RESPONSE OF VARIOUS MARKET CLASSES OF DRY BEANS TO HALOSULFURON. Nader Soltani, Christy Shropshire, and Peter H. Sikkema, Department of Plant Agriculture, University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0.

Four field trials were conducted over a two-year period (2006, 2007) in Ontario to evaluate the tolerance of black, cranberry, kidney, otebo, pink, pinto, small red Mexican (SRM), and white bean to halosulfuron applied preplant incorporated (PPI), preemergence (PRE), and postemergence (POST) at 35 and 70 g ai/ha. There was minimal visible injury (< 1%) in dry bean with halosulfuron applied PPI and PRE. Halosulfuron applied post at 35 and 70 g ai/ha caused 2.7 to 4.7% and 3.8 to 7.5% visible injury in dry bean, respectively at 1 week after application (WAA). The injury was transient with no significant injury at 2 and 4 WAA. Halosulfuron applied PPI, PRE, and POST at 35 and 70 g ai/ha caused no decrease in plant height of the different market classes of dry bean except for kidney bean which was reduced by 4% at 35 and 70 g ai/ha. Halosulfuron applied PPI, PRE, and POST at 35 and 70 g ai/ha caused no decrease in yield of various market classes of dry bean except for yield of kidney bean which was reduced 9% at 35 g ai/ha and 8% at 70 g ai/ha and yield of otebo bean which was reduced 3% at 70 g ai/ha. Based on these results, there is an adequate margin of crop safety for halosulfuron applied PPI, PRE and POST in black, cranberry, pink, pinto, SRM and white bean in Ontario. However, further research is required to ascertain the tolerance of kidney and otebo bean to halosulfuron especially when applied POST and further research is needed to determine the tolerance of varieties within market classes of dry bean to halosulfuron.

CONTROL OF WINTER CEREALS IN THE SPRING WITH GLYPHOSATE. Peter H. Sikkema, Christy Shropshire, and Nader Soltani. Department of Plant Agriculture, University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0.

Field experiments were established at the Huron Research Station and at University of Guelph Ridgetown Campus in 2005 and 2006 to evaluate different formulations of glyphosate (Weathermax vs Touchdown) at different rates (225, 450, 675, 900, or 1350 g ai/ha) for the burn off of winter cereals [soft white winter wheat (SWW), soft red winter wheat (SRW), hard red winter wheat (HRW) and fall rye] in the spring at two application timings (late April vs early May). There was no difference between the glyphosate formulations (Weathermax vs Touchdown) for the control of winter cereals at 7, 14, 21, and 28 days after treatment (DAT). There was generally improved control of winter cereals with glyphosate applications made in early May compared to late April however results were not always statistically significant. Winter cereals control generally increased as the glyphosate rate was increased from 225 to 1350 g ai/ha. The minimum rate of glyphosate required to provide 90% or greater control of SWW, SRW, HRW, and fall rye was 675 g ai/ha at 28 DAT. Glyphosate applied at 675 g ai/ha caused 97, 96, 97, and 98% reduction in shoot dry weight of SWW, SRW, HRW, and fall rye, respectively. Based on this study glyphosate (Weathermax or Touchdown) applied in late April or early May can be use at rates as low as 675 g ai/ha to adequately control SWW, SRW, HRW, and fall rye in the spring.

2008 North Central Weed Science Society Proc. 63:2.

RESPONSE OF WHEAT TO PREPLANT AND POSTEMERGENCE APPLICASTIONS OF 2,4-D and DICAMBA. James R. Martin, Charles R. Tutt, and Dorothy Call, Extension Professor, Research Specialist, and Technician, Department of Plant & Soil Sciences, University of Kentucky, Princeton, KY 42445-0469.

Applying 2,4-D or dicamba at the wrong time can cause injury to wheat. Historically these herbicides have been applied to wheat in Feekes growth stage 5 or when plants are fully tillered but prior to jointing and approximately 4 to 8 inches in height. This usually occurs around March to early April in Kentucky and will vary depending on environment and location. Some wheat growers have expressed an interest in using growth regulator herbicides in the fall when certain problem weeds are more easily managed, but they are concerned with the risk of crop injury. The objective of this research was to evaluate wheat response to fall burndown and fall postemerence applications of 2,4-D and dicamba.

Field trials referenced as 2005, 2006, and 2008 were conducted during 2004-2005, 2005-2006, and 2007-2008 growing seasons, respectfully. A field study was also conducted during the 2006-2007 growing season; however, freezing temperatures in the spring of 2007 caused substantial damage to wheat.

Wheat was planted with a no-till planter into corn stalks in mid October. The ground cover occupied by corn residue ranged from 85 to 95%. Herbicides used in all three studies were 2,4-D ester at 0.475 or 0.95 lb ae/A and dicamba at 0.125 lb ae/A. Application timings for all three studies were designated as PRE (preemergence at planting) and FALL POST (fall postemergence to 1- to 2- tiller wheat). The first two studies also included 2-WK EPP (approximately 2 weeks ahead of planting). A tank mix of 2,4-D ester at 0.18 lb ae/A with the premix of thfensulfuron at 0.25 oz ai/A plus tribenuron at 0.125 oz ai/A was included as a fall postemergence treatment in the 2006 and 2008 studies.

Some of the measurements used to quantify injury included plant stands (for the 2-WK EPP and PRE treatments only), head counts, test weight, and abnormal seedheads. Abnormal seedheads were observed in every sample, including the non-treated checks. The percent abnormal heads in the checks was 19% in 2005, 14% in 2006 and 6% in 2008. The symptoms of abnormal heads were in the form of twisted or curled heads, short length, and/or green in color.

The use of 2,4-D ester or dicamba as burndown treatments at 2-WK EPP or PRE did not affect wheat stands. These treatments did not affect other plant growth or yield factors such as percent of abnormal seedheads, test weight, or grain yield relative to the non-treated checks in either study, with the exception of one treatment involving 2,4-D. Wheat yield in the 2005 study was reduced by approximately 20 bu/A where 2,4-D ester at 0.95 lb ae/A was applied PRE at the time of planting.

FALL POST of applications of 2,4-D alone at both rates tended to cause injury in most instances. Head counts were less than those of the non-treated check in 2006. The percent of abnormal seedheads was greater where 2,4-D ester was applied FALL POST at both rates compared with the non-treated checks for all three years. Test weight of wheat was reduced with both rates of 2,4-D ester in 2005 and the low rate in 2006. Wheat grain yield was reduced when 2,4-D was applied postemergence at both rates in all studies, except for the low rate in 2008. The FALL POST treatment of 2,4-D ester with thifensulfuron plus tribenuron premix increased the percent of abnormal seedheads relative to the non-treated check in 2006, yet it did not limit wheat yield.

FALL POST applications of dicamba did not injure wheat except for a higher percentage of abnormal seedheads than the non-treated check in 2008. Applying dicamba to 1- to 2- tiller plants did not affect wheat grain yield in any of the studies.

These results support why 2,4-D should not be applied in the fall to emerged wheat with 1 to 2 tillers. The high rate of 2,4-D ester at planting can occasionally reduce wheat yield. However applications at two weeks ahead of planting appeared to be safe. This research helps support the use of dicamba in fall sprays. However dicamba applied to 1- to 2- tillering wheat may occasionally increase number of abnormal seedheads.

2008 North Central Weed Science Society Proc. 63:3.

EFFICACY OF PYRASULFOTOLE&BROMOXYNIL TANK MIXTURES IN WHEAT. Patrick W. Geier and Phillip W. Stahlman, Assistant Scientist and Professor, Kansas State University Agricultural Research Center, Hays, KS 67601.

An experiment conducted near Hays, KS in 2007-08 compared the efficacy and crop tolerance of pyrasulfotole&bromoxynil alone and in tank mixtures at two application timings in winter wheat. Treatments included pyrasulfotole&bromoxynil alone at 28&224 g/ha with AMS or UAN, pyrasulfotole&bromoxynil at 23&184 g/ha plus UAN and MCPA, dicamba, or metsulfuron. Comparative treatments included chlorsulfuron&metsulfuron plus UAN, triasulfuron&dicamba plus UAN, and a nontreated control. All herbicides included NIS at 0.5% v/v. Fall-applied (FPOST) herbicides and spring-applied (SPOST) pyrasulfotole&bromoxynil controlled blue mustard 98% or more. Flixweed control was greater than 95% regardless of herbicide or application timing. All FPOST herbicides controlled henbit 100%, whereas pyrasulfotole&bromoxynil alone or with MCPA or dicamba applied SPOST provided at least 90% control. Pyrasulfotole&bromoxynil plus metsulfuron, chlorsulfuron&metsulfuron alone, and triasulfuron&dicamba alone provided 84 to 86% henbit control when applied SPOST. Wheat chlorosis was generally greater with FPOST treatments compared to SPOST when evaluated at 12 days after treatment. Pyrasulfotole&bromoxynil plus dicamba, chlorsulfuron&metsulfuron alone, and triasulfuron&dicamba alone applied FPOST caused 8 to 9% chlorosis, whereas the same treatments applied SPOST caused 0 to 4% chlorosis. Herbicide-treated wheat matured 1 day earlier than nontreated wheat. Similarly, all wheat receiving herbicide treatment yielded 3020 to 3290 kg/ha more grain than nontreated wheat. However, no differences occurred between herbicides for wheat maturity or yield.

CHEAT AND JAPANESE BROME RESISTANCE TO ALS-INHIBITING HERBICIDES. Dallas E. Peterson* and Curtis R. Thompson, Professors, Department of Agronomy, Kansas State University, Manhattan, KS 66506-5504.

Cheat and Japanese brome are winter annual bromus species that commonly infest winter wheat fields of the southern Great Plains region. Sulfosulfuron and propoxycarbazone herbicides may be applied to wheat for selective control of winter annual bromes in wheat. Several cases of poor *bromus* control with sulfosulfuron and propoxycarbazone were reported in central Kansas during the 2006-2007 growing season. Cheat seed from Dickinson county and Japanese brome seed from Cowley county, Kansas were collected from wheat fields that had been unsuccessfully treated with propoxycarbazone. Greenhouse experiments were conducted to determine if the two *bromus* populations were resistant to ALS inhibiting herbicides. Propoxycarbazone, sulfosulfuron, imazamox, and pyroxsulam were applied at typical field use rates and with recommended adjuvants to susceptible and suspected ALS-resistant cheat and Japanese brome populations at the two leaf stage of growth. Propoxycarbazone also was applied at ten times the labeled field application rate to evaluate the degree of resistance. All herbicides evaluated provided greater than 85% control of susceptible *bromus* populations four weeks after treatment. Control of the suspected resistant *bromus* populations was less than 5% with propoxycarbazone, sulfosulfuron, or pyroxsulam at two and four weeks after treatment, even with the 10X rate of propoxycarbazone, confirming ALS resistance in both *bromus* populations. Imazamox suppressed growth of the resistant cheat and Japanese brome populations by 50 and 35% at four weeks after treatment, but plants were not killed and recovered over time. Both fields with resistant *bromus* populations had received several applications of propoxycarbazone or sulfosulfuron during the previous 10 year period. Isolated populations of cheat and Japanese brome in central Kansas have developed resistance to ALS-inhibiting herbicides labeled for *bromus* control in wheat. Alternative management practices such as crop rotation will be required in wheat fields that have developed ALS-resistant *bromus* populations.

DOES THE ADDITION OF TRIFLUSULFURON TO GLYPHOSATE ENHANCE CONTROL OF VELVETLEAF AND COMMON LAMBSQUARTERS? Jon-Joseph Q. Armstrong and Christy L. Sprague, Graduate Research Assistant and Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

Triflusulfuron-methyl is an acetolactate synthase (ALS) inhibiting herbicide commonly used in sugar beet. With the current rapid adoption of glyphosate-resistant sugar beet varieties and increasing prevalence of glyphosate-resistant and -tolerant weed species, tank mixing other products with glyphosate may be necessary to ensure satisfactory weed control. Greenhouse trials were conducted to determine if the addition of triflusulfuron-methyl to glyphosate could improve control of velvetleaf and common lambsquarters. Rates of glyphosate (0, 105, 210, 420, and 840 g ae/ha) and triflusulfuron-methyl (0, 4.4, 8.8, 18, and 35 g ai/ha) were chosen to represent 0-, 0.125-, 0.25-, 0.5-, and 1-times the label-recommended rate of each herbicide and these rates were combined in a factorial arrangement. Herbicide applications were made when weeds were 10 cm in height. Triflusulfuron-methyl alone was not effective at controlling 10 cm tall velvetleaf. Visual control of common lambsquarters with triflusulfuron-methyl ranged from 1 to 6%. Combinations of triflusulfuron-methyl and glyphosate were generally additive. Synergistic activity was observed for visual control of velvetleaf for combinations of triflusulfuron-methyl at 18 and 35 g ai/ha with glyphosate at 105 and 210 g ae/ha. Synergistic activity for visual control was also observed for common lambsquarters control for combinations of all rates of triflusulfuron-methyl with glyphosate at 420 g ae/ha. The only combination that resulted in a synergistic response for biomass reduction in velvetleaf was triflusulfuron-methyl at 35 g ai/ha and glyphosate at 105 g ae/ha. None of the herbicide combinations resulted in a synergistic reduction of biomass for common lambsquarters.

WINTER WHEAT TOLERANCE TO PRE AND POST APPLICATIONS OF SAFLUFENACIL.

Stevan Z Knezevic, Jon Scott, Avishek Datta, and Leo D. Charvat, Associate Professor, Research Technologist, Post Doctoral Fellow, University of Nebraska, Concord, NE 68728; Biology Area Manager, BASF Corporation, Lincoln, NE 68523.

Saflufenacil is a new PPO inhibiting herbicide being developed for pre-plant burndown and PRE broadleaf weed control in field crops, including corn, soybean, sorghum, and wheat. As part of studying potential use pattern of this herbicide, field experiments were conducted in 2007 and 2008 at Concord, northeast Nebraska, with the objective to determine winter wheat tolerance to various rates of saflufenacil applied PRE, and POST. POST applications were conducted in the fall, after crop emergence (V2-V3 stage, 5cm height, Feeks1), and in the spring (4^{th} node, 40cm height, ~ Feeks 7) with saflufenacil applied alone, or tank-mixed with NIS or COC. Dose-response curves based on log-logistic model were utilized to determine the ED (effective dose) values of saflufenacil for visual injury and relative yield loss of wheat with and without adjuvants. Applications rates of saflufenacil in PRE study included 25, 50, 100, 200, and 400 g ai/ha. The rates in POST studies were consisted of 6.25, 12.5, 25, 100, and 200 g ai/ha. There was no crop injury nor yield reduction in any of the rates tested with PRE application. That was also the case with the highest rate of 400g ai/ha, which could be as much as 8x higher that the proposed label rate (25-50g ai/a), suggesting high level of winter wheat tolerance to saflufenacil applied PRE. However, there was a range of crop injuries (5-95% in fall and 5-65% in spring) and yield reduction (21-66% in fall and 46-58% in spring) with POST application. Addition of adjuvants also increased crop injury levels. It appeared that wheat tolerated higher rates of saflufenacil applied POST in fall than in spring. For example, at 14DAT in the fall application, about 5% visual crop injury (ED_5) was evident with 82, 67, and 10 g ai/ha of saflufenacil compared to 51, 30, and 11 g ai/ha in the spring, with no adjuvant, or NIS, or COC, respectively. There were similar effects on crop yields. About 5% yield reduction with fall POST application was evident with 54, 38, and 10 g ai/ha applied alone, or tank-mixed with NIS, or COC, respectively. Similar level of yield reduction was evident with much lower rate of saflufenacil applied POST in spring, including 24, 7, and 4 g ai/ha of saflufenacil applied alone, or tank-mixed with NIS, or COC, respectively. These results suggest that PRE applications of saflufenacil would be safe for use in winter wheat, which is similar to the proposed use pattern of this herbicide. In addition, the proposed label does not suggest the POST use of saflufenacil in winter wheat, nor any other cereal crop, which is similar to what we have concluded from this study. Additional testing is needed to determine wheat tolerance at several other growth stages, adjuvant types, formulation types and environmental conditions (eg. cool temperatures at the time of POST herbicide application).

RESPONSE OF WINTER WHEAT AND WINTER ANNUAL WEEDS TO TWO SAFLUFENACIL FORMULATIONS. John C. Frihauf, Phillip W. Stahlman, and Patrick W. Geier, Graduate Research Assistant, Kansas State University, Manhattan, KS 66502, Professor, and Assistant Scientist, respectively, Kansas State University Agricultural Research Center, Hays, KS 67601.

Saflufenacil is an experimental herbicide for burndown and preemergence (PRE) control of broadleaf weeds in various crops. Research has shown preplant and PRE applications of saflufenacil to be generally safe to winter wheat. However, many wheat producers may be reluctant to use this herbicide because many to apply herbicides postemergence (POST) after wheat breaks dormancy in the spring. Field experiments were conducted at two locations during the 2007 to 2008 winter wheat growing season to evaluate the response of winter wheat and winter annual weeds to two saflufenacil formulations POST applied alone or mixed with 2,4-D amine. Herbicide treatments were POST applications of emulsifiable concentrate (EC) and water dispersible granule (WDG) formulations of saflufenacil at 13, 25, and 50 g/ha alone and in combination with 2,4-D amine at 533 g/ha. 2,4-D amine was also applied alone at 533 g/ha and crop oil concentrate (Agri-dex) at 1.0% v/v was added in all treatments except those that included 2,4-D amine. Blue mustard control was $\geq$ 90% when treatments included saflufenacil in both experiments regardless of saflufenacil formulation or rate. Saflufenacil at 25 and 50 g/ha controlled flixweed $\geq$ 90% regardless of formulation, but control was reduced when the WDG formulation was mixed with 2,4-D amine in both experiments. Generally the WDG formulation caused less necrosis than the EC formulation, and tank-mixing either formulation with 2,4-D amine reduced necrosis compared to solo treatments with adjuvant in both experiments. Wheat eventually fully recovered from necrosis in both experiments. Grain yields were similar among all herbicide-treated wheat in the Hays experiment. Yields of most herbicide-treated wheat were similar to wheat receiving 2,4-D amine at Manhattan. However, solo applications of EC and WGD formulations at 13 g/ha, and the tank-mix of the WDG formulation at 13 g/ha with 2,4-D resulted in yields 12, 11, & 10%, less than wheat treated with 2,4-D alone. Efficacy, injury, and yield data generally indicate POST applications of either saflufenacil formulation alone or tank-mixed with 2,4-D amine are safe in winter wheat and provide excellent control of blue mustard and flixweed.

EFFECT OF REDUCED HERBICIDE RATES ON WEED CONTROL AND YIELD OF CORN. Nader Soltani, Laura L. Van Eerd, Richard J. Vyn, Christy Shropshire, and Peter H. Sikkema, University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0.

A study was conducted over a 3-yr period (2003, 2004, and 2005) to evaluate the effect of reduced herbicide rates, 20, 40, 60, 80 and 100% of the manufacturer's recommended rate (MRR) on weed control, environmental impact (EI), yield and profitability of corn in Ontario. The herbicide rate required to provide 90% or greater control of velvetleaf, redroot pigweed, common ragweed, common lamb's-quarters and annual grasses was 60, 20, 60, 40, and 60% of the MRR for isoxaflutole plus atrazine, 100, 20, 40, 20, and 80% of the MRR for dimethenamid plus dicamba/atrazine, <100, 20, 60, 60, and 60% of the MRR for glufosinate plus atrazine, and 20, 20, 20, 20, and 40% of the MRR for nicosulfuron/rimsulfuron plus dicamba/diflufenzopyr, respectively. Yield of corn was not affected when isoxaflutole plus atrazine, dimethenamid plus dicamba/atrazine, glufosinate plus atrazine, or nicosulfuron/ rimsulfuron plus dicamba/diflufenzopyr were used at 20, 40, 60, 80 and 100% of the MRR. Nicosulfuron/rimsulfuron + dicamba/diflufenzopyr had the lowest EI. The results of regression analysis suggested that the MRR rates do not always maximize profit margins. In most cases profit margins was optimized by applying only 60% of the MRR.

BROADLEAF WEED MANAGEMENT IN CORN UTILIZING SYNERGISTIC HERBICIDE COMBINATIONS. Andrew J. Woodyard, Douglas J. Maxwell, and Dean E. Riechers, Graduate Student, Principal Research Specialist, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

The interaction of photosystem II (PSII) and the 4-hydroxyphenylpyruvate dioxygenase (HPPD) inhibitors is a useful herbicide interaction that can be utilized for managing problematic and herbicide-resistant weeds. Field studies were conducted during 2007 and 2008 in Urbana and Dekalb, IL to analyze rate requirements using synergistic combinations of two PS II inhibitors with the HPPD inhibitor, mesotrione. The studies evaluated and compared the control of three problematic broadleaf weed species in corn (waterhemp, common lambsquarters, and giant ragweed). Two rates of each herbicide were evaluated, with the highest rate representing a typical field-use rate and the lowest a fraction of a field-use rate. Synergistic responses in weed control were detected but varied by weed species and rates. Synergistic interactions were consistently detected for waterhemp control through visual assessment of herbicide injury from 10 to 30 d after treatment (DAT) regardless of rates, moisture accumulation, or plant height. A synergistic interaction was determined for common lambsquarters control in 2007, but taller weed heights in 2008 affected the interaction at lower herbicide rates. Synergism was determined for giant ragweed control with all rates in 2008, but synergism was not detected between bromoxynil and mesotrione in 2007, likely due to a dry early season.

EFFICACY OF TEMBOTRIONE PLUS ISOXADIFEN-ETHYL ON SYMPTOMATICALLY BLEACHED GRASSES. John Hinz, Brent Philbrook, and Mark Wrucke, Field Development and Market Support Representative, Research Product Development Manager and Regional Manager Bayer CropScience, Raleigh, NC 27612.

Field trials were conducted to evaluate phytotoxicity and weed control efficacy with tembotrione plus isoxadifen when sprayed on previously bleached grass weeds. Grasses were bleached by applying 105 g a/ha mesotrione + crop oil concentrate + urea ammonium nitrate approximately 7 days prior to applying 138 g a/ha tembotrione and isoxadifen-ethyl + 560 g a/ha atrazine + crop oil concentrate + urea ammonium nitrate. At tembotrione plus isoxadifen-ethyl application, giant foxtail (*Setaria Faberia*), green foxtail (*Setaria viridis*) and shattercane (*Sorghum vulgare*) averaged 32%, 20% and 70% bleaching, respectively. Final weed control was not affected by the bleaching pretreatment. Tembotrione plus isoxadifen-ethyl controlled both bleached and non-bleached grasses equally well. Adding thiencarbazone-methyl to tembotrione plus isoxadifen-ethyl increased efficacy, but there was no difference in weed control between the bleached and non-bleached treatments. There was no effect of pretreatment on broadleaf weed control. All treatments provided nearly 100% of the broadleaf weeds in this study.

SAFLUFENACIL: A NEW HERBICIDE FOR PREPLANT BURNDOWN AND PREEMERGENCE DICOT WEED CONTROL. Steven Bowe*, Rex Liebl, Helmut Walter, Thomas Holt, Bernd Sievernich and William Patzoldt, Biologists, BASF, Research Triangle Park, NC 27523 and Limburgerhof, Germany 67117.

Saflufenacil (BAS 800H) is new herbicide being developed by BASF for burndown and residual dicot weed control in multiple agricultural production systems and specialty markets. Saflufenacil is a protoporphyrinogen-IX-oxidase (PPO) inhibitor belonging to the pyrimidinedione class of chemistry. Saflufenacil is readily absorbed by foliage, root and shoot tissue of plants. Once absorbed, saflufenacil is predominantly translocated via the xylem, with limited movement via the phloem. Selectivity is conferred by physical placement and rapid metabolism of saflufenacil in tolerant crop species. Research indicates that saflufenacil applied at 18 to 25 g ai/ha can be used alone or mixed with glyphosate and applied preplant for rapid and complete burndown of weeds prior to emergence of crops including corn, soybean, cereals, and selected legumes. Saflufenacil complements glyphosate by controlling difficult to control weeds such as horseweed (*Conyza canadensis*) and prickly lettuce (*Lactuca serriola*). Research has shown that in corn, saflufenacil can be used preemergence at 50 to 125 g ai/ha for residual control of most dicot weeds including large-seeded species such as velvetleaf (*Abutilon theophrasti*), common cocklebur (*Xanthium strumarium*), ragweed (*Ambrosia* spp.), common sunflower (*Helianthus annuus*) and morningglory (*Ipomoea* spp). Saflufenacil's combination of broad dicot spectrum, complementarity with glyphosate, and preplant crop tolerance make it well suited to be an important component for preplant burndown and residual weed control in many production systems.

WEED MANAGEMENT IN CORN AND SORGHUM WITH SAFLUFENACIL. Caren A. Judge*, Steven J. Bowe, Leo D. Charvat, Troy D. Klingaman, and Walter E. Thomas, Biologists, BASF, Research Triangle Park, NC 27709.

Saflufenacil (BAS 800H) is a selective herbicide currently under development by BASF for preplant and preemergence broadleaf weed control in field corn and grain sorghum. In field research trials across the US from 2005 to 2008, saflufenacil provided residual control (> 80%) of many small- and large-seeded broadleaf weeds including common cocklebur (*Xanthium strumarium*), common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*Ambrosia trifida*), morningglory species (*Ipomoea* spp.), pigweed and waterhemp species (*Amaranthus* spp.), and velvetleaf (*Abutilon theophrasti*). Optimal residual weed control was obtained when at least 1.3 cm of rain and/or irrigation was received prior to weed emergence. Rates of saflufenacil that have been evaluated were based upon soil texture, organic matter, and length of residual weed control desired ranging from 50 to 125 g ai/ha. In a planned two-pass weed control program, lower saflufenacil rates have provided excellent residual broadleaf weed control until a postemergence herbicide application (such as glyphosate). At higher rates, saflufenacil has provided sufficient residual broadleaf weed control until canopy closure. For broad-spectrum residual weed control, a combination of saflufenacil with dimethenamid-p was evaluated and provided excellent control of many broadleaf, grass, and sedge weeds.

In addition to the residual weed control obtained at the rates described herein (50 to 125 g ai/ha), saflufenacil has also provided preplant burndown control of emerged broadleaf weeds when applied in reduced tillage or no-till crop management systems. However, for burndown weed control, saflufenacil required the addition of adjuvants such as crop oil concentrate or methylated seed oil plus ammonium sulfate. For broad-spectrum burndown weed control, glyphosate was the tank-mix partner most often evaluated and provided excellent control of emerged broadleaf and grass weeds with no observed antagonism. Additionally, low rates of saflufenacil (< 50 g ai/ha) have also been evaluated in corn and many other crops for preplant burndown of broadleaf weeds, with limited or no residual weed control.

In research, corn and sorghum have demonstrated excellent tolerance to applications of saflufenacil made prior to emergence; however, injury has resulted from saflufenacil applications made after crop emergence. Tolerance of sweet corn, popcorn, seed corn, and specialty sorghum to saflufenacil is currently under evaluation. Overall, saflufenacil has demonstrated utility for residual and preplant burndown broadleaf weed control in conventional or reduced-till production, herbicide-tolerant corn or conventional corn and sorghum, and planned one-pass or two-pass weed control programs.

GLYPHOSATE RESISTANT GIANT RAGWEED MANAGEMENT IN CORN AND SOYBEANS.
Jason Waite, D. Shane Hennigh, and Kassim Al-Khatib, Graduate Research Assistant, Graduate Research Assistant, Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Giant Ragweed *Ambrosia trifida* (AMBTR) has become a major weed in corn and soybeans. There are several management strategies for controlling AMBTR which includes tillage, a chemical burndown program as well as selective herbicides. With the widespread use of glyphosate resistant crops there has been an increase in the use of glyphosate to manage AMBTR in corn and soybeans. The increased use of glyphosate has led to the development of glyphosate resistant AMBTR. A population of glyphosate AMBTR was confirmed to be eight times more resistant than the susceptible populations (Al-Khatib personal communication). Field experiments were conducted near Topeka, KS in 2008 to evaluate the efficacy of selected herbicides and tank mixes for control of glyphosate resistant AMBTR in corn and soybeans. Other weed populations found in the field were common waterhemp, velvetleaf, Palmer amaranth, large crabgrass, morningglory species, horseweed and common sunflower. Crop injury, general weed control (GWC) and AMBTR control were visually rated at 14 and 28 days after the first postemergence application (DAT). Visual ratings were based on 0 = no crop injury or weed control and 100 = mortality. Herbicide treatments were applied when weeds were 7.5 to 10 cm in height. No corn injury was observed with any treatment except saflufenacil, where 30% injury was observed at 14 DAT. However, plants recovered from injury and were similar to nontreated control 28 DAT. At 28 DAT, s-metolachlor + atrazine followed by (fb) s-metolachlor + glyphosate + mesotrione, s-metolachlor + glyphosate + mesotrione + atrazine, glyphosate + diflufenzopyr + dicamba, saflufenacil + dimethenamid-P + atrazine, s-metolachlor + glyphosate + mesotrione, glyphosate + topramezone, and acetochlor + atrazine fb glyphosate gave 100% control of AMBTR in corn. In the soybean experiment, soybean injury with lactofen was 30% at 14 DAT, however, plants recovered from injury and were similar to nontreated control 40 DAT. At 28 DAT, flumioxazine + chloriumuron + glyphosate fb glyphosate + lactofen, saflufenacil + glyphosate fb glyphosate, and flumioxazin + chlorimuron + glyphosate fb glyphosate gave 100% control of AMBTR in soybeans. In conclusion several treatments gave excellent control of glyphosate resistant AMBTR in both corn and soybeans, however; producers should also take GWC into consideration when making management decisions to control glyphosate resistant AMBTR.

ABSORPTION, TRANSLOCATION, AND METABOLISM OF MESOTRIONE IN GRAIN SORGHUM. Mary Joy M. Abit and Kassim Al-Khatib, Graduate Research Assistant and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Studies were conducted under controlled growth chamber conditions to determine if differential absorption, translocation, or metabolism were the basis for the differential response of grain sorghum hybrids to mesotrione. Mesotrione-tolerant (‘Dekalb DKS35-70’) and -susceptible (‘Pioneer 84G62’) sorghum grain hybrids were treated with ten 1-µl droplets of ^{14}C-labeled mesotrione (specific activity 781 MBq/g). In general, mesotrione absorption was similar in both hybrids. At 1 day after treatment (DAT), absorption was 7% in both hybrids, however; absorption remained near steady 7 DAT in Pioneer 84G62 but increased to 12% in Dekalb DKS35-70. Translocation of ^{14}C-mesotrione in sorghum hybrids was minimal with less than 30% of the absorbed herbicide translocated out of the treated leaf by 7 DAT. A distinct metabolite of ^{14}C-mesotrione was identified in both hybrids at 3 DAT. The amount of mesotrione parent compound that remained in Pioneer 84G62 and DKS35-70 were 72 and 65%, respectively. Dekalb DKS35-70 had significantly less mesotrione at 3 DAT compared to Pioneer 84G62, but metabolism of mesotrione was similar for both hybrids at 7 DAT. These results indicate that differential metabolism may explain the differential response of grain sorghum hybrids to mesotrione.

VOLUNTEER CORN CONTROL EFFECT ON CORN AND SOYBEAN YIELD. Jill Alms, Mike Moechnig, Darrell Deneke, and Dave Vos, South Dakota State University, Brookings, SD.

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

The effect of volunteer corn on corn yield was determined by establishing volunteer corn densities at 0, 0.2, 0.8, 1.2, 1.9, 2.5, 2.7, and 3.5 plants m^{-2} in 2007 and 0, 1.3, 2.3, 3.4, 4.5, 5.3, 8.0, and 8.5 plants m^{-2} in 2008 in Dekalb DKC 46-60 VT3 corn. Volunteer corn density treatments were established in a RCB design with four replications. Volunteer corn seed collected from DKC 58-73 in 2006 was spread on the soil surface on May 14, 2007 and volunteer corn seed collected from DKC 51-45 in 2007 was spread on the soil surface on May 16, 2008. In each year, volunteer corn seed was incorporated approximately 0-4 cm below the soil surface using a field cultivator. Corn and volunteer corn was harvested with a plot combine in the center 1.5 m of each 3 m wide plot on November 10, 2007 and November 5, 2008. Corn yield loss ranged from 0-9% in 2007 and 0-40% in 2008. To quantify volunteer corn control using glufosinate, volunteer glyphosate-resistant corn was established in glufosinate-resistant corn at 3.5 plants m^{-2} in 2007 and 7 plants m^{-2} in 2008. Glufosinate (482 g a.e. ha^{-1}) was applied when volunteer corn was 13, 18, 28, or 46 cm tall in 2007 and 15, 30, 61, or 91 cm tall in 2008. These treatments were established in a RCB design with four replications. In each year, volunteer corn control was greatest when glufosinate was applied to 18-30 cm tall volunteer corn. Corn yield loss was not significant ($P>0.05$) among glufosinate treatments in 2007, but ranged from 0-23% in 2008. Corn yield loss in 2008 may have been due to partial control and early season competition. These results indicated that uncontrolled, partially controlled, or late controlled volunteer corn caused corn yield loss.

The effect of volunteer corn on soybean yield was determined by establishing volunteer corn densities in soybeans at 0, 0.2, 0.6, 1.5, and 3.5 plants m^{-2} in 2007 and 0, 0.2, 0.9, 2.3, and 4.4 plants m^{-2} in 2008. Volunteer corn treatments were established in a similar manner as the volunteer corn in corn studies. Soybean yield loss ranged from 0-54% in 2007 and 0-58% in 2008 among the volunteer corn densities. To quantify the effect of partially controlled volunteer corn on soybean yield, volunteer corn was established in soybean at 1.5 plants m^{-2} in 2007 and at 2.2 plants m^{-2} in 2008. Clethodim was applied at 12.7, 25.5, or 51 g a.i. ha^{-1} when volunteer corn was approximately 51-61 cm tall. At the low clethodim rate, 16% control resulted in 21% yield loss in 2007 and 12% control resulted in 14% yield loss in 2008. At the medium clethodim rate, 77% control resulted in 14% yield loss in 2007 and 54% control resulted in 18% yield loss in 2008. At the high clethodim rate, 98% control resulted in 5% yield loss in 2007 and 91% control resulted in 5% yield loss in 2008. These results indicated that volunteer corn greatly affected soybean yield and even partially controlled volunteer corn resulted in soybean yield loss.

POSTEMERGENCE HERBICIDE EFFECTS ON FIELD AND SILAGE CORN BIOMASS ACCUMULATION AND BIO-ENERGY QUALITY. Wesley J. Everman, Bradley J. Love, and Andrew J. Chomas, Assistant Professor, Field Research Assistant, and Research Technician, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

The increased interest in using corn as a renewable energy source for cellulosic ethanol production raises several questions about best production practices. Several herbicides have been shown to have an adverse affect on growth of corn when applied at labeled rates. A study was established in 2008 at the Michigan State University Agronomy Farm in East Lansing, MI to determine if postemergence herbicides labeled for use in corn affect biomass accumulation and cellulosic ethanol production. Silage and field corn hybrids were planted in a split plot design with a randomized complete block arrangement of treatments within each split plot. POST applications were applied at the V4 growth stage to both silage and field corn. Herbicide treatments consisted of atrazine at 1 lb a.i./A plus COC at 1 qt/A, 2,4-D amine at 0.475 lb a.i./A, bromoxynil at 0.375 lb a.i./A, a pre-mix of dicamba plus diflufenzopyr at 0.175 lb a.i./A plus NIS at 0.25% v/v and AMS 17 lb/100 gal, mesotrione at 0.09 lb a.i./A plus COC at 1% v/v and AMS at 8.5 lb/100 gal, nicosulfuron at 0.03 lb a.i./A plus COC at 1% v/v, and a non-treated plot maintained hand weed-free for comparison. Crop injury, height and stage measurements were taken every 2 weeks following herbicide application. Injury was observed in plots treated with 2,4-D and bromoxynil in both the field and silage corn hybrids. Corn heights and biomass yield differences at the end of the season were generally dependent upon hybrid.

COMPETITION OF VOLUNTEER CORN *(ZEA MAYS* L.*)* AND REMOVAL FROM TRANSGENIC CORN HYBRIDS. Tye C. Shauck, David L. Kleinsorge, and Reid J. Smeda, Graduate Research Assistant, Research Specialist, and Associate Professor, Division of Plant Sciences University of Missouri, Columbia, MO 65211.

Volunteer corn *(Zea mays* L.*)* results from seed dropped due to weather, insect, and disease induced lodging as well as harvest inefficiencies. The increasing popularity of glyphosate-resistant (Gly-R) corn results in additional Gly-R volunteer corn as a management problem. Gly-R volunteer corn is managed easily in Gly-R soybeans *(Glycine max)*, however, research is limited on the impact and management of Gly-R volunteer corn in corn. Field trials were established in Novelty, Missouri in 2008 to determine competition effects of volunteer corn in corn and Gly-R volunteer corn removal in glufosinate-resistant corn with glufosinate. On May 20, under no-till conditions, corn hybrids (population of 69,190 seed per hectare) were sown in 76 cm rows in a randomized complete block design. Nitrogen, at 168 kg/ha, was broadcasted at the time of planting. To determine competition effects, Gly-R volunteer corn was planted randomly with a jab planter at densities ranging from 0 to 4 plants/m², and was allowed to compete season-long. In a second study with glufosinate-resistant corn, Gly-R volunteer corn was planted randomly in plots to establish densities of 1 and 4 plants/m². Gly-R volunteer corn was treated with glufosinate at a rate of 0.49 kg ai/ha at heights of 10, 20, and 40 cm.

