cocklebur, galinsoga, horseweed, jimsonweed, ladysthumb, common lambsquarters, smooth and redroot pigweed, common ragweed, and velvetleaf. POST applications provide better control of many weeds, such as nightshade, yellow nutsedge, and giant ragweed, than PRE applications but snap bean injury is more likely. If applied PRE, halosulfuron needs to be combined with a grass-active herbicide to provide broad-spectrum weed control and to slow development of acetolactate synthase resistant weed biotypes. EPTC is a grass-active herbicide that halosulfuron can be tank mixed. Because of EPTC, the tank mix must be incorporated to a depth of 5cm. The incorporation may dilute the halosulfuron, reducing weed control or it may increase snap bean injury by placing the herbicide near the germinating seed. S-metolachlor is also registered for snap beans and will improve PRE grass control compared to halosulfuron alone. Halosulfuron tank mixes with halosulfuron do not need to be incorporated, possibly reducing snap bean injury and improving weed control. The objective of our research was to determine efficacy and snap bean safety for halosulfuron tank mixed with EPTC compared to halosulfuron tank mixed with s-metolachlor. The treatments were: 1) untreated, weedy control; 2) halosulfuron + EPTC at 0.019 + 4.0 kg/ha PPI; 3) halosulfuron + EPTC at 0.0285 + 3.0 kg/ha PPI; 4) halosulfuron + EPTC at 0.038 + 4.0 kg/ha PPI; 5) halosulfuron + s-metolachlor at 0.0285 + 1.0 kg/ha PRE; 6) s-metolachlor at 1.0 kg/ha PRE/ halosulfuron at 0.0285 kg/ha POST; 7) s-metolachlor at 1.0 kg/ha PRE/ halosulfuron at 0.0285 kg/ha POST; and 8) s-metolachlor at 2 kg/ha PRE/ imazamox + bentazon at 0.011 + 0.42 kg/ha POST. The experiment was a randomized complete block design with four replications. The plots were 7.7 by 3 m and consisted of 4 rows spaced 0.77 m apart. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 280 L/ha. The PPI treatments were applied on May 25 and incorporated with a field cultivar to a 6 cm depth. The plots were seeded immediately after herbicide incorporation using a Monosem planter. On the same day after seeding snap bean, we applied s-metolachlor. None of the herbicide treatments injured snap beans or reduced crop stand. The heavy, Drummer silty clay loam soil at our site and the warm soil temperatures at snap bean planting may explain the lack of crop injury. Halosulfuron + s-metolachlor provided poorer weed control than halosulfuron + EPTC. When applied with s-metolachlor, there were no weed control differences with PRE versus POST halosulfuron applications. The difference in weed control between halosulfuron with EPTC versus it with s-metolachlor is likely due to the rate of s-metolachlor (1 kg/ha) being too low. Combinations of halosulfuron with s-metolachlor merit further research because many snap bean growers prefer PRE herbicide applications.

NEW HERBICIDE POSSIBILITIES FOR WEED CONTROL IN STRAWBERRY. Michael G. Particka and Bernard H. Zandstra, Research Assistant and Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824.

Strawberry growers have only six or seven herbicides available for weed management. With the anticipated loss of methyl bromide more herbicides are needed to provide weed control options for producers. Experiments were conducted in 2002 – 2005 to identify safe and effective herbicides for strawberry. Sulfentrazone 0.5 lb ai/a applied in the fall to dormant strawberry did not injure strawberry in the spring and resulted in good yields. Fall applied flumioxazin at rates greater than 0.25 lb ai/a injured strawberry and reduced yield up to 80% when applied in the year of planting. Oxyfluorfen applied at 0.5 lb ai/a did not cause visible injury strawberry when applied in the fall, but yield was reduced slightly. There was no strawberry injury or yield reduction when pendimethalin or dimethenamid-P were applied in the fall. Pronamide injured strawberry severely and reduced yield 80%.

Flumioxazin applied in the spring at 0.38 lb ai/a and 0.512 lb ai/a reduced yield more than 50%. dimethenamid-P applied in the spring did not injure strawberry or reduce yield. Oxyfluorfen at 0.5 lb ai/a injured strawberry slightly but yield was not reduced. Spring applications, to strawberry that were established less than 1 year earlier, of sulfentrazone at 0.5 lb did injure strawberry in May but plants recovered by June. Applications of sulfentrazone to well established strawberry did not cause crop injury. Quizalofop and clethodim do not injure strawberry and provide good control of quackgrass and annual grasses.

SEQUENTIAL HERBICIDE APPLICATIONS TO MANAGE WEED COMPETITVE LOADS IN CORN. Timothy L. Trower, Chris M. Boerboom, and Joseph D. Bollman, Senior Outreach Specialist, Professor, and Graduate Student, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Two field studies were conducted at the University of Wisconsin Arlington Research Station to investigate the effects of sequential herbicide applications on weed competitive loads and corn yields. Competitive load (CL) is the parameter used in WeedSOFT to integrate weed density and competitive ability across weed species to calculate potential early season and total season yield loss. The CL of a weed species is defined as the number of plants per 100 ft^2 multiplied by its competition index (CI) multiplied by a crop-weed height modifier. The sum of the CLs equals the total competitive load (TCL). Giant foxtail and common lambsquarters were the main weed species in both studies and have CIs of 0.7 and 3, respectively. The first study consisted of preemergence applications of dimethenamid at 0.47 lb ai/a or dimethenamid plus atrazine at 0.42 plus 0.52 lb ai/a applied alone or sequentially with glyphosate at 0.75 lb ae/a compared with postemergence glyphosate. Three postemergence timings were compared: early postemergence (3 to 4 inch weeds in the nontreated control), mid-postemergence (3 to 4 inch weeds in the dimethenamid treatment), and late postemergence (6 to 8 inch weeds in the dimethenamid treatment). The second study investigated the effect of TCL on weed growth and corn yield with half-rates of acetochlor, atrazine, pendimethalin, flufenacet, metolachlor, and mesotrione plus metolachlor applied preemergence as compared with a sequential program of the soil-applied herbicides followed by glyphosate. Weed species counts and heights were collected for 8 weeks after planting from two permanent quadrants per plot placed over the corn rows. The trial design for both studies was a complete randomized block with four replications and plots that measured 10 by 25 feet.

The TCL value of the nontreated control in the first study was 1398 compared with 351 for dimethenamid and 8 for dimethenamid plus atrazine when evaluated on June 30. TCL ranged from 56 to 70 at the time of the sequential glyphosate applications when dimethenamid was applied preemergence. TCL ranged from 0 to 13 at the time of the sequential glyphosate applications when dimethenamid plus atrazine was applied preemergence. In contrast, TLC values of 1602, 1104, and 1208 were calculated for glyphosate applied postemergence at the early, mid-postemergence, and late postemergence application timings, respectively. Information collected from the study was entered into WeedSOFT to predict early season and total season yield losses. WeedSOFT predicted a 78 bu/a total season yield loss for the nontreated control compared with an actual yield loss of 105 bu/a. The top yielding treatment in the experiment was 207 bu/a. The predicted early-season yield losses with the sequential glyphosate treatments were less than 1%. All sequential glyphosate applications following dimethenamid yielded more than dimethenamid alone. Yields did not differ among dimethenamid plus atrazine applied alone or sequentially with glyphosate. WeedSOFT predicted early-season yield losses ranging from 11 to 16 bu/a with glyphosate applied alone postemergence. Yields did not differ among glyphosate treatments applied alone at the three postemergence timings and yields were similar to dimethenamid treatments, but generally less than dimethenamid plus atrazine treatments.

All soil-applied herbicides in the second study had lower TCLs compared to the nontreated control. The TCL for the nontreated ranged from 937 at 32 DAT to 2676 at 61 DAT. The herbicides were ranked from greatest to lowest TCL when evaluated at 61 days after application: metolachlor, flufenacet, pendimethalin, atrazine, mesotrione plus metolachlor, and acetochlor. Weed and crop information was entered into WeedSOFT to determine the predicted early-season and full season yield loss. With only one exception, the final yield rankings matched the WeedSOFT predictions. Yields did not differ between acetochlor and mesotrione plus metolachlor applied preemergence or as a sequential treatment with glyphosate. Conversely, a sequential application of glyphosate increased corn yield by 78 bu/a compared with flufenacet applied preemergence and 94 bu/a compared with metolachlor applied preemergence. The use of preemergence residual herbicides can reduce the early season weed density and height, which allows postemergence herbicide applications to be delayed without increasing the risk of yield loss from early season weed competition.

CONTROL OF VOLUNTEER CORN IN HERBICIDE-RESISTANT CORN. Aaron G. Hager, Douglas J. Maxwell, James L. Moody, Loyd M. Wax, Matthew J. Foes, Daniel Zinck, Erica J. Parker, and Terry W. Semmel, Assistant Professor, Research Specialists, and Emeritus Professor, University of Illinois, Urbana, IL 61801 and Market Development Representatives, Monsanto, Rockford, IL 61109.