In the competition study, chlorophyll SPAD meter readings, an indication of leaf nitrogen content, decreased for corn at the V8, VT, and R1 growth stages by 13, 20, and 6%, respectively at 4 volunteer corn plants/m² compared to the untreated control. However, in a year where rainfall during the growing season was 47.3 cm above normal, competition effects resulted in no significant yield losses due to increasing densities of volunteer corn. In the management study and at both volunteer corn densities, glufosinate resulted in control of ≥ 97, 19, and ≤ 50% at 10, 20, and 40 cm removal treatments, respectively. Dry weights of volunteer plants were reduced 74 to 99% for treated compared to untreated plants. Between the 10 and 40 cm removal timings, grain yield was reduced up to 8% in the 1 plant/m² density, but there was no relationship between treatment height and grain yield in the 4 plants/m² densities. Volunteer corn competes with planted corn for available nitrogen, but impacts on grain yield may be minimal with adequate levels of nitrogen and rainfall. Glufosinate is an adequate means of volunteer corn removal at early growth stages.

TOLERANCE OF SIX POPCORN HYBRIDS TO BAS 781. Thomas T. Bauman and Michael D. White, Professor and Research Associate, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

BAS 781 is a premix of dimethenamid-P + saflufenacel and is used as a soil applied pre emergence herbicide in corn. A field trial was conducted in 2008 to test the tolerance of six popcorn hybrids to three rates of BAS 781 (0.98, 1.47, and 1.95 kg ai/ha) and dimethenamid + atrazine (2.45 kg ai/ha). Plots were maintained weed free for the entire growing season with two mechanical cultivations (27 and 37 DAE).

A common injury symptom of BAS 781 is a necrotic lesion on leaves after they emerge from the soil. Significant necrosis was observed (17 DAE) on two hybrids treated with BAS 781 at the 1.95 kg/ha rate. Symptoms were not observed at the 49 DAE evaluation date. The 1.95 kg/ha rate of BAS 781 caused a reduction in crop stand with all six hybrids. A significant reduction in plant height was observed with all six hybrids treated at the two higher rates of BAS 781. No differences in plant height observed at harvest however. The high rate of BAS 781 caused a significant reduction in crop yield in all six hybrids at 10% level significance level but not at the 5% level. No significant effect on any hybrid was observed following application of a 0.98 kg/ha (X) rate of BAS 781.

RESPONSE OF CORN TYPES TO BROADCAST FLAMING. Santiago Ulloa*, Claudio Costa, Avishek Datta, Chris Bruening, George Gogos, and Stevan Z. Knezevic. Graduate Student, Undergraduate Student, Post Doc, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE 68728; Graduate student and Professor, Department of Mechanical Engineering, University of Nebraska, Lincoln, NE 68588, and Associate Professor, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE, 68728-2828.

Propane flaming has the potential to be included into an integrated weed management systems of both conventional and organic productions. Previous experiments tested flaming mostly in vegetable crops. In order to incorporate flaming in major agronomic crop such as corn, it is important to collect baseline data on the tolerance of different corn types to broadcast flaming. Field studies were initiated on two location at the Haskell Agricultural Laboratory in 2008 utilizing six rates of propane and three corn types, including field corn (*Zea mays* L.*)*, pop corn (*Zea mays* L. *var everta*), and sweet corn (*Zea mays* L.*var rugosa*). Propane rates were 0, 12, 31, 50, 68, and 87 kg/ha, corresponding to 0, 2.5, 6.5, 10.5, 14.4, and 18.4 gal/acre. Flaming treatments were applied utilizing an ATV mounted flamer moving at a constant speed of 6.5 km/h (4 m/h). Corn species response to propane flaming were estimated on the basis of visual damage and dry matter loss, and described by log-logistic models for each corn type. Overall response to propane flaming varied among the corn types, growth stages, and propane rates. Preliminary data suggested that all corn types presented high levels of tolerance to broadcast flaming. Sweet corn was the most tolerant while pop corn was the least tolerant regardless of the growth stages. Additional studies are needed to test the relationship between the injury level by flaming, and corresponding crop yields and yield components.

SIMULATED MESOTRIONE DRIFT FOLLOWED BY GLYPHOSATE, IMAZETHAPYR, BENTAZON OR CHLORIMURON IN SOYBEAN. Lynette R. Brown[1], Darren E. Robinson[1], Kevin Chandler[2], Clarence J. Swanton[2], and Peter H. Sikkema[1]. [1]University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0; [2]University of Guelph, Department of Plant Agriculture, Guelph, Ontario, Canada, N1G 2W1.

Six field experiments were conducted between 2005 to 2007 at Elora, Ridgetown, and Woodstock, Ontario in order to determine the effects of simulated mesotrione drift followed by in-crop applications of glyphosate, imazethapyr, bentazon and glyphosate plus chlorimuron on glyphosate-tolerant soybean [*Glycine max* (L.) Merr.] visual crop injury, plant height, density, dry weight, and yield. As the rate of simulated mesotrione drift increased, there was an increase in soybean injury and a decrease in dry weight, height, and yield. The application of the simulated mesotrione drift followed by bentazon resulted in synergistic responses in injury shortly after application in some environments. This increase in injury was transient, with no synergistic responses in density, dry weight, and yield. In contrast, antagonistic responses were observed when glyphosate, imazethapyr, or glyphosate plus chlorimuron were applied after simulated mesotrione drift in some environments.

EFFECTIVENESS OF PREEMERGENCE AND POSTEMERGENCE SOYBEAN HERBICIDES ON COMMON RAGWEED WITH RESISTANCE TO GLYPHOSATE AND ALS INHIBITORS.

Mark M. Loux and Anthony F. Dobbels, Professor and Research Associate, Department of Horticulture and Crop Science, The Ohio State Univ., Columbus, OH 43221.

Field studies were conducted in 2008 at a site in southwest Ohio with a common ragweed population resistant to glyphosate and ALS inhibitors, with the objective of developing recommendations for control of this population in soybeans. Glyphosate-resistant soybeans were planted under no-tillage conditions on May 7. The experimental area was treated with glyphosate and 2,4-D ester 7 days prior to planting to control emerged weeds. In the postemergence (POST) study, POST herbicides were applied on June 11, with sequential POST application on July 2. Common ragweed plants were 10 to 20 cm tall at the time of the initial POST application. In the preemergence/postemergence (PRE/POST) study, PRE herbicides were applied on May 7, and POST herbicides were applied on June 24. Common ragweed plants were 5 to 18 cm tall at the time of POST application. In both studies, POST herbicides were applied with methylated seed oil (1% v/v) and ammonium sulfate (2% w/v) in a volume of 195 l/ha.

In the POST study, one or two applications of glyphosate alone or in combination with cloransulam did not control more than 38% of the common ragweed at the end of the season. Control exceeded 90% for several fomesafen-containing treatments 3 weeks after the initial POST treatment (WAT). However, control did not exceed 83% in late August, even with two POST herbicide applications, due to regrowth of plants injured by herbicide. A single application of fomesafen at the rate of 350 or 440 g/ha controlled 64 and 78% of the common ragweed in late August. The addition of glyphosate, cloransulam, or bentazon to 350 g/ha of fomesafen did not improve control, compared with fomesafen applied alone. Two POST applications, consisting of fomesafen at 350 g/ha followed by lactofen at 100 or 210 g/ha, controlled 65 and 80% of the common ragweed.

In the PRE/POST study, control of common ragweed at the time of the POST application ranged from 44% for metribuzin at 420 g/ha to 72% for the combination of fomesafen and s-metolachlor at 270 and 1180 g/ha. PRE treatments containing flumioxazin at 71 g/ha controlled 56 to 61% of the common ragweed. POST application of fomesafen at 350 g/ha controlled 98% of the common ragweed 8 WAT, averaged over the five PRE treatments. Control with fomesafen was not affected by the addition of glyphosate or bentazon. The combination of glyphosate and cloransulam at 1680 and 18 g/ha controlled 34% of the common ragweed 8 WAT, averaged over PRE treatment.

Single or multiple applications of POST herbicides did not adequately control this multiple-resistant common ragweed population in the absence of PRE herbicides. PRE herbicides only partially controlled this common ragweed population, but this resulted in an increase in POST herbicide (fomesafen) effectiveness. It is possible that these results are indicative of a low level of resistance to PPO inhibitors in this population. Resistance may be manifested as reduced control of larger plants, and those not affected by previous application of PRE herbicide, which could explain the differences in control between these two studies.

EFFECT OF 2,4-D DRIFT ON ROUNDUP READY SOYBEAN YIELD COMPONENTS. Andrew P. Robinson and William G. Johnson, Graduate Student and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Although researchers report the effects of 2,4-D drift on soybean yield, no information is published for 2,4-D drift on Roundup-Ready soybean yield components. Our objective was to quantify 2,4-D drift on Roundup-Ready soybean growth, yield components, and seed composition. Two cultivars (Becks brand 342NRR and Croplan Genetics brand RC 2057) were sown on 2 July 2008 in Fowler, Indiana. Eight rates of 2,4-D (0, 0.112, 1.12, 11.2, 560, 1120, 2240, 4480 g ae ha^{-1}) were applied at two timings on Croplan Genetics brand RC 2057 (R2 and R4) and at one timing on Becks brand 342NRR (R1). Across cultivars and application timings yield ranged between 2.9 and 3.2 Mg ha^{-1} when spraying 0 to 11.2 g ae ha^{-1}, decreased to 1.2 Mg ha^{-1} at 560 g ae ha^{-1}, and was between 0.2 and 0 Mg ha^{-1} at higher spray rates. Yield was reduced when visual injury was 40% or greater at 31 DAT. Pods m^{-2}, seed mass, and seed pod^{-1} will be reported.

ESTABLISHED GLYPHOSATE RESISTANT ALFALFA REMOVAL WITH HERBICIDES. Andrew J. Chomas, Wesley J. Everman and James J. Kells, Research Technician, Assistant Professor, Professor, Department of Crop and Soil Sciences, Michigan State University. East Lansing, MI 48824-1325.

Periodically growers have the need to terminate an old alfalfa stand. Glyphosate is an effective herbicide for killing weed and legume species commonly found in old alfalfa stands. However, with the recent introduction of glyphosate resistant alfalfa, herbicide options without the use of glyphosate are needed. Field research was conducted from 2003-2007 at three sites in Michigan to examine the efficacy of fall and spring applied 2,4-D ester or dicamba. Glyphosate resistant alfalfa control was evaluated at 10, 20 and 30 days after spring application. Final glyphosate resistant alfalfa stands were then determined 30 days after spring application. Initial observations of dicamba applied in the fall, at 1lb ai/A provided 96 percent control or better of glyphosate resistant alfalfa over all three years when evaluated at the spring application timing. Spring applications of 2,4-D ester and dicamba were more effective at controlling glyphosate resistant alfalfa than the fall applications, providing 83 and 94% control, respectively. Alfalfa stand count reduction was greatest (93%) when dicamba was spring applied. Control of glyphosate resistant alfalfa following spring applications increased from 10 to 30 days after application; however, control following fall applications decreased during the same time period. Dicamba applied in the spring was the most effective glyphosate resistant alfalfa stand removal option evaluated.

EVALUATING WEED CONTROL OPTIONS IN DICAMBA TOLERANT SOYBEAN. Sara K. Carter*, Charles H. Slack, Glen P. Murphy and Paulette Pierson. Department of Plant and Soil Sciences, University of Kentucky, Lexington, The Monsanto Company, St. Louis, MO.

In 2007 and 2008, the University of Kentucky conducted research evaluating weed control measures and overall crop tolerance of soybean with traits exhibiting tolerance of dicamba and glyphosate applications. The trials took place at the Spindletop Research Facility in Lexington, KY. The study site was conventionally prepared on Maury Silt Loam soil. The 2007 study was planted on May 18 using a John Deere MaxEmerge planter at a depth of 1 inch and 30 inch row spacing. Preemergent applications of dicamba (.25 lb ae/A) were made the day of planting. Subsequent applications of dicamba (0.125 and 0.25 lb ae/A) were made when weed growth reached 3 and 6 inches and again when weed re-growth reached 6 inches. Each application of clarity was tank mixed with glyphosate (.75 lbs ae/A) and liquid ammonium sulfate (3.7% v/v). Visual ratings were taken 7 days after each application. The 2008 study was conducted on the same site, under the same field conditions as the 2007 study. Planting occurred on June 2 with preemergent applications of dicamba (.25 lb ae/A). Postemergent treatments were applied at 3 and 6 inches and again when weed re-growth reached 6 inches. Dicamba rates evaluated were 0.125 and 0.25 lb ae/A applied with glyphosate (0.75 lb ae/A) and ammonium sulfate (3.7% v/v). Visual evaluations were taken 7 days after each application.

Evaluations in 2007 showed excellent tolerance of the soybean variety to applications of dicamba regardless of when it was applied throughout the growing season. Weed control using the combination of glyphosate and dicamba resulted in at least 96% control of all weeds evaluated following the final application at 6 inch weed re-growth. Evaluations made in 2008 showed similar results to that of the previous year. Crop tolerance was excellent and weed control reached at least 93% following the final applications.

EFFICACY OF FALL AND SPRING APPLIED BAS 800 ON GLYPHOSATE-RESISTANT HORSEWEED (*CONYZA CANADENSIS*). Glenn R.W. Nice*, Vince M. Davis, William G. Johnson, Greg R. Kruger, Bryan G.Young, Stevan Z. Knezevic and Troy D. Klingaman; Purdue University, West Lafayette, IN 47906; Southern Illinois University, Carbondale, IL 62901; University of Nebraska, Concord NE 68728; BASF Corporation, Mahomet, IL 61853.

Glyphosate-resistant horseweed (*Conysa canadensis*), also known as marestail, has become a troublesome weed in Indiana no-till systems. Producers that are dealing with this in their fields are anticipating the development of tools to combat the problem. New and already available products are being positioned in the market to provide these tools to manage glyphosate-resistant horseweed while providing different modes of action to reduce the potential of resistance development. A new herbicide from BASF, BAS 800 [purposed common name of saflufenacil], was investigated for its residual activity on populations of glyphosate-resistant horseweed. Studies were conducted from 2006 to 2008 by Purdue University and Southern Illinois University in two locations; Butlerville, IN and Murphysboro, IL. Six herbicide treatments at four timings were investigated. The four timings were early fall (Oct. 15th - 30th), late fall (Nov. 15th – 30th), early spring (Mar. 15th – 30th) and late spring (Apr. 15th – 30th). Herbicide treatments were BAS 800 at 50 and 100 g ai/ha, chlorimuron-ethyl + tribenuron at 35 + 11 g ai/ha, respectively, flumioxazin at 72 g ai/ha, simazine at 1120 g ai/ha, and 2,4-D at 560 g ai/ha. Glyphosate at 840 g ae/ha + 257 g/1 L AMS was added to all treatments. Horseweed density was collected twice a month from late March to early July.

When treatments were applied early fall, chlorimuron-ethyl + tribenuron reduced horseweed density 76% at the early July timing. All other herbicides with residual activity, including both rates of BAS800 were comparable to the untreated check. However, the non-residual glyphosate + 2,4-D treatment had densities greater than the check. In the locations used for the study, horseweed predominantly emerges in the spring. Residual herbicides that are applied in the fall have to be active at high enough levels to have a large impact on horseweed in the spring. In the check there was horseweed suppression due to competition with uncontrolled winter annuals resulting in some suppression of horseweed in these checks. In these sites where horseweed predominantly emergences in the spring the controlling of winter annuals in the fall without any residual activity remaining in the spring can lead to higher horseweed numbers.

When applied in the spring the high and low rates of BAS800 decreased horseweed density 87% and 78% from the untreated check in the early July timing, respectively. When the applications were postponed to the late spring the high and low rates of BAS800 decreased horseweed 98% and 96%, respectively by late July. This study suggests that for effective horseweed control in regions that experience predominantly spring emergence, BAS800 would be best utilized in the spring. Only early fall application of chlorimuron-ethyl + tribenuron were effective. The uses of a non-residual herbicide in the fall might increase horseweed numbers due to lack of competition from winter annual weeds in the spring.

HERBICIDE COMBINATIONS WITH SAFLUFENACIL FOR PREPLANT BURNDOWN WEED MANAGEMENT IN SOYBEAN. Adam C. Hixson, John S. Harden, Leo D. Charvat, Troy D. Klingaman, and Walter E. Thomas, Agricultural Biologist, Senior Research Associate, Biology Area Development Manager, Biology Area Development Manager, and Field Biologist, BASF Corporation, Research Triangle Park, NC 27709.

Saflufenacil is a new herbicide being developed for broadleaf weed control in several crop and non-crop use patterns with federal registration expected in late 2009. Control of sensitive broadleaf weed species is through the inhibition of the protoporphyrinogen IX oxidase enzyme. Field research trials have been conducted across the United States and Canada to evaluate weed control and crop safety of saflufenacil in soybean. Saflufenacil provides rapid burndown of emerged broadleaf weeds when applied in conservation till or no-till soybean management systems. Saflufenacil has been shown to effectively control many key broadleaf species, including glyphosate or ALS resistant biotypes, such as horseweed (*Conyza canadensis*), prickly lettuce (*Lactuca serriola*), common lambsquarters (*Chenopodium album*), ragweed species (*Ambrosia* spp), and pigweed species (*Amaranthus* spp). Research has focused on burndown use rates of 18-25 g ai/ha. Results indicate that saflufenacil can be tank mixed with glyphosate to increase the burndown weed spectrum to include emerged grasses. Imazethapyr, imazaquin, pendimethalin or 2,4-D can be added to saflufenacil and glyphosate to further extend the residual weed control period up to an in-crop application of glyphosate in glyphosate-tolerant soybean cropping systems. These herbicide combinations with saflufenacil have provided greater than 80% broadleaf and grass weed control for 4 to 6 weeks following application. Research has indicated that soybean tolerance is good to excellent at the planned burndown use rates. Saflufenacil in combination with glyphosate and a residual herbicide can provide an effective treatment for preplant burndown and residual weed control in soybean cropping systems.

INFLUENCE OF TALL GOLDENROD REMOVAL ON TOTAL FORAGE YIELD AND QUALITY OF TALL FESCUE HAY FIELDS. Kristin K. Payne*, Eric B. Riley, Jimmy D. Wait, Kevin W. Bradley, Graduate Research Assistant, Research Specialist, Research Associate, Assistant Professor, University of Missouri, Columbia, MO 65211.

Field experiments were conducted in 2006 and 2007 to evaluate the effect of various herbicides on tall goldenrod (*Solidago altissima* L.) control, total forage quality and total forage yield in tall fescue (*Festuca arundinacea* Schreb.) pastures in Missouri. Aminopyralid, aminopyralid plus 2,4-D, aminopyralid plus metsulfuron, aminopyralid plus metsulfuron plus 2,4-D, metsulfuron, metsulfuron plus dicamba plus 2,4-D, and 2,4-D plus picloram were applied at various rates to tall goldenrod ranging from 26 to 28 cm in height in the spring of 2006 and 2007. Aminopyralid and aminopyralid plus 2,4-D provided the lowest tall goldenrod visual control and highest tall goldenrod density one year after treatment (YAT) compared to all other herbicides. All treatments except aminopyralid resulted in a 76 to 99% reduction in tall goldenrod stem density compared to the untreated control 1 YAT. There were no forage yield or quality differences between herbicide treatments, therefore all forage yield and quality data were combined across herbicide treatments and compared to the untreated control. Total forage yield was lower in herbicide-treated compared to untreated plots within season and 1 YAT, likely due to tall goldenrod remaining in untreated compared to herbicide-treated forage. One YAT, crude protein (CP) content increased by 2.5% and acid detergent fiber (ADF) and neutral detergent fiber (NDF) content decreased by 2.4 and 6.4%, respectively, in forage harvested from untreated compared to herbicide-treated plots. Pure samples of tall goldenrod collected at the time of each harvest were lower in CP, ADF and NDF content than pure samples of tall fescue collected at the same harvests. Results from this study indicate that a variety of herbicide treatments will provide good control of tall goldenrod, but tall goldenrod infestations may not reduce the quality or quantity of total forage harvested in tall fescue pastures. However, other factors such as tall goldenrod palatability and digestibility should be considered.

SOYBEAN RESPONSE TO SIMULATED SPRAY CONTAMINATION BY HPPD-INHIBITING HERBICIDES. Douglas J. Maxwell, Lisa C. Gonzini, Joshua T. Kunkel, and Aaron G. Hager, Principal Research Specialist, Research Specialists, and Assistant Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Herbicides that inhibit the HPPD enzyme have become popular options for postemergence control of annual broadleaf weeds in corn. Broadcast applications of mesotrione or tembotrione can be made to corn up to the 8-leaf stage, while topramazone may be applied up to 45 days prior to harvest. These herbicides are frequently applied in combination with other herbicides, such as atrazine, to broaden the spectrum of weeds controlled. The relatively wide application window increases the probability that soybean may be growing in the vicinity when postemergence applications of these herbicides are made in corn.

Herbicide drift outside the application area can injure sensitive, non-target vegetation. Previous research has demonstrated that soybean injury can occur following exposure to mesotrione at rates simulating drift. Field research was conducted in 2008 to characterize and compare soybean response to the HPPD-inhibiting herbicides mesotrione, topramazone, or tembotrione, applied in combination with atrazine at rates simulating spray drift or contamination.

Herbicide treatments were broadcast postemergence at 20 GPA on weed-free soybean 5 to 6 inches tall. Herbicide application rates corresponded to 1/2, 1/6, 1/18, and 1/54 of 1X field use rates for mseotrione (1X = 0.094 lb ai/A), topramazone (1X = 0.016 lb ai/A), and tembotrione (1X = 0.082 lb ai/A), all plus atrazine (1X = 0.25 lb ai/A). All herbicide treatments included corresponding rates of crop oil concentrate and 28% UAN. Regardless of application rate, all treatments caused visible soybean injury 7 days after treatment (DAT). By 56 DAT, visible soybean injury was still evident from the 1/2 and 1/6 rates of mesotrione and tembotrione and the 1/2 rate of topramazone. Reduced plant heights 56 DAT and delayed maturity corresponded with late-season soybean injury ratings. Soybean yield was reduced by the 1/2, 1/6, and 1/18 rates of tembotrione and the 1/2 and 1/6 rates of mesotrione, but only the 1/2 rate of topramazone.

LEAFY SPURGE CONTROL WITH TANK-MIXES OF IMAZAPIC AND SAFLUFENACIL.

Stevan Z. Knezevic, Ryan E. Rapp*, Avishek Datta, Jon Scott, Leo D. Charvat, and Joseph Zawierucha, Associate Professor, Graduate Student, Post Doctoral Fellow, Research Tcehnologist, University of Nebraska, Concord, NE 68728; Biology Area Manager, BASF Corporation, Lincoln, NE 68523 and Biology Project Leader, BASF Corporation, RTP, NC 27709.

Saflufenacil (BAS 800H) is a new herbicide being primarily developed for pre-plant and PRE broadleaf weed control in field crops (corn, soybean, sorghum, and wheat)**.** Saflufenacil is PPO inhibitor, and has both contact (burndown) and residual activity against variety of broadleaf weeds, thus there is an interest in testing it for use in non-crop areas. Leafy spurge is a serious weed problem in North America infesting over 5 million ha of rangeland and pasture. Imazapic is commonly used for leafy spurge control as a fall treatment only, because spring applications do not provide satisfactory control. Our hypothesis was that there might be synergism between imazapic and saflufenacil if applied in spring. Therefore, field experiments were conducted during spring of 2007 and 2008 with the objective to describe dose response curves of imazapic and salfufenacil applied alone and tank-mixed. Study was arranged in a RCBD with 21 treatments and three replications at O'Neill (North Central Nebraska). Treatments were applied to plots of 3×9 meters with a back sprayer delivering 187 L/ha aqueous solution through TeeJet 11003 flat fan nozzles at 234 kPa. Saflufenacil rates were: 0, 12.5, 25, 50, and 100 g ai/ha, and imazapic rates were: 0, 52.6, 105, and 158 g ai/ha. Dose-response curves based on log-logistic model were used to determine the ED_{90} (effective dose that provides 90% control) values of saflufenacil for each imazapic level utilizing the visual injury response variable. In general, none of the imazapic rates applied alone provided satisfactory leafy spurge control. In contrary, saflufenacil applied alone provided excellent leafy spurge control for about 30-90 DAT depending on the rates used, then the spurge started re-growing. The level of leafy spurge control was much longer lasting in the tank-mixes of the two herbicides, especially as the rates of both herbicides increased. The ED_{90} values of saflufenacil in the tank-mix with imazapic rate of 52.6 g ai/ha increased from 30 g to 340 g ai/ha with later rating dates, indicating that spurge was slowly regrowing over time (25-457 DAT). However, the ED_{90} values of saflufenacil in the tank-mix with imazapic rate of 105 g ai/ha were much more stable, and stayed around 25-30 g ai/ha for control up to 380 DAT, whereas 50 g ai/ha rate was needed for longer control up to 457 DAT. Similar trend occurred for ED_{90} values of saflufenacil tank-mixed with 158 g ai/ha rate of imazapic. Preliminary curve analysis suggested that the longest control of leafy spurge (400 DAT) was achieved with suflufenacil ED_{90} rate of about 25 g ai/ha tank mixed with 105 g ai/ha of imazapic. There was also cool season grass injury (10- 30%) with 158 g ai/ha of imazapic, which lasted for six weeks only. Results from this study indicated that indeed there is a synergism between the two herbicides, however additional studies are needed to determine the mechanism of such synergy.

INFLUENCE OF SOYBEAN PLANT POPLUATIONS AND ROW SPACING TO CURRENT AND FUTURE WEED CONTROL STRATEGIES. Jeffrey A. Bunting, Thomas J. Hunsley, Douglas J. Maxwell, and Aaron G. Hager, Weed Science Technical Manager, Soybean Product Manager, GROWMARK Inc. Bloomington, IL 61701 and Principle Research Specialist, Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Field research was conducted at Urbana, IL in 2008 to evaluate the effect of soybean plant population and row spacing on weed control and yield. Three herbicide management strategies were evaluated that included a preemergence followed by a post emergent application, single postemergent application, and a sequential postemergent application. Three plant populations were examined as well as two row spacings to evaluate the impact of canopy development, weed population, and yield. The growing season resulted in less than ideal emergence conditions and planting intention verses actual emergence was around 30% below expected. Fewer weeds emerged in the 38–cm rows, compared with the 76-cm rows. As soybean populations increased, fewer weeds were observed in the study, and increasing the soybean plant population within a row did not influence late-season weed emergence. The low population of soybean resulted in the highest number of weeds (giant foxtail, waterhemp, and ivyleaf morningglory), but there was no difference in the row spacing at the low population. The preemergence applications followed by postemergence application resulted in the lowest number of weeds observed in the study with no difference in row spacing. Ivyleaf morningglory weed count was higher in the 76-cm row width than the 38-cm row width and when only one application of glyphoste was applied. Soybean yields were higher in the 38-cm row width when compared to the 76-cm row width regardless at the low, medium, and high soybean populations. There was no significant advantage between the sequential weed management offerings when looking at soybean yield. Soybean yield was the lowest with the single postemergence application regardless of plant population and row spacing. As input costs increase there's a likelihood that soybean plant populations will decrease. This may challenge some of the new herbicide traits that are coming out in the next couple of years.

ASSESSING GLYPHOSATE SENSITIVITY IN ILLINOIS WATERHEMP (AMARANTHUS RUDIS) COLLECTIONS. Joseph L. Matthews, Bryan G. Young, and Julie M.Young, Researcher, Professor, and Researcher, Dept. of Plant, Soil and Agricultural Systems, Southern Illinois University, 1205 Lincoln Dr., MC-4415, Carbondale, IL 62901.

The commercialization of glyphosate-resistant crops has resulted in Illinois growers adopting postemergence glyphosate applications as a primary strategy for control of summer annual weeds in both soybean and corn. Reports from growers experiencing inconsistent control of common waterhemp with glyphosate prompted interest in assessing the glyphosate sensitivity of an existing Illinois waterhemp collection. In fall 2006 waterhemp seed was collected from five mature, female waterhemp plants per field in 77 random Illinois fields in 43 counties, as well as 26 fields in 12 counties that were suspected to contain PPO-resistant biotypes. An initial screen of the waterhemp collections was conducted in the greenhouse using the discriminating doses of 0, 860, and 2580 g ae/ha of glyphosate when waterhemp was 6 to 10 cm in height with two waterhemp seed sources included as comparative glyphosate-sensitive populations. This initial screen used a composite sample of the five mother plants from each collection site and included eight replications and was conducted twice. In addition to visual control estimates taken at 7, 14, and 21 days after treatment (DAT), waterhemp plants were harvested at 21 DAT and dry weight was determined and converted to a percentage of the nontreated. Less than 50% growth reduction was observed from 21 and 1.5% of plants treated with glyphosate at 860 and 2580 g/ha, respectively, with the surviving plants occurring in 95% of the seed sources and noticeably clustered in 41% of the seed sources. Further analysis identified 12 of the seed sources had the greatest frequency of plants with less than a 50% growth reduction over both runs of the experiment.

In order to further quantify glyphosate sensitivity in these 12 seed sources a dose response experiment was designed using glyphosate applications of 108, 215, 430, 860, 1,720, 3,440, 6,880, and 13,760 g/ha. The five individual mother plants from each collection site were treated independently to allow for greater characterization of the sensitivity of the waterhemp to glyphosate at each site. Data collection was identical to the previous experiment and data analysis was performed using log-logistic dose response curves fit using the drc package in the R software program. Differences in waterhemp sensitivity to glyphosate were found between collection sites as well as within collection sites. Estimated ED50 values ranged from 10 to 485 g/ha and were typically around 50 g/ha. The comparative glyphosate-sensitive plants grown from seed collected in 1999 and 2002 showed very little variability in glyphosate sensitivity with only 1 of 248 treated plants with less than a 50% growth reduction for any glyphosate dose. These results suggest a wide range of glyphosate sensitivity within the 2006 collection, distinct differences between collection sites, and provide evidence that inherent differences in glyphosate sensitivity among waterhemp populations are likely associated with increasing commercial failures of glyphosate for control of waterhemp.

EFFECT OF PREEMERGENCE HERBICIDES FOR CORN AND SOYBEAN ON THE WEED COMMUNITY. Dawn Refsell, Extension Specialist, University of Illinois, Urbana, IL 61801.

Field Studies were conducted in 2008 at four locations throughout Illinois to determine the effect that full and reduced-rate corn and soybean preemergence herbicides have on weed species abundance, density and height. Herbicides were applied at a 1x, 2/3x and 1/3x level in a RCB design with three replications. Data was collected weekly to bi-weekly at each location for 42 days.

Weed species diversity decreased as the rate of herbicide increased but these differences became less evident over time. Weed density was variable based on the herbicide treatment, regardless, density was reduced the greatest with the full rate compared to the reduced rates. Weed height varied by treatment, however most treatments followed the same trend with decreased height in associated with the full rate and these differences became more pronounced as time progressed.

COMPARISON OF POSTEMERGENCE HERBICIDE PROGRAMS UTILIZING BEST MANAGEMENT PRACTICE RATES OF ATRAZINE OR ATRAZINE REPLACEMENTS IN FIELD CORN AT ROCHESTER, MINNESOTA. Lisa M. Behnken*, Ryan P. Miller, Fritz R. Breitenbach, and Jeffery L. Gunsolus, Extension Professor, University of Minnesota, Rochester Regional Office, Rochester, MN 55904-4915, Assistant Extension Professor, University of Minnesota, Rochester Regional Office, Rochester, MN 55904-4915, Associate Extension Professor, University of Minnesota, Rochester Regional Office, Rochester, MN 55904-4915, and Professor, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108-6026.

Field research was conducted at Rochester, MN in 2007 and 2008 to 1) evaluate weed control of herbicide programs with and without atrazine applied at BMP rates, 2) evaluate performance of herbicides used as replacements for atrazine and 3) evaluate crop safety of potential replacements in field corn in southeastern Minnesota. The research site was a Lawler loam series with a pH of 7.0 and soil test P and K levels of 16 ppm and 160 ppm, respectively in 2007 and pH of 6.7 and soil test P and K levels of 22 ppm and 126 ppm, respectively in 2008. The corn hybrid, Pioneer 38H65, was planted on April 27, 2007, and the hybrid, DeKalb DKC50-19, was planted on May 9, 2008. They were planted at a depth of 3.8 cm in 76-cm rows at 79,073 seeds ha^{-1}. A randomized complete block design with four replications was used. Preemergence and postemergence treatments were applied with a tractor-mounted sprayer delivering 187 l ha^{-1} at 221 kpa using 11002 flat fan nozzles. A one-half label use rate of s-metolachlor at 1.07 kg ai ha^{-1} was applied preemergence to the entire plot area. .

In 2007, six postemergence treatments were evaluated, mesotrione at 0.105 kg ai ha^{-1}, mesotrione at 0.105 kg ai ha^{-1} + atrazine at 0.56 kg ai ha^{-1}, flumetsulam & clopyralid at 0.039 & 0.105 kg ai ha^{-1}, flumetsulam & clopyralid at 0.039 & 0.105 kg ai ha^{-1} + atrazine at 0.56 kg ai ha^{-1}, dicamba at 0.56 kg ai ha^{-1} and dicamba at 0.56 kg ai ha^{-1} + atrazine at 0.56 kg ai ha^{-1}. In 2008, four additional postemergence treatments were evaluated, mesotrione at 0.105 kg ai ha^{-1} + bromoxynil at 0.105 kg ai ha^{-1}, mesotrione at 0.105 kg ai ha^{-1} + dicamba at 0.14 kg ai ha^{-1}, flumetsulam & clopyralid at 0.039 & 0.105 kg ai ha^{-1} + mesotrione at 0.035 kg ai ha^{-1}, and dicamba at 0.56 kg ai ha^{-1} + mesotrione at 0.035 kg ai ha^{-1}. Weed control evaluations were conducted for giant ragweed, common lambsquarters and common waterhemp. Plots were also evaluated for corn injury and corn grain yield.

In 2007 and 2008 giant ragweed control was improved when treatments included atrazine. In 2008, mesotrione + either bromoxynil or dicamba provided similar giant ragweed control as mesotrione + atrazine. However, mesotrione + bromoxynil resulted in 20% injury to corn. Flumetsulam & clopyralid + atrazine or mesotrione at a reduced rate, 0.035 kg ai ha^{-1}, provided significantly greater giant ragweed control than flumetsulam & clopyralid applied alone. Flumetsulam & clopyralid + mesotrione provided greater control than flumetsulam & clopyralid + atrazine. In 2008, dicamba + mesotrione provided weed control equivalent to dicamba + atrazine. In 2007 and 2008, common waterhemp and common lambsquarters control were similar for mesotrione and mesotrione + atrazine. Flumetsulam & clopyralid + atrazine and dicamba + atrazine provided greater control of common waterhemp and common lambsquarters control in 2007. In 2008, common waterhemp control was improved significantly with the addition of the BMP rate of atrazine or mesotrione to flumetsulam & clopyralid as compared to flumetsulam & clopyralid alone. Also, common waterhemp control with flumetsulam & clopyralid + mesotrione at 0.035 kg ai ha-1 was significantly greater than with atrazine. Corn grain yields were greater for both mesotrione + atrazine and flumetsulam & clopyralid + atrazine when compared to their non-atrazine partners in 2007. Due to plot variability in 2008, corn yields were not significantly different at the $P \leq 0.10$. BMP rates of atrazine can improve the effectiveness of mesotrione, flumetsulam & clopyralid and dicamba on certain weeds and increase grain yields. The data from 2008 would indicate that bromoxynil, mesotrione, and dicamba may be potential replacements for atrazine. However more research is necessary and crop safety is a concern with bromoxynil.

2008 North Central Weed Science Society Proc. 63:34.

NORTH CENTRAL WEED SCIENCE SOCIETY WEED CONTEST 2008. Jess J. Spotanski, Midwest Research Inc., York, NE 68467. Greg Steckel, SGS Alvey Ag Research, Carlyle, IL 62231.

The 2008 NCWSS summer annual Weed Contest was hosted by SGS Alvey Ag Research in Carlyle, IL on Aug 13th and 14th. There were a total of 46 students from seven schools. The schools were Purdue University, Ohio State University, Kansas State University, Iowa State University, University of Illinois, University of Nebraska, and Michigan State University. Of the students who participated, there were 35 graduate students and 11 undergraduates. Volunteer support was excellent as over 30 people from both industry and academia helped to make the contest a success. The contest was made up of the traditional four events which were farmer problem solving, sprayer calibration, weed identification and unknown herbicide identification. A total of 23 awards were handed out to the highest scoring teams and individuals in both graduate and undergraduate divisions. The overall graduate team award winners were: 1st-Purdue, 2nd-Michigan State, 3rd-Kansas State. The overall undergraduate team award winners were: 1st-Illinois, 2nd-Ohio State. The overall graduate individuals were: 1st-Vince Davis, Purdue, 2nd-Valerie Mock, Purdue, 3rd-Chad Brabham, Purdue. The overall undergraduate award winners were: 1st-Molly Buckham, Michigan State, 2nd-Mark Bugg, Ohio State, 3rd-TIE-Calvin Glaspie, Ohio State, 3rd-TIE-Jared Roskamp, Illinois. The individual events and winners were: Team field calibration: Kansas State-graduate and Illinois-undergraduate; Written calibration individual: Chad Herrmann, Michigan State-graduate; Calvin Glaspie, Michigan State and Jared Roskamp, Illinois-TIE-undergraduate. Unknown herbicide individual: Valerie Mock, Purdue-graduate and Molly Buckham, Michigan State-undergraduate; Weed identification individual: Chad Brabham, Purude-graduate and Calvin Glaspie, Michigan State-undergraduate; Farmer problem solving individual: AJ Woodyard, Illinois-graduate and Melinda Hoffman, Ohio State-undergraduate. Thanks to all the volunteers who helped with the contest and congratulations to all the winners.

RESPONSE OF SELECTED COMMON RAGWEED ACCESSIONS TO GLYPHOSATE, FOMESAFEN, AND CLORANSULAM-METHYL. Jeff M. Stachler and John L. Luecke, Assistant Professor and Research Specialist, Department of Plant Sciences, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050.

Common ragweed is becoming increasingly difficult to control with postemergence soybean herbicides. Field experiments in 2007 indicated the presence of a common ragweed population resistant to PPO- and ALS-inhibiting herbicides in northern Clinton County, OH and another resistant to ALS-inhibiting herbicides and glyphosate in southern Clinton County, OH. A greenhouse study was established with seed from one sensitive common ragweed population, two original field collected resistant populations from Clinton County, OH, and five common ragweed subpopulations selected from the two resistant populations after various herbicide treatments. Two subpopulations from the northern Clinton County population were created by collecting seed from the best survivors of fomesafen plus cloransulam-methyl (3X) and fomesafen plus glyphosate (3X) in the greenhouse. Three subpopulations from the southern Clinton County population were created by collecting seed from the best survivors of glyphosate plus cloransulam-methyl (3X) and glyphosate plus cloransulam-methyl plus fomesafen (1X) in the greenhouse, and the best survivors of glyphosate plus fomesafen (1X) followed by glyphosate (1X) in the 2007 field experiment. Fomesafen plus cloransulam-methyl, glyphosate plus cloransulam-methyl, glyphosate plus fomesafen, and glyphosate plus cloransulam-methyl plus fomesafen were applied at 1X and 4X rates to all populations and subpopulations in a greenhouse sprayer. The 1X rate of fomesafen, cloransulam-methyl, and glyphosate was 342 g ai/ha, 18 g ai/ha, and 840 g ae/ha, respectively. Denstiny HC, a high surfactant oil (methylated) concentrate, and AMS was added to all herbicide combinations at 1% v/v and 2.8 kg/ha, respectively.

All herbicide combinations at the 1X and 4X rates controlled greater than 96% of the sensitive population. Fomesafen plus cloransulam-methyl at the 1X and 4X rates controlled less than 73% of the original northern Clinton County common ragweed population and its two subpopulations. Glyphosate plus cloransulam-methyl at the 1X and 4X rates controlled less than 85% of the original southern Clinton County common ragweed population and its three subpopulations. Fomesafen plus cloransulam-methyl, glyphosate plus cloransulam-methyl, glyphosate plus fomesafen, and glyphosate plus cloransulam-methyl plus fomesafen at 1X rates controlled 46, 48, 81, and 81%, respectively, of the southern Clinton County subpopulations selected with glyphosate plus cloransulam-methyl plus fomesafen. The level of resistance to glyphosate plus cloransulam-methyl was greater for all southern Clinton County subpopulations compared to the original southern Clinton County population.

These results indicate heritable resistance to a PPO- plus an ALS-inhibiting herbicide, an ALS-inhibiting herbicide with glyphosate, and an ALS- plus PPO-inhibiting herbicide with glyphosate in common ragweed. The level of resistance can increase in subsequent generations. This research suggests that multiple resistance can be selected and inherited if plants are not completely controlled by an herbicide combination.

FALL-APPLIED HERBICIDES DIFFER IN SPRING DANDELION CONTROL AND SURVIVORSHIP. Timothy L. Trower*, Chris M. Boerboom, and Mark J. Renz, Senior Outreach Specialist, Professor, and Assistant Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Dandelion is the most common overwintering weed of no-till fields in Wisconsin and it is difficult to obtain highly effective and consistent control with spring burndown herbicide treatments. Therefore, we wanted to determine the efficacy of fall-applied herbicide treatments for dandelion control. Experiments were initiated in the fall of 2006 and 2007 at the Arlington Agricultural Research Station in corn fields where the stalks were chopped and removed in 2006 and remained after combining in 2007. The 19 herbicide treatments consisted of five ALS-inhibiting herbicides or their premixtures, flumioxazin, glyphosate, 2,4-D, and their combinations. Treatments were applied on November 14, 2006 and October 3, 2007 with air temperatures of 5 and 7 C, respectively. Fifteen dandelion plants were marked in four selected treatments to determine survivorship the following spring. In the subsequent May, dandelion control was visually rated compared to a nontreated control. Winter survivorship was determined by counting marked plants with visible green growth and 15 cm of the roots were extracted from the soil, divided into 1 cm sections, and treated with tetrazolium chloride. Respiring roots stained red and we inferred that these roots were alive and could contribute to regrowth.

None of the eight individual herbicide or premixed herbicides controlled greater than 90% of the dandelions in both years. Chlorimuron at 18 g ai/ha controlled 93% of the dandelion on May 18, 2007 and glyphosate at 0.84 kg ae/ha controlled 96% of the dandelion on May 30, 2007. Iodosulfuron at 2 g ai/ha controlled over 80% of the dandelion in both years. Rimsulfuron plus thifensulfuron, tribenuron, chorimuron plus thifensulfuron, flumioxazin, or 2,4-D did not exceed 80% control in one or both years. Four tank mixtures that controlled dandelion at 95% or greater in both years were 1) rimsulfuron plus thifensulfuron plus tribenuron plus 2,4-D (12 g ai/ha plus 6 g ai/ha plus 7 g ai/ha plus 0.5 kg ae/ha) , 2) chlorimuron plus thifensulfuron plus tribenuron plus 2,4-D (6 g/ha plus 2 g/ha plus 7 g/ha plus 0.5 kg/ha), 3) chlorimuron plus tribenuron plus 2,4-D (17 g/ha plus 5 g/ha plus 0.5 kg/ha), and 4) chlorimuron plus flumioxazin plus tribenuron plus 2,4-D (22 g/ha plus 63 g ai /ha plus 4 g/ha plus 0.5 kg/ha). Measurement of plant survivorship and tissue viability with tetrazolium was not entirely consistent with the visual ratings. Dandelions survived glyphosate at 47 and 8% and 27 and 7% of roots were viable in 2007 and 2008, respectively, which were consistent with visual control ratings of 59 and 96%. Survival and root viability with the rimsulfuron plus thifensulfuron plus tribenuron plus 2,4-D treatment was 5% or less, which also corresponded to observed control of 96 to 97%. However, survival and root viability after 1 kg/ha of 2,4-D was less than 4% in both years, which indicated greater response than the 67 to 74% control observed. Overall, these results suggest that herbicide mixtures can be applied in late fall to obtain adequate or excellent dandelion control the following spring. Mixtures of ALS-inhibiting herbicides with 2,4-D or glyphosate increased control as compared to individual herbicides in several cases and the most effective and consistent treatments were always tank mixtures. Three of the most effective herbicide treatments are labeled for rotation to soybean in the spring and one highly effective treatment would allow rotation to corn. Wisconsin no-till growers should consider fall herbicide applications for effective dandelion control.

RESPONSE OF PIGWEED AND FOXTAIL SPECIES TO BROADCAST FLAMING. Stevan Z. Knezevic*, Avishek Datta, and Santiago M. Ulloa. Associate Professor, Post Doctoral Fellow and Graduate Student, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE, 68728.

Propane flaming could be an effective tool for weed control in organic cropping systems. However, susceptibility of major weeds to broadcast flaming must be determined in order to optimize its proper use. Therefore, field experiments were conducted during summer of 2008 at the Haskell Agricultural Laboratory, Concord, NE utilizing six rates of propane and four weed species, including green foxtail (*Setaria viridis*), yellow foxtail (*Setaria glauca*), waterhemp (*Amaranthus rudis*), and redroot pigweed (*Amaranthus retroflexus*) with the objective to collect some base-line information on their tolerance to broadcast flaming. Propane flaming response was evaluated at three growth stages for each weed species. The propane rates applied were 0, 12, 31, 50, 68 and 87 kg ha^{-1} corresponding to 0, 2.5, 6.5, 10.5, 14.4 and 18.4 gal $acre^{-1}$. Flaming treatments were applied utilizing an ATV mounted flamer moving at a constant speed of 6.5 km h^{-1} (4 m h^{-1}). The response of the weed species to propane rates was based on visual injury rating and percent biomass loss recorded at 14 days after treatment (DAT) and described by log-logistic model. Overall response of the weed species to propane flaming varied among species, growth stages, and propane rates. In general, foxtail species were more tolerant than pigweed species. Waterhemp and redroot pigweed did not differ in their response to broadcast flaming and were easily controlled (90% control) with propane rate of about 60 kg ha^{-1} when flamed at early growth stages (3-5 leaf stage), however they needed higher propane rate of about 90 kg ha^{-1} at later growth stages (9 leaf stage to flowering). Foxtail species differed in their response to broadcast flaming. Green foxtail was more tolerant than yellow foxtail regardless of the growth stage. Propane rate of 110 kg ha^{-1} was needed to provide 90% control of green foxtail irrespective of the growth stage. In contrast, 90% control of yellow foxtail was achieved with propane rate of 80 kg ha^{-1} for any growth stage. It is important to point out that foxtail species started re-growing at about 14 DAT regardless of the growth stage flamed, whereas pigweed species did not re-grow, especially when flamed with rates above 60 kg ha^{-1}.

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

Field research was conducted at Rochester, MN in 2007 and 2008 to determine which tank mix components and sequential applications improved glyphosate efficacy. A randomized complete block design with four replications was used. Soybean variety 'Dairyland DSR 199'was planted 3.8 cm deep in 76 cm rows at a rate of 370,500 seeds ha^{-1} on May 17, 2007. In 2008 soybean variety 'Dairyland DSR 1302' was planted 3.8 cm deep in 76 cm rows at a rate of 370,500 seeds ha^{-1} on May 23, 2008. All herbicide applications were made with a tractor-mounted sprayer delivering 187 l ha^{-1} at 221 kpa using 11002 flat fan nozzles. Treatments were made according to label instructions and adequate rainfall was received after each treatment date. A reduced rate of 0.42 kg ae glyphosate ha^{-1} was used to better determine the effect of corresponding tank mix and sequential treatments. In 2007 preemergence treatments included: flumioxazin and cloransulam-methyl at 89 & 29.4 g ai ha^{-1} (Gangster); flumioxazin at 89 g ai ha^{-1} (Valor); sulfentrazone and cloransulam-methyl at 130 & 16.6 g ai ha^{-1} (Sonic); s-metolachlor and fomesafen at 0.53 & 116 g ai ha^{-1} (Prefix), and sulfentrazone and metribuzin at 126 & 189 g ai ha^{-1} (Authority MTZ). In 2008 several preemergence treatments were added inclunding: sulfentrazone and imazethapyr at 346.6 & 70.4 g ai ha^{-1} (Authority Assist), chlorimuron ethyl, flumioxazin, and thifensulfuron methyl at 5.6, 71, and 17.25 g ai ha^{-1} (Enlite), and pendimethalin at 1596.5 g ai ha^{-1} (Prowl H_2O). All preemergence treatments were followed by a postemergence treatment. Postemergence treatments were 0.42 kg ae glyphosate ha^{-1} alone or tank mixed with one of the following components: fomesafen at 197 g ai ha^{-1} (Flexstar); lactofen at 105 g ai ha^{-1} (Cobra); flumiclorac pentyl ester at 30 g ai ha^{-1} (Resource); cloransulam methyl at 19.4 g ai ha^{-1} (FirstRate); chlorimuron ethyl at 4.37 g ai ha^{-1} (Classic); chlorimuron ethyl at 6.63 g ai ha^{-1} (Classic); chlorimuron ethyl and thifensulfuron methyl at 5.7 & 1.8 g ai ha^{-1} (Synchrony XP), thifensulfuron methyl at 17.4 g ai ha^{-1} (Harmony GT), imazethapyr at 70 g ai ha^{-1} (Pursuit). In 2008 fluthiacet-methyl at 3.2 g ai ha^{-1} (Cadet) was added as a tank mix treatment. Weeds were visually rated for percent control and plots were machine harvested and yields were calculated and adjusted to 13% moisture. Sequential treatments that included a preemergence application tended to have greater grain yields and better weed control than postemergence tank mix treatments.

RESPONSE OF FIELD COLLECTED INDIANA GIANT FOXTAIL POPULATIONS TO GLYPHOSATE. Benjamin E. Neild, Paul T. Marquardt, Greg R. Kruger, and William G. Johnson, Undergraduate Student, Research Associate, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, 47907.

Giant foxtail (*Setaria faberi*) is a problematic weed in for corn and soybean producers in Indiana. Recently there has been some concern about evolution of glyphosate resistance in grass weeds such as giant foxtail. The objective of this research was to evaluate a number of Indiana giant foxtail for glyphosate resistance. Seven giant foxtail populations were collected from various locations throughout Indiana. Dose response studies were conducted in the greenhouse and data were subjected to non-linear log-logistic analysis in R. The GR_{50} of the most susceptible population was 0.1605 ± 0.0150 (SE) kg ae/ha based on visual control estimates. The GR_{50} of the most tolerant population was 0.2835 ± 0.0283 kg ae/ha based on visual control estimates. The standard use rate for producers in Indiana is 0.84 kg ae/ha. We found that five of the seven populations had GR_{90} values above the 0.84 kg ae/ha. The GR_{90} of the most susceptible population was 0.5124 ± 0.3010 kg ae/ha based on visual control estimates. The GR_{90} of the most tolerant population was 1.7356 ± 0.4269 kg ae/ha based on visual control estimates.

WEED CONTROL AND ERADICATION STUDIES IN MISCANTHUS X GIGANTEUS.

Eric K. Anderson, Aaron G. Hager, Thomas B. Voigt and Germán A. Bollero, Graduate Research Assistant, Department of Crops Sciences, Assistant Professor, Department of Crop Sciences, Associate Professor, Department of Natural Resources and Environmental Studies, and Professor, Department of Crop Sciences, University of Illinois at Urbana-Champaign, Urbana, IL 61801.

The establishment of a crop of *Miscanthus* x *giganteus* (Mxg) is a costly investment, and to a great extent its success depends on controlling weed populations during this phase. Since there are no significant Mxg plantings in the U.S. to date, the limited work that has been done on weed control with the crop comes from the European Union. Current research at the University of Illinois at Urbana-Champaign (UIUC) focuses on the phytotoxic effects of a wide range of herbicide families on Mxg. Greenhouse experiments were conducted during 2007 and 2008. Initial results confirm and expand upon earlier research, indicating that there are several herbicides with different modes of action that could be used on Mxg with no or minimal herbicide injury or yield loss. The results also identify a few chemistries that are injurious to Mxg.

A second aspect of the research being conducted at UIUC is the eradication of a crop of Mxg. Although it is doubtful that this plant would become an invasive weed, it is nonetheless necessary to identify methods of eradicating the crop should the need arise. An experiment incorporating glyphosate applications with and without tillage was conducted in 2008 on a 4 year old stand of Mxg. Initial results suggest that glyphosate applications at various timings in conjunction with tillage may provide an adequate means of eradication.

PERFORMANCE INTERACTIONS BETWEEN TOPRAMEZONE AND ALS-INHIBITING HERBICIDES FOR THE CONTROL OF ANNUAL GRASSES. Allan C. Kaastra[1], Clarence J. Swanton[1], François Tardif[1], and Peter H. Sikkema[2]. [1]University of Guelph, Department of Plant Agriculture, Guelph, Ontario, Canada, N1G 2W1; [2]University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0.

There is little information available on performance interactions for tank mixtures of topramezone and ALS-inhibiting herbicides. Controlled-environment and field experiments were conducted in 2006 and 2007 to determine the interactions of topramezone when tank-mixed with ALS-inhibiting herbicides. Controlled-environment experiments were conducted on four annual grass species treated at the five- to six-leaf stage. Dose–response curves for large crabgrass, barnyardgrass, yellow foxtail, and green foxtail were generated for nicosulfuron or foramsulfuron alone and in combination with label rates of topramezone or mesotrione. Eight field experiments were conducted using registered rates of two HPPD-inhibiting and three ALS inhibiting herbicides alone and in combination. All herbicide treatments in the field were applied at the two- to three-leaf and five- to six-leaf stages of barnyardgrass, green foxtail, giant green foxtail, and witchgrass. In both the controlled environment and field experiments, antagonistic interactions were found to be species specific. In the controlled environment, nicosulfuron antagonized topramezone for the control of large crabgrass and barnyardgrass, but did not influence control of yellow or green foxtail. This antagonism was overcome with the addition of atrazine or an increased dose of nicosulfuron. Antagonism was not observed with tank mixtures of topramezone and foramsulfuron on the species tested under controlled-environment or field conditions. In the field, antagonism was not influenced by growth stage of the annual grasses. Antagonistic interactions were observed when topramezone was tank-mixed with nicosulfuron or nicosulfuron + rimsulfuron for the control of barnyardgrass and, to a lesser extent, giant green foxtail.

EXAMINING THE EFFECT OF GLYPHOSATE TREATMENT ON SHIKIMATE PATHWAY METABOLITES IN DIFFERENT PLANT SPECIES. Keith Kretzmer*, Mason Hughes, Ashleigh Norris and R. Doug Sammons, Monsanto Company, St. Louis, MO.

An HPLC-MS method was developed in order to identify and quantify the metabolites of the shikimic acid pathway in plant extracts. Metabolites were identified by using known standards or by the mass of both parent and daughter fragment negative ions. The following metabolites were measured: shikimate, shikimate 3-phosphate (S3P), 3-dehydroshikimate, chorismate, 3,4-dihydroxybenzoate (protocatechuate), and quinic acid. The identification of 3-dehydroquinate was equivocal.

The results showed that there were plant species differences in the levels of quantified metabolites, especially of shikimate, S3P and quinate. In addition, there were differences in the levels of accumulation of shikimic acid metabolites measured 3 days after Roundup treatment. Both shikimate and quinate accumulated to high levels after Roundup treatment in many species. In legumes, such as soybean and alfalfa, only shikimate accumulated. In several other species, and particularly monocot species more quinate than shikimate accumulated after Roundup treatment.

The highest levels of shikimate were measured to be 11.9, 10.7, 8.7 and 8.0 mg/gFW, in soybean, common ragweed, sunflower and alfalfa, respectively, 3 days after Roundup treatment. In the monocot species tested, quinate was measured to be 8.0, 5.6, 4.9 and 4.7, in perennial ryegrass, barnyard grass, sorghum, and wheat, respectively.

CHARACTERIZATION OF THREE HORSEWEED (*CONYZA CANADENSIS*) POPULATIONS WITH DIFFERENT ALS MUTATIONS. Greg R. Kruger, Vince M. Davis, Patrick J. Tranel, Stephen C. Weller, and William G. Johnson, Graduate Research Assistant, Graduate Research Assistant, Department of Botany and Plant Pathology, Purdue University, Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801, Professor, Department of Horticulture and Landscape Architecture, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Glyphosate resistant horseweed was first found in Indiana in 2002. Since then it has been identified in numerous counties. To control glyphosate resistant horseweed with postemergence herbicides in soybean, the addition of an ALS inhibitor is commonly recommended. However, over 30 counties in Indiana have been documented to have ALS resistant horseweed populations. Three different mutations in the ALS enzyme have been confirmed to cause resistance to ALS inhibitors in Indiana horseweed populations. The purpose of this study was to determine the influence of the mutation on horseweed tolerance to cloransulam. The frequency of resistance within each populations was determined by spraying 100 plants of four populations with 8.8 g ai/ha of cloransulam. The frequency of resistant plants in the each of the three resistant populations varied from 85 to 98% while all of the susceptible plants sprayed were dead at 28 DAT. A dose response study was conducted using the same four populations. Data were analyzed using non-linear log-logistic modeling in R. The two populations which had mutations at the 197 position exhibited a higher level of resistance (GR_{50} values: 10.3 and 13.9 g ai/ha) to cloransulam than the population which had a mutation at the 376 position (6.6 g ai/ha). The susceptible population had a GR_{50} value of 0.2 g ai/ha. The population with the mutation at the 376 position still had an R:S ratio of 33 while the two populations with the mutation at the 197 position had R:S ratios of 52 and 70, respectively.

CHARACTERIZATION OF GLYPHOSATE RESISTANCE OF *ARABIDOPSIS THALIANA* MEDIATED BY PHYB. Altanbadralt Sharkhuu, Ray A. Bressan, William G. Johnson, Stephen C. Weller, Department of Horticulture and Landscape Architecture, and Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Glyphosate is the most widely used herbicide in the world. It inhibits 5-enolpyruvylshikimate 3-phosphate synthase (EPSPS), the penultimate enzyme in the shikimate pathway of plants. Resistance to glyphosate has been engineered into all major agronomic crops. Glyphosate resistant (GR) crops are now grown on 120 million ha by 12 million farmers worldwide. The widespread use of glyphosate for weed control in GR crops has resulted in the appearance of 14 resistant weed biotypes. The specific mechanism(s) of resistance to glyphosate in most of these weeds is not known.

We identified several glyphosate responsive mutants in a forward genetic screen of a T-DNA tagged *Arabidopsis thaliana* population. One of the mutants *gre1* (*glyphosate response* 1) has a resistant phenotype to glyphosate treatment compared to wild type. Mutation of *gre1* results in a knock out of the *AtPHYB* gene that encodes an apoprotein of the red and far red light receptor phytochrome B (phyB). Our results show *EPSPS* expression of *gre1* is reduced. No change in sensitivity to glyphosate of EPSPS *in vitro* activity has been found. Glyphosate absorption is greater in mutant plants but translocation of glyphosate is reduced compared to wild type. Shikimate accumulation is two times lower than in wild type after glyphosate treatment. Glyphosate treatment also results in reduced expression of the plastidial membrane phosphate transporter, *PHT2;1*, and lower accumulation of anthocyanin in *gre1* than wild type, which are common responses to stress. These results indicate that light signaling plays an important role in plant response to glyphosate and mutation of *PHYB* causes glyphosate resistance.

INTERACTIONS OF GLYPHOSATE AND SAFLUFENACIL ON GLYPHOSATE-SUSCEPTIBLE AND GLYPHOSATE-RESISTANT HORSEWEED POPULATIONS.

Tracy G. Mellendorf, Bryan G. Young, and Joseph L. Matthews, Graduate Research Assistant, Professor, and Researcher, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Saflufenacil is a developmental herbicide with both foliar and residual control for use in several crop sites including soybean. Early research has documented that saflufenacil has significant foliar activity on horseweed which continues to be a management problem for growers in areas with populations of glyphosate-resistant horseweed. To further understand the utility of saflufenacil in burndown applications, greenhouse studies were conducted to evaluate the interaction between saflufenacil and glyphosate on two horseweed populations: a glyphosate-susceptible and a glyphosate-resistant population. A dose response of saflufenacil comprised of six rates (0, 0.10, 0.31, 0.93, 2.78, and 25 g ai/ha) was applied with three levels of glyphosate (0, 0.083, and 2.25 kg ae/ha). Preliminary tests indicated 0.083 kg/ha of glyphosate on susceptible populations and 2.25 kg/ha of glyphosate on resistant populations were sub-lethal doses appropriate for characterizing an interaction when tank-mixed with saflufenacil. The formulation of glyphosate used in this research did not include an activator adjuvant. Herbicide treatments were repeated with non-ionic surfactant (NIS) at 0.5% v/v and crop oil concentrate (COC) at 1% v/v. Visual evaluations of control were performed at 3, 7, 14, and 21 days after treatment (DAT) and plant shoots were harvested at 21 DAT for dry weight determination.

At 3 DAT horseweed treated with saflufenacil alone was necrotic, with the lower rates showing necrotic speckling and the higher rates resulting in near complete necrosis, regardless of horseweed population or adjuvant system. Treatments of glyphosate alone showed no symptoms. Tank-mixtures of the two herbicides resulted in more severe necrosis than saflufenacil applied alone. At 21 DAT horseweed was completely controlled by 2.78 g/ha of saflufenacil and 0.10 and 0.31 g/ha reduced horseweed dry weight up to 40%. The addition of COC to saflufenacil alone was more beneficial to controlling glyphosate-resistant horseweed than was the addition of NIS. Glyphosate applied at 0.083 kg/ha reduced the dry weight of the susceptible horseweed population by less than 30%, and had no effect on the resistant horseweed population. The susceptible horseweed population was completely controlled by glyphosate at 2.25 kg/ha, while, dry weight of the resistant horseweed population was reduced up to 70%. Adjuvant had no effect on the efficacy of glyphosate. The addition of glyphosate to saflufenacil at 0.10 and 0.31 g/ha with either adjuvant increased herbicide efficacy for both horseweed populations compared with either glyphosate or saflufenacil applied alone. The increased herbicide efficacy for the tank-mixture was not evident for saflufenacil at rates greater than 0.93 g/ha. The level of control observed from saflufenacil at the higher rates was almost complete for horseweed and likely did not allow for an increase to be detected for the tank-mix combinations. At no instance was antagonism observed for these herbicide combinations. This research demonstrates that glyphosate can enhance the activity of saflufenacil on both glyphosate-susceptible and –resistant horseweed.

CROP TOLERANCE OF TOPRAMEZONE RESIDUE AS AFFECTED BY SOIL PH. Rich Zollinger and Jerry Ries, Professor and Research Associate, Department of Plant Sciences, North Dakota State University, Fargo, ND 58108.

Replicated field research was conducted in 2007 and 2008 to evaluate crop tolerance of soybean, pinto and navy dry bean, sugarbeet, canola, and flax planted into topramezone residue applied to a soil of pH 5.9 and to a soil of pH 7.9 a year prior to planting crops. At both locations applications were made not to bare soil but at sites with normal crop foliage that would be present in May or early June. Light tillage was used to prepare the seedbed prior to seeding. At the research site of soil pH 5.9 volunteer sunflower emerged which gave another crop to evaluate for crop tolerance. Topramezone was applied at 0.175 oz ai/A (X rate for northern climates), 0.26 oz ai/A (X rate for mid-west), 0.35 oz ai/A (2X for northern climate), and 0.525 oz ai/A (2X for mid-west). At study site with soil pH 5.9 there was no soybean, pinto dry bean, navy dry bean, or flax injury at any topramezone rate. Topramezone residue at 0.35 and 0.525 oz/A caused 5 and 7% sugarbeet, 13 and 20% canola, and 53 and 70% sunflower injury at 12 months after application (MAA) but by 13 MAA sugarbeet injury was 5%, canola injury was 7% and sunflower injury was 47% at the highest rate. At study site with soil pH 7.9 there was no crop injury at any topramezone rate at 12 MAA. At 12.5 MAA 7% sugarbeet injury at the highest topramezone rate of 0.525 oz/A was the only injury observed. At 13 MAA there was no crop injury from topramezone residue at 0.175, 0.26, and 0.35 oz/A and canola and flax was unaffected at all rates. However, injury to soybean, pinto dry bean, navy dry bean, and sugarbeet from the highest topramezone rate of 0.525 oz/A was 15%, 23%, 7%, and 13%, respectively. Since the solubility of topramezone increases as pH increases it was thought that soil pH may affect rate of breakdown. The current crop rotation for soybean, dry bean, canola, sugarbeet in parts of the northern great plains including North Dakota is 18 months after topramezone application. This data may help support a reduced crop rotation of 9 months when topramezone is used at 0.175 oz/A.

2008 North Central Weed Science Society Proc. 63:48.

DOSE-RESPONSE OF 2,4-D AND GLUFOSINATE ON ABUTILON THEOPHRASTI, IPOMOEA SPECIES AND CHENOPODIUM ALBUM. Chad B Brabham, Andy Robinson, and Bill Johnson, Graduate Research Assistants and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

A dose response experiment was conducted to evaluate the efficacy of glufosinate and 2,4-D amine on velveltleaf, moringglories, pigweeds and common lambsquarters. The experimental design was a randomized complete block with a factorial arrangement of treatments. There were seven rates of each herbicide with glufosinate at 0, 0.111, 0.222, 0.444, 0.89, 1.77, 3.55 lbs of ai/A and 2,4-D amine at 0, 0.125, 0.25, 0.5, 1, 2, and 3 lbs of ae/A. A planter was used to plant rows of velvetleaf (*Abutilon theophrasti*), morningglory species (*Ipomoea spp.*) and pigweed species (*Amaranthus spp.*). Plant populations were at 28, 18, and 30 plants per foot, respectively. The experiment site also contained a natural population of common lambsquarters (*Chenopodium album*). Treatments were applied when weeds were 8 to 12 inches in length. Visual control ratings were recorded at 14 and 28 days after treatment (DAT) and fresh and dry weights were recorded 28 DAT. GR 50's and GR 90's for each weed species was determined from regression analysis. Velvetleaf, morningglory species, common lambsquarters and amaranthus species had GR 50s' at 0.133, 0.018, 0.20, and 0.21 lbs of ai/A and GR 90s' at 0.84, 0.34, 0.40, and 1 lbs of ai/A to glufosinate, respectively. The GR 50s' and GR 90s' in response to 2,4-D amine for velvetleaf, common lambsquarters and amaranthus species were 0.48 and 2.64, 1.53 and 9.99, and 0.097 and 0.060 lbs of ae/A, respectively. Tank mixtures of glufosinate at 0.222 lbs of ai/A and 2,4-D amine at 0.125 lbs of ae/A or any other mixtures with higher rates resulted in at least 90% control of the weeds in this study.

EFFECT OF COMBINING ATRAZINE AND MESOTRIONE ON CARRYOVER INJURY IN VEGETABLES. Darren E. Robinson, Assistant Professor, Department of Plant Agriculture, University of Guelph, Ridgetown Campus, Ridgetown, ON, N0P 2C0.

Trials were established in 2003, 2004 and 2005 in Ontario to determine the effects of residues of mesotrione, atrazine and mesotrione plus atrazine one and two years after application on broccoli, carrot, cucumber, onion and potato. One year after mesotrione application, injury was 43%, 37%, 18%, 24% and 0% in broccoli, carrot, cucumber, onion, and potato, respectively. The addition of atrazine to mesotrione in the year before planting increased injury to 55%, 53%, 30%, 42% and 3% in broccoli, carrot, cucumber, onion and potato, respectively. Plant dry weight and yield were also decreased by mesotrione residues the year after application in all crops except potato. The addition of atrazine to mesotrione accentuated the reduction in dry weight and yield in broccoli, carrot, cucumber and onion. There was no injury, or reductions in dry weight or yield in any crop planted two years after application of mesotrione alone or in tank mix with atrazine. A recropping interval of two years is recommended following applications of mesotrione or mesotrione plus atrazine for broccoli, carrot, cucumber and onion. Potato can be safely planted the year following application of mesotrione plus atrazine.

INFLUENCE OF TILLAGE AND HERBICIDES IN ONION. Sarah L Gegner*, Harlene M Hatterman-Valenti, Walter L Albus, and Collin P Auwarter, Graduate Student, Associate Professor, and Research Specialists, Carrington Research Extension Center, Oakes, ND and North Dakota State University, Fargo, ND 58105.

A field experiment was conducted during the field seasons of 2007 and 2008 at the NDSU Research Extension Center near Oakes, ND to evaluate the potential for strip-tillage in onion production and to understand the influence of strip-tillage on factors such as weed seed germination, soil moisture content, and soil temperature. In addition, the effect of strip-tillage on herbicide efficacy in onion prior to the two-leaf growth stage was evaluated. The experiment was arranged as a 2X4 factorial in 2007 and a strip plot with herbicide as the whole plot and tillage as the subplot in 2008. Herbicides included DCPA, pedimethalin, oxyfluorfen, and bromoxynil. DCPA and pedimethalin were applied pre-emerge at rates of 10 lbs/acre and 1.5 pt/acre, respectively. Four weekly micro-rate applications of oxyfluorfen and bromoxynil were made starting shortly after onion emergence at rates of 2 oz/acre and 4 oz/acre, respectively. Plots were hand harvested on September 4, 2007 and September 24, 2008. Onion bulbs were graded according to USDA standards into four classes: small (1-2 ¼ inches), medium (2 ¼-3 inches), large (3-4 inches), and colossal (>4 inches). Total marketable yield includes classes medium and large.

Results indicated that herbicide did not injure onions during establishment in either field season. In 2007, tillage had an effect on the germination of lambsquarters and redroot pigweed. There were significantly more weed seedlings in the conventionally tilled plots than the strip-tilled plots. Hairy nightshade was significantly reduced with the weekly applications of herbicide. 2007 showed a significantly higher amount of lambsquarters weed seedlings in the pedimethalin treatment. Redroot pigweed and hairy nightshade were best controlled with micro-rate applications of oxyfluorfen and bromoxynil. There was little to no redroot pigweed pressure in all treatments during the 2008 field season. In 2008 lambsquarters and hairy nightshade weed pressure was significantly reduced with the weekly applications of herbicide. DCPA had significant more hairy nightshade pressure than the other three herbicides. Results of 2008 showed no significant difference of tillage on weed seed germination.

In 2007 and 2008, onion yield grade did vary between tillage system and herbicide but generally was only numerically higher with the strip-tillage and herbicide treatment for the various onion grades. Results of 2007 indicated a significant increase in onions graded between 3 and 4 inch diameters within the strip-tilled treatments.

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

Field research was conducted at the Northern Plains Potato Grower's Association Irrigation Research site near Tappen, ND to evaluate Russet Burbank growth the year following glyphosate simulated drift to irrigated potatoes. In 2007 the study compared the injury from glyphosate applied at the tuber hooking (TH), tuber initiation (TI), early tuber bulking (EB), and late tuber bulking/early senescence stage (LB) on yield. Glyphosate was applied at rates one-third, one-sixth, and-twelfth, and one-twenty-forth the standard use rate (0.25, 0.125, 0.0625, and 0.0313 lb ae/A) at the TI, EB, and LB stages, and at 0.25 lb ae/A at the TH stage. Tuber samples from these plots were stored and used for seed in 2008. Seed was planted and plants maintained until harvest.

Potatoes treated with glyphosate at the TH stage yielded significantly lower after harvesting in 2007 (51 cwt/A), however daughter tubers planted from the 2007 seed yielded 405 cwt/A in 2008. The untreated yielded 451 and 418 cwt/A in 2007 and 2008, respectively.

Daughter plants from potatoes treated with 0.25 and 0.125 lb/A glyphosate the previous year at the LB stage or 0.25 lb/A glyphosate the previous year at the TI stage had a significantly lower yields compared to all other treatments, 89, 168, and 233 cwt/A, respectively. In contrast, daughter plants from potatoes treated with 0.0313 lb/A glyphosate at the LB stage the previous year had the highest yield with 450 cwt/A, followed by daughter plants from potatoes treated with 0.0625 lb/A glyphosate at the LB stage the previous year with 419 cwt/A. The untreated had the third highest yield.

Potatoes treated with 0.25 and 0.125 lb/A glyphosate at the LB stage showed a yield loss of 200 and 100 cwt/A, respectively, compared to the untreated during 2007. In 2008, seed from these two treatments resulted in a loss of 329 and 250 cwt/A (potatoes treated with 0.25 and 0.125 lb/A glyphosate at LB stage in 2007).

TOLERANCE OF POTATO MINI-TUBERS TO PRE AND POST HERBICIDE APPLICATIONS.
Calvin Glaspie, Wesley Everman, Chris Long and Andrew Chomas, Graduate Research Assistant, Assistant Professor, Extension Specialist, Research Technician, Department of Crop and Soil Sciences Michigan State University, East Lansing MI 48864.

Demand for disease free potato seed in Michigan is high due to a large economic return upon planting disease and virus free seed potatoes. Using aseptically grown plants produced from tissue culture, potato mini-tubers can be planted as a clean seed source. However, many generally accepted cultural practices for managing mini-tubers are adopted from cut seed piece, including weed management programs. In 2007, growers observed injury from different herbicides treatments on particular potato cultivars grown from mini-tubers. Field trails were conducted at the Montcalm Research Farm in Lakeview Michigan in 2008, to evaluate the effect of labeled herbicide programs on three cultivars of potato mini-tubers. Potato cultivars; Atlantic, Frito Lay (FL) 1867 and FL 1922 were planted in 34-inch rows, 2.5 inches deep at 8 inch spacing and hilled at planting. Fifteen treatments were arranged in a strip plot design with four replications. Treatments were, 1) *S*-metolachlor (1.27 lb ai/A), 2) pendimethalin (0.71 lb ai/A), 3) metribuzin (0.5 lb ai/A). 4) linuron (0.5 lb ai/A), 5) rimsulfuron (.023 lb ai/A), 6) dimethenamid (0.66 lb ai/A), 7) imazosulfuron (0.4 lb ai/A), 8) linuron (0.5 lb ai/A) plus *S*-metolachlor (1.27 lb ai/A), 9) linuron (0.5 lb ai/A) plus *S*-metolachlor (1.27 lb ai/A) plus metribuzin (0.09 lb ai/A), 10) metribuzin (0.09 lb ai/A) plus *S*-metolachlor (1.27 lb ai/A) plus pendimethalin (0.24 lb ai/A), 11) metribuzin (0.09 lb ai/A) plus *S*-metolachlor (1.27 lb ai/A) plus pendimethalin (0.24 lb ai/A) plus glyphosate (0.77 lb ai/A) plus ammonium sulfate (3.4 lb/A), 12) linuron (0.5 lb ai/A) plus *S*-metolachlor (1.27 lb ai/A) followed by rimsulfuron (0.016 lb ai/A) plus non-ionic surfactant (.05 gal/A), 13) linuron (0.5 lb ai/A) plus *S*-metolachlor(1.27 lb ai/A) followed by rimsulfuron (0.016 lb ai/A) plus metribuzin (0.25 lb ai/A) plus non-ionic surfactant (.05 gal/A), 14) KIH-485 (1.26 lb ai/A) 15) non-treated. Plots were grown following practices similar to those used in commercial seed production in Michigan, with plots maintained weed free by hand. Visual injury was rated throughout the season on a 0-100% scale and at yield data was collected at the end of the season for, tuber count and tuber defects. Visual ratings show differences in cultivar response to treatments with greater injury observed in FL1867 and FL1922. Treatments displaying visual injury in both cultivars contained *S*-metolachlor, metribuzin, linuron alone or in combination. Treatments that caused yield reductions in all cultivars were V-10142 and treatments containing POST applications of rimsulfuron. Purposed herbicide programs are suggested for safe application to potato mini-tubers based on results.