The number of acres planted with herbicide-resistant corn hybrids, with the concomitant use of glyphosate or glufosinate for weed control, has been increasing in Illinois during the past two years. Expectations are for this trend to continue into the foreseeable future. These herbicide-resistant hybrids may offer new opportunities to control weed species not effectively controlled by other commercially-available herbicides. Previous research has investigated the interference potential of volunteer corn in soybean and has identified herbicide options that control volunteer corn in soybean. However, little is known about the interference potential of volunteer corn growing with field corn or herbicide options for its control. The objective of this research was to determine the interference potential of volunteer corn and evaluate options for its control using a field corn hybrid with resistance to glyphosate and glufosinate. At the Urbana location, all postemergence treatments of either glufosinate or glyphosate provided 87 percent or greater control of volunteer corn regardless of application timing. At the Dekalb location, control of volunteer corn with glufosinate was improved when applications were made to 13- or 24-inch volunteer corn compared with 9-inch volunteer corn. By mid-July, control of volunteer corn with glufosinate was 90 to 92 percent from applications made to 13- or 24-inch volunteer corn, respectively, but only 29 percent when applied to 9-inch volunteer corn. Glyphosate provided complete control of volunteer corn. Corn yield was significantly reduced by interference of volunteer corn. Allowing volunteer corn to interfere the entire season reduced corn yield 42 percent at Urbana and 60 percent at Dekalb compared with the weed-free treatments.

HERBICIDE AND ADJUVANT TANK-MIXES WITH GLYPHOSATE FOR WEED CONTROL.
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Glyphosate is frequently tank-mixed with adjuvants and/or other herbicides to control a variety of weed species. Ammonium sulfate (AMS) is recommended to be tank-mixed with glyphosate to minimize the adverse effect of poor water quality on efficacy. Several products are available to growers to substitute for the AMS additive. Field experiments were established near Manhattan and Garden City, KS to evaluate AMS replacements with a K salt of glyphosate, “Roundup WEATHERMAX” and an IPA salt of glyphosate, “Cornerstone”. Treatments were applied when the temperature was 89 F and 55% RH in 15 gpa to 6 to 12-in velvetleaf, 16-in sorghum, 20-in corn, and 12 to 16-in sunflower on July 12, 2005 near Manhattan. In experiment 1 near Garden City, treatments were applied in 10 gpa to 2 to 6-in Palmer amaranth and 3.5 to 4-lf volunteer winter wheat with 70 F and 78% RH on July 18, 2005. In Experiment 2, treatments were applied to 3 to 8-in Palmer amaranth and 4 to 4.5-lf winter wheat, with 68 F and 82% RH on July 22, 2005. All adjuvants were applied consistent with label recommendations. Glyphosate rates were Roundup WEATHERMAX at 0.27 lb/a near Manhattan, Roundup WEATHERMAX at 0.38 lb/a in experiment 1, 0.5 and 0.75 lb/a Cornerstone in experiment 1, and 0.38 lb/a Cornerstone in experiment 2. Carfentrazone “Aim EW” was applied at 0.119 oz/a in experiment 2. Glyphosate tank-mixed with liquid or dry formulations AMS, gave equal or better control of all plant species treated. Choice, Request, Guardian, Blendmaster, US 500, and Citron AMS replacements tank-mixed with glyphosate consistently gave less control of the plant species evaluated than AMS tank-mixed with glyphosate in all experiments. Aim EW at 0.119 oz/a tank-mixed with Cornerstone controlled 15% less volunteer wheat than Cornerstone at 0.375 lb/a applied alone. These results suggest that choosing an AMS replacement or herbicide to tank-mix with glyphosate may influence the effectiveness of glyphosate to control several plant species.

AN UPDATE ON THE DISTRIBUTION OF GLYPHOSATE-RESISTANT HORSEWEED (CONYZA CANADENSIS) IN INDIANA. Vince M. Davis*, William G. Johnson, and Kevin D. Gibson, Research Associate, Associate Professor, and Assistant Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Indiana soybean producers have been concerned with the geographic distribution and frequency of glyphosate resistant horseweed (GRH) for the last few years. The objective of this project was to develop a field survey system to determine both geographic distribution and frequency of GRH occurrence across the state. An additional project goal was to quickly disseminate this information to agriculture practitioners across the state. In 2003, counties were selected for sampling with highest priority on counties with confirmed or suspected glyphosate-resistance and counties which had a high percentage of cropland in conservation tillage systems. Survey sites within a county were randomly pre-selected using maps developed from the Cropland Data Layer program conducted by the National Agricultural Statistical Service. The coordinates for the randomly selected soybean fields were downloaded to a GPS unit and a driving route was developed to facilitate efficient travel time between survey sites. A form was used at each survey site to gather information including all weed escapes protruding through the soybean canopy and other cropping practices. If horseweed escapes were present at the survey site, seed heads from forty plants were collected. The random survey system was supplemented by taking up to one additional sample between pre-selected points from soybean fields in which horseweed was clearly visible from the road. Supplemental survey sites were not included in frequency analysis. In the fall of 2003 and 2004, 1116 sites were surveyed, 450 horseweed samples were collected and 141 populations demonstrated less than 60% visual control at 21 days after an initial 1.5 lb ae/A glyphosate screen. GRH has been randomly detected in all regions of the state, but the frequency of GRH escapes in soybean fields is the highest in the southeastern region at 38%. The results from the horseweed survey and subsequent herbicide screening efforts have been disseminated through a website which contains useful and readily accessible information to all agriculture practitioners concerned with the problem of GRH.

RESPONSE OF A GIANT RAGWEED POPULATION TO GLYPHOSATE. Jeff M. Stachler and Mark M. Loux, Program Specialist and Professor, Dept. of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210, and Brad A. Miller and Jeffrey B. Taylor, Technology Development Representatives, Monsanto Company, St. Louis, MO 63167

The introduction of glyphosate-resistant soybeans in 1996 provided growers with an effective new tool for management of giant ragweed. Many growers subsequently utilized multiple glyphosate applications in soybeans for control of giant ragweed, to the exclusion of other herbicides. Giant ragweed control has become more variable in recent years, which may be an indication of changes in the sensitivity of giant ragweed populations to glyphosate. Several separate samples of giant ragweed seed were collected in 2004 from a field where glyphosate had been the sole herbicide used for at least four years, and postemergence applications appeared to becoming less effective. Greenhouse and field studies were conducted in 2005 to determine if a biotype of giant ragweed with reduced sensitivity to glyphosate had developed.

In the greenhouse study, the isopropylamine salt of glyphosate (Roundup UltraMAX®) was applied at 0, 0.84, and 3.36 kg ae/ha to giant ragweed plants with 3 to 4 nodes and a height of 4 to 10 cm. Treatments included ammonium sulfate at the rate of 2% (w/v). Control of a sensitive biotype was 84 and 91% for glyphosate applied at 0.84 and 3.36 kg/ha, respectively. Control of plants from two suspect samples was reduced by 20 to 26% at 0.84 kg/ha, compared to a sensitive biotype. Control of one of the suspect samples was reduced by 12% at 3.36 kg/ha.

In a small-plot field study, giant ragweed seed of a sensitive biotype and four suspect samples was planted late May in a single 7.6 m-long row in the center of a 2 m by 7.6 m plot. Approximately 40 plants were flagged in each row prior to the herbicide application. Glyphosate was applied at 0.84 kg/ha in late June to giant ragweed plants with 3 to 6 nodes that were 10 to 50 cm tall. Glyphosate provided less than 95% control of 22 to 27% of the individual plants 20 DAT from two samples. A second application of 1.68 kg/ha of glyphosate in late July resulted in 100% control of all plants in the sensitive population, but less than 95% control of at least 10% of the plants in two suspect populations. Glyphosate was applied initially at a rate of 1.68 kg/ha to plants of one suspect sample, which resulted in less than 95% control of 8% of the individual plants after the second application.

Small- and large-plot studies were conducted at the suspect field in Licking County, OH. In the small-plot study, the potassium salt of glyphosate (Roundup WeatherMAX®) was applied at rates of 0.84, 1.26, 1.68, and 3.36 kg/ha. Cloransulam at 17 g ai/ha and fomesafen at 0.26 kg ai/ha were applied alone and in combination with glyphosate at 0.84 kg/ha. Treatments were applied to 15 to 36 cm tall plants on June 20, 2005. Twenty individual plants were flagged in each plot prior to the herbicide application. Control of giant ragweed 23 DAT ranged from 56 to 79% for all treatments, and a maximum of 35% of the flagged plants were dead. Exceptions to this included glyphosate at 3.36 kg/ha and fomesafen at 0.26 kg/ha, which killed 63 and 66% of the plants, respectively. A second application of 1.68 kg/ha of glyphosate on July 19, 2005 improved control in all treatments, but control exceeded 90% only where the initial treatment was glyphosate at 3.36 kg/ha, fomesafen, or cloransulam.

In the large-plot study, a commercial sprayer was used to apply the following three treatments: potassium salt of glyphosate at 0.84 and 1.68 kg/ha; and glyphosate at 0.84 kg/ha plus cloransulam at 17 g/ha. All treatments included ammonium sulfate at the rate of 2% (w/v). Twenty individual plants were flagged in each of six patches in each plot. Control of giant ragweed 23 DAT ranged from 70 to 80% among treatments, but only 30 to 49% of the individually flagged plants were dead. On July 19, 2005, glyphosate was applied again at 0.84 or 1.68 kg/ha, so that the total glyphosate applied per plot was 2.52 kg/ha. At least 86% of the flagged plants were dead 23 DAT, but a number of other plants survived and produced viable seed.

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The results of these studies may indicate the presence of a biotype of giant ragweed with reduced sensitivity to glyphosate. This biotype survived up to 3.36 kg/ha of glyphosate in greenhouse studies. In field studies, plants survived multiple glyphosate applications, where the total amount applied was up to 5 kg/ha. Surviving plants produced viable seed when treated with up to 3.36 kg/ha glyphosate in the field. Reduced sensitivity of this biotype to glyphosate may be an evolved response, which could be likely to occur in other fields with similar selection pressure.