WEED CONTROL IN NEWLY ESTABLISHED FRENCH-AMERICAN HYBRID GRAPES. Harlene M. Hatterman-Valenti and Collin P. Auwarter, Professor and Research Specialist, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105

Field research was conducted at the NDSU Agricultural Experiment Station Research site near Kindred, ND to evaluate the influence of cultural and chemical weed management strategies on weed control and plant growth in newly established grapes. The trial was arranged as a split plot with three cultural (landscape fabric, wheat straw, and wood chips) and one chemical (flumioxazin at 0.375 lb ai/A + oryzalin at 3 lb ai/A) weed management strategies as the main plot and four grape cultivars (DM8521, MN1131, MN1200, and St. Croix) as sub-plots, replicated three times. Two year old grape plants were transplanted May 25, 2008 with two plants per experimental unit. Weed management treatments were applied the same day. Herbicides were tank-mixed with glyphosate (1 lb ae/A) using a CO_2-pressurized backpack sprayer with a 2-nozzle boom equipped with 8002 flat fan nozzles with an output of 20 GPA and a pressure of 30 psi since weeds were present. Annual weeds were removed by hand (perennials treated with glyphosate) prior to the application of the mulches. Soil volumetric water content and soil temperature at 4-inch depths were recorded hourly in each main plot. No supplemental water was provided.

Weed control evaluations 5 weeks after treatment (WAT) indicated that all treatments provided satisfactory control ($\geq$ 85%) of common lambsquarters, horseweed, and yellow foxtail. Glyphosate applied just prior to the application of wood chips or wheat straw did not provide the anticipated control of Canada thistle or dandelion. Populations were variable, but more prevalent in these treatments. Spot applications with glyphosate reduced the Canada thistle population and eliminated the dandelions. Weed control evaluations were similar at 16 WAT except that the yellow foxtail control decreased in the chemical treatment. Soil water content was greater within the wheat straw mulch treatment than other treatments and soil temperature was cooler until September when the soil temperature within the chemical treatment began to reflect the much cooler night temperatures. Soil water content was lowest and soil temperature had the greatest daily fluctuation within the chemical treatment. Soil temperature and soil water content differences did not affect vine growth (stem number and stem height) but may affect winter hardiness, bud break, fruit production, or fruit ripening. These factors will be evaluated the next two years as well as weed control to determine if cultural weed management methods are feasible strategies for grape production in North Dakota.

SIMAZINE-TREATED MULCHES IMPROVE WEED CONTROL AND MANAGEMENT OF TRIAZINE-RESISTANT COMMON LAMBSQUARTERS (*CHENOPODIUM ALBUM*) IN *VINIFERA* VINEYARDS. Linjian Jiang, Imed Dami, Hannah Mathers and Doug Doohan, Graduate Student, Assistant Professor, Associate Professor and Associate Professor, Department of Horticulture and Crop Science, The Ohio State University/Ohio Agricultural Research and Development Center, Wooster, OH 44691.

In order to achieve successful *vinifera* grape production, growers in cold regions mound soil over the graft union in autumn to protect the graft union from winter injury. In the following spring, the soil hills are removed to avoid *vinifera* scion rooting and the subsequent susceptibility to the soil insect, phylloxera. This annual double-tillage practice, called “winter hilling”, is causing increased soil erosion and complicating weed control. In this study, we proposed that herbicide-treated mulches could be an alternative method for weed management in *vinifera* vineyards while simultaneously providing winter protection and soil conservation. Trials were conducted in two vineyards to test weed management by simazine treated soil, straw and bark. Density data were recorded for each identified species and subjected to ANOVA. Mulch provided significant suppression of most weeds in both vineyards. The efficiency of simazine on the suppression of whole weed community decreased as the season progressed. Simazine, a triazine herbicide, controlled common lambsquarters by killing triazine-sensitive biotype, resulting in a homogenous triazine-resistant population at both locations. However, simazine-treated mulches effectively controlled common lambsquarters without increasing the abundance of the triazine resistant biotype. In conclusion, simazine-treated mulches provided good weed control and a potential tool to manage triazine resistance biotypes.

POSTEMERGENCE SHIELDED FLAMING FOR WEED CONTROL IN VEGETABLE CROPS.
Chad M. Herrmann and Bernard H. Zandstra, Graduate Research Assistant and Professor, Michigan State University, East Lansing, MI 48824.

Propane flaming is widely used in organic cropping systems as a method of preemergence weed control. However, due to the susceptibility of many vegetable crops to heat stress, postemergence weed control is a major obstacle in organic production. We have developed a computer-guided, shielded flamer for use in vegetable row crops. Four 1.5m long shields effectively trap and direct heat into inter-row spaces while the computer vision guidance system steers the implement in close proximity to the vegetable crop.

Field trails were conducted in 2008 to assess the potential for postemergence flaming in snap beans. Each plot was 15.2m long and contained three rows of snap bean spaced at 0.41m. Experimental design was a 3 X 3 factorial assessing propane pressures of 0.07, 0.14, and 0.28 MPa and tractor speeds of 1.61, 3.22, and 6.44 KPH. Crop injury occurred in all treatments for which the tractor speed was 1.61 KPH. When compared with the untreated control, total weed biomass was significantly reduced in all treatments except the 0.07 MPa-6.44 KPH treatment. At high pressures and low speeds, there was a trend toward decreased weed biomass. Further investigation on additional vegetable crops will help to assess the feasibility of implementing postemergence flaming in organic vegetable production.

THE EFFECT OF GLYPHOSATE PLUS DICAMBA DRIFT RATES ON COMMERCIAL PROCESSING TOMATOES. Greg R. Kruger, William G. Johnson, and Stephen C. Weller, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907.

Commercial processing tomatoes are grown on 3,250 ha in Indiana and have been shown to be sensitive to both glyphosate and dicamba, so issues concerning potential drift of these herbicides are a serious concern for growers. The objective of this study was to evaluate the effect on processing tomatoes of simulated drift of glyphosate and dicamba tank-mixtures. The study was conducted in West Lafayette, IN in 2008 in two independent experiments. Experiments were established in a randomized complete block design with four replications with herbicides applied approximately two weeks after transplanting. Treatments based on a use rate of 0.64 kg ae/ha of glyphosate and 0.56 kg ae/ha of dicamba respectively, were 0, 0.006, 0.021, or 0.064 kg ae/ha (0, 1/100th, 1/30th, and 1/10th of normal use rate) of glyphosate or 0, 0.006, 0.019, 0.056 kg ae/ha (0, 1/100th, 1/30th, and 1/10th of normal use rate) of dicamba. Additionally, tank-mixture treatments of 0.006 + 0.006, 0.021 + 0.019, 0.064 + 0.056 kg ae/ha of glyphosate + kg ae/ha dicamba (1/100th + 1/100th, 1/30th + 1/30th, and 1/10th + 1/10th of normal use rates of glyphosate and dicamba), respectively, were included. Treatments were applied with a backpack sprayer delivering 140 l/ha at 117.2 kPa of pressure. Spray solutions contained 2.8 kg/ha of AMS and 0.25%v/v NIS and the herbicide(s). Injury was rated two and five weeks after application for visual injury on a scale of 0 to100 with 100 representing dead plants. No yield was obtained since experiments were established late in the summer. Data were analyzed using Colby's analysis to determine additive or synergistic effects of tank-mixtures and data were pooled across experiments. Tomatoes were severely injured by all three rates of glyphosate and all three rates of dicamba when applied alone, but injury was greater when the two herbicides were mixed. An additive response was observed for 1/30th + 1/30th glyphosate + dicamba tank-mixtures at two weeks after treatment and all three tank mixes at five weeks after treatment. A synergistic response was observed for the 1/100th + 1/100th and 1/10th + 1/10th glyphosate + dicamba tank-mixtures at two weeks after treatment. These results suggest that drift of tank mixtures of glyphosate and dicamba onto commercial processing tomatoes will likely show an additive response.

MULTIPLE APPLICATIONS OF REDUCED-RATE HERBICIDES FOR WEED CONTROL IN ONION. James R. Loken*, Harlene M. Hatterman-Valenti and Collin P. Auwarter, Graduate Research Assistant, Associate Professor and Research Specialist, Plant Sciences Department, North Dakota State University, Fargo, ND 58105.

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

Greenhouse experiments evaluated nine herbicides, applied two times at reduced rates, on weed control of redroot pigweed and common lambsquarters, and crop safety to onion. The herbicides carfentrazone, bromoxynil, oxyfluorfen, metribuzin, halosulfuron, primisulfuron, mesotrione, bentazon, and acifluorfen were applied at 1/8 the lowest labeled rate in two sequential applications on a four day interval when weeds were in the cotyledon to first true-leaf stage and onion were in the flag-leaf stage. An untreated check was included for weed control and crop safety comparisons. To determine herbicide effectiveness, visual evaluations were taken 3 days after the first treatment (DAT 1), 7 DAT 1, and 3 days after the second treatment (DAT 2). Crop safety was evaluated visually and by measuring onion heights 3 DAT 2. Experiments were arranged in a randomized complete block design.

In the statistical analysis of percent injury 3 DAT 2, bromoxynil (0%), metribuzin (2%), bentazon (9%), and mesotrione (11%) were not significantly different than the untreated check (0%) and were considered safe to onion at reduced rates. Height measurements supported visual data as the treatments causing the least seedling onion injury symptomology were among the tallest 3 DAT 2. Oxyfluorfen, metribuzin, acifluorfen, and carfentrazone exhibited the best weed control of redroot pigweed 3 DAT 2 (all 100%). While oxyfluorfen (99%), carfentrazone (98%), bromoxynil (92%), and mesotrione (72%) exhibited the best control of common lambsquarters 3 DAT 2.

The results indicate that crop safety and weed control can be achieved with multiple applications at reduced rates and that further field research is warranted.

COMPETITION OF GLYPHOSATE-RESISTANT VOLUNTEER CORN WITH GLYPHOSATE-RESISTANT SOYBEAN. Paul T. Marquardt and William G. Johnson, Research Associate, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, 47907.

Transgenic volunteer corn expressing glyphosate-resistance is a significant problem weed in corn/soybean rotational systems. Over 90% of soybeans planted in North America are glyphosate-resistant (GR), and glyphosate is often the only weed management treatment practice used in these fields. Previous studies have shown a positive correlation between the adoption of GR corn and increasing cases of volunteer corn in soybean following corn, indicating that this is a growing problem. This issue is particularly timely due to the increasing prevalence of stacking both glyphosate and insect-resistant (mainly Bt) traits into the same genetically-modified plant. GR volunteer corn expressing insect-resistant traits can potentially add increased selection pressure to insect pests outside resistance management programs. GR volunteer corn can also compete with soybean, lowering yields. The objective of this study was to determine how different densities of GR volunteer corn would affect soybean growth and yield. Volunteer corn seed was harvested from GR plants in 2007. This seed was then hand-planted at densities which ranged from 0.5 plants/m^2 to 16 plants/m^2 within soybean plots. Data collected included leaf area measurements (corn and soybean), plant dry weight (corn and soybean), and soybean yield. Soybean yield reductions between 272 and 1568 kg/ha occurred at corn densities of 0.5 plants/m^2 to 16 plants/m^2. Significant yield reductions occurred when 2 plants/m^2 emerged at the same time that soybean emerged.

VEGETATION CONTROL WITH LIME, SODIUM CARBONATE (ASH), AND IMAZAPYR ON SANDBARS ALONG MISSOURI RIVER. Stevan Z. Knezevic, Avishek Datta*, Charles Shapiro, Jon Scott, and Mike Mainz Associate Professor, Post Doc, Professor, and Technologists. Haskell Agricultural Laboratory, University of Nebraska, Concord, NE, 68728

Lack of bare sandbars due to vegetative overgrowth is the main reason for the reduction of nesting habitats for two endangered bird species, Piping Plovers (*Charadrius melodus*) and Interior Least Terns (*Sterna antillarum*). In an effort to create suitable nesting habitats (e.g. open bare sand areas), a series of vegetation management practices are being tested on existing sandbars along the Missouri River. Field studies were initiated on two exiting sandbars in 2007 and 2008 by Springfield, SD with the objective to test vegetation control as influenced by liming, ash, imazapyr, and their interactions. The sites were treated with 3 quarts of glyphosate to control existing vegetation prior to the experiment initiation. The experimental design was a split plot with 18 treatments replicated 4 times. The main plot was soil amendment (lime or sodium carbonate surface applied) each at 3 rates (0, 3, and 6 t/ha) and the sub-plot of imazapyr (0, 0.56, and 1.58 kg/ha). The dominant weed species of the sandbars were nutsedge, waterhemp, sweet clover, common ragweed, horsetail, and marestail. Best overall vegetation control was achieved with imazapyr applied alone at 1.68 t/ha, or following application of lime at 3 t/ha, which provided more than 70% control of most weed species one year after application. Lime or ash applied alone, or a combination of ash and imazapyr did not provide adequate weed control.

REMOVAL TIMING OF WINTER ANNUAL WEEDS IN A NO-TILL CORN AND SOYBEAN CROPPING SYSTEM AND ITS EFFECT ON SOIL WATER AVAILABILITY AND YIELD.

Venkatarao Mannam and Mark L. Bernards, Graduate Research Assistant and Assistant Professor, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68588-0915.

The adoption of no-till has led to increased winter annual weed pressure in many fields. There is little data available on how winter annual weeds affect corn and soybean growth and yield. A particular concern in Nebraska is how much soil water winter annuals may transpire. The objective of this research was to measure how winter annual weed removal timing affects soil water availability and yield of corn and soybean. A field experiment was conducted at the South Central Agricultural Laboratory (SCAL) near Clay Center, NE and at the Agronomy Farm in Lincoln, NE. Weeds were removed at five timings: mid-November, mid-March, mid-April, mid-May, and mid-June. Plots were kept weed free after the removal timing. Volumetric soil moisture to a depth of 1 m was measured weekly using a Troxler model 4301 ^{241}Am (Be) neutron probe. Corn and soybean were planted on May 15 in both the locations. Grain was harvested using a small plot combine and yield was calculated. At SCAL there were no differences in soil moisture among removal timing treatments at the time of planting. Delaying removal until mid-June depleted soil water in the surface 12” in corn treatments but not in soybean. At the time of planting in Lincoln there was less soil moisture available in the mid-May and mid-June removal timing treatments compared with the earlier removal timings. Delaying removal until mid-June further depleted soil moisture in the surface 12” of both corn and soybean crops. Corn yield was reduced by delaying weed removal until mid-May or mid-June at both Lincoln and SCAL. Soybean yield was reduced by delaying weed removal until mid-June in Lincoln. Weed removal timing did not have an effect on soybean yield at SCAL.

A KANSAS KOCHIA POPULATION FOUND RESISTANT TO A USE RATE OF GLYPHOSATE.
Curtis R. Thompson and Dallas E. Peterson, Professors, Department of Agronomy, Kansas State University, Manhattan, KS 66506-5504.

Kochia (*Kochia scoparia* L.) has been reported to be resistant to herbicides in the triazine, ALS inhibiting, and synthetic auxin families. An increased number of complaints concerning inadequate control of kochia with glyphosate have occurred during the growing seasons of 2006 through 2008 in western Kansas. Seed was gathered from a meandering row of kochia indicating a common maternal parent kochia plant had rolled across a cotton field in Stevens County, KS. The cotton field was generally free of weeds except for the row of kochia plants. The field had been treated three times with 0.84 kg ha^{-1} ae glyphosate. The objective of this experiment was to determine if the suspected glyphosate resistant kochia population would respond differently to glyphosate than a known susceptible kochia population. Greenhouse experiments were conducted using the Stevens County biotype (R) and a susceptible kochia biotype (S) which was gathered from the sandhills of Finney County, KS. Seeds were planted in 1 L pots and after emergence thinned to four plants per pot. Glyphosate at 0, 0.42, 0.84, 1.68, and 3.36 kg ae ha^{-1} was applied to 2 to 4 cm kochia in Experiment 1 and at the same rates plus 1.26 and 2.52 kg to 7 to 10 cm kochia in Experiment 2. All glyphosate treatments were applied with ammonium sulfate at 2% w/w. Visual injury ratings were taken 2 and 4 weeks after treatment (WAT). Live and dead kochia plants were counted to determine percent mortality 2 and 4 WAT. The S kochia biotype was controlled 100% when glyphosate at 0.84 kg was applied to kochia 2 to 4 or 7 to 10 cm tall 4 WAT. However, the R kochia biotype treated with 0.84 kg glyphosate when plants were 2 to 4 cm tall was injured 88% and had 42% mortality 4 WAT. When 7 to 10 cm R kochia were treated with 0.84 kg glyphosate, a 43% injury rating and 0% mortality rate were observed. Clearly there is a differential response to glyphosate when the R and S biotypes were compared. The R biotype had escapes when glyphosate at 3.36 kg was applied to 2 to 4 cm plants and when glyphosate at 1.68 kg was applied to 7 to 10 cm plants. Thus 0.84 kg ae use rate of glyphosate likely will not control the R kochia biotype in the field. The greenhouse experiments confirm the 2007 field observation which suggests that the R biotype would withstand 0.84 kg ae glyphosate and actual field observations indicate that kochia would produce viable seed while other genetically unrelated kochia in the treated field were controlled. Glyphosate resistance in kochia likely will become an increasing problem where glyphosate only is used for weed control.

IDENTIFICATION OF POLYMORPHIC PLASTIDIC DNA SEQUENCES FOR WATERHEMP POPULATION GENETICS. Jianyang Liu, Kate Thinglum, Patrick J. Tranel, and Adam S. Davis, Post Doctoral Researcher, Graduate Research Assistant, Associate Professor, University of Illinois, Urbana, IL 61801 and Ecologist, USDA-ARS Invasive Weed Management Unit, Urbana, IL 61801.

Waterhemp (*Amaranthus tuberculatus*) is a major problem weed in the North Central states, and it has developed resistances to a number of commonly used herbicides. As a dioecious species, waterhemp may spread herbicide-resistance traits among populations by the dispersal of both seeds and pollen. To model the patterns of herbicide resistance spread, it is necessary to estimate the relative contributions of seed and pollen movement to total gene flow, as they are of different dispersal modes. Chloroplast DNA (cpDNA) is maternally inherited, and disperses in seeds but not in pollen. In light of that, comparing the spatial distribution of cpDNA polymorphisms with that of biparentally inherited nuclear DNA would help to evaluate the relative influences of seed and pollen dispersal on total gene flow and their effectiveness in spreading resistance. In this study, we investigated cpDNA polymorphisms by amplifying non-coding regions which are reported to be highly polymorphic in other species, and a set of cpSSR primers developed with SSR Finder were also tested. Due to the relative rarity of variation in the conserved cpDNA genome, low polymorphisms in waterhemp cpDNA have been found thus far. A single nucleotide polymorphism was found in the rpoB-trnC^{GCA} region, and this polymorphism was not directly related to the geographic distance between samples. In addition, the rpl32-ndhF and trnL^{UAG}-rpL32 regions were also found to be potentially polymorphic and, therefore, useful for population-level studies.

WINTER ANNUAL WEED INFLUENCE ON SOIL TEMPERATURE AND SOYBEAN CYST NEMATODE POPULATION DENSITY. Valerie A. Mock, J. Earl Creech, William G. Johnson. Graduate Research Assistant, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Assistant Professor, University of Nevada Cooperative Extension, University of Nevada, Fallon, NV, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Winter annual weeds are problematic in row crop production due to the reduced reliance of residual herbicides, and the increased adoption of conservation tillage. Six winter annual weeds have been found to be alternate hosts to soybean cyst nematode (*Heterodera glycines* Ichinohe; SCN). The strongest known winter weed hosts are purple deadnettle (*Lamium purpureum*), and henbit (*Lamium amplexicaule*). We have shown that SCN can reproduce on purple deadnettle during the fall after soybeans have been harvested. If winter annual weeds are uncontrolled they may keep soil temperatures cooler in the spring and delay planting. The objectives of this study were to determine if fall or spring winter annual weed removal timing influenced SCN population densities and if winter weeds influence soil temperature. This experiment was established in 2006 at the Agronomy Center for Research and Education (ACRE) in West Lafayette, IN. This experiment had two plant species, SCN-susceptible soybean and *Lamium spp*. The soybeans were present at densities of zero or 108 m^{-2} and the *Lamium spp*. were present at densities of zero or 161 m^{-2}. Four winter weed removal timings were established which included no weed removal, or October, December, or May weed removal. At these removal timings soil samples were collected for SCN egg extraction and enumeration. Soil temperatures were monitored throughout the year. Effects of SCN-susceptible soybean and *Lamium spp*. on SCN population density will be presented. Temperature data from this experiment showed no differences in plots with soybean, *Lamium spp*., both species, and fallow ground in spring.

GROWTH AND SEED PRODUCTION OF MULTIPLE GLYPHOSATE- AND ACETOLACTATE SYNTHESIS-RESISTANT HORSEWEED (*CONYZA CANADENSIS*) BIOTYPES. Vince M. Davis, Greg R. Kruger, and William G. Johnson, Graduate Research Assistant, Graduate Research Assistant, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Glyphosate and acetolactate synthesis (ALS) inhibitors are the first and second most commonly used postemergence herbicides in U.S. soybean production, respectively. Glyphosate-resistant horseweed (*Conyza canadensis*) biotypes are documented in over 1/3 of the states in the continental U.S., and frequencies of glyphosate-resistant horseweed have been documented in up to 38% of no-till soybean fields in the southeastern region of Indiana. Horseweed biotypes resistant to ALS herbicides also occur frequently throughout the eastern cornbelt. Horseweed populations with mixtures of glyphosate- and ALS-resistant biotypes as well as biotypes with multiple-resistance to glyphosate+ALS inhibitors have also been documented in the region. These biotypes are particularly problematic because when additional herbicides are added to postemergence glyphosate, ALS inhibiting herbicides are a common tank-mix selection to increase postemergence horseweed control in soybean. The objective of this experiment was to characterize the growth and seed production capability of glyphosate-, ALS-, and multiple glyphosate+ALS-resistant horseweed biotypes in a fallow (common garden) field experiment. A four herbicide by four horseweed population factorial field experiment was conducted in the southeastern region of Indiana in 2007 and repeated in 2008. Four horseweed populations were collected from Indiana or Ohio and confirmed resistant to glyphosate, ALS, both, or neither in greenhouse confirmation screening experiments. The four herbicide treatments were untreated, 0.84 kg ae ha^{-1} glyphosate, 35 g ai ha^{-1} cloransulam, and 0.84 kg ae ha^{-1} glyphosate + 35 g ai ha^{-1} cloransulam. Seeds were germinated in the greenhouse and seedlings were transplanted to a tilled fallow field area in the middle of May each year. Herbicides were applied when horseweed reached 10 cm tall. Three plants per replication were harvested for biomass accumulation at 12 WAT and seed production was determined by weight 100 $seeds^{-1}$ multiplied by total seed weight. Data were analyzed as a mixed model factorial with year and replication as random effects. Biomass accumulation of the glyphosate-resistant, ALS-resistant, and glyphosate+ALS-resistant biotypes was not less when sprayed with glyphosate, cloransulam, and glyphosate+cloransulam, respectively, than their respective untreated biotype cohorts at the P=0.1 level. Most importantly, the glyphosate+ALS-resistant biotype produced as much seed (219,000 seeds $plant^{-1}$) following the 0.84 kg ae ha^{-1} glyphosate + 35 g ai ha^{-1} cloransulam treatment as it did with no herbicide treatment (208,000 seeds $plant^{-1}$) in 2007. Based on this experiment, season-long biomass and seed production potentials can remain as high in glyphosate-, ALS-, and glyphosate+ALS-resistant horseweed biotypes when treated with the herbicide or herbicide combination they have evolved to resist. Soybean producers in the eastern cornbelt should judiciously use glyphosate+ALS inhibitor tank-mix combinations to control horseweed postemergence, and consider it to be a second best management approach to controlling horseweed prior to crop planting with preplant herbicides that provide residual horseweed activity.

OPEN-POLLINATED TRANSFER OF GLYPHOSATE RESISTANCE IN HORSEWEED (*CONYZA CANADENSIS*) IN GREENHOUSE ISOLATION. Ryan S. Henry, Vince M. Davis, and William G. Johnson, Undergraduate Student, Graduate Research Assistant, Associate Professor, and Associate Professor. Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Horseweed (*Conyza canadensis)* has rapidly become a major weed in crop production fields of the United States. In the U.S., glyphosate-resistant (GR) plants have been found as far east as Delaware, as far west as California, and from Michigan to Mississippi. In Indiana, farmers have repeatedly ranked horseweed as one of the top five worst weeds in their fields. A field survey conducted from 2003-2005 found that the frequency of GR horseweed in southeastern Indiana was as high as 38% of total soybean production. Previous studies have determined that an incompletely dominant, single-locus gene confers resistance to glyphosate in GR horseweed biotypes. However, the mechanism or mechanisms and the gene responsible for glyphosate resistance are not presently known. In addition to glyphosate resistance, horseweed has also developed resistance to other popular herbicides, including ALS inhibitors and paraquat. The objective of this experiment was to quantify the potential for GR horseweed to outcross in open pollinated populations with mingling GR and glyphosate–susceptible (GS) biotypes in close proximities. This information will increase our understanding of the potential for horseweed to transfer glyphosate resistance to biotypes that may also be resistant to other herbicides even in the absence of selection pressure. Parental plants were from a known GS population and a known GR population that was purified with half the normal field use rate of glyphosate (0.42 kg ae ha^{-1}) on rosettes less than 5 cm width to guarantee resistant plants would be used in crosses. Plants were maintained in greenhouse conditions until 10% - 25% of the flowers opened. Six plant clusters that contained 8:1 GR:GS ratios were then generated. Three clusters spaced 3-m apart were isolated in two separate greenhouses and were allowed to open-pollinate. Seeds were collected from the six susceptible plants, propagated in the greenhouse, and plants were sprayed with 0.84 kg ae ha^{-1} glyphosate at 3 to 5 cm width to isolate heterozygous, GR F_1 plants. F_1 plants were grown and self-pollinated under wax paper bags and maintained to maturity. The progeny (F_2 generation) was then grown and sprayed with 0.84 kg ae ha^{-1} glyphosate at 3 to 5 cm horseweed rosette width to determine positive resistance transfer by expected Mendelian segregation ratios. Segregation ratios were determined by both visual assessment and digital imaging analysis software. Outcrossing for the 8:1 GR:GS clusters ranged from 1.1% to 3.8% and segregation for F_2 plants fit expected 3:1 R:S ratios according to chi-square goodness-of-fit analyses. Our results confirmed that glyphosate resistance in horseweed can transfer to a closely located, putative GS biotype under open-pollinated conditions at low frequencies in greenhouse conditions.

SURVEY OF COMMON SUNFLOWER AND GIANT RAGWEED POPULATIONS IN KANSAS.
Analiza Henedina M. Ramirez, Aifheli M. Ndou and J. Anita Dille, Graduate Research Assistant, Graduate Research Assistant and Associate Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Common sunflower (HELAN) and giant ragweed (AMBTR) are important weed species of the north central region of the US. A survey was conducted from 2006 to 2008 to determine the occurrence and distribution of these two weed species in Kansas. Regions of Kansas were surveyed for the presence of the two weed species. Once populations were found, geographic coordinates for the location were noted and mapped. HELAN and AMBTR were found along roadsides, in agricultural fields, and pasture areas. In agricultural fields, both species were mostly found within the fence line along the edge and in some cases within the field. Agricultural fields where these two weeds species were found either had a history of herbicide resistance or were poorly managed. HELAN was mostly found in the northern half of the state while AMBTR was found in the eastern third of the state. The database maintained by the Kansas State University Herbarium indicates that both species could be found throughout the state but these survey results indicate otherwise. Although these two weed species are generally present in the state, they may not be a problem in agricultural fields especially when these fields are well managed and do not have a history of occurrence of herbicide resistance.

EFFECT OF FORAGE SOYBEAN AFTER WHEAT HARVEST ON PALMER AMARANTH AND DOWNY BROME. Justin Petrosino, J. Anita Dille, Kraig Roozeboom, and Mark Claassen, Graduate Research Assistant, Associate Professor, Assistant Professor, Professor, Department of Agronomy, Kansas State Univeristy, Manhattan, KS 66506

Palmer amaranth (*Amaranthus palmeri*) and downy brome (*Bromus* tectorum) are two common weeds in Kansas that flourish during the fallow period from winter wheat harvest to planting of the following summer annual crop. The potential exists to minimize weed emergence, survivorship, and fecundity without the use of herbicides by cultural methods such as replacing the fallow period with a cover crop. Field experiments were established in 2008 at the Department of Agronomy North Farm in Manhattan, KS and at the Harvey County Experiment Field in Hesston, KS to determine how the replacement of the fallow period after wheat harvest with a forage soybean planted at varying seeding rates and terminated by three different methods would affect weed emergence, survivorship, and fecundity. A randomized complete block design with four replications was established with five soybean seeding rates (100,000, 225,000, 350,000, 475,000 and 600,000 seeds/ha) and a no-cover control as treatments. Weeds were established in 1 m^{-2} micro plots in each treatment. Maximum forage soybean biomass was obtained at 350,000 seeds ha^{-1} in Manhattan, and 225,000 seeds ha^{-1} in Hesston. Palmer amaranth emergence was higher in Hesston compared to Manhattan but it was not different across soybean seeding rates. Presence of the forage soybean cover crop decreased individual Palmer amaranth biomass compared to the no-cover control. Total Palmer amaranth biomass per treatment was negatively affected by increasing soybean biomass at both locations. Downy brome emergence was lower in the rolled and sprayed termination methods compared to the standing method in Manhattan. The presence of the forage soybean cover crop affected Palmer amaranth biomass accumulation and the cover crop termination method affected downy brome emergence.

METHODS FOR CULTURING *FUSARIUM LATERITIUM*. Nabaraj Banjara, John L. Lindquist, Gary Yuen, Graduate Research Assistant and Associate Professor, Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE 68583 and Professor, Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583.

Research has shown that the soil fungus, *Fusarium lateritium*, can be pathogenic to velvetleaf (*Abutilion theophrasti*) in the field. To effectively quantify the effect of *F. lateritium* on velvetleaf demographic parameters in the field, large areas of soil lacking the fungus will need to be inoculated with sufficient populations of *F. lateritium* to elicit a pathogenic effect. Cultural media and temperature affect fungal growth and the number of reproductive structures produced. Two experiments were conducted to determine optimal temperature conditions and media for culturing *F. lateritium* to produce sufficient quantities of reproductive structures for mass soil inoculation. In the first experiment, a pure culture of *F.lateritium* was used to inoculate ½ Potato Dextrose Augar (PDA) media in 12, 9 cm diam Petri dishes. Two dishes were placed in each of 6 growth chambers set at 12, 17, 20, 28, 32 and 37 C. Growth of *F. lateritium* was quantified by measuring the diameter of colonies after 6 d of growth. The second experiment was conducted to quantify *F. lateritium* growth in three types of culture media, tall fescue (*Festuca arundinacea*) seed (15 g), wheat straw (15g dry) with a nitrogen source (3 g ammonium nitrate, NH_4N0_3), and wheat straw (15 g) plus tall fescue seed (3g). Each media was inoculated with *F. lateritium* grown on ½ PDA media and incubated for two weeks, then dried at room temperature for one week. Dry samples were sieved with a 0.2 mm screen and thoroughly mixed with 1000 gram of sterile soil to produce a stock inoculum soil. Number of *F. lateritium* colony forming units (CFU) per gram of stock soil was determined by dilution plating on Nash Snyder (NS) media. *F. lateritium* growth was optimal between 20 and 28 C and completely inhibited above 37 C. The stock soil produced from growing *F. lateritium* on only 15 g tall fescue seed produced 6 x 10^5 CFU's per gram of soil compared to only 4.5 x 10^5 and 7500 CFU's per g soil for wheat straw plus tall fescue seed or wheat straw with nitrogen source, respectively. We will grow *F .lateritium* on tall fescue seed to inoculate field soils and quantify its effect on velvetleaf demographic parameters in monoculture and in mixture with corn.

NATIVE AND INVASIVE PLANTS IN THE HERBACEOUS LAYER OF FORESTS IMPACTED BY EMERALD ASH BORER.Wendy Klooster, Catherine P. Herms, Kathleen S. Knight, Kamal Gandhi, Annemarie Smith, Daniel A. Herms and John Cardina, The Ohio State University, Wooster, OH 44691, USDA Forest Service, Northern Research Station, Delaware, OH 43015; Ohio Department of Natural Resources, Division of Forestry, Columbus, OH 43229 (72)

Disturbed areas are highly susceptible to colonization by invasive species. We are studying invasive plant colonization in forests experiencing canopy gap formation due to emerald ash borer (EAB; *Agrilus planipennis)* induced ash (*Fraxinus* spp) tree mortality. The emerald ash borer killed nearly all ash trees in southeastern Michigan, and is expected to continue to spread throughout eastern forests. Since ash trees typically grow as individuals in stands dominated by other tree species, they create canopy gaps when they die, potentially facilitating invasion by exotic plant species. We established plots in seven state or metro parks in southeast Michigan that have extensive public forested lands (Highland, Hudson Mills, Indian Springs, Island Lake, Kensington, Pontiac Lake, and Proud Lake). Plots were grouped into hydrological classifications based on the dominant *Fraxinus* species present: hydric (*F. nigra*), mesic (*F. pennsylvanica*) and xeric (*F. americana*). Within each plot, we counted seedlings in four 4 m^2 quadrats placed 8 m from the center in each cardinal direction. All woody species less than 1.3 m tall and 2.5 cm diameter were counted; individuals were distinguished as either new (having cotyledons) or established (having over one year's growth). Percent cover was estimated for each species, and diversity indices were calculated for species in the 4 m^2 quadrats. Plots in hydric environments had more species (19), more abundant species (9), more very abundant species (6.5), and greater evenness (0.67) than plots in mesic and xeric settings. The most abundant native species in the plots, regardless of hydrological classification, were *Fraxinus* species (grouped by genus due to difficulties in classification at the seedling stage); the most abundant invasive species was *Rhamnus cathartica* for the hydric and mesic plots, while *Rhamnus frangula* was most common in xeric plots.

EVALUATION OF GARLIC MUSTARD (ALLIARIA PETIOLATA) CONTROL WITH SPRING AND FALL HERBICIDE APPLICATION. Vijaikumar Pandian and Mark J. Renz, Brown County Horticulture Extension Educator, Department of Agriculture & Natural Resources Extension and Assistant Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Studies were conducted in Green Bay, Sparta and Postville, Wisconsin in 2007 to evaluate the effectiveness of herbicide treatments in reducing both garlic mustard cover and seed production when applied at various timings. Studies were randomized complete block designs with three to five blocks applied with a CO2 backpack sprayer at 168-224 liters per hectare. At each site, distinct phenological stages of garlic mustard were present, with rosettes present in the spring Green Bay site, plants just beginning to produce a stem (early bolting) at the Sparta site, plants with visible stems expanding (late bolting) at the Postville site, and only fall rosettes present at the fall Green Bay site.

All spring applications in Green Bay reduced the cover of 2^{nd} year plants compared to untreated areas at 89 days after application (DAT), but seedling control varied among treatments with imazapic, imazapic + glyphosate, sulfometuron, and metsulfuron treatments reducing seedling cover greater than flumioxazin and glyphosate treatments. Spring application at the early bolting stage at the Sparta site reduced 2^{nd} year cover of garlic mustard compared to untreated plots with imazapic, imazapic + glyphosate, metsulfuron, flumioxazin, kjm44 and sulfosulfuron reducing the cover of 2^{nd} year plants to 0% at 83 DAT. However, the seed mass/m^2 and seedling cover was reduced in all treatments compared to untreated areas with imazapic, imazapic + glyphosate, sulfometuron , flumioxazin, kjm44 and sulfosulfuron eliminating the seedling cover at 83 DAT. Spring application at late bolting stage in the Postville site also resulted in a reduction of 2^{nd} year cover with glyphosate, metsulfuron, sulfometuron, imazapic, imazapic + glyphosate, flumioxazin, kjm44 and sulfosulfuron providing greater than 95 % reduction at 68 DAT. However, seedling control varied among treatments and only imazapic, imazapic + glyphosate, sulfometuron, metsulfuron and sulfosulfuron treatments reduced the seedling cover to 0%. Late fall application of all treatments except flumioxazin at the Green Bay site showed the reductions in cover of 2^{nd} year plants compared to untreated plots with metsulfuron eliminating the 2^{nd} year cover of garlic mustard at 219 DAT. No treatments reduced the seedling cover compared to the untreated control at the fall application. Results across four sites demonstrate that a range of herbicides can effectively reduce the cover of 2^{nd} year plants applied at late fall and spring season with imazapic, imazapic + glyphosate, sulfometuron and metsulfuron showing to be the most consistent results across sites. Control of seedlings proved to also be accomplishable at all three sites when treatments are applied after emergence in the spring with imazapic, imazapic + glyphosate, sulfometuron and metsulfuron. Glyphosate, the standard treatment in most control efforts, varied in it success across all sites with the reduction in cover at 88%, 60%, 100%, and 81% in spring Green Bay, Sparta, Postville, and fall Green Bay respectively. This indicates that the effectiveness of glyphosate may differ depending on stage of growth or environmental factors specific to each site.

SALTCEDAR CONTROL USING FOLIAR AND BASAL BARK TREATMENTS. Walter H. Fick and Wayne A. Geyer, Associate Professor, Department of Agronomy, Professor, Department of Horticulture, Forestry, and Recreation Resources, Kansas State University, Manhattan, KS 66506.

Saltcedar [*Tamarix ramosissima*] is an invasive woody species in riparian zones and along streambanks in the southwestern and southeastern U.S. and throughout the Great Plains. Saltcedar respouts following top removal by fire or mechanical cutting. Herbicides are commonly used to control saltcedar. The objectives of this research were to 1) determine the efficacy of foliar and basal-applied herbicides for saltcedar control, and 2) determine associated vegetative cover changes. The study was conducted on the Cimarron National Grasslands, near Elkhart, Kansas. Herbicides were applied on August 16, 2006 and on an adjacent site on August 30, 2007. Foliar treatments consisted of 0.56 and 1.12 kg ha^{-1} imazapyr, and imazapyr + glyphosate at 0.56 + 1.12 kg ha^{-1}. All three foliar treatments contained 1% methylated seed oil (v/v). Triclopyr was applied as a basal bark treatment at 48 g L^{-1} of diesel. All treatments were applied using a hand sprayer. Treatments were applied to 6.1 by 6.1 m plots in a completely randomized design with four replications. Saltcedar plants were 1 to 3-m tall at the time of herbicide application. Saltcedar mortality was determined about 1 year after treatment (YAT). Vegetative foliar cover was estimated using Daubenmire's Canopy Coverage method at the time of herbicide application and about 1 YAT. All herbicides provided greater than 85% mortality of saltcedar 1 YAT. Vegetative cover changes varied with treatment. Bare ground increased following treatment in 2007 because of much dryer than normal precipitation in late 2007 through most of the 2008 growing season. Perennial grasses such as alkali sacaton, inland saltgrass, and western wheatgrass were generally decreased following application of treatments containing imazapyr and glyphosate. A reduction in perennial grasses was often associated with an increase in annual forbs such as Russian thistle and kochia.

POPULATION VARIATION IN ALLELOPATHIC AND COMPETITIVE EFFECTS OF LONICERA MAACKII ON THE NATIVE ANNUAL PILEA PUMILA. Dan M. Romanek and Don Cipollini, Graduate Student, Department of Biological Sciences, Wright State University, Dayton, OH 45435, Professor, Department of Biological Sciences, Wright State University, Dayton, OH 45435.

Recent studies suggest the common forest invader *Lonicera maackii* possesses allelopathic potential. However, no research has effectively determined if allelopathic potential of *L. maackii* is a significant contributor to its invasiveness relative to its ability to compete for below ground resources. Also, most studies have only focused on single populations of *L. maackii* in determining any allelopathic effects. We conducted a full factorial multi-population study to isolate the competitive and allelopathic effects *L. maackii* on the native forest annual *Pilea pumila*. Individual *P. pumila* plants were grown in pots in the greenhouse in commercial potting soil containing a transplanted 2-3 yr old *L. maackii* from one of six Ohio populations. *Pilea pumila* grown alone served as a control. Activated carbon was incorporated into the soil of half the pots from each treatment in order to ameliorate effects of potential allelochemicals and to account for direct effects of carbon treatment. The effect of *L. maackii* on final total, above, and below ground biomass of *P. pumila* was compared between treatments using ANOVA. After accounting for initial size, the presence of *L. maackii* strongly decreased the final total biomass of *P. pumila* overall, but populations did not vary in their effects. Activated carbon strongly increased total biomass of *P. pumila* in the absence of *L. maackii*, but the benefit was limited in the presence of *L. maackii* in a similar fashion across populations. Activated carbon benefited the above ground biomass of *P. pumila* to a lesser extent than below ground biomass in the presence or absence of *L. maackii*. Final biomass of *L. maackii* was independent of the presence of carbon. We conclude that Ohio populations of *L. maackii* do not vary in their ability to compete for below ground resources or in their allelopathic potential. The lack of response of *L. maackii* to activated carbon and its ability to inhibit the positive effects of carbon on *P. pumila* suggest that *L. maackii* exerts its effects through some combination of resource competition and allelopathy.

HOST SPECIFICITY AND DISTRIBUTION OF A POWDERY MILDEW FUNGUS ATTACKING GARLIC MUSTARD, ALLIARIA PETIOLATA, IN SOUTHWESTERN OHIO. Victoria L. Ciola* and Don Cipollini, Department of Biological Sciences, Wright State University, Dayton, OH 45435.

In Southwestern Ohio, many garlic mustard populations are infected with the powdery mildew *Erysiphe cruciferarum* that can reduce the growth and fitness of garlic mustard. *E. cruciferarum* was assessed in order to guide decisions regarding its potential use in the management of garlic mustard. We determined the distribution of *E. cruciferarum* on garlic mustard and we determined the potential risk of *E. cruciferarum* to native brassicaceous species and selected crops. We surveyed 19 parks in Southwestern Ohio and made a distribution map of disease incidence of *E. cruciferarum* on garlic mustard using GIS ERSI (ArcMap) software. Five native spring ephemeral mustards were surveyed and then obtained from local wooded areas in May 2008. Individual plants were transplanted in the greenhouse and then exposed to infected garlic mustard plants. The native plants surveyed showed no obvious signs of *E. cruciferarum* infection. All of the native plants subjected to powdery mildew under greenhouse conditions at this time became mildly infected with *E. cruciferarum*. Twelve crops in the family Brassicaceae along with 3 crops in the Cucurbitaceae, Fabaceae, and Solanaceae families were planted and inoculated with *E. cruciferarum* and only one Savanna Mustard (*Brassica juncea*) became infected with powdery mildew. Our field survey revealed Montgomery County Ohio as the "hot spot" for *E. cruciferarum* infection on garlic mustard with disease incidence decreasing away from Montgomery County. Results from the greenhouse study indicate that *E. cruciferarum* likely poses little threat to native brassicaceous plants because the phenology of native plants is early and allows them to escape infection. *E. cruciferarum* poses little threat to cultivated crops since only one crop became infected and Savanna Mustard is not a common cultivated variety in Ohio.

WHAT WEED SCIENTISTS SHOULD KNOW ABOUT THE SEED INDUSTRY. Tracy Linbo, Sr. Marketing Manager, Pioneer Hi-Bred, Johnston, IA 50131.

The seed industry is ever-changing with the overall goal focused on evolving customer needs. Increased global demand for food, feed, fuel and fiber have caused the American farmer to adopt new technologies that enable increases in productivity to meet these demands. With limited opportunity for global expansion of agricultural acres, the seed industry continues to increase research and development to provide growers with products with increased yields and greater management flexibility around weeds, insects, diseases, agronomics and end-use. Many factors must now be integrated in product development including, but not limited to, regulatory requirements externally and life cycle management internally. It is extremely important weed scientists understand how plant breeding and biotechnology interact with pest management as these disciplines become linked in the introduction of new technologies and products. We must also prepare students across these disciplines to compete in the seed and crop protection marketplace.

DOW AGROSCIENCES HERBICIDE TOLERANCE TRAITS IN CORN AND SOYBEAN. David M. Simpson*, T. R. Wright, R.S. Chambers, M. A. Peterson, C. Cui, A. E. Robinson, J. S. Richburg, D. C. Ruen, S. Ferguson, B. E. Maddy, E. F. Schreder; [1]Dow AgroSciences, Indianapolis, IN.

Dow AgroSciences is developing a family of herbicide tolerance traits that provide tolerance to certain broadleaf and grass herbicides, including the phenoxy auxins like 2,4-D, as well as the aryloxyphenoxypropionate grass herbicides. The mechanism for conferring herbicide tolerance is a rapid single-step metabolic detoxification process mediated by an α- ketoglutarate-dependent dioxygenase enzyme. The genes coding for these enzymes were isolated from naturally occurring gram negative soil bacteria. The traits have shown broad utility in multiple broadleaf and grass crop species. Robust tolerance is observed from the early seedling stage to the reproductive stage at application rates four to eight times the current field use rates. These traits will enable 2,4-D to be applied from pre-emergence, without planting restrictions, to the reproductive stage of the crop, providing broad-spectrum broadleaf weed control including control of ALS, triazine or glyphosate resistant broadleaf weeds. Combining these traits with other current herbicide tolerance traits will allow growers maximum flexibility to use multiple modes of action to enhance broadleaf weed control.

CAN THE DHT TRAIT SOLVE ALL OF OUR GLYPHOSTE RESISTANCE PROBLEMS? Mark M. Loux, Professor, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43221.

Dow AgroSciences is developing DHT, a trait that confers resistance to 2,4-D in corn and soybeans, and resistance to "fop" herbicides in corn. 2,4-D remains an extremely important herbicide in weed management programs for corn and soybeans. It is an inexpensive and widely used component of preplant herbicide treatments in no-tillage systems, to control or help control emerged broadleaf weeds. Another primary use has been in early POST treatments in corn to supplement atrazine and other herbicides. Lack of crop tolerance is the major limitation to more widespread use of 2,4-D in corn and soybeans. 2,4-D ester can be safely used in soybeans when it is applied at least 7 days before planting, because the combination of its relative immobility and rapid degradation in soil precludes phytotoxicity. Postemergence use in corn is limited to early growth stages, because the crop becomes susceptible to injury from 2,4-D with increasing size and advancing growth stage. Early postemergence application to small corn often fails to adequately control summer annual broadleaf weeds that have a tendency to emerge into June.

Although the current lack of crop tolerance limits its utility, 2,4-D has activity on all of the broadleaf weeds that have developed resistance to glyphosate. It is already an important component of the recommendations for management of certain resistant weeds, especially those that have emerged by the time of soybean planting. Application of 2,4-D prior to no-till soybean planting helps control emerged glyphosate-resistant horseweed, which accounts for much of the horseweed population that can infest the crop. Common and giant ragweed can also emerge early in the growing season, and are readily controlled by preplant application of 2,4-D.

Herbicide-tolerance technology that allows expanded use of 2,4-D, especially postemergence use in soybeans and a wider window of postemergence use in corn, would have substantial utility for reducing the risk of glyphosate resistance and managing resistant populations. Many populations of glyphosate-resistant broadleaf weeds have resistance to other herbicide sites of action also, resulting in a lack of effective alternatives to glyphosate. DHT technology could greatly improve growers' ability to manage problematic populations of horseweed, common and giant ragweed, and waterhemp, for which glyphosate and other current postemergence herbicides are becoming increasingly ineffective.

DEVELOPMENT OF LIBERTYLINK SOYBEAN TRAIT TECHNOLOGY. Jayla Allen, Product Development Manger, Jon Fischer, Product Manager, Bayer CropScience, Research Triangle Park, NC 27709.

Bialaphos is a naturally occurring enzyme found in *streptomyces*. Bialaphos degrades into phosphinothricin, which is herbicidally active. Glufosinate-ammonium is a synthetic molecule nearly identical to phosphinothricin. Glufosinate-ammonium is a broadspectrum non-selective herbicide that controls more than 120 weed species.

The phosphinothricin acetyl transferase (PAT) protein was first isolated from *Streptomyces viridochromogenes*. The soybean event A2704-12 was developed by inserting the PAT gene into an elite commercial soybean line, A2704-12, using the microprojectile bombardment method. PAT deactivates the herbicide glufosinate-ammonium by attaching an acetyl group, conferring tolerance of the plant to glufosinate-ammonium.

The elite soybean event, A2704-12, was chosen due to its molecular characterization, herbicide tolerance, yield and agronomic performance. Studies show that A2704-12 has no yield drag compared to the isoline.

Soybean varieties containing the A2704-12 event will be available in 2009 under the trade name LibertyLink. LibertyLink traits are currently commercially available in canola, corn, and cotton. Current breeding efforts for LibertyLink soybeans are in place with significant germplasm originators. Varieties intended for sale in 2009 range from maturity group 0.5-4.9. LibertyLink soybeans will compete toe to toe for yield and overall agronomic performance with best available soybean herbicide tolerant traits.

UTILITY OF LIBERTYLINK SOYBEAN IN FUTURE PRODUCTION SYSTEMS. Kevin W. Bradley, Assistant Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211.

Soybeans that have been genetically engineered to withstand applications of glufosinate are expected to be commercially available for the first time during the 2009 growing season. These new varieties, designated as LibertyLink, will offer growers an alternative, broad-spectrum, non-selective herbicide that has not previously been available for use in soybean production systems. In this regard, perhaps the greatest advantages of the LibertyLink system are, 1) to reduce the selection pressure imparted by glyphosate in current corn and soybean production systems, and 2) to manage glyphosate-resistant weed species that are already present in these systems. Results from field trials conducted in locations with glyphosate-resistant waterhemp have revealed that a residual preemergence (PRE) herbicide application followed by a timely postemergence (POST) application of glufosinate can provide good control of glyphosate-resistant waterhemp in LibertyLink soybeans. Results from other trials have also revealed that good annual grass and broadleaf weed control and high soybean yields can be achieved with this residual PRE followed by POST glufosinate program. POST-only glufosinate programs in LibertyLink soybean are less likely to be successful due to the contact nature of glufosinate and the importance of applying glufosinate to small weeds, generally less than 15 cm in height. Additionally, current label restrictions pertaining to maximum glufosinate application rates and timings may not favor POST-only glufosinate program resulting in poor control of weeds that exhibit a discontinuous emergence pattern and form late-season infestations.

OPTIMUM® GAT® TRAIT – NEW WEED MANAGEMENT TOOL FOR ROW CROPS. David Saunders, Product Development Manager, DuPont Crop Protection. Johnston, IA 50131.

The Optimum® GAT® Trait is a new herbicide-tolerance trait under development by Pioneer Hi-Bred. Corn hybrids and soybean varieties containing the Optimum GAT trait will be tolerant to applications of glyphosate as well as a wide range of ALS-inhibitor herbicides. New herbicide mixtures enabled by the Optimum GAT trait will introduce important tools for addressing unmet weed management needs of farmers. Optimum GAT preemergence and postemergence herbicide offerings will help farmers meet their ever-changing weed control needs by providing broader spectrum weed control options than are presently available with today's glyphosate-based programs. Optimum GAT herbicide programs will provide improved options for controlling existing weed problems, including those weeds which have developed herbicide resistance. Seed products with the Optimum GAT trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum GAT trait are not currently registered for sale or use in the United States.

OPTIMUM® GAT®: REVISITING THE VALUE OF SULFONYLUREA CHEMISTRY FOR TODAY'S WEED PROBLEMS. Bryan G. Young, Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

The sulfonylurea herbicides, and more broadly the ALS-inhibiting herbicides played critical roles in our ability to manage weeds in corn and soybean in the 1990s. The advent of ALS-resistant weeds and commercialization of glyphosate-resistant crops have reduced the use of these herbicides dramatically. Without argument, the use of glyphosate-resistant crops and associated applications of glyphosate have provided excellent overall weed control including ALS-resistant weed species. However, after a little more than a decade of adopting glyphosate-resistant soybean and corn the weed spectrum and herbicide sensitivity of weeds to glyphosate has evolved to the point where an integrated and diverse herbicide strategy is necessary to achieve successful weed management.

The eventual commercialization of Optimum GAT corn and soybean will allow for more flexibility in applying sulfonylurea herbicides with glyphosate to obtain more consistent weed control or even control of glyphosate-resistant weed species. In soybean, the use of chlorimuron in some market segments has proven valuable as it was the third-ranked herbicide for area treated behind only glyphosate and 2,4-D in 2006. In corn, the negative association with ALS-inhibiting herbicides has typically been focused on the crop safety aspect and to a lesser extent the herbicide activity on important weed species. Optimum GAT corn and soybean should provide the level of crop safety expected by growers and provide substantial improvements in weed control as offered by a host of herbicide active ingredients planned for commercialization as multiple herbicide premixes: chlorimuron, rimsulfuron, thifensulfuron, tribenuron, mesotrione, and flumioxazin. University research in Optimum GAT corn has shown that the combination of rimsulfuron, chlorimuron, and mesotrione can provide effective control of velvetleaf and ALS-resistant waterhemp in preemergence applications and mixtures of rimsulfuron, chlorimuron, and glyphosate are effective for postemergence control of morningglory. In Optimum GAT soybean, university research has shown that thifensulfuron, tribenuron, and chlorimuron in postemergence applications with glyphosate can improve control of non-ALS resistant giant ragweed and giant foxtail by 20 to 50% late in the season compared with glyphosate applied alone. Research conducted on glyphosate-resistant waterhemp supported the utility of mesotrione and flumioxazin as components of an integrated approach to weed management with the sulfonylurea and glyphosate combinations.

Optimum GAT corn and soybean can be used to control problematic weeds currently experienced by growers as well as certain glyphosate-resistant weeds such as horseweed. Adoption of the diverse herbicide components envisioned for use in Optimum GAT crops has the potential to mitigate resistance to glyphosate as well. Since the sulfonylurea herbicides do not currently play a major role in the management of volunteer corn or soybean, the use of Optimum GAT corn or soybean would not likely create any problems with volunteer management beyond glyphosate-resistant crops. Even though the sulfonylurea herbicides and rates in Optimum GAT crops may not impose any special crop rotational restrictions compared with traditional corn and soybean herbicides, the use of this technology and associated herbicide applications may be a concern in cropping systems that go beyond corn and soybean.

GLYPHOSATE-RESISTANT HORSEWEED CONTROL IN DICAMBA GLYPHOSATE RESISTANT SOYBEANS. Lawrence E. Steckel and Robert F. Montgomery, Assistant Professor, Department of Plant Sciences, The University of Tennessee, Jackson, TN 38301 and Area Technology Development Manager, Monsanto Company, Union City, TN 38261.

Introduction

Glyphosate-resistant (GR) horseweed (*Conyza canadensis*) is a serious pest problem in no-till soybean production in Tennessee (Heap 2008). Currently, the typical GR horseweed management program in Tennessee is 0.25 lb ae/A of dicamba tank mixed with 0.75 lbs ae/A of glyphosate applied 30 to 14 days before planting (Steckel et al. 2007). The draw back to the dicamba and glyphosate tankmix is that in dry soil conditions horseweed control has been inconsistent and soybean injury from the dicamba has occurred. In addition, GR horseweed emerges 11 months out of the year in Tennessee (Main et al. 2006) and even fields that are weed free at planting can have subsequent GR horseweed emergence. In 2007 in Tennessee, Monsanto field tested soybean varieties that have both a glyphosate tolerant trait stacked with a dicamba tolerant trait. Soybeans tolerant to dicamba could provide soybean producers a number of possible application timing options to control GR horseweed. Therefore, the objectives of our studies were to (1) determine how effective post emergence applied programs that center around dicamba controlled GR horseweed and (2) evaluate soybean tolerance to the herbicide applications.

Materials and Methods

Studies were conducted in 2007 and 2008 in a soybean field near Union City. The soybean variety was provided by Monsanto and contained both glyphosate tolerant and dicamba tolerant traits. Herbicide applications were made with a CO^2 pressurized backpack sprayer equipped with Flat Fan 1100015VS nozzles under a pressure of 40 psi which provided an application volume of 10 gallons/acre. Application timings are listed in Table 1. GR horseweed control ratings were taken 21, 30 and 50 days after treatment (DAT). The treatments evaluated are listed on Table 2.

Table 1.

Location/Year	Application Timing	Date	Horseweed Size
Union City 2008	PRE	June 6	12"
Union City 2007	PRE	June 3	3"
Union City 2008	6" Weeds	July 2	24"
Union City 2007	6" Weeds	July 16	8"
Union City 2008	3 WAT	July 23	30"
Union City 2007	3 WAT	July 26	0

Table 2.

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

Trt 1. RWM Pre/fb RWM on 6" weeds/ fb RWM 3 WAT.
Trt 2. RWM /fb RWM + dicamba 0.5 lbs ae/A on 3" weeds/ fb RWM + dicamba 0.5 lbs ai/A 3 WAT.
Trt 3. RWM Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6" weeds/ fb RWM + dicamba 0.5 lbs ae/A 3 WAT.
Trt 4. RWM Pre/ fb RWM + dicamba 0.25 lbs ae/A on 3" weeds/ fb RWM + dicamba 0.5 lbs ae/A 3 WAT.
Trt 5. RWM Pre/ fb RWM + dicamba 0.25 lbs ae/A on 6" weeds/ fb RWM + dicamba 0.5 lbs ae/A 3 WAT.
Trt 6. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM on 6" weeds/ fb RWM 3 WAT.
Trt 7. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6" weeds/ fb RWM 3 WAT.
Trt 8. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6" weeds/ fb RWM + dicamba 0.5 lbs ae/A 3 WAT.
Trt 9. RWM + dicamba 0.5 lbs ae/A Pre/ fb RWM on 6" weeds/ fb RWM + dicamba 1.5 lbs ae/A 3 WAT.

Trt 10. RWM + sulfentrazone 0.25 lbs ai/A + cloransulam 0.25 oz ai/A Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6” weeds/ fb RWM 3 WAT.
Trt 11. RWM + imazaquin 0.125 lbs /A Pre/ fb chlorimuron + thifensulfuron 1 oz/A 6” weeds.
Trt 12. RWM + cloransulam 0.25 oz ai/A Pre/ fb RWM + imazamox 4 oz/A 6” weeds.
Trt 13. RWM + flumioazin 0.25 lbs ai/A Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6” weeds.
Trt 14. RWM + flumioazin 0.25 lbs ai/A + cloransulam 0.25 oz ai/A Pre/ fb RWM + dicamba 0.5 lbs ae/A on 6” weeds.

Results and Discussion

The horseweed at the Union City location showed about 50% control with glyphosate and is a typical biotype for Tennessee with respect to glyphosate tolerance. Treatments where glyphosate was applied Pre and then followed with glyphosate + dicamba applications on 6” weeds showed consistently poor horseweed control (60 to 80%). Treatments where glyphosate + dicamba was applied Pre followed by glyphosate or a sequential glyphosate + dicamba application on 6” weeds provided the best horseweed control (>96%). Across all of the treatments in both years of the study the soybeans showed no leaf cupping or epinasty typical of dicamba injury to soybeans. The Pre application of glyphosate + dicamba provided better horseweed control than a common farmer standard of glyphosate + FirstRate. The data from this study would suggest that GR horseweeds can be successfully controlled in a system where dicamba can be sprayed up to 0.5 lbs ae/A either pre emergence or over the top of soybeans. These data also point out that once horseweed is stressed with a glyphosate alone application follow up dicamba applications are not as effective. It also showed that the dicamba tolerance in the trait provides soybeans excellent crop safety to dicamba. All treatments resulted in acceptable weed control by the end of the season. Yield did not differ in this study but some horseweeds persisted until R2 soybean growth stage in treatments where dicamba was not applied in initial applications. Yield reduction would likely result under heavy infestation levels for these treatments.

Heap, I. 2008. International Survey of Herbicide Resistant Weeds. Web page: http://www.weedscience.com. Accessed: November 1, 2087.

Main, C. L., L. E. Steckel**,** R. M. Hayes and T. C. Mueller. 2006. Biotic and abiotic factors influence horseweed emergence. Weed Sci. 54:1101-1105.

Steckel, L. E., C. C. Craig and R. M. Hayes. 2006. Glyphosate-resistant horseweed (*Conyza canadensis*) control with glufosinate prior to planting no-till cotton. Weed Technol. 20:1047-1051.

Heap, I. 2008. International Survey of Herbicide Resistant Weeds. Web page: http://www.weedscience.com. Accessed: November 1, 2007.

ROUNDUP READY SUGARBEET – BRINGING BIOTECH TRAITS TO SPECIALTY CROPS. Paulette E. Pierson, Technology Development Manager, Monsanto Company, St. Louis, MO 63167.

The launch of Roundup Ready sugarbeets was driven by the sugarbeet industry's desire for a better weed control option that would help them to remain competitive. Herbicides traditionally used for sugarbeets have not consistently provided growers with satisfactory levels of weed control and crop safety. Herbicides often had to be supplemented with mechanical weed control, including cultivation and arduous hand weeding. Roundup Ready sugarbeets created an opportunity to introduce a new in-crop herbicide mode of action into the production system.

An effective partnership among the sugarbeet industry the biotechnology industry and growers resulted in the successful launch of Roundup Ready sugarbeets. The launch was led by the seed companies, processers and by growers. Monsanto provided the Roundup Ready trait, supported the use of Roundup agricultural herbicides and led product stewardship efforts. KWS developed the transgenic event, H7-1. All sugarbeet seed companies are using this same event in the development of Roundup Ready sugarbeet hybrids and the seed companies lead the marketing efforts.

A key component in the successful product launch was the formation of the Sugar Industry Biotech Council (SIBC). The SIBC is a collaborative group representing U.S. and Canadian sugarbeet and U.S. sugarcane growers and processors, the sugar industry, technology companies and seed companies. The Council plans its work jointly and all council members have specific responsibilities. The SIBC developed a biotech acceptance platform and a communication framework for the sugar industry. Although the first product is Roundup Ready sugarbeets, other products for both sugarbeets and sugarcane are anticipated in the future.

The multilateral and multidisciplinary scope of the SIBC enabled the organization to anticipate potential concerns and effectively address them. The council was able to respond to challenges that have confronted other biotech food crops and maintain acceptance and active support throughout the sugar supply chain. The unique understanding and support built through the SIBC accelerated delivery of Roundup Ready sugarbeets' benefits to all parties, helped sustain an important crop and built a continuing platform for future collaborative efforts.

The international sugar industry is now looking to SIBC leadership to share the council's success as a model for supporting the acceptance of biotechnology in Australia, South Africa and Brazil, as well as for restarting the process in Europe. The collaborative model can also be applied to other crops and other world areas.

ROUNDUP READY SUGARBEET: AN INDUSTRY CHANGING TRAIT. Christy L. Sprague, Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

The 2008 growing season marked the initial wide-scale launch of the first ever biotechnology trait in sugarbeet. Roundup Ready (glyphosate-resistant) sugarbeet first developed in the late-1990s has had a slow start to the market. However, now that Roundup Ready sugarbeets are commercially accepted the adoption rate of this technology could surpass all other biotechnology crops. It is estimated that there will be over 90% adoption of this technology in the second year of its commercialization. This technology will lead to wide-spread changes in how growers manage weeds in sugarbeets. Conventional weed management programs commonly consisted of mixing four or five herbicide active ingredients and were applied anywhere from two- to five-times on weeds less than 1-cm tall. Sugarbeet injury and inconsistent weed control were common with many of these programs. When these herbicide programs did not work cultivation and hand-weeding were often used to supplement weed control. The commercialization of Roundup Ready sugarbeet provides growers with an alternative weed management program that is safer to the crop, more consistent, and is truly more flexible in application timings. Glyphosate applications in Roundup Ready sugarbeets should start when weeds are 5-cm in height and subsequent applications are usually when weeds are 10-cm tall. Changes in the intensity of weed control can also lead to major changes in production practices. If cultivation is no longer needed, sugarbeets may be planted in narrower row widths. Because glyphosate is effective on a number of plants including perennials and cover crops there may also be opportunities to plant sugarbeets no-till or in systems that utilize cover crops. Sugarbeets are also intensively managed for diseases and the flexibility in glyphosate application timing may also allow for the use of tank-mixtures with fungicides ultimately saving in trips across the field. However, as with most benefits there are also potential disadvantages to the wide-spread adoption of the technology. Because glyphosate is the main component of the weed control program in Roundup Ready sugarbeet, many of the conventional herbicides currently used for sugarbeet weed control are being discontinued. This leaves sugarbeet growers very few alternatives when glyphosate-resistant weeds develop. This trait is extremely important to sugarbeet growers and needs to be managed to make it sustainable in the future.

THE FATE OF GIANT RAGWEED (*AMBROSIA TRIFIDA L.)* SEED IN NATURAL AND ARTIFICIAL SOIL SEED BANKS. Xianhui Fu, Joanne Chee-Sanford, Martin M. Williams II and Adam S. Davis, Ph.D student, Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL 61801, Environmental Microbiologist, United States Department of Agriculture-Agricultural Research Service, Affiliate, Department of Natural Resources and Environmental Sciences, University of Illinois, Affiliate, Department of Crop Sciences, University of Illinois, Urbana, IL 61801, Ecologist, United States Department of Agriculture-Agricultural Research Service, Assistant Professor, Department of Crop Sciences, University of Illinois, Adjunct Professor, Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL 61801, and Ecologist, United States Department of Agriculture-Agricultural Research Service, Assistant Professor, Crop Sciences, University of Illinois, Faculty member, Program in Ecology and Evolutionary Biology, University of Illinois, Affiliate, Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL61801.

The dominant use of herbicides in agricultural weed control strategies has raised issues concerning development of resistance or tolerance to herbicides by weeds, residual carry-over, and environmental contamination. The primary focus is to control emergent plants, with far less emphasis on controlling underground seed reserves, or weed seed banks, which are the greatest source of annual weed infestation in the crop systems. Seeds of many annual weed species are resilient and highly adaptive, and their abundance and persistence in soil makes weed control a continuing challenge. Knowledge of mechanisms affecting the fate of weed seeds in soil is critical for development of long-term and sustainable weed management strategies. To investigate the fate of weed seeds in soil, we conducted a study at the Northern Agronomy Research Center at Dekalb, IL, at a field site with an extensive seed bank of an annual weed species, giant ragweed (*Ambrosia trifida* L.). *In situ* assessments of seed fate, along with seed bank dynamics, were examined in both natural and artificial seed banks from Nov. 2005 to Nov. 2006. The natural seed bank was examined using soil cores removed from the study site containing the natural dispersed seeds, while the artificial seed bank was comprised of mesh bags containing defined numbers of seed and soil from the study site. Experimental variables included burial depth, seed density, and time. Germination, predation, and microbial-mediated seed decay accounted for the majority fate of giant ragweed seed in the natural seed bank, while germination and microbial-mediated seed decay accounted for most of the seed depletion in the artificial seed bank. The seed density of the natural soil seed bank changed over soil depth and time with the highest density of 732 seeds/ m^2 in the depth of 0-3 cm in Mar. 2006, and the lowest density of 0 seed/m^2 at a depth of 12-15 cm in Nov. 2006. Microbial-mediated decayed seeds accounted for most of the seed depletion in later seasons of 2006. The results from the artificial soil seed bank showed that giant ragweed seeds began to deplete after 1 month following initial burial, and the proportion lost to germination or decay significantly increased over time with the highest depletion ratio as high as 97% by Nov. 2006. Following 2 to 4 months of burial, germination was the major mechanism contributing to seed depletion, with the onset of decay becoming major mechanism of seed depletion after 7 to 12 months of burial. Few intact and viable seed remained by the end of the year study. During the one year time period, the effects of burial depth and seed density on both germination and seed decay were not significant ($P > 0.05$). The outcome of the study supported the hypothesis that microbial-mediated seed decay was a major mechanism of seed bank depletion, and provided the basis for a follow-up study that is currently ongoing to closely examine the microbial populations involved in seed decay processes. This research increases our understanding of the fate of weed seeds in soil and provides useful information for development of future weed management strategies.

2008 North Central Weed Science Society Proc. 63:96.

MOLECULAR BASED IDENTIFICATION AND PHYLOGENY OF THE *CHENOPODIUM* COMPLEX WITHIN THE NORTH CENTRAL STATES. Sukhvinder Singh and Patrick J. Tranel, Graduate Research Assistant and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL.

The genus *Chenopodium* is a complex group as it includes several species which have considerable genetic and morphological variation, sometimes even within species as is the case with *Chenopodium album*, known as common lambsquarters. Several species of *Chenopodium* resemble each other e.g., *C. album*, *C. berlandieri* and *C. strictum*, due to similar morphology. Recently, it was reported that common lambsquarters, becoming more difficult to control with glyphosate. To plan a proper weed control strategy, we need to correctly identify the weed species. This study was initiated to identify the prevalent *Chenopodium* species that are found in the North Central States. To investigate this, a molecular based phylogeny was developed from twelve *Chenopodium* species prevalent in North Central states using the sequence from the internal transcribed spacer (ITS) region. Using the ITS based key, we studied the diversity of *Chenopodium* species in five different North Central states. Preliminary studies from ITS sequence from these samples showed that there is no variability in these samples and they all fall in the same cluster with *Chenopodium album*. ITS sequence data also indicated that there was no difference in molecular phylogeny between the most and the least glyphosate sensitive populations. Further, we found variability in response to glyphosate among the different *Chenopodium* species and also among different populations within the states. Some species, such as *C. ficifolium* and *C. berlandieri*, have higher tolerance to glyphosate than *C. album*. Despite the fact that there is variability in response to glyphosate among populations from different states, this variability cannot be attributed to variable response among the *Chenopodium* species. In other words increased glyphosate tolerance is occurring due to evolution of *C. album* rather than a species shift.

CROP ROTATION AND HERBICIDE USE INFLUENCE POPULATION DYNAMICS OF GLYPHOSATE-RESISTANT HORSEWEED (*CONYZA CANADENSIS*) IN NO-TILL CROP MANAGEMENT SYSTEMS. Vince M. Davis*, Kevin D. Gibson, and William G. Johnson, Graduate Research Assistant, Associate Professor, and Associate Professor. Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

Horseweed, *Conyza canadensis*, is an increasingly common and problematic weed in no-till soybean production in the eastern cornbelt due to the frequent occurrence of biotypes resistant to glyphosate. The objective of this study was to determine the influence of crop rotation, winter wheat cover crops (WWCC), residual non-glyphosate herbicides, and preplant application timing on the population dynamics of glyphosate resistant (GR) horseweed. A field study was conducted from 2003 to 2007 in a no-till field located in southeastern Indiana where spring emerging glyphosate-resistant biotypes are a common occurrence in no-till fields. The experiment was a split-plot design with crop rotation (soybean-corn or soybean-soybean) as main plots and management systems as subplots. Management systems were evaluated by quantifying in-field horseweed plant density, and seedbank density. The soybean-corn rotation reduced horseweed densities more than soybean-soybean rotation in the third and fourth years of the study. Spring preplant application timings consistently provided better horseweed control than fall application timings, and residual preplant herbicides demonstrated better control than glyphosate applied alone. Management systems also influenced the population structure (the ratio of GR and GS biotypes) after four years of management. The most dramatic shift was from the initial GR:GS ratio of 3:1 to a ratio of 1:6 after four years of residual preplant herbicide use followed by non-glyphosate postemergence herbicides. However, spring applied residual preplant herbicides followed by postemergence glyphosate reduced horseweed densities while providing equal or better crop yields compared to all other herbicide systems. Soybean producers with infestations of spring emerging GR horseweed populations should apply herbicides in the spring and diversify their weed management systems by rotating herbicide mode-of-actions and crops. Rotating herbicides had the quickest reduction in GR horseweed densities and were observed in the first year of the study while crop rotation provided a horseweed density reduction after the third and fourth years.

WEED COMMUNITY CHARACTERISTICS OF CORN AND SOYBEAN FIELDS MANAGED POSTEMERGENCE IN WISCONSIN. Nathanael D. Fickett, Chris M. Boerboom, and Clarissa M. Hammond, Graduate Student and Professor, University of Wisconsin, Madison, WI 53706, and Weed Scientist, Department of Agriculture, Trade, and Consumer Protection, Madison, WI 53718**.**

Knowledge of weed species, height, density, and duration in a field is necessary to determine the severity of early-season weed-crop competition. To assess the potential yield loss due to weed competition in Wisconsin corn and soybean fields that are managed with postemergence herbicide programs, the weed communities must first be characterized. In 2008, weed populations were surveyed in corn fields of 10 counties, and in soybean fields of eight counties. Approximately five fields per county that were at least 3 miles apart were randomly selected to be surveyed. A total of 48 fields of corn and 30 fields of soybean were surveyed. For each field, a surveyor walked a horseshoe pattern through the field starting and ending at the field's edge. Heights and densities of predominant weed species were estimated in 10 1-m^2 quadrats per field spaced at intervals of 30 paces. The surveys were repeated every 3 to 4 days until the fields were treated with a postemergence herbicide, which marked the end of early-season weed competition. On average, 7.7 ± 3.5 weed species were observed in the corn fields, and 7.6 ± 2.6 weed species were observed in the soybean fields. When the corn fields were treated postemergence, the weed population had a mean height of 15 ± 0.9 cm and a mean estimated density of 19 ± 3.0 plants m^{-2} with a range of 8 ± 1.2 to 28 ± 4.7 plants m^{-2}. When the soybean fields were treated postemergence, the weed population had a mean height of 30 ± 2.8 cm and a mean density of 25 ± 8.9 plants m^{-2} with a range of 10 ± 5.2 to 28 ± 12.8 plants m^{-2}. Corn fields were, on average, treated postemergence at the V5 growth stage on June 18 and soybean fields were, on average, treated at the V4 growth stage on July 7. The dominant weeds species in both crops were common lambsquarters, annual grasses (not identified to species), velvetleaf, dandelion, and common ragweed. In corn fields, they were present in 96, 94, 94, 58, and 50% of the fields, respectively. When the corn fields were treated, these weeds had mean heights of 13 ± 0.8, 18 ± 1.0, 10 ± 0.6, 15 ± 1.2, and 15 ± 1.1 cm, respectively, and mean density ranges of 13 ± 3.9 to 42 ± 12.0, 27 ± 8.1 to 91 ± 23.0, 3 ± 0.7 to 10 ± 2.0, 2 ± 0.5 to 5 ± 1.5, and 3 ± 0.9 to 9 ± 2.4 plants m^{-2} among the fields, respectively. In soybean fields, common lambsquarters, annual grasses, velvetleaf, dandelion, and common ragweed were present in 97, 97, 70, 67, and 63% of the fields, respectively. At the time of treatment, these weeds had mean heights of 25 ± 2.8, 36 ± 2.7, 23 ± 2.9, 15 ± 1.2, and 15 ± 4.6 cm, respectively, and mean density ranges of 6 ± 1.9 to 18 ± 6.0, 46 ± 16.0 to 119 ± 39.0, 5 ± 1.6 to 18 ± 5.1, 3 ± 2.6 to 14 ± 10.5, and 3 ± 1.7 to 7 ± 4.5 plants m^{-2} among the fields, respectively. Based on the data from this survey, the timing of postemergence herbicide treatment may exceed the critical time of weed removal in a moderate percentage of corn and soybean fields in Wisconsin. Thus, crop yield loss may be occurring from early-season weed competition. This data, in combination with a bioeconomic model, will be used to predict the potential yield loss from weed competition in corn and soybean grown in Wisconsin.