COMMON LAMBSQUARTERS CONTROL WITH GLYPHOSATE: WHAT'S THE PROBLEM?
Andrew R. Kniss, Stephen D. Miller, and Robert G. Wilson, Assistant Research Scientist and Professor, University of Wyoming, Laramie, 82071, and Professor, University of Nebraska, Scottsbluff, 69361.

Common lambsquarters is a difficult weed to control in glyphosate-resistant cropping systems. Field and growth chamber research has been carried out on common lambsquarters collected from long-term glyphosate weed shift trials being conducted in Colorado, Nebraska, and Wyoming. Growing common lambsquarters under controlled conditions requires special attention to lighting conditions, as it is a short day species. A photoperiod of at least 16h, high red:far red ratio, and high light intensity all help delay floral evocation in common lambsquarters. Initiation of flowering can significantly reduce the response of this weed to glyphosate in the greenhouse. High variability in glyphosate response has been observed from plants collected from within the same field history and in close proximity. At either end of the tolerance spectrum, growth chamber studies tend to mirror field studies. However, lines that show intermediate response to glyphosate may produce more variable results in the growth chamber than in the field.

FIELD RESPONSE OF SIX OHIO COMMON LAMBSQUARTERS POPULATIONS TO GLYPHOSATE. Jeffrey B. Taylor and Brad A. Miller, Technology Development Representatives, Monsanto Company, St. Louis, MO 63167, and Mark M. Loux and Jeff M. Stachler, Professor and Program Specialist, Dept. of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

Field studies were conducted in glyphosate-resistant soybeans at six locations across Ohio in 2005 by Monsanto and The Ohio State University to determine the response to glyphosate of six common lambsquarters biotypes that had exhibited variable response to glyphosate in greenhouse studies (reported in a separate abstract). Glyphosate treatments were applied to large plots with commercial application equipment. Although herbicide treatments were not replicated, individual common lambsquarters plants were marked before treatment in 5 to 6 random areas within each plot in order to evaluate control and plant survival after treatment. Postemergence treatments included glyphosate (Roundup WeatherMAX®) at 0.84 kg ae/ha, 0.84 kg/ha with an additional 0.25% (v/v) nonionic surfactant, and 1.68 kg/ha. All treatments were applied with 2% (w/v) ammonium sulfate when lambsquarters plants were 8 to 20 cm tall. Plots were retreated with glyphosate (Roundup WeatherMAX®) at 0.84 kg/ha for the 1.68 kg/ha rate, and at 1.68 kg/ha for the 0.84 kg/ha rate approximately 21 days after the initial treatment. Treatments were visually evaluated for control approximately 21 days after treatment (DAT), 21 to 31 days after retreatment, and just prior to soybean harvest. The injury to marked common lambsquarters plants was evaluated at these same intervals using the following scale: 1 - plant death; 2 - plants injured but no regrowth evident; and 3 - plants injured but showing regrowth.

The addition of nonionic surfactant to glyphosate (Roundup WeatherMAX®) did not appear to improve control, and results are discussed here for the 0.84 and 1.68 kg/ha rates without additional surfactant. Control of common lambsquarters approximately 21 days after the first application ranged from 85% to 99% for 0.84 kg/ha, and 94% to 99% for 1.68 kg/ha, among all locations. At this evaluation, 0 to 18% of marked plants received a score of 3, or showed signs of regrowth for the 0.84 kg/ha rate, and four of the six locations had at least one marked plant receiving this score. Among the six locations, none of the marked plants received a score of 3 at the 1.68 kg/ha rate. Control of lambsquarters 21 to 31 days after retreatment ranged from 95 to 99% for 0.84 kg/ha and 97 to 99% for 1.68 kg/ha. Only one of the six locations had any marked plants showing signs of regrowth at the 0.84 kg/ha rate, and only 2% of marked plants were in this category for this rate. None of the marked plants showed signs of regrowth at the 1.68 kg/ha rate. Similar results occurred for evaluations at the time of soybean harvest.

While plants of these common lambsquarters biotypes survived glyphosate applications in the greenhouse, this did not occur at five of six field locations by the end of the season. Results showed that all six biotypes were controlled with two applications of a labeled rate of glyphosate (Roundup WeatherMAX®) under field conditions in 2005. Plants marked prior to treatment were able to survive two glyphosate applications at only one location. Reduced control of individual plants can be caused by several different factors, including environmental conditions, and this may be one reason for infrequent survival of plants in these studies.

RESPONSE OF COMMON LAMBSQUARTERS TO GLYPHOSATE IN THE GREENHOUSE AND GROWTH CHAMBER. Mark M. Loux and Jeff M. Stachler, Professor and Program Specialist, Dept. of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210, and Brad A. Miller and Jeffrey B. Taylor, Technology Development Representatives, Monsanto Company, St. Louis, MO 63167

Over the past several years, some Ohio growers have observed inadequate control of common lambsquarters with postemergence glyphosate treatments in glyphosate-resistant soybean. Weed scientists at The Ohio State University (OSU) collected seed from lambsquarters plants surviving one or glyphosate applications in a number of fields in 2002 through 2004, to determine whether control problems could be due to the presence of biotypes with reduced sensitivity to glyphosate. OSU conducted greenhouse studies between 2003 and 2005 with a number of different populations to determine whether biotypes with reduced sensitivity to glyphosate could be identified. Monsanto conducted additional greenhouse and growth chamber studies in 2005 with selected biotypes provided by OSU.

In OSU greenhouse studies, a commercial formulation of the isopropylamine salt of glyphosate (Roundup UltraMAX®) was applied at rates of 0.84 and 3.36 kg ae/ha with 2% (w/v) ammonium sulfate when lambsquarters plants had 3 to 10 nodes and were 2 to 9 cm tall. A total of 12 lambsquarters biotypes appeared to have reduced sensitivity to glyphosate in one or more studies. However, results of ANOVA indicated that significant differences between a certain suspect biotype and a sensitive biotype were not necessarily observed in every study. Reduced sensitivity was exhibited primarily as less effective control at 0.84 kg/ha, although control was occasionally reduced at 3.36 kg/ha. For one biotype, studies included the initially collected composite sample from a field where glyphosate effectiveness appeared to be reduced, and seed from plants surviving glyphosate in a field or greenhouse study. Plants from the latter were less effectively controlled by glyphosate, compared to those from the original composite sample.

A dose-response study was conducted by OSU to further characterize the response of three of the suspect biotypes. A formulation of the potassium salt of glyphosate was applied at rates ranging from 0.08 to 84 kg/ha. Treatments were applied with 0.25% (v/v) of a proprietary nonionic surfactant blend and 2% (w/v) of ammonium sulfate when lambsquarters plants had 5 to 10 nodes and were 3 to 8 cm tall. The study was conducted twice, and nonlinear, logistic dose-response curves were fit to the combined data to calculate GR_{50} values. The suspect biotypes exhibited GR_{50} values that were 2.5- to 4.4-fold higher than a susceptible biotype on a dry-weight basis.

Monsanto completed two greenhouse studies and one growth chamber study by the time of abstract submission, with two more studies in progress. In these studies, one or two sensitive biotypes were compared to three biotypes identified to be less sensitive in OSU greenhouse studies. A commercial formulation of the potassium salt of glyphosate (Roundup WeatherMAX®) was applied at rates of 0.84, 1.68, and 3.36 kg/ha with 2% (w/v) ammonium sulfate when lambsquarters plants were 10 to 15 cm tall. Results of ANOVA for completed studies showed differences in the response of biotypes to glyphosate, but there was an interaction between biotype and glyphosate rate in the two greenhouse studies. In the growth chamber study, control of all biotypes, averaged over glyphosate rate, ranged from 82 to 94%. Control of the three suspect biotypes was significantly less than the sensitive biotype. Lambsquarters control in the greenhouse studies ranged from 47 to 100%, and differences among biotypes occurred only at the lower two glyphosate rates. In both greenhouse studies, all three suspect biotypes were less sensitive than a sensitive biotype at 0.84 kg/ha, and two of the suspect biotypes were less sensitive than the sensitive biotype at 1.68 kg/ha.

The authors conducted large-plot field studies in 2005 at sites where suspect biotypes were collected, and these are reported in a separate abstract. In addition, OSU conducted a small-plot field

study with one sensitive biotype and 6 suspect biotypes. Seeds of these biotypes were sowed in the experimental area, and each plot consisted of a single row of lambsquarters plants 7.6 m in length. A commercial formulation of the isopropylamine salt of glyphosate (Roundup UltraMAX®) was applied at 0.84 kg/ha with 2% (w/v) ammonium sulfate when lambsquarters plants were 10 to 15 cm tall. Control of individual plants of all biotypes 21 DAT exceeded 95%. A second application of glyphosate at a rate of 1.68 kg/ha 32 days after the first application resulted in 100% control of all plants.

These studies show that lambsquarters biotypes can vary in their response to glyphosate in the growth chamber and greenhouse. There appears be reduced sensitivity of some biotypes to rates of glyphosate up to 3.36 kg/ha, although the expression of this varies among studies. Results of a single field study conducted in 2005 did not corroborate those from greenhouse and growth chamber studies. Reduced sensitivity of some common lambsquarters biotypes to glyphosate may be an evolved response, and could be a contributing factor to poor performance of postemergence glyphosate treatments occasionally observed in growers' fields.

BROADLEAF WEED CONTROL IN WHEAT WITH FALL AND SPRING APPLICATIONS OF HERBICIDES. James R. Martin and Dorothy L. Call, Extension Professor and Research Technician, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445.

There is an increasing interest in applying herbicides in the fall rather than delaying treatments until the spring for controlling broadleaf weeds in wheat. This approach is beneficial for achieving optimum yields in no-tillage wheat and for obtaining effective control of certain species such as cornflower. However, it is unclear if fall applications provide an advantage over spring applications for managing such weeds as common chickweed and henbit in wheat planted in a conventional tilled seedbed.