CORN-VELVETLEAF INTERFERENCE UNDER VARIABLE WATER SUPPLY. Logan G. Vaughn, John L. Lindquist, Mark L. Bernards and Timothy J. Arkebauer, Graduate Research Assistant, Associate Professor, Assistant Professor, and Professor, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583.

Rainfall during the corn growing season is highly variable throughout Nebraska and the north central USA and greatly impacts all aspects of agroecosystems and their management. Better understanding of the growth response and competitiveness of crop and weed species to varying water supply can improve both crop and weed management decisions. Field experiments were conducted at Clay Center, NE to determine the effects of variable water supply on corn and velvetleaf interference. Corn planted at 7.6 and 7.3 plants m^{-2}, in 2007 and 2008, respectively, was grown in monoculture and in mixture with velvetleaf at densities of 2, 6, and 12 plants m^{-1} row. A linear move irrigation system was used to maintain water treatments at 0, 25, 50, and 100% full replacement of evapotranspiration. Volumetric water content was measured in selected treatments within the top 20 and 50 cm of soil using time-domain reflectometry (TDR) in 2007 and a TH_2O probe in 2008. Weed-free corn yield was greatest (12.7 Mg ha^{-1}) in the 50% irrigation treatment in 2007 and did not vary among the other three irrigation treatments (11.4 Mg ha^{-1}). Corn yield loss increased with velvetleaf density in all treatments. Yield loss was greatest in the 25% treatment followed by the 50%, 0% and 100% treatments Volumetric soil water content was greatest in the 100% irrigation treatment throughout the season. A substantial drought period occurred between 30 and 50 DAE, during which the 25 and 50% irrigation treatments had the smallest volumetric water content. Yield loss increased linearly with increasing velvetleaf leaf area index (LAI) within an irrigation treatment, but the intercept of this relationship varied among irrigation treatments, indicating that plant size was not the main contributor to the amount of yield loss observed between water treatments. Difference between corn and velvetleaf height was greatest in the 100% irrigation treatment, reducing the competitive ability of velvetleaf and thereby yield loss in this treatment. In 2008, weed-free corn yield was greatest (14.2 Mg ha^{-1}) in the 50% irrigation treatment and did not differ among the other three irrigation treatments (13.3 Mg ha^{-1}). Wet and cool early season temperatures contributed to a delay in velvetleaf emergence resulting in reduced growth and competitive ability throughout the season in 2008. Corn yield loss increased with velvetleaf density only in the 0 and 100% irrigation treatments. Corn yield loss was greatest in the 0% irrigation treatment followed by the 100, 50, and 25% treatments. Volumetric soil water content was similar among treatments throughout the vegetative growth stage of corn but was smaller in the 0% irrigation treatment from anthesis until physiological maturity. This presumably resulted in water stress during grain fill and a higher yield loss in this treatment. Corn yield loss increased as velvetleaf LAI increased in all treatments. Difference between corn and velvetleaf height was smallest in the 0% treatment, resulting in increased competition between these species and subsequently smaller soil water content in these treatments. This study has shown that velvetleaf has an even greater impact on corn yield under conditions of limited water supply. Therefore, our results suggest that crop tolerance to velvetleaf interference is greatest when there is sufficient soil water available to supply the full water demand of the corn crop.

RELATIVE FITNESS OF SHATTERCANE, SORGHUM, AND THEIR HYBRIDS. Lilyrani Sahoo, Jared J. Schmidt, John L. Lindquist, Don J. Lee and J. F. Pedersen, Graduate Research Assistant, Graduate Research Assistant, Associate professor, Professor, Department of Agronomy and Horiculture, University of Nebraska, Lincoln NE 68583, Adjunct Professor, USDA-ARS, University of Nebraska, Lincoln NE 68583.

Grain sorghum (*Sorghum bicolor ssp. bicolor*) can interbreed with its closest weedy relative, shattercane (*Sorghum bicolor L. Moench ssp. drummondii*).This hybridization can contribute to changes in fitness and the potential invasiveness of shattercane. Traits contributing to shattercane fitness include seed dormancy and germinability, vegetative growth and competitive ability, and fecundity. Understanding the fitness of shattercane x sorghum hybrids is particularly important because if alleles from the crop can become introgressed into the weed population, then a transgene and its associated trait introduced in a crop also may become introgressed into the weed population. The object of this research was to assess the fitness of shattercane x sorghum hybrids relative to their parents.

Four genetic lines were evaluated in this research. The commercial inbred sorghum line RTx430 was used as the male parent (SO) and an inbred shattercane line with A3 male sterility was used as the female parent (SHA3). Their progeny were the F1 hybrid (F1). The inbred wild-type shattercane (SH) used to produce the A3 male sterile shattercane was included as the fertile shattercane parent. Several fitness characteristics were measured including: germination, early emergence and seedling survival, phenological development, plant height, tiller number and height, leaf area, above ground biomass and seed production. Shattercane seeds in a natural state are potentially dormant. Our first experiment was conducted to compare the dormancy and germinability of the four lines at various temperatures in germination chambers. Temperature treatments included four constant temperatures (20, 25, 30, and 35 C) and three variable temperatures: standard germination test for sorghum (varying from 20-30 C over the course of a day, used as control), cold germination (prechill at 10 C for 5 d followed by standard germination), and accelerated aging germination (accelerated aging at 43 C for 3 d at high humidity followed by standard germination). A second experiment was conducted at Lincoln and Mead, Nebraska to compare fitness characteristics of the four lines in two field environments. Fifty seeds of each line were sown in a uniform spacing by hand to a depth of 2 cm in a single 3 m long row. Four adjacent rows, one for each line, were spaced 0.76 m apart to make up a complete block. There were four replicate blocks at each location. Emergence and mortality were measured every other day or as required for the first twenty days. Five plants were randomly selected and permanently marked within the first week of emergence and plant height, growth stage, tiller height and number of tillers was measured on a weekly basis throughout the growing season. Total plant biomass and leaf area were measured by clipping five plants per experimental unit at the soil surface at panicle emergence. Panicles of five plants were bagged after pollination and tied to a stake to ensure no loss of seed and panicles were harvested when seeds were fully mature. Seeds of each panicle were threshed by hand and seed number and 100 seed weight and were determined. Results were analyzed using ANOVA and nonlinear regression analysis. Where possible, results from the shattercane lines were pooled.

The germination chamber experiments showed that shattercane and the F1 hybrids were partially dormant 20 C and some sorghum seeds died. Both sorghum and the F1 hybrids were more sensitive to the high temperatures of the accelerated aging treatment than shattercane. However, the accelerated aging treatment increased the rate of shattercane and the F1 hybrid germination (to 1.9 d) more than sorghum (2.4 d) indicating that the germination patterns of F1 hybrids were more like shattercane, but the sensitivity to environmental conditions were more like sorghum. In the field experiments, the F1 hybrids were taller and produced more total aboveground biomass compared to either parent, but the

F1 leaf area index (LAI) was intermediate between sorghum and shattercane. The greater height and LAI of the F1 hybrids compared to the shattercane imply that the hybrid may be more competitive than shattercane. The weight of 100 seeds was greatest for sorghum, intermediate for the F1 hybrid and smallest for shattercane. Seed production per panicle was similar for the F1 hybrid and shattercane and smaller for sorghum. These combined results indicate that the fitness of F1 hybrids would be relatively greater than its wild shattercane parent. Therefore, traits introduced into a crop are likely to be successfully introgressed into the shattercane population unless they have a specific deleterious effect on the fitness of the shattercane plant.

RESPONSE OF ANNUAL WEEDS AND SELECT TURFGRASSES TO YELLOW MUSTARD SEED MEAL. Daniel T. Earlywine, Reid J. Smeda, Travis C. Teuton and Carl E. Sams, Graduate Research Assistant, Associate Professor, Former Assistant Professor, Division of Plant Sciences University of Missouri, Columbia, MO 65211 and Professor, Department of Plant Sciences University of Tennessee, Knoxville, TN 37996-4561.

Soil fumigants control many soil-borne pests, and professionals in the turfgrass industry often use soil fumigants prior to turfgrass establishment or replacement of existing turf. Yellow mustard (*Sinapis alba* L.) seed meal (MSM) is an organic fumigant that controls many weeds in cropping systems, but few studies have been conducted in turfgrass. Field experiments were conducted at the University of Missouri during 2007 and 2008 to evaluate the response of annual weeds and select turfgrasses to MSM. Treatments consisted of soil applied MSM at 1120, 1680, 2240, 2800, and 3360 kg/ha and sealed with polyethylene plastic sheets (tarped) for 7 days or left uncovered (untarped). All treatments were compared to dazomet at 390 kg/ha with plant densities, heights, and biomass recorded to elucidate effects. Annual bluegrass (*Poa annua*), tall fescue (*Lolium arundinacea*), perennial ryegrass (*Lolium perenne*), common bermudagrass (*Cynodon dactylon* L.) large crabgrass (*Digitaria sanguinalis*), buckhorn plantain (*Plantago major*), and white clover (*Trifolium repens*) were established in treated areas.

In general, deleterious affects on the weeds in this study (annual bluegrass, large crabgrass, buckhorn plantain, and white clover) were noted in 2007 and 2008. For large crabgrass and buckhorn plantain, plant densities in 2007 and 2008 were reduced 10 to 75% and 17 to 69 % respectively, although height and biomass of emerged plants was not impacted. For white clover in 2008, plant density and biomass were reduced 67 and 66%, respectively for the high rates of MSM compared to the untreated control. Annual bluegrass was most sensitive to MSM residues, with plant density and biomass reduced up to 73 and 48% in 2007 and 2008, respectively. MSM residues at the rates used in this study had no negative impact on tall fescue, perennial ryegrass, and bermudagrass. Rather, available nitrogen from MSM residues often increased plant biomass as rates increased. During both years, dazomet resulted in complete suppression of all species tested, except large crabgrass at 75% compared the untreated control during 2007. For both years, the process of tarping improved weed suppression up to 70% over untarped treatments, except annual bluegrass where no differences among tarping for 2008 were evident. Collectively, results indicate MSM selectively suppresses the emergence of several problem weeds in common turfgrass species.

SIMULATING WEED EMERGENCE UNDER DIFFERENT CROP CANOPIES. Rutendo P. Nyamusamba*, Michael J. Moechnig, Darrell L. Deneke, Graduate Research Assistant, Assistant Professor, Integrated Pest Management Coordinator, Plant Science Department, South Dakota State University, Brookings, SD 57006

Growth chamber and field studies were established to calibrate and validate models to predict emergence of green foxtail (*Setaria viridis*), redroot pigweed (*Amaranthus retroflexus*), and common lambsquarters (*Chenopodium album*) in corn, soybeans, spring wheat, field peas, alfalfa, and fallow. The objectives of this research were to determine if weed emergence rates differed under different crop canopies and, if so, modify hydrothermal-based coefficients to account for crop canopy effects.

To quantify the effects of crop canopies on weed emergence, crop species treatments (corn, soybeans, spring wheat, field peas, alfalfa, and fallow) were arranged in a RCB design with four replications. Plots were 6 m wide and 15 m long. All plots were tilled and planted on May 9, 2007 and May 5, 2008 using local standard agronomic practices for each crop species. In each plot, three 30 cm by 30 cm subplots were permanently marked in which emerged weeds were counted twice a week for the first month and weekly thereafter until August in each year. Emerged green foxtail, redroot pigweed, and common lambsquarters seedlings were removed by hand after each counting. Crop leaf area growth was estimated from weekly measurements of total leaf area (using a LI-COR 3100 area meter) from three randomly selected crop plants from each plot. In each plot, daily soil moisture and temperature were measured approximately 2.5 cm below the soil surface using a gypsum block moisture sensor and thermocouple attached to a data logger In each year, the time required for each weed species to reach 50 or 90% emergence was similar ($P > 0.05$) among crop species. However, leaf area index differed ($P < 0.05$) among crops at 38 days after tillage in each year, which was approximately the time to 90% weed emergence. These results indicated that crop canopies did not affect weed emergence rates. Consequently, it was not necessary to modify our hydrothermal-based models to simulate weed emergence under different crop canopies.

Coefficients for hydrothermal-based weed emergence models were determined from growth chamber experiments where weeds emerged in different soil moisture and temperature environments. Four pots filled with field soil were placed in a growth chamber set at day/night temperatures of 30/20, 20/15, or 15/10ºC. For each day/night temperature, different moisture environments were created by watering the pots daily or every two, four or six days. In each pot, daily soil moisture and temperature were measured approximately 2.5 cm below the soil surface using a gypsum block moisture sensor and thermocouple attached to a data logger. Emerged green foxtail, redroot pigweed, and common lambsquarters were counted and removed daily. Iteration methods were used to identify the base temperature and moisture values that minimized the root mean square error (RMSE) associated with empirical functions of weed emergence among the different temperature and moisture environments. The estimated base temperature (ºC)/moisture (g water/g wet soil) values were 0/0.0001, 0/0.03 and 9/0 for green foxtail, redroot pigweed, and common lambsquarters, respectively.

Hydrothermal coefficients determined from the growth chamber experiments were validated using observed weed emergence values in each crop from the 2007 and 2008 field studies. Among the six crop environments, the RMSE ranged from 0.11 – 0.15, 0.11 – 0.16, and 0.21 – 0.29 for green foxtail, redroot pigweed, and common lambsquarters, respectively in 2007 and ranged from 0.12 – 0.18, 0.20 – 0.27, and 0.06 – 0.17, respectively in 2008. These results indicated that the hydrothermal coefficients determined from the growth chamber experiments were adequate to predict weed emergence in several crop species.

CROPPING SYSTEM EFFECT ON THE GROWTH OF FOUR WEED SPECIES. Rachel B. Paskey and Robert G. Hartzler, Graduate Student and Professor, Department of Agronomy, Iowa State University, Ames, IA 50011.

Field experiments were conducted in central Iowa to determine the effects of two cropping systems on the growth of common waterhemp, common lambsquarters, giant ragweed, and velvetleaf. The cropping systems were a corn-soybean rotation relying on convention inputs and a low-external input system based on a corn-soybean-oat-alfalfa rotation. The cropping systems have been in place since 2002. Experiments were conducted during the soybean phase of the rotations. Between 2002 and 2007, soybean in the four-year rotation out yielded the soybean in the corn-soybean rotation in five out of six years. Our hypothesis was that small-seeded weeds would be affected more by changes in soil quality and crop growth between the two cropping systems than large-seeded weeds.

The first experiment evaluated emergence and survival of the four species under a common weed management program. Glyphosate was applied to all plots on June 30th, 2008 at a rate of 0.75 lbs ae/ac. The majority of giant ragweed and common lambsquarter emerged prior to soybean planting, whereas the greatest emergence of waterhemp and velvetleaf was between planting and the postemergence glyphosate application. No differences in emergence or survival were found between the rotations within weed species. A second study evaluated the growth of the four weed species in the absence of any control tactics. Seeds were planted immediately following planting and when soybean were at the V2 stage. While there was no difference in soybean yields in 2008 between the rotations, those in the two-year rotation were shorter than those in the long rotation. There were no differences in biomass of common waterhemp, common lambsquarters, and giant ragweed between the two rotations. Velvetleaf plants in the two-year rotation produced less biomass than those in the four-year rotation. Velvetleaf plants in the longer rotation were also taller than their counterparts in the short rotation. Results from the weeds planted at the soybean V2 stage did not show differences in growth between the two cropping systems.

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

Six winter annual weeds have been reported to be alternate hosts to soybean cyst nematode (*Heterodera glycines* Ichinohe; SCN). These winter annual weeds include purple deadnettle (*Lamium purpureum*), henbit (*Lamium amplexicaule*), field pennycress (*Thlaspi arvense*), shepherd's-purse (*Capsella bursa-pastoris*), small-flowered bittercress (*Cardamine parviflora*), and common chickweed (*Stellaria media*). One cool season perennial mouseear chickweed (*Cerastium vulgatum*) has also been reported as being an alternative host for SCN. In addition, we have shown that SCN can reproduce on purple deadnettle during the fall after soybeans have been harvested. The objective of this study was to determine if SCN population density and weed densities are influenced by winter annual weed management. Field trials were established in 2003 at the Southwest Purdue Agricultural Center (SWPAC) in Vincennes, IN and the Agronomy Center for Research and Education (ACRE) in West Lafayette, IN. This experiment had two crop rotations: soybean-corn and continuous soybean. Treatments for weed management included two cover crops which were winter wheat (*Triticum aestivum*) and fall-seeded annual ryegrass (*Lolium multiflorum*). Winter weed control treatments with glyphosate included an untreated control, fall and spring control, spring control, and fall control. After establishment, the treatments remained on the same plots throughout the entire experiment to determine long term treatment effects over time. Weed counts and soil samples for SCN egg enumeration were collected in the spring at planting and in the fall after harvest. Treatment effects on SCN population density were only significant at the ACRE location and had a three way interaction with weed management, rotation, and season. Treatment effects on SCN egg counts will be discussed. Herbicides were more effective than cover crops at reducing the amount of weeds in the spring weed counts.

TIME REQUIREMENT FROM POLLINATION TO SEED MATURITY IN WATERHEMP. Michael S. Bell and Patrick J. Tranel, Graduate Research Assistant and Associate Professor, Department of Crop Sciences, University of Illinois at Urbana-Champaign, Urbana, IL 61801.

Experiments were conducted to determine the viability of waterhemp seeds at different times after pollination. A waterhemp population designated as ACR was used due to its low level of seed dormancy. Plants were grown in 7.5 L pots in the greenhouse, and seven females were isolated from males as soon as they were identified as females. Females were grown in isolation until an adequate number of flower branches had developed, at which time five of the seven females were again placed with the males. Eight flowering males were used to pollinate five flowering females in the morning by shaking the males over the females. The females were left in close proximity to the males for 24 hours, at which time the females were pollinated once more and then were immediately removed and isolated from the males. Two branches, each containing at least 500 flowers, were harvested from each female at the time of the initial pollination, designated as 0 days after pollination (DAP), as well as at multiple other preselected times after pollination based on results of a preliminary experiment. One branch from each harvest was stored at 30° C for 48 hrs, while the other branch was stored at -20° C for 48 hrs. Branches were then stored at room temperature until all harvests were complete, at which time ~20 seeds from each branch at each time after pollination were collected and stratified. Germination tests were then conducted to determine at what time seeds become viable after pollination. Preliminary results indicate that seeds become viable between 9 and 12 DAP.

DEPTH AND TIME OF ASIATIC DAYFLOWER EMERGENCE IN CORN. José M. Gómez and Micheal D.K. Owen, Graduate Research Assistant and Professor, Department of Agronomy, Iowa State University, Ames, IA 50011.

Natural seed banks have been studied extensively by researchers to gain a better understanding of how and when weed seed germination and seedling emergence occurs in crop fields. Asiatic dayflower (*Commelina communis* L.) is a difficult weed to control with glyphosate, and has become an increasing problem in glyphosate resistant soybeans. Research concerning biological factors of Asiatic dayflower has been meager. The objective of this research was to study the time and depth of Asiatic dayflower emergence under field conditions. Two studies were conducted in corn fields near Vinton and Osceola, IA in the summer 2008. Both fields were cultivated after planting. Asiatic dayflower germination was recorded from mid-June to the first week of August. No subsequent germination was observed during mid-August and September. In Vinton, the germination depth ranged from 0 to 9 cm, while in Osceola germination depth ranged from 0 to 7 cm. The average depth of Asiatic dayflower emergence for Vinton and Osceola was 2.21 and 2.54 cm, respectively. Two morphological characteristics were observed and will be of interest in further research. First, the apocole (cotyledonary limb) of Asiatic dayflower, although not a unique feature for this weed, contributed to the successful emergence of the seedling from deeper depths. The apocole connects the seed with the seedling, nourishing the growing seedling. Second, Asiatic dayflower produced large and small seeds in different proportions. The proportion of small seeds per plant ranged between 80 to 91%, while large seeds ranged between 8 to 13%. It is then hypothesized that Asiatic dayflower seed size variation could explain the extended emergence pattern due to a difference in dormancy levels, but further research needs to be done.

INFLUENCE OF COVER CROPS ON GLYPHOSATE-RESISTANT SUGAR BEET. Molly M. Buckham, Christy L. Sprague, Erin C. Taylor, Gary E. Powell, Graduate Research Assistant, Associate Professor, Research Associate, Research Associate, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

Questions have been posed as to whether or not the recent commercialization of glyphosate-resistant sugar beet will allow for changes from current production practices. A field study was conducted in 2008 in Saginaw, Michigan to investigate the effects of cover crops and strip tillage on weed management, stand establishment, and crop yield in glyphosate-resistant sugar beet. The study was established as a strip-strip-strip plot. The main plot was cover crop, the sub-plot was tillage, and the sub-sub plot was glyphosate application timing. Cover crops included in this study were oilseed radish, oriental mustard, oats, winter wheat and no cover as a control. These crops were planted the previous fall and all winter killed except for wheat. Two weeks prior to planting, half of the plots were strip-tilled. Glyphosate at 0.84 kg ae/ha plus ammonium sulfate at 2% v/v was applied two weeks prior to planting in the winter wheat plots and applied at planting and two weeks after planting in all other plots. Weed populations were counted 14, 31, and 50 days after planting. Sugar beet stand was evaluated mid-season and at harvest and were harvested for yield. There was a significant interaction between cover crop and glyphosate application timing for sugar beet stand and yield. Data showed that cover crop treatments with the highest stand counts resulted in the highest yields. The highest yielding treatments were plots that were planted in the no cover crop control (66,620 to 70,816 kg/ha). The lowest yielding treatment was where wheat was controlled two weeks after planting (26,693 kg/ha). Tillage also had a significant effect on sugar beet yield. Average yields were significantly higher in the no-till system (56,237 kg/ha) compared with the strip-till system (51,543 kg/ha). Overall results showed that treatments with no cover crop and no tillage had significantly higher yields than strip-till or cover crop treatments.

WINTER WHEAT TOLERANCE TO BROADCAST FLAMING. Santiago M. Ulloa*, Avishek Datta, and Stevan Z. Knezevic. Graduate Student, Post Doctoral Fellow and Associate Professor. Haskell Agricultural Laboratory, University of Nebraska, Concord, NE, 68728-2828

Propane flaming could be included as an additional tool for weed control program in organic wheat productions. However, the crop tolerance to broadcast flaming must be determined first. Therefore, field experiment was conducted at the Haskell Agricultural Laboratory, Concord, NE in 2008 to determine winter wheat response to six propane rates applied at three growth stages of the crop, including: shoot elongation (SE), first node (FN), and boot stage (BS), which corresponded to the 4.0, 6.0, and 10.1 stages according to the *Feeks* scale of wheat growth and development. The propane rates included: 0, 12, 31, 49, 68, and 87 kg/ha (0, 2.5, 6.5, 10.5, 14.4, and 18.4 gal/acre). Flaming treatments were applied utilizing an ATV mounted flamer moving at a constant speed of 6.5 km/h (4 m/h). The response of wheat to propane flaming was evaluated in terms of visual injury at 7, 14, and 28 DAT, effects on yield components (spikes/m^2, seeds/spike, and 100-seed weight) and grain yield. Crop responses were described by log-logistic model. Overall response of wheat to propane flaming varied among growth stages and propane rates. In general, all three growth stages were sensitive to flaming and presented similar visual damage at 28 DAT. In particular, SE had the least yield loss and the least affected yield components compared to BS, which was the most susceptible stage to flaming resulting in highest yield loss, and largest loss of all yield components. Yield reduction is main concern with broadcasts flaming. Preliminary curve analysis suggested that arbitrarily acceptable yield reduction of about 5% (eg. threshold level) was achieved with the propane rate of about 5 kg/ha, regardless of the flaming stage. Based on our previous studies, propane rate of 60 kg/ha was needed for control most weed species, however such propane rate caused unacceptable yield losses of 25%, 32%, and 43% in this study for SE, FN, and BS, respectively. Therefore, due to unacceptable yield losses, we do not recommend the use of broadcast flaming in wheat at the above tested growth stages.

WEED CONTROL IN WIDE- AND NARROW-ROW GLYPHOSATE-RESISTANT SUGAR BEET.

Jon-Joseph Q. Armstrong and Christy L. Sprague, Graduate Research Assistant and Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

The recent commercialization of glyphosate-resistant sugar beet varieties provides growers with alternative weed management programs that will reduce the need for in-row cultivation. As a result, producers may be able to adopt planting sugar beets in narrower row widths. Field trials were conducted at three locations in 2007 and 2008 to evaluate the effect of row width on yield and weed management in glyphosate-resistant sugar beet. Three row widths, 38-, 51-, and 76-cm, were investigated at two locations and only 38- and 76-cm row widths were investigated at one location, due to equipment limitations. Populations were thinned to a uniform stand of 77,000 plants/ha in all row widths. Treatments included glyphosate applied at 0.84 kg ae/ha plus ammonium sulfate at 2% v/v when weeds averaged 5- and 10-cm in height with follow-up treatments when weeds were 10-cm in height, single glyphosate applications when weeds averaged 10- and 15-cm, conventional sugar beet herbicide programs of either a standard-split program applied twice or micro-rate program applied four times (desmedipham + phenmedipham plus clopyralid plus triflusulfuron-methyl), and weed-free and untreated control plots. Sugar beet root yields were highest in 38- and 51-cm rows at locations that compared the three row-widths and highest in 38-cm rows at the other location. When averaged over row widths, yields were lowest when glyphosate applications were delayed until weeds were 15-cm in height at all locations. Yields were also lowest in the conventional herbicide treatments at the location where only the 38- and 76-cm row widths were compared. In treatments which received only a single glyphosate application when weeds were 10-cm tall, subsequent weed biomass accumulation was reduced by at least 70% in 38-cm rows and 65% in 51-cm rows compared with 76-cm rows. Results from this study indicate that planting glyphosate-resistant sugar beet in narrow rows may result in higher yields and the suppression of late-season weed growth.

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

Field experiments were conducted at the Kansas State University Agricultural Research Center near Hays, in 2007 and 2008 to assess the effects of single and sequential postemergent applications of tribenuron on broadleaf weed control and crop response in tribenuron-tolerant sunflower. Herbicide treatments included tribenuron at two rates (8.75 and 17.5 g ai/ha) applied 3 weeks after planting (WAP), tribenuron at the higher rate applied 4 WAP, and sequential applications of tribenuron at either of the two rates applied at both timings. Other treatments included imazamox at 35 g/ha applied 3 WAP, and weed-free and untreated controls. Tribenuron treatments were supplemented with one application of quizalofop (61 g/ha) to control grass weeds. Methylated seed oil (MSO) at 1 % v/v was added to all herbicide treatments. Weed species were Russian thistle, kochia, tumble pigweed, and puncturevine in 2007 and tumble pigweed, puncturevine, and redroot pigweed in 2008. The following results are based on visual ratings at 3 weeks after application (WAA) in 2007 and 4 WAA in 2008. Regardless of rate, tribenuron applied once at the earlier timing or applied sequentially provided >98% control of Russian thistle and >95% control of puncturevine in 2007, however, all tribenuron treatments provided >98% puncturevine control in 2008. Kochia and tumble pigweed in 2007 and redroot pigweed in 2008 required either sequential applications of tribenuron or the higher rate applied at the earlier timing to achieve >90% control, whereas none of the tribenuron treatments exceeded 85% control of tumble pigweed in 2008. Imazamox provided similar control of tumble pigweed and redroot pigweed compared to the higher tribenuron rate applied at the earlier timing or when tribenuron at either rate was applied sequentially. None of the tribenuron treatments caused significant crop injury. In comparison, imazamox caused considerable crop injury in both years and reduced seed yield substantially in 2008, but not in 2007. These results indicate that tribenuron at 17.5 g/ha applied early postemergence can provide satisfactory control of the evaluated broadleaf weed species without significant injury to tribenuron-tolerant sunflower.

WINTER WHEAT RESPONSE AND WEED CONTROL EFFICACY OF SAFLUFENACIL APPLIED WITH GROWTH REGULATOR HERBICIDES. John C. Frihauf, Phillip W. Stahlman, and Patrick W. Geier, Graduate Research Assistant, Kansas State University, Manhattan, KS 66502, Professor, and Assistant Scientist, respectively, Kansas State University Agricultural Research Center, Hays, KS 67601.

Saflufenacil is an experimental herbicide developed for burndown and preemergence (PRE) control of broadleaf weeds in small grains, soybeans, and various other crops. This herbicide inhibits protoporphyrinogen oxidase and may be a useful tool to control herbicide resistant weeds. However, the use of saflufenacil in winter wheat may be limited since many growers prefer to apply spring postemergence (POST) herbicides after wheat has broken dormancy. Field experiments were conducted at two locations during the 2007 to 2008 winter wheat growing season to determine winter wheat and weed response to POST-applied saflufenacil in combination with 2,4-D amine, 2,4-D ester, MCPA ester, dicamba, or bentazon. Saflufenacil was POST-applied at 13 or 25 g/ha alone or tank-mixed with 2,4-D amine, 2,4-D ester, MCPA ester, dicamba, or bentazon (533, 533, 520, 140, or 560 g/ha, respectively). Companion herbicides were also applied alone and COC was included at 1% v/v with all solo saflufenacil treatments and tank-mixes with bentazon. Treatments including saflufenacil provided greater than 90% control of blue mustard. Flixweed control with saflufenacil treatments was also excellent (≥ 95%) except when tank-mixed with bentazon (53%). Averaged over experiments, solo application of saflufenacil caused 21% necrosis, but saflufenacil in combination with MCPA ester or 2,4-D ester increased necrosis by 10% compared to saflufenacil applied alone at 3 or 4 DAT. Necrosis was minimal in the remaining treatments at both locations. Grain yields of all herbicide-treated wheat at both locations were higher than the untreated control. Grain yields were greatest for wheat receiving saflufenacil in the Hays experiment; whereas, grain yields in the Manhattan experiment were similar among most herbicide treatments. Generally, efficacy, necrosis, and yield data showed saflufenacil at 25 g/ha applied alone or tank-mixed with 2,4-D amine, 2,4-D ester, MCPA ester, dicamba, or bentazon was safe in winter wheat and provided excellent control of blue mustard. However, the addition of bentazon with saflufenacil reduced flixweed control to unacceptable levels.

EFFICACY OF POSTEMERGENCE HERBICIDE TANKMIXES IN ACETOLACTATE SYNTHASE RESISTANT GRAIN SORGHUM. D. Shane Hennigh, Kassim Al-Khatib, and Mitch Tuinstra, Graduate Research Assistant, Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506 and Professor, Department of Agronomy, Purdue University, West Lafayette, IN 47907.

Postemergence herbicide treatments to control grasses are limited in grain sorghum. Acetolactate synthase (ALS)-inhibiting herbicides are very effective in controlling many grass species in corn, however, uses of these ALS-inhibiting herbicides is not an option in conventional grain sorghum due to grain sorghum being highly susceptible to these herbicides. With the development of ALS-resistant grain sorghum, several postemergence ALS-inhibiting herbicides can be used to control weeds in grain sorghum. Field experiments were conducted near Manhattan, KS in 2007 and 2008 to evaluate the efficacy of nicosulfuron + rimsulfuron (26 + 13 g ha^{-1}) applied alone or in combination with, atrazine (1.2 L ha^{-1}), bromoxynil (1.2 L ha^{-1}), carfentrazone-ethyl (36.5 mL ha^{-1}), halosulfuron + dicamba (47 g + 0.3 mL ha^{-1}), prosulfuron (35 g ha^{-1}), 2,4-D (0.9 mL ha^{-1}), metsulfuron methyl + 2,4-D (7 g + 0.6 mL ha^{-1}), or a combination of these herbicides with atrazine on grass and broadleaf weeds. Herbicide treatments were applied when weeds were 7.5 to 15 cm in height in both years. Barnyardgrass, green foxtail, giant foxtail, velvetleaf, ivyleaf morningglory, common sunflower, overall grass, and overall broadleaf control was visually determined 2 and 4 weeks after treatment (WAT) based on a scale where 0% = no control, and 100% = complete control. There was no interaction between treatment and years so means were averaged over years. Percent control of barnyardgrass, green foxtail and giant foxtail was greater than 90% and 80% for all herbicide treatments 2 and 4 WAT respectively except for the treatment nicosulfuron + rimsulfuron + carfentrazone-ethyl + atrazine 4 WAT. Overall broadleaf control was greater than 80% for all treatments 2 and 4 WAT. Nicosulfuron + rimsulfuron + metsulfuron methyl + 2,4-D and Nicosulfuron + rimsulfuron + halosulfuron + dicamba both controlled greater than 94% of all grasses and broadleaf weeds 2 and 4 WAT. Overall control of grass and broadleaf weeds was greater when nicosulfuron + rimsulfuron was applied with various broadleaf herbicides as compared to when it was applied alone.

CONTRIBUTION OF THIENCARBAZONE-METHYL FOR GRASS WEED MANAGEMENT IN CORN. Dan K. Tiedemann, Bryan G. Young, Ronald F. Krausz, and Joseph L. Matthews, Graduate Research Assistant, Professor, and Researchers, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Thiencarbazone-methyl (TCM) is an ALS-inhibiting herbicide under development for foliar and residual control of grasses and broadleaves in corn. Currently, all commercial plans would use TCM in combination with other herbicides and TCM would not be available as a single active ingredient. However, a basic understanding of the efficacy that TCM provides in these herbicide combinations would be beneficial in efforts to optimize foliar adjuvant systems or as a foundation for building best management practices for herbicide-resistant weeds. Therefore, the objectives of this research were 1) to assess the grass efficacy from TCM and tembotrione independently and as a formulated premix of TCM:tembotrione and 2) to compare TCM with competitive standards for postemergence grass control including topramezone, nicosulfuron, and glyphosate.

A field experiment in field corn was conducted in 2008 at Southern Illinois University research farms in Carbondale, and Belleville IL. The experiment was a factorial of herbicide treatment and application timing arranged in randomized complete block with three replications. The herbicide treatments were TCM (15 g ai/ha), tembotrione (75 g ai/ha), the premix of TCM:tembotrione (15:75 g/ha), topramezone (17 g ai/ha), nicosulfuron (35 g ai/ha), and glyphosate (860 g ae/ha) applied at an early postemergence (EPOST), mid-postemergence (MPOST), and a late postemergence (LPOST) timing. The height of grass plants ranged from 0 to 7.5, 8 to 15 and 16 to 22.5 cm for the EPOST, MPOST, and LPOST timings respectively. Visual estimates of corn injury and weed control at various intervals after application were preformed along with weed plant densities.

All treatments containing TCM resulted in an initial corn response in the form of shortened internodes at 7 days after treatment (DAT). Corn injury was no longer visible by 14 DAT. Significant corn injury was not observed with any other herbicide at any application timing. The herbicide treatments of TCM, TCM:tembotrione, topramezone, and nicosulfuron resulted in the greatest control of fall panicum at 14 DAT when applied at the EPOST and MPOST timings (83% or greater) compared with the LPOST timing. Tembotrione applied alone provided the least overall control of fall panicum (40 to 55%) at 14 DAT compared with any other treatment. Glyphosate efficacy was similar across all three application timings for control of fall panicum (84 to 95%). Thiencarbazone applied alone resulted in 93, 83, 63% control of fall panicum at the EPOST, MPOST, and LPOST timings respectively. The combination of TCM:tembotrione was similar in activity on fall panicum to TCM alone at the EPOST and MPOST timing. At the LPOST the addition of tembotrione to TCM did increase control of fall panicum from 63 to 78% at 14 DAT compared to TCM applied alone. The treatment trends for control of fall panicum at 56 DAT was similar to 14 DAT.