The objective of this research was to evaluate the influence of fall and spring applications of the premix thifensulfuron 50% + tribenuron 25% (Harmony Extra 75 DF) and metribuzin on common chickweed and henbit control and yield of wheat planted in a conventional tilled seedbed.

A total of nine studies were conducted in western Kentucky during the last four growing seasons. All studies were conducted in areas where the previous rotational crop was field corn. Plot areas were prepared after corn harvest with multiple passes of a field disk or by a combination of chisel plowing and disking. Wheat was planted in early to mid October. Fall treatments were applied in mid to late November and included Harmony Extra at 0.225 oz ai or 0.38 oz ai/A plus nonionic surfactant at 0.25% v/v and metribuzin at 1.5 oz ai or 3 oz ai/A. Spring treatments were applied in late March to early April and included Harmony Extra at 0.38 oz ai/A plus nonionic surfactant at 0.25% v/v and metribuzin at 3oz ai or 4.5 oz ai/A. The approximate size for broadleaf weeds ranged from 0.5 to 3 inches in diameter for fall treatments and from 3 to 7 inches in diameter for the spring treatments. The broadleaf weed densities that were determined in late November to early December ranged from a low of 3 plants/ ft^2 to a high of 92 plants /ft^2. Visual ratings for broadleaf weed control were made in late April to early May. Wheat was harvested with a small plot combine in mid to late June.

The level of broadleaf weed control achieved with Harmony Extra or metribuzin was good to excellent for all herbicide treatments and usually exceeded 90% regardless of application time. However, henbit control with fall-applied metribuzin at the low rate of 1.5 oz ai/A was only 86% at Warren County in the 2001-2002 season and 87% at Calloway County in the 2003-2004 season. Henbit control with spring - applied Harmony Extra at 0.38 oz ai/A was 89% at Warren County in the 2002-2003 season.

The use of good management strategies resulted in competitive wheat stands and optimum grain yields. Yields ranged from a low of 72.3 bu/A to a high of 112.6 bu/A. The good to excellent broadleaf weed control achieved in these studies seldom enhanced wheat yield. Herbicide-treated plots out-yielded the non-treated check plots in only two of the nine studies. The increase in wheat yield tended to occur where common chickweed was present.

The fact that herbicide treatments provided good to excellent control of common chickweed and henbit, but rarely increased wheat yield, indicates that in many cases competition from these broadleaf weeds is not a limiting factor in wheat planted after corn in a conventional tilled seedbed.

UTILIZATION OF CLEARFIELD TECHNOLOGY FOR WEED CONTROL IN WINTER AND SPRING WHEAT. Steven R. King, Assistant Professor, Montana State University, Southern Agricultural Research Center, Huntley, MT 59037.

In Montana, wild oat (*Avena fatua*), feral rye (*Secale cereale*), and cheat (*Bromus secalinus*) are three of the most troublesome and difficult to control weeds in dryland small grains. Two separate experiments were performed in 2005 to evaluate the efficacy of imazamox applied postemergence (POST) for the control of these species in imidazolinone-tolerant wheat (*Triticum aestivum*). The first experiment evaluated imazamox applied with two different additives (ammonium sulfate (AMS) or nitrogen), with growth regulator herbicides (2,4-D, dicamba, or 2,4-D plus dicamba), or applied at two different growth stages (pre or post joint) of winter wheat (CL 1159) for the control of feral rye. The second experiment evaluated imazamox, BAS777 02H, fenoxaprop, and clodinafop treatments for the control of wild oat and cheat in spring wheat. Both experiments were designed as randomized complete blocks with three and four replications in the winter and spring wheat studies, respectively. Control of feral rye at 38 or 76 d after treatment (DAT) with the addition of AMS to treatments of imazamox did not differ from treatments of imazamox applied in combination with nitrogen. Control of feral rye was 87% or greater at 38 DAT due to treatments of imazamox applied with or without the addition of growth regulator herbicides, and no difference in feral rye control was observed among treatments. At 76 DAT, however, imazamox treatments containing 2,4-D or 2,4-D plus dicamba controlled feral rye greater than imazamox alone or in combination with dicamba. Feral rye was controlled 99 and 100% with post-joint applications of imazamox and imazamox plus dicamba, respectively, compared to only 65 and 75% control with pre-joint applications of imazamox and imazamox plus dicamba, respectively, in June. Post-joint applications of imazamox and imazamox plus dicamba were more effective than pre-joint applications because additional feral rye plants germinated subsequent to pre-joint applications. No differences in winter wheat yield occurred among imazamox treatments. In the spring wheat trial, wild oat control was 95% or greater with any treatment at 29 and 42 DAT. Imazamox and BAS777 02H controlled cheat 89% or greater at 29 and 42 DAT. Fenoxaprop and clodinafop treatments did not affect cheat. No differences in spring wheat yield were observed among treatments regardless of the level of cheat control. Results of these experiments indicated that the use of imazamox or BAS777 02H in imidazolinone-tolerant wheat are efficacious for the control of feral rye, wild oat, and cheat.

IMIDAZOLINONE-TOLERANT WINTER WHEAT RISK ASSESSMENT. Phillip W. Stahlman, Anthony D. White, Patrick W. Geier, and John C. Frihauf, Professor, Visiting Scientist, Assistant Scientist, Kansas State University Agricultural Research Center, Hays, KS 67601, and Biological Science Technician, USDA-ARS, Urbana, IL 61801.

An experiment has been conducted annually since 2001 near St. John, KS to assess the risk of moving imidazolinone herbicide tolerance into a jointed goatgrass population, to determine the rate of resistance integration into jointed goatgrass and investigate jointed goatgrass-wheat hybrid population dynamics, and to investigate management practices to prevent development of imidazolinone tolerant jointed goatgrass. The experimental area was initially overseeded with spikelets of three jointed goatgrass accessions grown in different years and environments. Conventional hard red winter wheat (‘Jagger’) and imidazolinone-tolerant hard red winter wheat (‘AP502CL’) were grown using Best Management Practices (inversion tillage after the third crop year and non-inversion tillage in other years; large sized-seed; 50% higher-than-normal seeding rate; and narrow row spacing; in-furrow starter fertilizer plus spring N topdress) compared to conventional production practices (non-inversion tillage; normal sized seed, seeding rate and row spacing; and broadcast fertilizer without starter plus spring N topdress). Certified Jagger and AP502CL winter wheat was seeded each year as well as certified AP502CL the first year followed by saved (bin-run) seed in subsequent years. Jagger wheat was sprayed each year with sulfosulfuron at 0.031 lb/A, and AP502CL wheat was sprayed with imazamox at 0.024 or 0.40 lb/A. In all years, combining BMPs with imazamox use in imidazolinone-tolerant wheat dramatically reduced jointed goatgrass populations, both in the crop and in the 3-month fallow period between crops, compared to conventional wheat production. Occurrence of jointed-goatgrass-wheat hybrid spikes varied by year; none were found in the 2002 or 2004 wheat crops but 441 and 376 were found in the 2003 and 2005 wheat crops, respectively. The germination rate of hybrid spikelets collected in 2003 was 1.1%. These were transplanted to pots and grown in a greenhouse. Twenty-five of 63 F_1 hybrid plants (40%) survived treatment with imazamox at 0.031 lb/A to produce 139 spikes and 1360 spikelets. From these, only five seeds were recovered, three germinated, and two survived transplanting to pots in the greenhouse and were sprayed with imazamox at 0.031 lb/A. One of the two plants died and the other was severely injured and did not produce seed. Winter wheat yield differences between treatments within years were significant only in 2003. In that year, despite jointed goatgrass presence, Jagger yielded more than AP502CL sprayed with imazamox. Yields of AP502CL were higher when grown using BMPs than when grown using conventional production practices. The experiment is continued.

DOWNY BROME CONTROL WITH HERBICIDES IN SPRING. Kirk A. Howatt, Assistant Professor, North Dakota State University, Fargo, ND 58105-5051.

Downy brome is a winter annual grass that can be pervasive in winter wheat production. In North Dakota, downy brome is extending far beyond the region of winter wheat production and quickly becoming a problem in spring wheat and other spring seeded crops. Downy brome is able to invade spring cropping systems because of the adoption of minimum tillage and zero tillage practices. Experiments were conducted to determine which herbicides would control downy brome if the infestation was not discovered until after crop emergence. Treatments were applied to three-leaf downy brome that was tillered but panicles were not pronounced in stems on May 5. Imazamox had greater activity than other ALS-inhibiting herbicides 14 d after treatment (DAT), which was similar to activity of non-selective ACCase-inhibiting herbicides, 77 to 82%. Clodinafop was not different from untreated downy brome 14 DAT and expressed only minor symptoms 35 DAT. Clethodim, quizalofop, and imazamox provided greater than 90% control of downy brome 35 DAT. Propoxycarbazone gave 83% control, but downy brome control with remaining herbicides was less than 60% 35 DAT. Flucarbazone control of downy brome was increased more with nonionic surfactant or methylated seed oil adjuvants than when the adjuvant system contained a source of nitrogen.

RIMFIRE - A NEW SELECTIVE HERBICIDE FOR GRASS CONTROL IN WHEAT. Dean W. Maruska, James E. Anderson, Jack D. Otta, Michael C. Smith, Kevin B. Thorsness, and Mary D. Paulsgrove, Field Development Representative, Bayer CropScience, Research Triangle Park, NC 27709.

Rimfire is a new postemergence wheat herbicide designed to control ACC-ase resistant and susceptible wild oats and numerous key broadleaf weeds, while providing partial control of grasses such as foxtails, quackgrass, cheat, downy brome, Japanese brome and Persian darnel. It is a formulated as a 10.17% WDG containing the sulfonylurea mesosulfuron methyl and propoxycarbazone, a sulfonylaminocarbonyl triazolinone, both inhibiting ALS (acetolactate synthase). These active ingredients are combined with a crop safener, mefenpyr diethyl to provide excellent tolerance in spring, durum and winter wheat.

Rimfire was applied at 12.5 g ai/ha targeting 1-leaf to 2-tiller grasses. Several adjuvant system options are available: methylated seed oil at 1.75 l/ha, basic blend at 1% v/v or NIS 0.5% v/v + 4.7 l/ha UAN. Maximum spring wheat crop response was 6% when applied alone and less than 9% when tank mixed with a broadleaf herbicide.

Rimfire provided greater than 94% control of AVEFA when applied alone or in combination with a broadleaf herbicide. Research data also show residual effects on secondary weed flushes. There was a numerical reduction in emergence of both AVEFA and CHEAL 4-5 weeks after application without crop interference.

Rotational crop flexibility for key corps is excellent with Rimfire. Wheat and millet may be planted 0 to 4 months, respectively, after an application of Rimfire and alfalfa, barley, canola, dry beans, flax, lentils, oats, peas, soybeans, safflower and sunflowers may be planted 10 months after application.

Rimfire will control numerous broadleaf weeds including mustard species and volunteer canola. Flexible tankmix options with broadleaf herbicides can be tailored for specific, season-long grass and broadleaf weed control. The Rimfire label was approved by EPA on Nov 8, 2005.

THE USE OF RIMFIRE™ HERBICIDE FOR GRASS CONTROL IN WHEAT. Kevin B. Thorsness, James E. Anderson, Dean W. Maruska, Jack D. Otta, Michael C. Smith, and Mary D. Paulsgrove, Technical Service Representative, Bayer CropScience, Research Triangle Park, NC 27709.

Rimfire is a new postemergence wheat herbicide developed by Bayer CropScience to control ACC-ase resistant and susceptible wild oats and numerous broadleaf weeds, while suppressing important grasses such as foxtails, quackgrass, cheat, downy brome, Japanese brome, barnyardgrass, foxtail barley, and Persian darnel. It is formulated as a 10.17% WDG that is composed of mesosulfuron methyl, a sulfonylurea and propoxycarbazone, a sulfonylaminocarbonyl triazolinone, plus the safener, mefenpyr diethyl, to provide excellent crop tolerance in spring, durum, and winter wheat.

Rimfire was applied at 12.5 g ai/ha to spring wheat in the tillering stage of growth and grass weeds in the 1-leaf to 2-tiller stage of growth. Several options for spray adjuvant systems were tested: methylated seed oil at 1.75 L/ha, basic blend at 1% v/v, or NIS at 0.5% v/v + UAN at 4.7 l/ha.

Maximum crop response in spring wheat was 11% with Rimfire, regardless of adjuvant system or broadleaf tank mix partner. Rimfire plus a basic blend adjuvant provided 80% control of barnyardgrass and 85% control of Japanese brome. While Rimfire plus a methylated seed oil provided 75% control of yellow foxtail. Regardless of adjuvant system tested, Rimfire alone provided 94% or greater control of wild oat. When Rimfire was combined with broadleaf herbicide tank mixes, wild oat control was 91% or greater regardless of adjuvant system or broadleaf tank mix partner.

Rimfire will provide growers with an important tool for management of wild oat including ACC-ase resistant wild oat as well as other important grass weeds in spring, durum, and winter wheat.

PINOXADEN – A NEW POSTEMERGENCE GRAMINICIDE FOR WHEAT AND BARLEY. Peter C. Forster and Donald J. Porter, Syngenta Crop Protection, Greensboro, NC 27419.

Pinoxaden is a new selective herbicide discovered by Syngenta Crop Protection and being developed for the control of annual grass weeds in wheat and barley. Pinoxaden is a novel grass active compound from the chemical class phenylpyrazolin and is formulated with the safener cloquintocet-mexyl. Pinoxaden is taken up primarily through leaves of treated grasses and then translocated basipetally and acropetally in plants. Pinoxaden has excellent crop safety to all varieties of spring wheat, winter wheat and barley. Results from wheat and barley tolerance trials indicate crop safety is maintained even at double the use rate without any negative effect on grain yields. Pinoxaden 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 8.2 oz/A, Pinoxaden 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. Pinoxaden can be tank mixed with broadleaf herbicides for flexible one-pass grass and broadleaf weed control in wheat and barley crops. Results from plant-back trials following Pinoxaden applications show no rotational crop limitations the following growing season. Pinoxaden has a very favorable toxicological and ecotoxicological profile. Based on its broad grass weed control spectrum, flexibility of use, and excellent crop safety, Pinoxaden will become a new standard for grass weed control in wheat and barley crops.

IS FLUMIOXAZIN SAFE ON SUNFLOWER - REVISITED. Richard K. Zollinger and Brian M. Jenks, Associate Professor and Research Specialist, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105, Phillip W. Stahlman, Kansas State University, Hays, KS 67601, Darrell Deneke, South Dakota State University, Brookings, SD 57007, and Alan Helm, Colorado State University, Holyoak, CO 80523.

Replicated field research was conducted in 2005 at Valley City and Minot, ND, Hays, KS, Brookings, SD, and Holyoak, CO to evaluate sunflower tolerance grown in no-till conditions to flumioxazin applied at 0, 1, 1.5, 2, and 3 oz ai/A. Sulfentrazone was applied at 0.25 lb ai/A. All treatments were applied 3, 2, and 1 week before planting (WBP) and preemergence. Sunflower populations were measured after sunflower establishment by counting all plants in the two center rows of each plot. Soil texture ranged from sandy loam in Valley City to clay loam in Brookings, soil pH from 5.0 in Valley City and Minot to 7.9 in Hays, and organic matter 2.8% in Brookings to 4.7% in Valley City.

Previous research in the west and midwest has shown unacceptable sunflower injury and stand loss to preemergence flumioxazin applied in conventional tillage but flumioxazin applied early preplant in no-till sunflower has not been fully studied. Limited supplies of sulfentrazone in 2005 created interest in flumioxazin use in sunflower. Flumioxazin label allows many crops, including sunflower to be planted 30 days after application. Flumioxazin rate of a rate of 1.5 oz/A is considered the optimum rate for residual weed control in no-till conditions.

Sunflower does not have tolerance to flumioxazin. Flumioxazin reduced sunflower population at all rates and all application timings but sunflower showed the most tolerance at Hays. Reduction in sunflower population was greatest at Minot (24 to 89%), followed by Valley City (20 to 83%), Brookings (7 to 37%), and Hays (0 to 29%). Flumioxazin applied at 1.5 oz/A 3 WBP, the preferred rate and timing for use in no-till caused greater than 53% sunflower stand loss at Valley City and Minot, and 0% in Brookings and Hays. At Brookings, treatments were applied earlier than 3 WBP. Sunflower populations at 4 and 5 WBP were 0% and 12% at the 1.5 oz/A rate and 15% and 33% at the 3 oz/A rate. At Hays, sunflower stands were reduced by flumioxazin at 1.5 oz/A at all application timings from 0% to 12% but sunflower yield was reduced up to 23%. Sulfentrazone applied at all locations at the highest labeled rate of 0.25 lb/A caused less than a 5% reduction in sunflower stand and did not reduce sunflower yields at all locations. The entire study at Holyoak unintentionally received an additional application of 0.125 lb/A of sulfentrazone at 1WBP but no stand reductions were observed (data not included). This data supports previous research that showed sunflower tolerance to flumioxazin was greatest when applied in no-till conditions. Sunflower tolerance is greater in CO, but less in the plains region, and least in the northern plains.

WEED EMERGENCE: A REVISED WEEDCAST AND ITS USER VERSATILITY. Frank Forcella, Dave Archer, Ed Luschei, Kurt Spokas, and Andy Korth. Research Agronomist, Agricultural Scientist, Associate Professor, Soil Scientist, and Computer Science Student, USDA-ARS Soils Lab, Morris, MN 56267; University of Wisconsin, Madison; and University of Minnesota, Morris.

WeedCast is a software program that simulates timing of seedling emergence and rate of seedling growth of weeds important in crops within the north central region of the United States and adjacent Canada. The program was revised recently as a Java application. New features include the following: (1) Allowance of user-supplied soil temperature data (5 cm depth). This feature avoids previous errors associated with prediction of soil temperatures based upon air temperatures. However, for users without access to soil temperature information, this important variable still can be estimated by WeedCast from air temperatures. (2) Ability to alter default values for base temperature, base water potential, and coefficients of nonlinear equations specific for each weed species. (3) Support of user-inserted equations that describe emergence responses to soil hydrothermal time, or seedling growth responses to thermal time (air growing degree days). Default equations (and coefficients) are saved and can be resurrected at any time. (4) Capacity for users to add new species to the list of weeds already in the WeedCast database. Thus, the revised WeedCast can serve as a modeling shell for users who are interested in experimenting with new species or improving models of currently listed species. The revised WeedCast may have utility in classroom, extension, industry, and field settings. It can be downloaded freely from http://www.weedcast.net/.

CAN BIOTECH AND TRADITIONAL CROPS COEXIST? Richard S. Fawcett, Fawcett Consulting, Huxley, IA 50124.