A SURVEY OF WINTER ANNUAL WEEDS AND EARLY-SEASON PESTS IN MICHIGAN NO-TILL SOYBEAN. Kelly A. Barnett*, Christy L. Sprague, Christina D. DiFonzo, and Fred W. Warner, Graduate Student, Associate Professor, Department of Crop and Soil Sciences, Professor, Nematode Diagnostician, Department of Entomology, Michigan State University, East Lansing, MI 48824.

Winter annual weeds and early-season pests have become more prevalent in Michigan soybean fields due to the increase in reduced- and no-till systems. Control of winter annual weeds may be crucial to reducing early-season pests. In May 2008, a survey was conducted to determine what early-season pests of soybean may be associated with winter annual weeds present in no-till fields. Fifty-five fields were sampled in the main soybean producing regions of Michigan. Nineteen fields were sampled in the lower two tiers of counties (South), 17 fields were sampled in the next two tiers of counties (Central), and 19 fields were sampled in the next two tiers of counties (North). Fields sampled were selected based on the presence of no-till corn stubble and winter annual weeds. In each field, six soil core samples were taken with a 10-cm diameter golf-cup core cutter to a depth of 15-cm. Winter annual weeds were identified and root samples from each winter annual were analyzed for soybean cyst and lesion nematode using the root shake method. This method quantifies cyst nematodes in the J2 (juvenile) stage. Soil samples were analyzed for nematode communities and insects including grubs. Of the weeds sampled, 44% were common chickweed, 21% purple deadnettle, 12% shepherd's-purse, 7% field pennycress, 5% henbit, 3% purslane speedwell, 3% yellow rocket, 3% dandelion, 1% horseweed, and 1% annual bluegrass. Lesion nematodes with numbers ranging from 1 to 135 per 0.4g root tissue were found in forty-eight percent of the weeds sampled. Lesion nematodes had penetrated the roots of common chickweed, purple deadnettle, shepherd's-purse, henbit, field pennycress, purslane speedwell, dandelion, and yellow rocket. Only three root samples purple deadnettle (2 samples) and field pennycress had J2 cyst nematode present at low levels. From the soil samples only 4 fields sampled contain cyst nematode. European chafer, May/June beetle, Japanese beetle, and Asiatic garden beetle grubs were present in four percent of the samples.

MANAGEMENT OF GLYPHOSATE-RESISTANT GIANT RAGWEED IN SOYBEAN. Chad B. Brabham, Bill Johnson, and Mark Loux, Graduate Research Assistant and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Professor, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210.

Tank mixing glyphosate and fomesafen can be an effective means of controlling glyphosate-resistant giant ragweed. The objective of this research was to determine the effectiveness of various adjuvants on giant ragweed control with glyphosate plus fomesafen. The experimental design was a randomized complete block with a factorial arrangement of treatments which included glyphosate rates of 0 or 0.75 lbs ae/A, fomesafen rates 0, 0.176, or 0.353 lbs of ai/A, and three different adjuvants. The chemical formulation of glyphosate used was the Roundup PowerMAX ™ product. Adjuvant treatments were either no adjuvant, non-ionic surfactant (NIS) at 0.5% v/v, a crop oil concentrate/ NIS (COC/NIS) blend at 0.5% v/v, or dimethenamid at 0.47 lbs of ai/A. Giant ragweed density was 15 plants per square yard and 6 to 44 inches in height where the treatments were applied. The trial was visually rated at 14, 28, 42, and 84 days after treatment (DAT) and soybean yield was recorded. Fomesafen applied alone at 0.176 lbs/A or 0.353 lbs/A provided 50 and 68% control, respectively. Glyphosate alone controlled giant ragweed 90%. The addition of fomesafen or adjuvants did not improve giant ragweed control over glyphosate alone. In a glufosinate-resistant soybean study, sequential POST treatments of glufosinate provided better control than single treatments. The addition of fomesafen to glufosinate improved giant ragweed control over single applications of glufosinate.

MAXIMUM WEED CONTROL IN ONION USING FLUMIOXAZIN AND OXYFLOURFEN. Chad M. Herrmann, Bernard H. Zandstra, and Rodney V. Tocco, Graduate Research Assistant, Professor, and Research Assistant, Michigan State University, East Lansing, MI 48824.

The poor competitive ability of onion requires that season long weed control be practiced. Recently, herbicides have become available that appear to improve weed control while minimizing crop phytotoxicity. Experiments were conducted at the MSU Muck Research Farm in 2008 to assess usage patterns of several newly formulated and recently labeled onion herbicides. Plots were 25 feet long and contained three rows of onions. Cultivars planted were the yellow storage types ‘Sherman’, ‘Santana’, and ‘Festival’.

In one field trial, the experimental design consisted of a 3 X 5 factorial, in which flumioxazin was applied at 0.064, 0.032, or 0.0 lb/ac alone or tank mixed with maximum labeled rates of either pendimethalin (Prowl H2O or Prowl EC), *s*-metolachlor, or dimethenamid-P. Applications were made at the 2 leaf stage (LS) and again at the 4 LS. When flumioxazin was applied alone or tank mixed with Prowl H2O no significant injury or yield loss occurred in any of the cultivars, regardless of the rate of flumioxazin applied. In tank mixes with Prowl EC, *s*-metolachlor, or dimethenamid-P all cultivars suffered significant height reductions, delayed development, and yield loss. In another experiment assessing flumioxazin’s preemergence potential, flumioxazin was applied at 0.032 lb/ac and provided good preemergence control of several broadleaf species but did not provide preemergence control of yellow nutsedge or large crabgrass. Preemergence application of flumioxazin did not reduce stand count or yield.

In an experiment assessing the crop tolerance and efficacy of different formulations of oxyflourfen, oxyflourfen (Goaltender or Goal XL) was applied at 0.031, 0.063, 0.125, or 0.188 lb/ac to onions at the 1 LS. Identical applications were made again at the 2 LS and 3 LS. The 0.188 lb/ac application of Goal XL resulted in significant reductions in onion height, leaf number, and yield among all cultivars. Goal XL applied at the 1 LS produced visual injury symptoms in the Festival and Santana cultivars when applied at rates of .063 lb/Ac or greater. Goaltender applied at the 1 LS to the same cultivars did not produce significant injury unless applied at 0.188 lb/ac. Further testing will help refine usage patterns for flumioxazin, oxyflourfen, and other onion herbicides.

DOES ANYTHING KILL SCOURINGRUSH? CONTROL STRATEGIES TESTED IN NEBRASKA. Eric E. Frasure and Mark L. Bernards Graduate Research Assistant and Assistant Professor, Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE 68583.

Scouringrush (*Equestium hyemale L.*) patches are becoming more common in corn and soybean fields in southeastern Nebraska. Scouringrush grows naturally in moist areas along waterways and field edges and in the absence of tillage will spread into the drier soils of fields. Dense patches impede planting and reduce crop yield. Scouringrush is often misidentified as field horsetail. Although the two species look similar during early spring growth, they respond very differently to herbicide treatments. In addition, scouringrush is a larger plant, and is able to tolerate drier conditions than field horsetail. There is little information published on controlling scouringrush. The objective of this research was to identify effective strategies for controlling scouringrush. We conducted field studies that screened numerous herbicides and evaluated tillage and mowing treatments. Herbicides were applied using a backpack sprayer with a carrier volume of 187 L/ha and Turbo TeeJet 110015 nozzles. A roto-tiller was used for the tillage treatments and mower set at 10 cm used for the mowing treatments. Intense tillage repeated 3 times a year reduced biomass and stem counts over 80% compared to untreated controls. Three repeated mowing treatments reduced biomass but did not reduce stem counts. Of the herbicides evaluated, chlorsulfuron (158 g ai/ha) killed scouringrush and prevented the growth of new shoots for more than one year. MCPA (3100 g ae/ha) applied in the spring killed the shoots, but new shoots began to grow four months later. Sulfometuron (69 g ai/ha), imazapyr (2630 g ae/ha), triclopyr (1680 g ai/ha) and metsulfuron (84 g ai/ha) reduced stem counts and biomass but did not provide complete control. Dichlobenil (6700 g/ha), which must be incorporated by tillage, reduced biomass and stem counts over 90%. None of the herbicides that were effective at controlling scouringrush are labeled for use in corn and soybeans. Each may cause carryover issues for subsequent crops. Most of the herbicide that have been reported as being effective for controlling field horsetail had no visible effect on scouringrush. Correctly identifying the species (either scouringrush or field horsetail) is critical for planning appropriate control strategies. The most effective strategies for controlling or containing scouringrush are intensive tillage and/or chlorsulfuron application.

Examining Yellow Flash in Roundup Ready Soybean. Doug Sammons and Mientien Tran, Monsanto, St. Louis, MO 63167

The introduction of Roundup Ready soybeans in 1995 was soon followed by antidotal reports of “Yellowflash” occurring in glyphosate treated fields 4-10 days after treatment. The yellow chlorosis was always in the upper canopy and was usually noted at a pause of the spray boom or a spray boom overlap consistent with a double dose or more of glyphosate. Affected plants recovered in 10-20 days under good growing conditions with no yield loss. Reddy et al first (2004 Journal of Agricultural and Food Chemistry 52:5139-5143) reported that the chlorosis was due to glyphosate metabolism to aminomethylphosphonate (AMPA). Our studies on the yellowflash phenomena confirm that AMPA correlates to the appearance of chlorosis. No evidence of shikimate formation was found in any Roundup Ready plants treated with glyphosate or AMPA showing that inhibition of EPSPS was not occurring. Further, those tissues expressed CP4 EPSPS normally. We have correlated the oxidation of 14C-glyphosate to 14C-AMPA and the dose dependence to the intensity of chlorosis in glyphosate-resistant soybeans. The formation of AMPA is not light or metal ion dependent and so not a photochemical degradation of glyphosate in the upper canopy. The formation of AMPA is temperature dependent with a doubling of the rate between 25C and 35C. 14C-AMPA is phloem mobile like glyphosate and accumulates in the growing sink tissues like glyphosate. We investigated a number of possible nutrient associations and found no correlation to any nutrient metal ion or nitrogen deficiency. We found that plant growth was rarely affected although the normal greening of the leaf could be delayed, that is chlorophyll development was delayed but not leaf expansion. Yellowflash occurs faster in glyphosate-resistant soy expressing glyphosate oxidase when treated with glyphosate. Yellowflash intensity occurs as a function of AMPA dosage applied as a spray treatment on glyphosate-resistant soybeans but not in transgenic soy expressing an enzyme capable of N-acetylating AMPA. Our results support those of Reddy et al (2004) and correlate the appearance of yellowflash to the soybean oxidation of glyphosate to AMPA.

DOSE-RESPONSE OF 2,4-D AND GLYPHOSATE ON *ABUTILON THEOPHRASTI*, *IPOMOEA SPP*. AND C*HENOPODIUM ALBUM*. Andrew P. Robinson, Chad B. Brabham, and William G. Johnson. Graduate Student, Graduate Student, and Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907.

New trait technologies incorporating 2,4-D and glyphosate tolerance in soybean will enable farmers to apply POST tank mixed 2,4-D and glyphosate to control summer annual weeds. Our objective was to evaluate the response of *Abutilon theophrasti*, *Ipomoea spp*. and C*henopodium album* to various rates of 2,4-D (0, 70, 280, 560, 1120, 2240, 3360 g ae ha^{-1}) and glyphosate (0, 75, 210, 420, 840, 1680, and 3360 g ae ha^{-1}) in field. This paper will discuss GR_{90} as well as synergistic and antagonistic effects of tank mixed 2,4-D and glyphosate.

INVESTIGATION OF THE MOLECULAR BASIS OF RESISTANCE TO PPO-INHIBITING HERBICIDES IN COMMON RAGWEED. Stephanie L. Rousonelos, Ryan M. Lee, and Patrick J. Tranel, Graduate Research Assistant, Postdoctoral Research Assistant, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61820.

To date there are three weed species in the world that have evolved resistance to PPO-inhibitors: waterhemp, common ragweed, and wild poinsettia. Resistance to PPO-inhibiting herbicides in waterhemp was shown to result from a unique mechanism: a single codon deletion in *PPX2L*, which encodes both plastid- and mitochondrial-targeted PPO isoforms. It was originally understood that this species contained several *PPX* genes: *PPX1*, *PPX2S*, and *PPX2L*. The resistant biotype contained *PPX2L*, with the 3-bp deletion, but *PPX2S* was absent. Recently, it has been determined, after further testing, that there are likely only two *PPX* genes in waterhemp, *PPX1* and *PPX2L*.

The most recent weed species to develop resistance to PPO-inhibiting herbicides is common ragweed. Research was conducted to determine if the resistance mechanism in this species was similar to that identified in waterhemp. Sequences of *PPX1* and *PPX2* were obtained by screening a cDNA library of sensitive common ragweed. A resistant common ragweed biotype from Delaware was crossed to a sensitive biotype to create an F_1 population. The F_1 population was then selfed to create an F_2 population. A molecular marker was designed based on polymorphisms between the parental alleles of *PPX2* identified from the F_1 population. This marker was used for segregation analysis of *PPX2* in the F_2 population and was determined to co-segregate with resistance. Polymorphisms identified from the F_1 common ragweed sequence are being tested with site-directed mutagenesis of a vector containing *PPX2* from waterhemp. RACE amplification is being performed at the 5' end to obtain full-length clones of these target-site genes and to test if a long form of *PPX2* is present in common ragweed.

POTENTIAL INTERACTIONS OF SLOW ACTING AND FAST ACTING HERBICIDES. Rachel K. Bethke, Christy L. Sprague and Donald Penner, Department of Crop and Soil Sciences, Michigan State University, East Lansing MI 48824.

The stacking of genes to provide resistance to several herbicides previously injurious to a crop provides new opportunities for control of herbicide resistant weeds. Specifically the opportunity may exist to control glyphosate resistant weeds with glufosinate or an acetolactate synthase (ALS) inhibitor previously not advisable. Combining a fast acting herbicide with a slow acting herbicide has the potential for the occurrence of unexpected interactions. The objectives of this study were to evaluate combinations of glyphosate, glufosinate, chlorimuron and thifensulfuron-methyl on three annual weeds prevalent in Michigan, giant foxtail, common lambsquarters, velvetleaf and the perennial weed, Canada thistle, in greenhouse and field studies. In the field study combining chlorimuron or thifensulfuron-methyl with glyphosate did not affect glyphosate efficacy on velvetleaf, giant foxtail and common lambsquarters. Including glufosinate in the spray tank increased the efficacy on velvetleaf and common lambsquarters. In the greenhouse study, both antagonistic and synergistic interactions were observed depending on herbicides applied, the application rate and the species.

RESPONSE OF SELECTED INDIANA HORSEWEED (*CONYZA CANADENSIS*) POPULATIONS TO GLYPHOSATE AND CLORANSULAM. Greg R. Kruger, Vince M. Davis, William G. Johnson, and Stephen C. Weller, Graduate Research Assistant, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907.

Horseweed populations which are resistant to glyphosate and cloransulam or chlorimuron have been identified in Indiana. The purpose of this study was to characterize the response of glyphosate and ALS resistant horseweed populations to glyphosate and cloransulam. A greenhouse study was designed with a factorial arrangement with six rates of glyphosate (0, 0.21, 0.42, 0.84, 1.68, and 3.36 kg ae/ha) and six rates of cloransulam (0, 6, 12, 24, 48, and 96 g ai/ha) in all combinations for five different horseweed populations. The experiment was set up in a randomized complete block design with five replications in each of three runs. Plants were visually evaluated and harvested at 28 days after treatment. Data were analyzed using a modified version of Colby's method for joint activity analysis. The R:S ratios ranged from 2.5 to 8.1 based on the GR_{50} values in response to cloransulam applications. The R:S ratios ranged from 1.4 to 50.3 based on the GR_{50} values in response to glyphosate applications. Three of the populations tested were resistant to both glyphosate and cloransulam. The joint activity of the two herbicides for three tank-mixes were antagonistic. The two populations which had the lowest levels of resistance had one and two tank-mixes which had synergistic activity. All other populations and tank-mix combinations had an additive joint activity response. In order to effectively manage multiple resistant horseweed populations with postemergence herbicides in soybean, it is important to understand the characteristics of the individual population when producers try to control horseweed. For example, a producer trying to control a population with a low level of resistance to glyphosate should not cut the rate of glyphosate if cloransulam is added to the spray mix.

MOLECULAR GENETICS OF GLYPHOSATE RESISTANCE IN PALMER AMARANTH. Todd A. Gaines, Philip Westra, Jan E. Leach, Sarah M. Ward, Bekir Bukun, Stephen T. Chisholm, Dale L. Shaner, Christopher Preston, A. Stanley Culpepper, Timothy L. Grey, Ted M. Webster, William K. Vencill, and Patrick J. Tranel, Graduate Student, Professor, Professor, Associate Professor, Visiting Scientist, and Assistant Professor, Colorado State University, Fort Collins, CO 80523, Plant Physiologist, USDA-ARS, Fort Collins, CO 80526, Lecturer, University of Adelaide, Australia, Associate Professor and Assistant Professor, University of Georgia, Tifton, GA 31794, Research Agronomist, USDA-ARS, Tifton, GA 31794, Associate Professor, University of Georgia, Athens, GA 30602, and Associate Professor, University of Illinois, Urbana, IL 61801.

Glyphosate resistant Palmer amaranth populations were identified in Georgia. The molecular basis of resistance is unknown. No target site mutations known to confer resistance were identified in resistant alleles of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene, the target of glyphosate. Glyphosate selection in cell culture results in EPSPS gene amplification, so copy number and expression level were compared. DNA blot analysis of Palmer amaranth gDNA suggested more copies of EPSPS in resistant than susceptible plants. Estimation of gene copy numbers of EPSPS relative to acetolactate synthase (ALS) in gDNA by quantitative PCR (qPCR) revealed the same threshold cycle (Ct) for ALS and EPSPS in gDNA from susceptible plants and the same Ct for ALS in both resistant and susceptible plant gDNA. In contrast, the Ct for EPSPS in gDNA from resistant plants was six to seven cycles earlier than the Ct for ALS, suggesting that resistant plant genomes contain 64 to 128 times more copies of EPSPS than ALS. qPCR on cDNA revealed that EPSPS was expressed at 30 to 40 times higher levels in resistant plants. Elevated EPSPS copy number is heritable and correlates with expression level and resistance in F_2 populations. The molecular basis of resistance is likely due to increased production of EPSPS due to gene amplification. The possibility exists that one or a few genomic copies have higher expression due to promoter changes, or have a target-site mutation that has not been detected. This is the first documented occurrence of EPSPS gene amplification in a weed population under glyphosate selection pressure.

INTERACTIONS BETWEEN MESOTRIONE AND ATRAZINE IN A VELVETLEAF BIOTYPE WITH METABOLISM-BASED ATRAZINE RESISTANCE. Andrew J. Woodyard, Josie A. Hugie, and Dean E. Riechers, Graduate Students, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

The joint activity of mesotrione and atrazine can display synergistic effects on the control of both triazine-sensitive (TS) and site of action-based triazine-resistant (TR) broadleaf weeds in a tank mix. However, little is known about this interaction in weed biotypes displaying metabolism-based atrazine resistance (AR). The first objective of this study was to evaluate a preemergence application of atrazine followed by a postemergence application of mesotrione for potential interactions in both site of action-based TR redroot pigweed and metabolism-based atrazine-resistant (AR) velvetleaf. Results from these sequential experiments demonstrated that synergism was detected in reducing biomass of the TR redroot pigweed but was not observed in the AR velvetleaf with metabolism-based resistance. The second objective was to evaluate the joint activity of mesotrione and atrazine in a tank mix on the AR velvetleaf biotype. Greenhouse studies and whole-plant chlorophyll fluorescence imaging were used to determine if synergism is achievable in the metabolism-based AR biotype. Greenhouse studies indicated that synergism resulted from a tank mix with a constant mesotrione rate of 3.2 g ai ha^{-1} in mixture with atrazine ranging from 126 to 13,440 g ai ha^{-1} in the AR velvetleaf. Chlorophyll fluorescence imaging also revealed a synergistic interaction in the AR velvetleaf when 3.2 g ai ha^{-1} of mesotrione was paired with 126 g ai ha^{-1} of atrazine beginning 36 h after treatment and persisting through 72 h.

THE EFFECT OF HERBICIDES, ADJUVANTS AND NOZZLE TIPS ON SPRAY PARTICLE SIZE.

Robert N. Klein and Jeffrey A. Golus, Western Nebraska Crops Specialist and Technician, University of Nebraska West Central Research and Extension Center, North Platte, NE 69101-7751.

Spray particle size is the major factor in pesticide application affecting pesticide efficacy and spray drift. In 1987, the British Crop Protection Council adopted the spray droplet classification primarily to enhance efficacy. They use the term Spray Quality for droplet size categories. In 2000, the American Society of Agricultural Engineers Pest control and Fertilizer Committee developed ASAE S572, Spray Nozzle Classification by Droplet Spectra, primarily to control spray drift. This standard defines spectrum categories for the classification of spray nozzles, relative to specified reference fan nozzles discharging spray into static air, or so that no stream of air enhances atomization. The droplet spectra produced by single elliptical orifice reference nozzles with specified liquid mixture, flow rates, operating pressures and spray angles, are specified by the standard to establish the threshold of division between nozzle classification categories. The standard is based on spraying water through the reference nozzles and the nozzles to be classified. However, spray solution properties may affect droplet sizes.

Research has been conducted with a Sympatec Helos KF Analyzer. The system uses laser diffraction to determine particle size. With the R6 lens, it can determine particle sizes in a large range from 0.5 to 1230 microns. The nozzle tips are mounted on a boom with an electric linear actuator which moves the entire spray plume through the laser beam. A study was done to determine the particle size and distribution of glyphosate and ammonium sulfate with and without different adjuvants. Spray Systems Extended Range, Turbo TeeJet, Turbo Flood, Air Induction, and Air Induction Extended Range nozzles were evaluated. Both the herbicide and adjuvants affected particle size. Some nozzles are affected more than others, and would result in the nozzle receiving a different droplet spectra classification.

THE INFLUENCE OF SPRAY COMPONENTS AND NOZZLE TYPE ON SPRAY DISTRIBUTION AND COVERAGE. Gregory K. Dahl, Joe V. Gednalske and Eric Spandl, Research Coordinator, Manager of Product Development and Agronomist, Winfield Solutions LLC, St. Paul, MN 55164.

The influence of herbicide, formulation, adjuvant system, nozzle type and size can greatly affect the size and distribution of spray droplets. Comparisons were made between an XR 11004 extended range flat fan nozzle, an AI 11004 air induction nozzle and an AIXR 11004 air induction extended range nozzle. Mixtures sprayed through each of the nozzles included water alone, an adjuvant system that simulated the spray droplet size distribution of fully loaded K-salt glyphosate herbicides, the simulated glyphosate adjuvant system along with a modified vegetable oil deposition aid and drift control adjuvant and the simulated glyphosate adjuvant system with a guar type spray thickener drift control adjuvant. All treatments were applied at 10 gpa. The XR flat fan and the AIXR nozzles were sprayed at 30 psi and the AI nozzle was sprayed at 50 psi. Each spray mixture by nozzle comparison was conducted with no wind present and then again with a 7.5 to 8 mph wind.

A high speed photograph was taken of each spray mixture, nozzle type and wind combination. The camera used was a Hasselblad 553 medium format camera with a Leaf 65 digital back. The lens used was a Zeiss Sonnar 120 mm. Shots were taken at f 8.5 at 1/500 second shutter speed. The pictures were backlit with a Prism SPOT strobe using a 500 nanosecond flash.

The high speed photography provided excellent detail of the spray droplets in the spray patterns. The XR flat fan pattern contained smaller droplets than the patterns for the AI or AIXR nozzles. The simulated glyphosate adjuvant system contained many more very small droplets than water or the other mixtures and this was most evident with the XR flat fan nozzle. Both mixtures with deposition and drift reduction had fewer fines than the simulated glyphosate adjuvant alone mixture when using the XR flat fan nozzle. The mixture with modified vegetable oil deposition and drift control had fewer fines than the simulated glyphosate adjuvant alone when sprayed through the AI and AIXR nozzles. The guar type spray thickener drift control adjuvant greatly decreased the spray angle demonstrating why it should not be used with AI or AIXR nozzles.

IMPORTANCE OF ADJUVANT SYSTEM FOR GLYPHOSATE HERBICIDE COMBINATIONS IN SOYBEANS. Nathan R. Johanning, Bryan G. Young, Dawn E. Refsell, and Gordon K. Roskamp, Researcher, Professor, Southern Illinois University, Carbondale, IL 62901, Extension Specialist, University of Illinois, Urbana, IL 61801, and Professor, Western Illinois University, Macomb, IL 61455.

Field studies were conducted in 2008 at six locations in Illinois to determine the influence of adjuvant system on soybean injury and weed control from combinations of glyphosate with either lactofen or fomesafen. Treatments included glyphosate (860 g ae/ha) applied alone and tank-mixed with lactofen (105 and 210 g ai/ha) or fomesafen (165 and 330 g ai/ha). The adjuvant systems evaluated included: no adjuvant, nonionic surfactant (NIS) at 0.5% v/v, crop oil (petroleum) concentrate (COC) at 1.0% v/v, methylated seed oil (MSO) at 0.5% v/v, and high surfactant oil concentrate (HSOC) at 0.5% v/v. Data collected included visual crop injury and weed control as well as soybean yield.

No soybean injury was observed from glyphosate. Soybean injury at 7 to 9 days after treatment from combinations of lactofen or fomesafen with glyphosate was highly variable across sites, ranging from 5 to 57% and 5 to 33%, respectively. At most locations, soybean injury from lactofen plus glyphosate was increased when the adjuvant was COC, HSOC or MSO compared with no adjuvant. In contrast, combinations of NIS with fomesafen at 165 g/ha plus glyphosate resulted in greater soybean injury than no adjuvant whereas adjuvant system did not influence soybean injury from fomesafen at 330 g/ha plus glyphosate at 5 of 6 locations.

Control of giant foxtail, common lambsquarters, velvetleaf, common cocklebur, and common waterhemp was at least 90% from glyphosate alone at 14 days after treatment and was not influenced by tank-mix partner or adjuvant system. Glyphosate controlled only 50% or less of annual morningglory species with no improvement in control of tall morningglory with the addition of lactofen at 105 g/ha. However, control of tall morningglory was increased from combinations of lactofen at 210 g/ha with HSOC or MSO. Tank-mixtures of fomesafen plus glyphosate with no adjuvant provided greater tall morningglory control than glyphosate alone, but the addition of adjuvants to fomesafen plus glyphosate usually resulted in control similar to glyphosate alone. Ivyleaf and pitted morningglory control was increased with the addition of either lactofen or fomesafen to glyphosate, and control was further enhanced by increasing the lactofen or fomesafen rate with no adjuvant. The type of adjuvant system used did not affect ivyleaf and pitted morningglory control with either rate of fomesafen or lactofen at 210 g/ha plus glyphosate. However, adding HSOC or MSO to lactofen at 105 g/ha plus glyphosate increased control of ivyleaf and pitted morningglory compared with no adjuvant.

HOW LONG CAN VARIOUS HERBICIDES REMAIN IN THE SPRAY TANK PRIOR TO APPLICATION IN THE FIELD? Robert E. Nurse and Peter H. Sikkema, Research Scientist, Agriculture and Agri-Food Canada, Harrow, ON N0R 1G0 and Associate Professor, Ridgetown Campus, University of Guelph, Ridgetown, ON N0P 2C0.

Ten field trials were conducted at two locations in Southwestern Ontario between 2006 and 2008 to determine the length of time herbicides can remain in the spray tank prior to application in the field without impacting efficacy. Four preemergence and five postemergence herbicides were mixed at their labeled rates and then applied in field corn following label specifications. Herbicides were either applied immediately, or after being left for 1, 3 or 7 days in the spray tank. The most common weed species in the trials were *Abutilon theophrasti*, *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, and *Chenopodium album*. Delaying herbicide application did not affect the efficacy of postemergence herbicides in this study. Similarly, control of *A. retroflexus* and *C. album* was not affected by a delay in the application of preemergence herbicides. However, control of *A. theophrasti* was decreased when isoxaflutole + atrazine, dimethenamid + dicamba/atrazine, or rimsulfuron + s-metolachlor + dicamba applications were delayed by more than 1 day. Nonetheless, there were no decreases in yield for any treatment combinations. These data provide valuable information which growers can use to make informed decisions on whether to apply herbicides in non-ideal weather or postpone application. The results of this study suggest that for most herbicides and weed species it is better to postpone application rather than make applications under non-ideal conditions.

COMMON LAMBSQUARTERS RESPONSE TO GLYPHOSATE UNDER FIELD AND GREENHOUSE CONDITIONS. Andrew R. Kniss, Assistant Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071.

Field and greenhouse studies were conducted in Laramie, Wyoming to quantify the effect of common lambsquarters size on mortality caused by glyphosate application. Contradictory results were obtained in field and greenhouse studies. In greenhouse studies, increasing size of common lambsquarters at the time of treatment increased the probability of survival after treatment with glyphosate at 840 g ae/ha. Similar results have been found by other researchers in greenhouse and growth chamber studies. However, field studies conducted in 2007 and 2008 do not show a similar trend. In 2007, a parabolic response was observed in the field with respect to common lambsquarters height; that is, plants were more likely to survive glyphosate applications as they increased in size up to approximately 12 cm, then became less likely to survive glyphosate application at heights greater than 12 cm. In 2008 field studies, common lambsquarters was less likely to survive glyphosate applications as height increased from 2 to 12 cm. Spray contact and retention may be responsible for the differences observed between greenhouse and field studies, as environmental conditions (particularly light quality and intensity) alter the phenology of common lambsquarters.

COMPARISON OF POSTEMERGENCE HERBICIDES IN CORN WITH RESISTANCE TO GLYPHOSATE AND GLUFOSINATE. Mark M. Loux, Anthony F. Dobbels, William G. Johnson, Bryan G. Young, Chris Boerboom, Kevin Bradley, and Aaron Hager, Professor and Research Associate, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH 43221, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Professor, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901, Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706, Assistant Professor, Division of Plant Sciences, University of Missouri, Columbia, MO 65211, and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

Glyphosate-resistant corn is now the predominant type of corn grown in the Midwestern United States, and many glyphosate-resistant corn hybrids are also resistant to glufosinate. Glyphosate is currently priced about the same or higher than glufosinate and several other broad-spectrum postemergence (POST) corn herbicides. A primary objective of this research was to determine whether similar weed control and crop yield occurs when other POST herbicides are substituted for glyphosate in glyphosate-resistant corn.

A field study was conducted at six sites in 2008 to determine the effectiveness of four POST herbicide systems in corn resistant to glyphosate and glufosinate. POST herbicide systems included: glyphosate (840 g ae/ha); glufosinate (450 g/ha)/atrazine (560 g/ha); tembotrione (92 g/ha)/atrazine (560 g/ha); and rimsulfuron (13 g/ha)/nicosulfuron (26 g/ha)/dicamba (84 g/ha)/diflufenzopyr (34 g/ha). The two types of herbicide applications in the study were: 1) EPO - early POST application of a combination of POST and residual herbicides, when weeds were less than 7 cm tall; and 2) PRE/POST - application of residual herbicides at the time of corn planting, followed by POST herbicide application when corn was about 18 inches tall. The study was a 3-way factorial, where the factors were type of application, residual herbicide, and POST herbicide system. The residual herbicides were preformulated combinations of atrazine and s-metolachlor, or atrazine, s-metolachlor, and mesotrione. These were applied at 67% of the typical labeled rate for the soil type. Weed control was determined at the time of and 21 days after POST application, and just prior to corn harvest. The late-season weed control and grain yield results are discussed here.

Control of several weeds exceeded 90% at the end of the season regardless of treatment. Weeds in this group included velvetleaf, common lambsquarters, prickly sida, wild sunflower, yellow foxtail, redroot pigweed, ivyleaf morningglory, barnyardgrass, large crabgrass, prickly sida, and Pennsylvania smartweed. The following weeds were more effectively controlled by the PRE/POST than the EPO application, by a margin of 3 to 9%, when control was averaged over other factors: giant foxtail, tall waterhemp, common cocklebur, common ragweed, fall panicum, and tall morningglory. Tall waterhemp, common cocklebur, common ragweed, and tall morningglory were most effectively controlled where the residual herbicide was atrazine, s-metolachlor, and mesotrione.

POST herbicide system affected control of four weeds, and also corn yield. Control of giant foxtail and fall panicum generally followed the following order, from highest to lowest: glyphosate, rimsulfuron/nicosulfuron, glufosinate/atrazine, and tembotrione/atrazine. Control of tall waterhemp and common ragweed was affected by POST herbicide for EPO application only, and only where the residual herbicide was atrazine and s-metolachlor. For these treatments, tembotrione/atrazine controlled 97% of the waterhemp, and control ranged from 75 to 81% for the other POST herbicides. The nicosulfuron/rimsulfuron/dicamba treatment controlled 82% of the common ragweed, while control ranged from 98 to 100% for the other POST herbicide systems. Corn yield for the four POST herbicide systems, averaged over the other factors, was as follows: glyphosate – 199 bu/A; tembotrione/atrazine – 193 bu/A; glufosinate/atrazine – 190 bu/A; and rimsulfuron/nicosulfuron/dicamba/diflufenzopyr – 186 bu/A.

2008 North Central Weed Science Society Proc. 63:133.

THE RESPONSE OF A NORTH DAKOTA COMMON RAGWEED POPULATION TO GLYPHOSATE IN THE FIELD. Jeff M. Stachler and John L. Luecke, Assistant Professor and Research Specialist, Department of Plant Sciences, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050.

A common ragweed population was inadequately controlled with multiple glyphosate applications in a glyphosate-resistant soybean field in Traill County, ND in 2007. In 2008, small-plot field research was conducted to confirm the presence of a glyphosate-resistant common ragweed biotype in the population and the impact upon the population of single and multiple glyphosate applications. No crop was planted at the study location. Glyphosate was applied once at 0.8, 1.3, 1.7, and 3.4 lb ae/ha to $\leq$ 2.5, $\leq$ 5, and <12.7 cm common ragweed on June 4, 13, and 26, 2008, respectively. Glyphosate was also applied at 0.8, 1.3, and 0.8 kg/ha to $\leq$ 2.5 and $\leq$ 5 cm common ragweed and then followed about 16 days later with glyphosate at 0.8, 0.8, and 1.3 kg/ha, respectively. Plots of three additional treatments per timing were treated in the same fashion initially and followed about 16 days later with glyphosate at 0.8 kg/ha across each treatment for a total of three glyphosate applications. This same sequence of treatments were repeated and followed about 16 days later with a fourth application of glyphosate at 0.8 kg/ha. Glyphosate was applied at 0.6 kg/ha on August 7th to the entire plot of three replications and to 80% of the final replication of treatments where glyphosate was applied once to $\leq$ 2.5 and $\leq$ 5 cm common ragweed. The glyphosate was applied to control other weed species germinating after the initial application. Fifteen common ragweed plants were flagged per plot prior to the initial glyphosate applications.

This field research suggests the presence of a glyphosate-resistant common ragweed biotype in Traill County, ND. Increasing glyphosate rates improved control and individual plant mortality at harvest with all application timings. The greatest mortality of flagged plants was achieved when glyphosate was initially applied to $\leq$ 2.5 cm common ragweed compared to the later initial timings. Increasing the number of glyphosate applications increased control and individual plant mortality and decreased seed production. Late-season glyphosate applications appeared to reduce common ragweed seed production compared to early-season applications.

TEACHING WEED MANAGEMENT IN WINTER WHEAT. Robert N. Klein, Western Nebraska Crops Specialist, University of Nebraska West Central Research and Extension Center, North Platte, NE 69101-7751.

A PowerPoint presentation has been developed which begins with several questions on weed management in winter wheat which the audience answers with the "clickers". This gets the audience involved and also lets the presenter know the level of knowledge of the audience in regard to the subject being presented. The presenter then can stress points more or less depending on the pre-survey with the clickers.

The PowerPoint then shifts to crop residues and how they affect weed management in winter wheat and the entire cropping system involving winter wheat. Management practices such as winter wheat seeding date, fertility, fertilizer placement, the effect of fallow period before seeding winter wheat on weed density, and how these items affect plant competition and weeds are discussed. The Weed Management Guide and the information it contains such as dose response levels and how weeds affect winter wheat yields, problem weeds in winter wheat, their identification and management are included in the presentation. Other points presented include combining nitrogen and herbicides and the effect on winter wheat injury and yields. Fertilizer application and herbicide timing and methods complete the presentation.

BURNDOWN CONTROL OF COVER-CROP WHEAT AND LITTLE BARLEY. James R. Martin, Charles R. Tutt, and Dorothy L. Call, Extension Professor, Research Specialist, and Technician, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445-0469.

Cool-season grasses tend to be difficult to control with burndown herbicides, especially when plants have overwintered and developed multiple tillers. Examples of grasses include wheat planted as a cover crop and little barley that occurs as a weedy plant during the winter following corn or soybean harvest. Studies were conducted to compare burndown control of these grasses with glyphosate or paraquat applied with a triazine herbicide at different times.

Cover-crop wheat control was evaluated in the spring of 2007 and 2008. The three application timings in the 2007 study were February 28, March 21, or April 18, when wheat was 3, 4.5, or 12.5 inches in height, respectively. The timings for the 2008 study were February 25, March 24, or April 21 when wheat was 4, 8, or 15 inches tall, respectively. Burndown herbicides included glyphosate at 0.56, 0.77 and 1.13 lb ae/A; or paraquat at 0.5 and 0.75 lb ai/A. These herbicides were applied either alone or in combination with atrazine at 1.5 lb ai/A.