Speaking tours were conducted in Australia, New Zealand, Russia, and Italy in 2004 and 2005 on behalf of the USDA Foreign Agricultural Service and U.S. State Department with the purpose of increasing international understanding of the U.S. experience with biotech crops, including economic and environmental benefits. Meeting audiences in each country included farmers, general public, scientists, legislators, and regulators. One of the issues of greatest interest in these countries was that of coexistence, the ability to grow, store, transport, and process biotech crops without unintended mixing with traditional crops.

Farmers in Italy and Australia were anxious to have new biotech crops approved for planting, but were concerned about maintaining markets for non-biotech grains for consumers preferring such a product. Such concerns reduced farmer enthusiasm about biotech crops in New Zealand. Provinces in Italy were in the process of writing Coexistence Plans in preparation for planting biotech crops.

There are no labeling laws concerning biotech crops in the U.S. Because almost 90% of soybeans and 50% of corn grown in the U.S. are biotech, nearly all processed foods contain some biotech grain. There is general awareness about the presence of biotech crops in the food supply by U.S. consumers. Although some consumers are concerned about the safety of biotech crops, in a 2004 International Food Information Council survey of U.S. consumers, only 1% identified biotechnology as information that they would like to see added to a food label. The position of U.S. regulatory agencies is that while certain traits of crops may require labeling, the method of breeding need not be identified.

Crops must, however, be labeled as to biotech origin in some countries, including those of the European Union (EU). The EU has set a biotech labeling standard of 0.9%. If food or feed contains less than 0.9% biotech, it is considered non-biotech. Lower thresholds are being considered for crop seeds. Meeting such standards will require measures such as separation distances or buffers to prevent pollen or other movement from biotech fields to non-biotech fields, cropping intervals and control of volunteer crops, and segregation of the harvested crop. For example, the UK has adopted a separation distance for biotech sweet corn of 200 m. Controlled studies showed that a smaller buffer of 24.4 m would meet a 0.9% labeling standard.

Although biotech crops are not required to be labeled or segregated in the U.S., farmers who sell grain which is exported to areas such as Europe which do have labeling laws and where more public concern may exist about biotech crops, need to segregate biotech crops from non-biotech crops in order to meet labeling standards. Because some biotech crop varieties approved for use in the U.S. may not be approved in other countries, these crops must be segregated for domestic use, not export. Also, there is growing concern about potential unwanted mixing of biotech crops with organic crops. Thus, general recommendations have been developed to help farmers segregate biotech crops (and certain identity-preserved crops) from non-biotech crops. Some crops have low potential for gene flow to non-biotech crops. Others have greater risk due to factors such as pollen movement or dormant seed leading to volunteer plants. Thus, coexistence standards will have to be crop specific. Pollen flow potential makes corn a crop that requires adequate buffers to prevent excessive pollen movement.

Several state seed certifying agencies that offer identity-preserved grain programs require that non-biotech identity-preserved corn be planted at a distance of at least 200 m from any biotech corn. If non-biotech fields have border rows (which would be harvested separately and marketed as non-identity-preserved grain that may be either biotech or non-biotech), the isolation distance may be reduced. The border rows ensure that the non-biotech field is "flooded" with non-biotech pollen that will reduce any potential impact of biotech pollen. Removing 8 border rows at harvest allows a separation distance of 50 m to qualify. These isolation requirements are designed to produce corn grain that is no more than 0.5% contaminated with biotech crops, almost twice as stringent as the EU

0.9% labeling standard. Thorough cleaning of planting and harvesting equipment is essential. Planters and combines can be "flushed" with non-biotech seed or grain (to be sold as non-identity-preserved grain which can be either biotech or non-biotech) before planting or harvesting non-biotech grain.

Fawcett Farms, in Eastern Iowa, produces biotech and non-biotech crops, as well as a number of non-biotech specialty grains bred through traditional breeding techniques. These include a low linolenic acid soybean that produces a more healthful oil, highly extractable starch corn, and high oil corn. In order to receive a premium price for these crops, they must meet stringent standards. For example, when delivering a truckload of non-biotech grain, the load is sampled, analyzed in a lab, and accepted before it can be unloaded. This process takes 20 to 30 min. Some identity-preserved grains are tested on the farm before delivery to insure standards are met. Fawcett Farms has voluntarily participated in the ISO 9000 program. The International Organization for Standardization has mainly involved industrial and commercial standards in the past, but is now being applied to agriculture. Detailed management plans are developed and records are kept of everything that is done to fields from planting to harvest, and how a crop was stored and marketed. Annual external audits are conducted to document record keeping and quality control of grains.

Changes in management such as switching from screw-type augers to more easily cleaned pneumatic augers to move grain have aided segregation of different types of grain on the farm. Grain buyers have also specialized so that only certain types of grain may be purchased or certain grains purchased only on specific days, so that chances of commingling are reduced. In several years of growing and marketing identity-preserved crops, no grain produced by Fawcett Farms has ever been rejected due to not meeting standards, illustrating that with proper management, coexistence of biotech and traditional crops is possible.

TEACHING CALIBRATION OF SPRAYERS. Robert N. Klein, Professor, University of Nebraska, North Platte, NE 69101.

Applying the correct rate of a product is an important part of obtaining good results with pesticide sprayers. With a pesticide application, too little product can mean poor control, while too much can mean crop injury, extra costs, and possible residue on the crop and/or carryover.

Many methods can be used to calibrate sprayers, including the ounce calibration and formula-based methods. With the ounce calibration method, 1/128 of an acre is sprayed and the spray is collected. When measured in ounces the amount collected would be equal to the number of gallons applied per acre since there are 128 ounces in a gallon. Other methods involve using formulas which need to be remembered or recorded for easy use. These methods also may require converting some of the information you have.

The methods discussed in this presentation are simple relationships and do not require remembering formulas. However, you do need a general understanding of cross multiplication. The important thing is to be consistent: if you put an item on the top of an equation on one side, the same item also goes on the top of the other side.

The three factors that determine sprayer application rate are: 1) Speed, 2) Nozzle spacing, 3) Nozzle output (determined by orifice size, pressure, and density of spray solution).

A NebGuide which illustrates this method, G03-1511A "Calibration of Sprayers (Also Seeders)" is available on the University of Nebraska Web Site at http://ianrpubs.unl.edu/farmpower/.

Following in Figure 1 is how these relationships are used in determining speed in mph.

Figure 1. How to determine speed in mph using relationships.

If we travel 297 feet in 27 seconds, what is our speed?

$$\frac{27 \text{ sec}}{297 \text{ ft}} = \frac{60 \text{ sec}}{D}$$

$$27\ D = 60 \times 297$$

$$27\ D = 17{,}820$$

$$D = \frac{17{,}820}{27}$$

$$D = 660 \text{ ft}/60 \text{ sec}$$

Divide by 88 since 1 mph = 88 ft/60 sec (1 min)

$$\frac{660}{88} = 7.5 \text{ mph}$$

USE OF AN ELECTRONIC RESPONSE SYSTEM TO ENGAGE AUDIENCES. Bob Hartzler and M.D.K. Owen, Professors, Department of Agronomy, Iowa State University, Ames, 50011.

Student response systems consist of hand-held infrared transmitters (similar to a TV remote control), an infrared receiver, and software to manage the equipment. The systems are being promoted for use in large classroom settings, with proposed benefits of engaging all students, increasing student involvement, and promoting instant feedback to students and instructors. The system used by the Agronomy Department is InterWrite PRS (www.gtcocalcomp.com), but other similar products are available.

The InterWrite system allows the user to enter multiple choice questions directly into a Powerpoint presentation. During the presentation participants answer questions using their remote. Each user's remote has a unique frequency, and the successful reception of their response is indicated on the screen. After the allotted time a bar graph appears on the screen that displays the distribution of responses by all participants. The software maintains records of the entire session so that the knowledge base of the participants can be evaluated following the meeting.

Our department purchased the system over two years ago, but currently only two faculty have actually used it. I have used the system at the Integrated Crop Management Conference and at the Herbicide Short Course. Both of these Extension meetings were full day events in which participants tend to show 'lecture fatigue'. The use of the response system helped maintain the focus of the audience and provided valuable feedback on the knowledge level of Extension clients. Approximate cost of the system is $1700 for a package with 1 receiver and 32 transmitters, or $2600 for 2 receivers and 50 transmitters.

ASSESSING THE IMPACT OF THE PESTICIDE APPLICATOR RECERTIFICATION PROGRAM IN INDIANA. Willliam G. Johnson, Glenn R.W. Nice, and Fred Whitford, Associate Professor, Weed Science Extension Specialist, and Director of Pesticide Programs, Purdue University, West Lafayette, IN 47907.

Farmers who purchase and apply restricted use pesticides in Indiana are required to hold a private applicator pesticide license. To maintain the license over time, the pesticide use governing agency in Indiana, which is the Office of the Indiana State Chemist (OISC) requires growers to attend two, county-based Pesticide Applicator Recertification Programs (PARP) within a three-year period or retake the certification test. As expected, most prefer to attend the PARP meetings as opposed to taking an exam.

PARP meetings are organized by county Extension educators. The structure of the meeting is somewhat flexible, but OISC mandates that attendees are exposed to a 30 minute regulatory topic and an additional 120 minutes of pest or pesticide management topics. Regulatory topics in the past have included issues such as drift management and bulk storage rules and regulations. The objective of the regulatory topic requirement is to keep farmers up to date on legislative issues pertinent to pesticide use or address pesticide management issues, such as herbicide drift. In 2005, the PARP regulatory topic involved environmental and regulatory issues associated with atrazine herbicide use in Indiana. This topic was chosen because of frequent detections in surface water supplies and the new regulations regarding atrazine mitigation in surface water supplies in the U.S.

We developed a slide show that outlined the extent of the issue in Indiana, highlighted the new monitoring and mitigation program put in place by the registrant and EPA, and discussed various practices for reducing off-site movement of atrazine into surface water. To assess the impact of this program, we asked attendees to complete a short survey about the program which addressed their current knowledge about the importance of the issue, their awareness of the limitations regarding application spelled out specifically on the label, and how much they thought their yields would be reduced or herbicide expenses would increase, and whether they would modify their atrazine use patterns.

Survey responses were collected from over 1900 individuals. The survey showed that 33% of the growers were concerned about the environmental issues associated with atrazine use before the PARP program and over 60% were concerned after the program. However, over 90% of the growers feel that atrazine or atrazine containing products are important or very important to their corn weed control programs. Most growers expected to lose between 5 and 20 bu/A of corn yield if they could not use atrazine and spend 4 to 20 $/A more to control weeds without the use of atrazine. The growers indicated that the mitigation practices that they would most like adopt to reduce atrazine movement to surface water included better attention to setback requirements listed on the label, reducing atrazine use rates by tankmixing with other herbicides, light incorporation of soil-applied atrazine, establishing filter strips around surface water, being careful not to apply just prior to heavy rain, and utilization of herbicide-resistant corn hybrids.

MAKING COMMERCIAL WEED CONTROL TRIALS RELEVANT TO GROWER AUDIENCES. Christy L. Sprague, Kathrin Schirmacher, and James J. Kells, Assistant Professor, Graduate Research Assistant, and Professor, Michigan State University, East Lansing, MI 48824.

With the number of weed control programs available, finding programs that are effective, low-cost, and high yielding can be difficult for growers. In 2004 and 2005, field trials were conducted to compare weed control, crop injury, yield, and economic returns of dominant weed control programs being marketed to Michigan growers. Each year representatives from the major herbicide manufacturing companies were asked to submit up to four commercial weed control programs for use in corn and soybean. Company representatives were given the soil types and weed infestation histories of the sites where the studies were going to be conducted. The programs could be preemergence (PRE), PRE followed by postemergence (POST), or total POST and had to consist of herbicides that were registered for use in Michigan. Treatments could be selected for application on either glyphosate-resistant or conventional crops and company representatives were asked to specify the appropriate herbicide formulations, recommended additives (trade names), applications rates, and any special application timing instructions (i.e. weeds 2 inches in height). Field trials following the weed control programs outlined by the companies were then conducted. The total cost of each program was calculated by estimating the following: (1) custom application fees, (2) additional seed costs (if glyphosate-resistant treatment), and (3) the cost of the herbicides and additives. The trials were evaluated for crop injury and weed control, and plots were harvested at the end of the season for yield. With the harvest data, a gross margin analysis was performed for each weed control program. These trials were highlighted at the Michigan State University Weed Control Tours in 2004 and 2005. At these tours growers, consultants, agribusiness personnel, and extension educators were allowed to evaluate the programs for themselves and the cost of each program was included on the field tour signs. Special tours were also arranged with a number of groups to view these trials in 2005. Results including the economic analysis of these trials were presented to over 1,500 people at 15 different extension meetings in 2005 and information from the 2005 trials will be presented during the 2006 extension programming season. Results from these studies were also summarized in printed form and were distributed to growers, extension offices, and retail outlets and were made available on the world-wide-web. Grower reactions about these trials were extremely favorable and they viewed these trials as a valuable opportunity to compare efficacy and economic returns of several weed control programs that they could potentially use on their farms.

WISCONSIN STYLE: HOME-BREWED OUTREACH IDEAS AND TOOLS. Chris M. Boerboom and Jerry D. Doll, Professor and Professor Emeritus, University of Wisconsin-Madison, Department of Agronomy, Madison, WI 53706.

Novel approaches can creatively engage our Extension clientele and improve the delivery of weed management information. In Wisconsin, we used creative techniques in four areas. The first program is the "Biggest Weed Contest," which is held annually at the Wisconsin Farm Technology Days, a 3-day summer farm show. At our Weed Doctor's booth in the Extension tent, we provide weed identification and management recommendations to attendees. To increase interest and activity at our booth, we hosted the biggest weed contest for 7 years where the public is encouraged to bring their biggest weed to the farm show. The contest is publicized throughout the state before the event. Each weed is given a "size score," determined as the product of the weed height and width. A single-day and 3-day winners are selected and weed-related prizes are awarded. An average of 21 weeds were entered by contestants each year. The contest creates publicity for the Weed Doctors when people see assorted 5- to 13-feet tall weeds being carted through the grounds to enter the contest and we often have a small crowd gather as weeds are measured. The contest has increased the visibility of our booth, assisted people with weed identification and management, added what is now an annual attraction to Farm Technology Day and increased interaction with general attendees and youth.

The second activity involves WeedSOFT, a bioeconomic decision support system for weed management. The software program contains important elements that are both educational and critical in assessing weed management options. "WeedSOFT Casino" is an interactive presentation that was developed to illustrate many of these biological (e.g., weed-crop interactions that effect yield), regulatory (e.g., label restrictions on herbicide use), and economic (e.g., economic returns to management) features. The presentation starts with a brief overview of WeedSOFT's goals and how to operate the software. Next, several scenarios related to these features are presented under the guise of casino games with specific answers. Participants bet with play money on the answers, which are based on WeedSOFT predictions. At the conclusion of these scenarios, the participant with the greatest "winnings" can purchase a door prize. This format is highly interactive in small audiences and is an effective method to engage audiences and highlight the value of WeedSOFT features. In large audiences, the presentation can be modified so the audience uses score cards to track their responses.

The third project is a simple method to demonstrate herbicide rainfast requirements under field conditions. This project's unique approach was to simulate rain using a standard field sprayer with a 1,000 gallon tank, equipped with large flood nozzles and operated at the slowest speed possible (1.1 mph) to deliver more than 200 gallons of water per acre. Herbicide treatments were applied at four time intervals in a randomized block design prior to the simulated rain. Plots were arranged so that a 15-foot section of the spray boom would "rain" on half of each 30-foot long plot, which left a "non-rain" control for each treatment. All herbicide treatments received the simulated rain nearly simultaneously with this method. Several passes of the sprayer were made until the 1,000 gallons of water were applied to 0.25 acres. The method successfully demonstrated reduced efficacy of glyphosate applied at 0.5 to 4 hours before simulated rain under field conditions.

The fourth idea was creating tools to aid in teaching and diagnosing herbicide injury symptoms. A 2-page herbicide mode of action key with decision points based on site of uptake, translocation, selectivity, and classic symptomology (via corn and soybean images) has been enhanced and reprinted. This key is useful in teaching important diagnostic characteristics at field workshops. A searchable database of herbicide injury images is also being compiled and suggested for regional adoption. These are four examples of novel and extension delivery techniques and tools that we have successfully used with our clientele.

MSU'S CROP MANAGEMENT AND FIELD DIAGNOSTIC SCHOOL: 3-YEARS OF SUCCESS.
Christy L. Sprague, Steven Gower, and Carrie A.M. Laboski, Assistant Professor, Academic Specialist, and Assistant Professor, Michigan State University, E. Lansing, MI 48824 and University of Wisconsin, Madison, WI 53706.

The Michigan State University Crop Management and Field Diagnostic School (CM&FDS) is a one-day hands-on crop management school where ag professionals, county Extension Educators, farmers, and government personnel have the opportunity to hone their field decision making and problem solving skills by interacting with MSU Extension Specialists. This program has been conducted for 3 years and provides participants with university research-based information to sharpen their diagnostic skills and stay on top of the latest information in production agriculture. The CM&FDS has been held during the last week of July each year and is set up with four 1.5-hour in-depth field training sessions. Subjects covered in these sessions include topics in weed science, soil fertility, crop management, entomology, nematology, application technologies, and plant pathology. Each year subjects vary, depending on topics that are relevant for that growing season. Registration fees cover program expenses for field demonstrations, training materials, and participant lunches. Attendance for this program has been 66, 68, and 120 participants for the 2003, 2004, and 2005 programs, respectively. Based on surveys each year, over 80% of growers who have participated in the school said that they may change some of their farm practices based on knowledge gained during the School. Of all of the non-grower participants (ag professionals, county Extension Educators, farmers, and government personnel) that attended, over 95% said the knowledge they gained during the School will improve the quality of the services they offer their clientele. It has been expected that participants have used the knowledge gained at the CM&FDS to make scientifically based crop management decisions that improve farm profitability and reduce the environmental impacts of agriculture.

SUCCESS WITH COMMODITY GROUP SPONSORED FIELD DAYS. Brady F. Kappler, Weed Science Educator. University of Nebraska, Lincoln, NE 68583-0910

For the past seven years the University of Nebraska has been successfully working with the Nebraska Soybean Board to deliver field days orientated towards producers. This program is a “turn-key” program for the Nebraska Soybean Board in which they contract with the University of Nebraska to handle all of the logistics of the field day event from marketing, to catering, to program delivery. Each year the field days know as Soybean Management Field Days (SMFD) have been held in 4 locations throughout the state of Nebraska. The 4 locations are all held on consecutive days in August. The program, which is conducted on actual producers’ fields, is formatted into four 1 hour presentations throughout each day with the attendees rotating through each stop. Each stop typically has a tent for formal presentations and also a field plot area in which the presenters are able to demonstrate principles discussed in the formal presentation. The topics typically include crop production, economics and marketing, one or two pest management topics and / or a tillage/irrigation topic. The program has been very successful with over 3,328 producers attending these meeting since 1999. Less than 1% of those in the attendance were not satisfied with the program. Each year at least 87% of the participants have reported that they probably or definitely will make changes in their operation based on what they learned at the SMFD event. Overall, the program on average has impacted over 500,000 acres per year and the participants report a value of the program of over $3.5 million per year. The model of utilizing funds from a commodity organization combined with a strong extension team has been quite successful in Nebraska.

DODDER (*CUSCUTA CAMPESTRIS*) CONTROL ON SEVERAL ORNAMENTAL PLANTS. Shawn M Hock*, Research Associate III, and Greg Wiecko, Professor, Univ. of Guam, Mangilao, GU, 96923.

Field and greenhouse experiments were conducted in 2005 in Guam to develop dose-response curves for glyphosate for crop tolerance in ornamental plants and for dodder control. The effective dose (e.g., ED_{10} = 10% visual quality reduction) were 1050, 960, 910, 820, 590, 390, 130, and 130 g/ha for hibiscus, paper gardenia, croton, ixora, schefflera, duranta, king's mantle, and allamanda, respectively. Preliminary data collected on dodder control after attachment indicates that a dose of only 280 g/ha of glyphosate is required to effectively manage dodder attached to ornamental plants. shock79@gmail.com

HILL MUSTARD (*BUNIAS ORIENTALIS*): ON THE MOVE IN WISCONSIN. Jerry D. Doll, Weed Scientist Emeritus, Univ. of Wisconsin, Department of Agronomy, Madison, WI 53706.

Hill mustard originated in southern Europe and is already present in most northeastern states, Virginia, Ohio and Michigan. The presence of hill mustard in Green Co. Wisconsin was documented in 1958. The original Wisconsin site is about four miles north of the county seat, Monroe, WI and the population apparently spread very slowly for many years. The first call we received regarding hill mustard as a plant of concern came from a crop consultant in 2002 who noticed a dense population of yellow flowering plants in a CRP site that spring. He sent us plant samples and the University of Wisconsin Herbarium confirmed our identification that the plant was hill mustard. Others reported a “new yellow-flowered weed” in the same vicinity in 2003 and 2004. The county agricultural Extension agent identified the land owner of the original site. We visited this site in 2004 and established an initial herbicide demonstration trial that included three modes of action: a growth regulator, an ALS inhibitor and a photosynthesis inhibitor. The results suggest that growth regulators and ALS inhibitors need to be tested further to determine the optimal time and rate of application.

The intriguing aspect of hill mustard in Wisconsin is that the infested area is very small, perhaps no more than 100 acres, and yet its potential to spread is in the moderate to high range. If we had a functional noxious weed program, this species would seem to be an ideal “prohibited” weed. In the absence of an effective program, we tried to document the distribution of hill mustard in Green Co. by driving all the roads within the area of the original infestation. The results were both encouraging and surprising. Encouraging because most of the infestations were within three miles of the epicenter, and the most distant populations in Green Co. were approximately five miles from the original site. And these observations were also discouraging because clearly the weed had invaded new sites and no one was taking action to prevent further spread. Further evidence of the weed’s spread occurred a few days later when several hill mustard populations were detected in Lafayette Co. (adjacent to Green Co. to the west); some of these included hill mustard in no-till soybean fields. Previously infestations were only noted in non-disturbed sites such as roadsides, CRP fields and waterways. The Lafayette Co. infestation are 20 to 25 miles from the epicenter in Green Co.

Most of the literature on hill mustard is from Europe where this species is considered highly invasive. If this is the case in the region of origin, we should give due attention to its threat to become an aggressive invader in North America. The epicenter gives us a preview of what can happen if no action is taken.

Since 1958, when first detected, areas of the original site are now 100% hill mustard. The species is a perennial with a huge but non-spreading taproots so it achieved this dominance via prolific seed production, numerous seedlings in open areas, a very large rosette leaf area (rosettes nearly 1 meter in diameter have been observed), aggressive early season growth, and perhaps allelopathy. Mature plants are highly aromatic. Another common name for this species is Turkish warty cabbage. Turkish for its region of origin, warty for the tubercles found on the stems (and perhaps the leaves), and cabbage for the strong cabbage smell emitted when stems or leaves are crushed. Whether these aromatic compounds (or others) in hill mustard are inhibitory to other species should be investigated.

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Hill mustard is described as a biennial or perennial. In Wisconsin, it seems to behave as a perennial. Plants flower once in late spring (about 10 to 14 days later than yellow rocket) and flowers produce a highly aromatic nectar and plants are prolific seed producers. Many fruits remain on plants until the end of summer. Thus mowing after viable seeds are formed seems to be the primary threat of spreading hill mustard to new sites. Seedlings of hill mustard can form a complete ground cover in open areas.

Much can be done to contain and hopefully eliminated many of our hill mustard infestations. Educational opportunities include preparing and disseminating printed material on hill mustard biology and management, working with local highway departments to prevent further spread of hill mustard, and encouraging early detection of infestations via the Wisconsin “Weed Watcher” program. Research opportunities are abundant. We need information on 1) seed biology (dormancy and germination; seed production; seed bank dynamics); 2) how to convert of dense infestations into desired vegetation (method of control, the role of soil tillage in rejuvenating infested sites, species to reintroduce), 3)practical management programs that roadside managers, farmers and others can adopt; and 4) ecological studies to determine how it spread and dominates other species and to understand its habitat range.

On the regulatory front, hill mustard in Wisconsin could be the poster child of how to address the appearance of a relatively new invader. Before implementing any of these ideas, a hill mustard assessment and planning session is needed so that the interests and concerns of land owners, highway departments, Departments of Natural Resources and Agriculture, University Extension, private environmental groups (The Nature Conservancy, Prairie Enthusiasts) and the Invasive Plants Association of Wisconsin are included. A multi-state or regional effort would be even more beneficial. Perhaps that could be done at our next NCWSS meeting.

CANADA THISTLE CONTROL WITH AMINOPYRALID. Robert G. Wilson*, University of Nebraska, Scottsbluff, NE 69361.

Field studies were initiated at two locations in western Nebraska to examine the efficacy of aminopyralid for Canada thistle control. Three experiments were initiated in the spring of 2003 and two were started in the spring of 2004. Comparisons were made between different rates of aminopyralid, picloram, clopyralid, dicamba, and chlorsulfuron applied at the bud or fall rosette growth stage. An additional experiment was also begun in the early summer of 2004 to explore the influence of mowing before and after aminopyralid treatment on Canada thistle control. Canada thistle shoot counts and visual observations of thistle control were taken approximately 6, 12, and 18 mo after treatment. Application of aminopyralid at 120 g ae/ha in late spring at the bud growth stage provided 91% control of Canada thistle 12 mo following treatment and control was equivalent to picloram at 420 g/ha. Fall rosette applications of aminopyralid at 87, 105, 120 g/ha provided on average 11% greater Canada thistle control than treatments made in the spring. Aminopyralid at 120 g/ha, applied in the fall, reduced Canada thistle shoot density 93%, 12 mo following treatment while picloram at 420 g/ha, clopyralid at 420 g/ha, dicamba at 1120 g/ha, and chlorsulfuron at 78 g/ha reduced Canada thistle shoot density 89, 81, 48, and 70%, respectively. Aminopyralid did not injure range grasses, sedges, and brush species at the study sites. Application of aminopyralid on June 9, 2004, 14 d before mowing did not influence the herbicides ability to control Canada thistle. However, mowing 7 d before or 7 to 14 d after aminopyralid treatment did reduce Canada thistle control 16%. Waiting 21 d after mowing before treatment with aminopyralid was long enough to avoid a reduction in Canada thistle control. Results from these trials showed that aminopyralid was very effective in controlling Canada thistle.

MANAGING USA RANGELAND INVASIVE PLANTS WITH AMINOPYRALID. Robert A. Masters, Vanelle F. Carrithers, Mary B. Halstvedt, Product Technology Specialists, Dow AgroSciences, LLC, Indianapolis, IN 46268, Celestine A. Duncan, Weed Scientist, Weed Management Services, Helena, MT 59601, Joseph M. DiTomaso, Weed Scientist, University of California, Davis, CA 95616, Robert G. Wilson, Weed Scientist, University of Nebraska, Scottsbluff, NE 69361, and Steven A. Dewey, Weed Scientist, Utah State University, Logan, UT 84322.

Aminopyralid is a new systemic herbicide developed by Dow AgroSciences specifically for use on rangeland, pasture, rights-of-way, such as roadsides for vegetation management, Conservation Reserve Program acres, non-cropland, and natural areas in the United States and Canada. The herbicide is formulated as a liquid containing, 240 g ae/liter of aminopyralid as a salt. The herbicide has postemergence activity on established broadleaf plants and provides residual control of germinating seeds of susceptible plants. Field research has shown aminopyralid to be effective at rates between 53 and 120 g ae/ha, which is about 1/4 to 1/20 less than use rates of currently registered rangeland and pasture herbicides with the same mode of action including, clopyralid, 2,4-D, dicamba, picloram, and triclopyr. Aminopyralid controls over 40 species of annual, biennial, and perennial broadleaf weeds including Russian knapweed, absinth wormwood, plumeless thistle, musk thistle, diffuse knapweed, spotted knapweed, yellow starthistle, oxeye daisy, Canada thistle, bull thistle, henbit, stinking mayweed, bulbous buttercup, curly dock, Carolina horsenettle, tropical soda apple, and common cocklebur. Most warm- and cool-season rangeland and pasture grasses are tolerant of aminopyralid applications at proposed rates. Research continues to determine the efficacy of aminopyralid on other key invasive weeds and on the role of aminopyralid in facilitating plant community improvement and restoration in land management programs.