When averaged across application timings, burndown control of wheat with all glyphosate treatments was 97%. Control of cover-crop wheat with glyphosate at 0.77 and 1.13 lb ai/A was least 88% regardless of timing. Glyphosate applied alone February 28, 2007 at the low rate of 0.56 lb ai/A provided 73% control of wheat; however, control improved to 88% when atrazine was included as a tank mix partner. Atrazine tended to limit the speed of control with glyphosate; however, in most instances the antagonism from atrazine to glyphosate diminished by mid May.

When averaged across application timings, burndown control of wheat with all paraquat treatments was 78%. Control with paraquat was inconsistent across application timings. Paraquat alone the high rate on March 21, 2007 provided 90% control, yet this treatment provided only 50% control when applied March 24, 2008. Including atrazine with paraquat tended to enhance wheat control in most timings. As expected, the initial burndown control was more rapid with paraquat than with glyphosate; however, in some cases regrowth of wheat occurred by four weeks after application of paraquat.

Little barley control was evaluated using early peplant applications made in the fall or spring. Treatments were applied November 14, 2006, February 21, March 14, or April 12, 2007 when plants were 4, 3.5, 5, or 11 inches in height, respectively. Glyphosate and paraquat were applied at the same rates as those in the cover-crop wheat studies. All burndown treatments in the little barley study included simazine at 1 lb ai/A as a tank mix partner. Burndown control was evaluated at weekly intervals during the first four weeks after application.

Results of the little barley study indicated that control was at least 95% when glyphosate or paraquat was applied with simazine on November 14 to 4 inches tall plants. However, control of little barley from applications on February 14, March 21, or April 12 was usually better with glyphosate than that with paraquat. Control at 4 weeks after application ranged from 96 to 100% when glyphosate plus simazine was applied February 21, March 14, or April 12. The use of paraquat at 0.5 or 0.75 lb/A in combination with simazine provided 63 or 77% control, respectively, when applied February 21. Delaying the application of paraquat treatments until March 14 or April 12 improved control of little barley, however the low rate of paraquat provided seven to 10 % less control than that of the high rate.

In summary, glyphosate tended to provide effective control of wheat and little barley more consistently than paraquat in spring burndown treatments. The use of atrazine with paraquat tended to enhance control of cover-crop wheat. Although atrazine tended to slow the activity of glyphosate on burndown control of cover-crop wheat, it seldom reduced control when evaluated in mid May. The use of glyphosate or paraquat with simazine in the fall provided effective season-long control of little barley. Applications of glyphosate plus simazine during late February through mid April were usually more effective than the low rate of paraquat plus simazine in controlling little barley.

2008 North Central Weed Science Society Proc. 63:136.

TWENTY YEARS OF UNIVERSITY CORN YIELD DATA: WITH AND WITHOUT ATRAZINE.
Richard S. Fawcett, Fawcett Consulting, Huxley, IA 50124.

Herbicide efficacy studies reporting corn yields published in the North Central Weed Science Society Research Report were analyzed to calculate average corn yields for treatments either containing atrazine or not containing atrazine. To prevent unequal comparisons, studies and treatments had to meet conservative selection criteria in order to be included in the analysis. Treatments had to control both broadleaf and grass weeds (normally containing at least two active ingredients), and active ingredients had to be currently registered for use and used at label rates. For the 20-year period, 1986-2005, 236 qualifying studies were identified, with a total of 5,871 qualifying treatments. For the period 1986-1995, corn yielded an average 6.3 bushels/acre higher or 5.9% higher with atrazine than without. For the period 1996-2005, corn yielded an average 5.4 bushels/acre higher or 4.6% higher with atrazine. For the entire 20-year period, the average yield with atrazine was 5.7 bushels/acre higher or 5.1% higher with atrazine than without. Corn yields with atrazine continued to be higher than with non-atrazine treatments as new active ingredients and new technologies such as herbicide-tolerant corn hybrids were introduced. University researchers have increasingly added atrazine to new active ingredients to improve weed control. In 1986, 55% of all evaluated treatments in studies contained atrazine. As many new active ingredients were evaluated, treatments containing atrazine dropped to 17% in 1995. However, by 2005, 79% of all treatments in the studies evaluated contained atrazine. Considering the value of increased corn yields with atrazine and the lower cost of atrazine compared to alternatives, atrazine use added an estimated $25.74 per acre income to farmers in 2005, with a total U.S. benefit to farmers of $1.39 billion.

Introduction

In 1996, on behalf of the Triazine Network, Fawcett Consulting prepared for the Special Review Division of USEPA an analysis of corn yields with and without atrazine herbicide, using university studies annually published in the Research Report of the North Central Weed Science Society (Submission to the docket OPP-3-0000-60). Data for the 10-year period 1986 to 1995 were analyzed to determine corn yield benefits from the use of atrazine for weed control. In order to determine if beneficial yield impacts of atrazine treatments continued in more recent years, a similar data analysis was later conducted from NCWSS Research Reports for the years 1996 through 2005, the last year the Research Report was published. As many studies do not report yield data, only studies reporting yields can be analyzed. Because some universities never report yields in the Research Report and some report yields on only a few studies, most studies available for analysis are from Wisconsin, Minnesota, Illinois, Iowa, and Nebraska, with a few studies from South Dakota, Kansas, and Indiana. In order to eliminate potential unequal comparisons between herbicide treatments, selection criteria were developed for studies used, and for treatments within studies. In absence of conservative selection criteria, yield summaries would not be realistic for several reasons. For example, rates lower than label rates are sometimes tested, resulting in low yields. Or single active ingredient treatments included as standards may not control grasses or broadleaf weeds.

Study Selection Criteria

The following criteria were used to select studies and treatments within studies:

1. The study must be designed to evaluate weed control. Some studies have no weeds or are hand weeded and investigate other factors such as crop safety, and thus are not suitable for this summary.

2. The study must evaluate both grass and broadleaf weeds. Some studies are seeded to single weed species (often grasses such as woolly cupgrass and wild proso millet) and thus are not suitable to measure the contribution of atrazine.
3. Atrazine must be included in at least 10%, but no more than 90% of treatments, with at least 2 atrazine or non-atrazine treatments. This criterion is to avoid situations where only one or two treatments (either atrazine or non-atrazine) would be used to calculate an average yield from a test, increasing the influence of experimental error. If a study involves more than one method of application (such as preemergence or postemergence), representative atrazine and non-atrazine treatments should be included for each application method. For example, due to dry weather, all preemergence treatments might fail, while postemergence treatments might be effective, biasing comparisons if one method of application lacked either atrazine or non-atrazine treatments.

Treatment Criteria

1. The treatment must have both grass and broadleaf activity. This usually means that at least 2 active ingredients are used. Often single ingredient standards are included in studies, producing low yields due to controlling only part of the weed spectrum.
2. All active ingredients included in treatments must be registered for use at the time of the analysis. Active ingredients which were experimental at the time of the study, but were registered at the time of the analysis, are included.
3. Rates must be within current label ranges. Studies early in the development of experimental herbicides often test several rates, including ineffective low rates, and rates above eventual label rates. As atrazine label rates have been reduced, some treatments in past studies have atrazine rates above current label rates. These treatments are not included.
4. If additional weed control measures such as cultivation are used, data is included only if all treatments received the additional measure.

Yield Results

Table 1 shows data summaries for 88 corn experiments conducted between 1986 and 1995. Average yield differences for atrazine-containing treatments and non-atrazine treatments are reported for studies in each year. Both bushel/acre differences in yields, as well as percentage differences in yields, are presented. The average yield increase with atrazine for this 10-year period was 6.3 bu/A, for a 5.9% increase in yield compared to non-atrazine treatments. Average yields with atrazine were higher in 73 studies, lower in 14 and equal in one study.

Table 2 shows data summaries for 148 studies for the years 1996 through 2005. Over the 10-year period, the average yield increase with atrazine was 5.4 bu/A, for a 4.6% yield increase compared to non-atrazine treatments. Thus, despite the introduction of numerous new herbicide active ingredients to the marketplace since 1995, atrazine still produces weed control and yield benefits, compared to alternative herbicides. For the entire 20-year period of 1986 through 2005, the average yield increase with atrazine was 5.7 bu/A or 5.1%.

Statistical Analysis

Figure 1 shows the distribution of corn yields as a percent difference for yields with atrazine versus yields without atrazine. The data are not normally distributed, being skewed to the right. Also, five data points might be considered outliers. All of these five data points come from trials containing ALS-resistant common waterhemp biotypes, where ALS herbicides applied to ALS-tolerant corn failed to control the weed, resulting in lowered yields. Inclusion of atrazine resulted in dramatically higher yields.

The mean percentage yield increase with atrazine for the 1986-2005 period was 5.09%, with a standard deviation of 11.99, standard error of the mean of 0.78, upper and lower 95% confidence intervals of 6.63 and 3.55, respectively, and n of 236. As a parametric test may not be considered appropriate due to non-normal distribution of data, data were analyzed both by t-test and Wilcoxon Signed-Rank test. Both tests result in highly significant probabilities that the percent increase in yield with atrazine is greater than 2.0. The result of the t-test is significant, while the Wilcoxon Signed-Rank test is not significant that the percent increase in yield is greater than 3.0.

Herbicide-tolerant Crops

The introduction of herbicide-tolerant corn hybrids is a major technological change since the 1986-1995 data summary. During the 1996-2005 period, corn hybrids tolerant to glyphosate, glufosinate, sethoxydim and the imidazolinone herbicides imazethapyr and imazapyr have been introduced. To determine if inclusion of atrazine with these herbicides on herbicide-tolerant corn hybrids influenced corn yields, an analysis of data from 1996-2005 was conducted using the previously described study and treatment criteria. Table 3 shows results of the herbicide-tolerant corn comparisons. Inclusion of atrazine increased average corn yields on all categories of herbicide-tolerant corn. Yields were increased by 10.6, 4.9, 4.8, and 2.0 bu/A with imidazolinone, glufosinate, sethoxydim, and glyphosate-tolerant corn hybrids, respectively. Atrazine was particularly beneficial with imidazolinone-tolerant corn. In one experiment (1997-2), tall waterhemp was determined to be resistant to ALS herbicides, causing poor weed control with the normally broad-spectrum imazethapyr + imazapyr treatment. Low rates of atrazine included with the imidazolinone treatments increased yields by 52.5 bu/A. A subsequent study at the same location in 2002 demonstrated a 46.8 bu/A yield benefit from atrazine. Atrazine is an important tool in weed resistance management, as it has a different mode of action than any of the products used on herbicide-tolerant corn. As adoption of these corn hybrids increases, atrazine will become more important in both improving control of certain weed species and in preventing the increase of herbicide-resistant weed biotypes.

Application Practices

Herbicide use practices have changed during the 20 years encompassed by data in these analyses, including rates and numbers of active ingredients used and number of herbicide applications made. Possible changes in these factors related to atrazine usage were investigated by comparing all 1986 studies to all 2001 and 2005 studies (Because 2002-2005 studies are dominated by Minnesota studies with similar designs, 2001 studies representing more states and study designs were also analyzed.), recording number of active ingredients per treatment, number of application trips per treatment, and atrazine rates per acre. Results of the analysis are reported in Table 4. Average number of active ingredients per treatment and application trips used in research studies have increased during the period. Considering non-atrazine treatments, average number of active ingredients increased from 2.09 to 2.64, and application trips increased from 1.45 to 1.61, comparing 1986 to 2001. Fewer average application trips were made for atrazine-containing treatments, both in 1986 and 2001. In 2001, an average 1.53 application trips were made with atrazine-containing treatments compared to 1.61 application trips for non-atrazine treatments. In 2005, due to Minnesota study designs, slightly more application trips were made for atrazine-containing treatments (1.54 vs 1.40 for non-atrazine treatments). Average atrazine application rates declined from 1.17 lb/A in 1986 to 0.88 lb/A in 2001 and to 0.61 lb/A in 2005. This represents a 48% rate decline over the period.

Atrazine Use with New Actives

Atrazine remains an important weed management tool, despite the introduction of numerous new herbicide active ingredients and introduction of new technology such as herbicide-tolerant crops.

Atrazine is applied with most new active ingredients either as a component of package mixes or in tank mixes. Table 5 shows a list of 57 herbicide package mix products containing atrazine. Seventeen different active ingredients are found in these products. As new active ingredients have been registered for use, manufacturers have been quick to combine them with atrazine in package mixes and to label them for use with atrazine in tank mixes. University researchers have also dramatically increased evaluations of atrazine in combination with other active ingredients. This increase has occurred both due to industry protocols that have requested that new actives be evaluated with atrazine and researchers' own initiatives to try to overcome weaknesses of new actives on specific weeds.

Table 6 shows an analysis of percent of all treatments meeting treatment selection criteria that contained atrazine for the 20 years of studies analyzed. This analysis contains more data than was used in the yield analysis, as studies that could not be used in the yield analysis due to too few non-atrazine treatments (or too few atrazine treatments) could still appropriately be used in this analysis. In recent years many studies reporting yields could not be used in atrazine yield benefit calculations because all treatments or all except one treatment contained atrazine. For example, in 2005, 20 NCWSS Research Report studies reported yields. Eleven were suitable for inclusion in calculating atrazine yield benefits, while seven could not be used because they had atrazine included in 100% of treatments or had only one non-atrazine treatment. Two were excluded because of not meeting other selection criteria. In the late 1980s about 60% of treatments evaluated in university studies contained atrazine. As many new active ingredients were evaluated in the 1990s, the percent of treatments containing atrazine steadily declined to a low of 17% in 1995. However, for the next decade, use of atrazine steadily increased until 80% of all treatments evaluated in 2004 contained atrazine. This dramatic increase in inclusion of atrazine with other active ingredients came about as university and industry researchers observed the shortcomings of new actives and turned to atrazine to solve these shortcomings.

Researchers searching for improved weed control are applying more active ingredients and making more applications today than in the past. Even though more active ingredients and more applications are being used, addition of atrazine still produces corn yield increases, compared to non-atrazine treatments. Atrazine-containing treatments averaged 5.4 bushels per acre more yield than non-atrazine treatments for the 1996-2005 period, compared to 6.3 bushel per acre advantage in the 1986-1995 period. Some of the biggest yield increases produced by atrazine were in herbicide-tolerant corn trials, where atrazine controlled herbicide resistant weed biotypes. Besides improving yield, atrazine use on such hybrids helps to prevent selection for herbicide resistant weeds.

Atrazine Cost

Atrazine has produced weed control and yield benefits to farmers at a remarkably low cost. Atrazine sold in package mix products often costs less than when purchased alone. To determine the average cost of atrazine to farmers, the costs of companion active ingredients, when purchased separately, were subtracted from costs of respective package mix products containing atrazine, using the University of Minnesota 2005 price lists. Table 7 shows the costs of atrazine per pound active in three common atrazine-containing package mix products, and the cost of atrazine when purchased alone. The average cost of the atrazine in the four sources is \$2.18 per pound active ingredient. Table 8 compares the average atrazine cost to the average per acre costs of 14 non-atrazine broadleaf control herbicides in corn according to the University of Minnesota publication. At the rate of 1.13 lb per acre, the average U.S. atrazine rate used in the 2005 National Agricultural Statistics Service (NASS) survey, the cost of atrazine per acre is only \$2.46. The only broadleaf herbicide less expensive is 2,4-D, at \$1.63 per acre. The corn injury and drift risk with this herbicide limit its use to only a small acreage. The next closest cost competitor is Aim at \$2.70 per acre. This herbicide controls only a few specific species and does not compete with atrazine for that reason. The average per acre cost of non-atrazine alternatives of \$12.34 is \$9.88 per acre more than atrazine.

Atrazine users receive economic benefits from higher yields and from lower herbicide costs. Using the 2005 average yield increase with atrazine of 6.1 bu/A and the USDA Target Price for corn of $2.60 per bushel (the effective price received by farmers participating in USDA Farm Programs), atrazine users gained added income of $15.86 per acre. Adding the savings of lower cost of atrazine versus alternatives of $9.88 per acre, corn farmers using atrazine received a total economic benefit of $25.74 per acre. NASS reports that 82 million acres of corn were planted in 2005. If 66% of U.S. corn was treated with atrazine (NASS survey data from 2005), then about 54.1 million acres of corn would have been treated with atrazine in the U.S. in 2005. Using the $25.74 per acre value of increased income for atrazine use, an estimated total economic benefit to U.S. farmers of about $1.39 billion occurred in 2005.

Conclusions

Analysis of university weed control studies published in the NCWSS Research Report for the period 1996-2005 shows a corn yield advantage for treatments including atrazine of 5.4 bushel per acre or 4.6% compared to non-atrazine treatments. This yield benefit is similar to a yield benefit of 6.3 bushels per acre or 5.9% calculated for the previous 10 years of study. Despite the availability of many new herbicide active ingredients, atrazine continues to produce economic benefits for corn farmers. This has occurred despite the practice of including more active ingredients per treatment (in absence of atrazine) and making more herbicide applications during the 1996-2005 period. Average atrazine application rates in these university studies declined from an average 1.17 lb/acre in 1986 to 0.61 lb/acre in 2005. Atrazine is especially useful on herbicide-tolerant corn hybrids, where it controls herbicide-resistant weeds and helps to prevent future increases in herbicide-resistant weeds. Atrazine brings these benefits at a remarkably low cost, with the cost of the average 1.13 lb atrazine used in 2005 by U.S. corn farmers being $2.46 per acre, compared to $12.34 per acre, the average cost of 14 alternative broadleaf control herbicides in corn. Considering added income from higher yields and lower herbicide costs, atrazine use resulted in added income to farmers of $25.74 per acre in 2005, with a total U.S. benefit to farmers of about $1.39 billion.

Acknowledgements

Leslie Fuquay of Syngenta Crop Protection is thanked for providing the statistical analyses.

Literature Cited

1986 Studies

1986-1. Harvey, R.G., J.F. Schun, and R.K. Nelson. 1986. Annual weed control in field corn study. NCWSS Res. Rep. 43:125-127.

1986-2. Kapusta, G. and T.L. Feldick. 1986. Corn preemergence herbicide study. NCWSS Res. Rep. 43:149-150.

1986-3. Harvey, R.G. and J.F. Schuh. 1986. Field corn herbicide studies. NCWSS Res. Rep. 43:151-154.

1986-4. Gunsolus, J.L. and D.D. Warness. 1986. Herbicide performance at Morris, MN. NCWSS Res. Rep. 43:159-160.

1986-5. Gunsolus, J.L. and H.J. Ford. 1986. Herbicide performance in corn at Lamberton, MN. NCWSS Res. Rep. 43:167-168.

1986-6. Roeth, F.W. 1986. Corn herbicide evaluations. NCWSS Res. Rep. 43:169-170.

1986-7. Gunsolus, J.L. and W.E. Leuschen. 1986. Herbicide performance in corn at Waseca, MN. NCWSS Res. Rep. 43:205-206.

1986-8. Moomaw, R.S. 1986. Selective weed control for dryland corn in northeast Nebraska. NCWSS Res. Rep. 43:213-214.

1987 Studies

1987-1. Harvey, R.S., M. G. Myers, and C.D. Kleppe. 1987. Field corn weed control study. NCWSS Res. Rep. 44:129-133.

1987-2. Martin, A.R. and T.A. Hayden. 1987. Selective control of weeds in corn with herbicides. NCWSS Res. Rep. 44:133-135.

1987-3. Gunsolus, J.L. and W.E. Leuschen. 1987. Herbicide performance in corn at Waseca, MN. NCWSS Res. Rep. 44:137-139.

1987-4. Roeth, F.W. 1987. Corn herbicide evaluations, 1987. NCWSS Res. Rep. 44:160-161.

1987-5. Gunsolus, J.L. and D.D. Warnes. 1987. Herbicide performance in corn at Morris, MN. NCWSS Res. Rep. 44:169.

1987-6. Gunsolus, J.L. and H.J. Ford. 1987. Herbicide performance in corn at Lamberton, MN. NCWSS Res. Rep. 44:180-181.

1987-7. Moomaw, R.S. 1987. Evaluation of experimental postemergence herbicides for corn. NCWSS Res. Rep. 44:188.

1987-8. Kapusta, G. and D.L. Zinck. 1987. Corn no-till early preplant study. NCWSS Res. Rep. 44:322-325.

1988 Studies

1988-1. Kapusta, G. and R.F. Krausz. 1988. Corn preemergence herbicide study. NCWSS Res. Rep. 45:277.

1988-2. Harvey, R.G., C.A. Morton, and J.L. Kutil. 1988. Field corn weed control study. NCWSS Res. Rep. 45:278-280.

1988-3. Martin, A.R., R.E. Mack and W.J. Bates. 1988. Selective weed control in corn with herbicides at Lincoln, NE. NCWSS Res. Rep. 45:280-282.

1988-4. Gunsolus, J.L. and W.E. Leuschen. 1988. Herbicide performance in corn at Waseca, MN. NCWSS Res. Rep. 45:288-290.

1988-5. Harvey, R.G., C.G. Kleppe, and J.W. Albright. 1988. Annual weed control in corn study. NCWSS Res. Rep. 45:302-304.

1988-6. Gunsolus, J.L. and H.J. Ford. 1988. Herbicide performance in corn at Lamberta, MN. NCWSS Res. Rep. 45:306-307.

1988-7. Harvey, R.G. and J.L. Kutil. 1988. Annual broadleaf weed control in corn study. NCWSS Res. Rep. 45:327-328.

1989 Studies

1989-1. Radliff, E.E. and G. Kapusta. 1989. Influence of postemergence broadleaf herbicides on efficacy of DPX-V9360 in corn. NCWSS Res. Rep. 46:313-314.

1989-2. Harvey, R.G., C.D. Kleppe, and C.A. Morton. 1989. Annual weed control in field and sweet corn studies. NCWSS Res. Rep. 46:329-332.

1989-3. Kapusta, G., J.L. Matthews, and M. Khan. 1989. Corn experimental preemergence herbicide study. NCWSS Res. Rep. 46:373.

1989-4. Gunsolus, J.L. and H.J. Ford. 1989. Herbicide performance in corn at Lamberton, MN. NCWSS Res. Rep. 46:374-375.

1989-5. Gunsolus, J.L. and W.E. Leuschen. 1989. Herbicide performance in corn at Waseca, MN. NCWSS Res. Rep. 46:378-380.

1989-6. Owen, M.D.K., J.F.Lux, and E.L. Franzenburg. 1989. Herbicide combinations for weed control in corn, Nashua, Iowa. NCWSS Res. Rep. 46:388-389.

1989-7. Owen, M.D.K., J.F. Lux, and E.L. Franzenburg. 1989. Evaluation of various herbicide combinations for weed control in corn, Wyman, Iowa. NCWSS Res. Rep. 46:390-391.
1989-8. Harvey, R.G., C.A. Morton, and C.D. Kleppe. 1989. Field corn weed control studies. NCWSS Res. Rep. 46:394-398.

1990 Studies

1990-1. Morton, C.A., R.G. Harvey, and J.W. Albright. 1990. DPX-V9360 field corn weed control studies. NCWSS Res. Rep. 47:228-231.

1990-2. Kapusta, G., M.R. Hellmer, and R.F. Drazsz. 1990. Corn all postemergence herbicide study. NCWSS Res. Rep. 47:283-284.

1990-3. Gunsolus, J.L. and W.E. Leuschen. 1990. Herbicide performance in corn at Waseca, MN. NCWSS Res. Rep. 47:332-334.

1990-4. Radliff, E.E. and G. Kapusta. 1990. Influence of postemergence broadleaf herbicides on efficacy of DPX-V9360 in corn. NCWSS Res. Rep. 47:341.

1990-5. Harvey, R.G. and J.W. Albright. 1990. Annual weed control in field corn studies. NCWSS Res. Rep. 47:356-359.

1991 Studies

1991-1. Owen, M.C.K., J.F. Lux, and E.L. Franzenburg. 1991. Herbicide combinations applied postemergence for weed control in corn. NCWSS Res. Rep. 48:129-130.

1991-2. Owen, M.D.K., J.F. Lux, and E.L. Franzenburg. 1991. Evaluation of weed control in corn with various herbicide combinations and application timings, Ames, Iowa. NCWSS Res. Rep. 48:153-154.

1991-3. Harvey, R.G., C.R. Wagner, J.W. Albright, and J.L. Kutil. 1991. Field corn herbicide studies. NCWSS Res. Rep. 48:161-164.

1991-4. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1991. Annual weed control in field corn studies. NCWSS Res. Rep.48:169-172.

1991-5. Kapusta, G. and A.F. Dobbels. 1991. Corn postemergence weed control with V-23031. NCWSS Res. Rep. 48:174-175.

1991-6. Dobbels, A.F. and G. Kapusta. 1991. Corn all postemergence weed control with nicosulfuron combinations. NCWSS Res. Rep. 48:175-176.

1991-7. Dobbels, A.F. and G. Kapusta. 1991. Postemergence weed control in corn with nicosulfuron combinations. NCWSS Res. Rep. 48:177-178.

1991-8. Owen, M.D.K., J.F. Lux, and E.L. Franzenburg. 1991. Evaluation of weed control in corn with postemergence herbicide applications, Ames, Iowa. NCWSS Res. Rep. 48:179-180.

1991-9. Pike, D.R., M.J. Mainz, and G.A. Rains. 1991. The use of banded herbicide applications and cultivation for weed control in corn. NCWSS Res. Rep. 48:187-189.

1991-10. Bauman, T.T., E.K. Peregrine, M.D. White, and L.D. Guevara. 1991. Efficacy of thifensulfuron in corn, West Lafayette, Indiana. NCWSS Res. Rep. 48:193-194.

1991-11. Kapusta, G., R.F. Krausz, and J.A. Bailey. 1991. Corn postemergence weed control with pyridate and CL-23601. NCWSS Res. Rep. 48:196-197.

1992 Studies

1992-1. Rabaey, T.L., R.G. Harvey, T.M. Anthon, and J.L. Kutil. 1992. Miscellaneous herbicide-fertilizer treatments. NCWSS Res. Rep. 49:120-121.

1992-2. Kapusta, G., A.F. Dobbels, and M.R. Obermeier. 1992. Corn postemergence weed control with MON 12000. NCWSS Res. Rep. 49:126.

1992-3. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of metribuzin tank mixtures applied postemergence for weed control in corn, Ames, Iowa. NCWSS Res. Rep. 49:130-132.

1992-4. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of V-23031 plus bromoxynil for postemergence weed control in corn, Ames, Iowa. NCWSS Res. Rep. 49:132-133.

1992-5. Dobbels, A.F. and GH. Kapusta. 1992. Corn all postemergence weed control with nicosulfuron combinations. NCWSS Res. Rep. 49:145-146.

1992-6. Dobbels, A.F. and G. Kapusta. 1992. Postemergence weed control in corn with nicosulfuron combinations. NCWSS Res. Rep. 49:156.

1992-7. Owens, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of thifensulfuron combinations for weed control in corn, Ames, Iowa. NCWSS Res. Rep. 49:158-159.

1992-8. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1992. Annual weed control in imidazolinone resistant and imidazolinone tolerant field corn study. NCWSS Res. Rep. 49:166-167.

1992-9. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1992. Field corn weed control in conservation tillage studies. NCWSS Res. Rep. 49:170-173.

1992-10. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1992. Annual weed control in field corn studies. NCWSS Res. Rep. 49:176-179.

1992-11. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of imazethapyr combinations for weed control in herbicide resistant corn, Ames, Iowa. NCWSS Res. Rep. 49:182-183.

1992-12. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of V-23031 applied postemergence for weed control in corn, Ames, Iowa. NCWSS Res. Rep. 49:189-190.

1992-13. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Herbicide applications for shattercane control in corn, Ames, Iowa. NCWSS Res. Rep. 49:190-191.

1992-14. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Evaluation of V-23031 applied postemergence in combinations with atrazine for broadleaf weed control in corn, Ames, Iowa. NCWSS Res. Rep. 49:198-199.

1992-15. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1992. Weed management strategies in no till corn, Ames, Iowa. NCWSS Res. Rep. 49:304-305.

1993 Studies

1993-1. Owen, M.D.K., J.R. Lux, and K.T. Pecinovsky. 1993. Evaluation of imazethapyr and other herbicide combinations for weed management in a genetically altered corn hybrid, Ames, Iowa. NCWSS Res. Rep. 50:128-131.

1993-2. Obermeier, M.R. and G. Kapusta. 1993. Corn weed control with CGA 152005 plus companion post broadleaf herbicides. NCWSS Res. Rep. 50:132-133.

1993-3. Harvey, R.G. J.W. Albright, T.M. Anthon, and J.L. Kutil. 1993. Field corn herbicide studies. NCWSS Res. Rep. 50:178-183.

1993-4. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1993. Postemergence broadleaf weed control in field corn study. NCWSS Res. Rep. 50:192-194.

1993-5. Rathjen, M.E. and A.R. Martin. 1993. Evaluation of preemergence and postemergence herbicides in no-till corn at Lincoln, NE. NCWSS Res. Rep. 50:318-320.

1994 Studies

1994-1. Harvey, R.G., B.J. Williams, J.W. Albright, and T.M. Anthon. 1994. Annual weed management in sethoxydim-tolerant field corn study. NCWSS Res. Rep. 51:73-78.

1994-2. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1994. Field corn herbicide evaluation. NCWSS Res. Rep. 51:79-83.

1994-3. Obermeier, M.R. and G. Kapusta. 1994. Corn weed control with CGA-152005 plus other postemergence broadleaf herbicides. NCWSS Res. Rep. 51:89-91.

1994-4. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1994. Imazethapyr treatments for weed control in IR field corn study. NCWSS Res. Rep. 51:98-101.

1994-5. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1994. Annual weed control in field corn studies. NCWSS Res. Rep. 51:102-105.

1994-6. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1994. Evaluation of CGA-152005, CGA-248757, nicosulfuron, and primisulfuron for weed management in corn, Ames, Iowa. NCWSS Res. Rep. 51:112-114.

1994-7. Owen, M.D.K., J.F. Lux, and K.T. Pecinovsky. 1994. Evaluation of pyridate, primisulfuron, and bromoxynil combinations applied postemergence for weed management in corn, Crawfordsville, Iowa. NCWSS Res. Rep. 51:115-117.

1994-8. Kapusta, G., M.R. Obermeier, and M.J. Tweedy. 1994. Corn weed control with postemergence herbicides. NCWSS Res. Rep. 51:134-135.

1994-9. Leuschen, W.E., J.K. Getting, and J.L. Gunsolus, 1994. Coron herbicide evaluation at Lamberton, MN. NCWSS Res. Rep. 51:138-139.

1994-10. Hoverstad, T.R. 1994. Weed control in imidazolinone resistant corn at Waseca, MN. NCWSS Res. Rep. 51:150.

1994-11. Leuschen, W.E. and J.K. Getting. 1994. Eastern black nightshade control in corn at Lamberton, MN. NCWSS Res. Rep. 51:174-175.

1994-12. Leushen, W.E. and J.K. Getting. 1994. Weed control strategies for imidazolinone resistant corn at Lamberton, MN. NCWSS Res. Rep. 51:176-177.

1994-13. Kapusta, G. 1994. No-till corn weed control with postemergence herbicides. NCWSS Res. Rep. 51:313.

1995 Studies

1995-1. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1995. Broadleaf weed control in SR field corn studies. NCWSS Res. Rep. 52:144-146.

1995-2. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1995. Field corn herbicide studies. NCWSS Res. Rep. 52:152-156.

1995-3. Kapusta, G., S.T. Autman, and S.E. Curvey. 1995. Corn weed control with postemergence rimsulfuron & thifensulfuron combinations. NCWSS Res. Rep. 52:161-162.

1995-4. Leushen, W.E. and J.K. Getting. 1995. Weed control strategies in sethoxydim resistant corn at Lamberton, MN. NCWSS Res. Rep. 52:163-164.

1995-5. Harvey, R.G., B.J. Williams, J.W. Albright, and T.M. Anthon. 1995. Annual weed management in sethoxydim-tolerant field corn study. NCWSS Res. Rep. 52:176-181.

1995-6. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1995. Annual weed control in SR field corn studies. NCWSS Res. Rep. 52:186-191.

1995-7. Gunsolus, J.L. and D.D. Warnes. 1995. Herbicide performance in corn at Morris, MN. NCWSS Res. Rep. 52:200-203.

1995-8. Autman, S.T. and G. Kapusta. 1995. No-till corn weed control with postemergence herbicides. NCWSS Res. Rep. 52:402-403.

1996 Studies

1996-1. Leuschen, W.E. and J.K. Getting. 1996. Sequential weed control strategies in sethoxydim resistant corn at Lamberton, MN, 1996. NCWSS Res. Rep. 53:114-115.

1996-2. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1996. Weed management in sethoxydim-resistant field corn studies. NCWSS Res. Rep. 53:128-136.

1996-3. Kapusta, G., J.L. Matthews, and S.T. Autman. 1996. Gulfosinate-resistant corn weed control efficacy study. NCWSS Res. Rep. 53:145-147.

1996-4. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1996. Annual weed control in glufosinate-tolerant field corn study. NCWSS Res. Rep. 53:156-157.

1996-5. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 1996. Evaluation of several herbicide systems for weed control in glufosinate-resistant corn, Ames, Iowa, 1996. NCWSS Res. Rep. 53:158-159.

1996-6. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1996. Annual weed control in field corn study – soil treatments. NCWSS Res. Rep. 53:201-205.

1996-7. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1996. Annual weed control in field corn studies. NCWSS Res. Rep. 53:206-217.

1996-8. Hoverstad, T.R. and J.L. Gunsolus. 1996. Herbicide performance in corn at Waseca, MN in 1996. NCWSS Res. Rep. 53:226-227.

1996-9. Hoverstad, T.R. 1996. A comparison of bromoxynil formulations for weed control in corn. NCWSS Res. Rep. 53:243.

1996-10. Krausz, R.F. and G. Kapusta. 1996. Yellow nutsedge control in corn with MON 12000 and pyridate. NCWSS Res. Rep. 53:248.

1996-11. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 1996. Evaluation of SAN-1269H, dicamba, pyridate, and ALS inhibitor herbicides for weed control in corn, Ames, Iowa, 1996. NCWSS Res. Rep. 53:262-263.

1996-12. Harvey, R.G., S.J. Langton, J.W. Albright, and T.M. Anthon. 1996. Field corn herbicide studies. NCWSS Res. Rep. 53:266-268.

1996-13. Krausz, R.F. and G. Kapusta. 1996. Corn no-till early prelant weed control with reduced triazines rates. NCWSS Res. Rep. 53:435-437.

1996-14. Fandel, P.J., G.A. Janssen, D.R. Jenkins, and E.L. Knake. 1996. Evaluation of herbicides for no-till – East Peoria. NCWSS Res. Rep. 53:452-453.

1996-15. Anderson, A.H., P.J. Fandel, J.J. Prater, D.R. Pike, R.E. Dunker. 1996. Evaluation of herbicides for no-till corn – Urbana.

1997 Studies

1997-1. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1997. Sethoxydim-resistant field corn herbicide studies. NCWSS Res. Rep. 54:165-171.

1997-2. Kapusta, G., J.L. Matthews, and R.F. Krausz. 1997. Corn weed control with imazethapyr & imazapyr combinations. NCWSS Res. Rep. 54:179-181.

1997-3. Krausz, R.F. and G. Kapusta. 1997. Evaluation of weed control with nicosulfuron & rimsulfuron & atrazine, imazethapyr & imazapyr, and imazamox in IT corn. NCWSS Res. Rep. 54:182-183.

1997-4. Geier, P.W. and P.W. Stahlman. 1997. Evaluation of EXP31130/A in conventional-till corn. NCWSS Res. Rep. 54:194-195.

1998 Studies

1998-1. Spotanski, J.J., A.R. Martin, and J.T. Krumm. 1998. Weed control with glufosinate in corn at Lincoln, NE in 1998. NCWSS Res. Rep. 55:134-135.

1998-2. Mickelson, J.A., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1998. Wild-proso millet control in glufosinate-tolerant field corn study. NCWSS Res. Rep. 55:140-142.

1998-3. Kapusta, G., J.L. Matthews, and E.S. Chadbourne. 1998. Corn weed control with glufosinate combinations. NCWSS Res. Rep. 55:142-143.

1998-4. Maxwell, D.J., L.M. Wax, and S.E. Hart. 1998. Weed control in glyphosate and glufosinate resistant corn, Urbana, Illinois, 1998. NCWSS Res. Rep. 55:144-145.

1998-5. Mickelson, J.A., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1998. Wild-proso millet control in glufosinate-resistant field corn study. NCWSS Res. Rep. 55:146-147.

1998-6. Spotanski, J.J., A.R. Martin, and J.T. Krumm. 1998. Weed control with glyphosate and carfentrazone in corn at Lincoln, NE in 1998. NCWSS Res. Rep. 55:154-155.
1998-7. Fisher, D.W., R.G. Harvey, and J.D. Doll. 1998. Yellow nutsedge control in glyphosate-tolerant field corn study – Watertown, WI. NCWSS Res. Rep. 55:156-157.
1998-8. Harvey, R.G., J.W. Albright, and T.M. Anthon. 1998. Weed competition study in glyphosate-tolerant field corn study. NCWSS Res. Rep. 55:162-163.
1998-9. Harvey, R.G., J.W. Albright, and T.M. Anthon. 1998. Glyphosate-tolerant field corn weed control study. NCWSS Res. Rep. 55:164-167.
1998-10. Kalaher, C.J., E.W. Stoller, and D.J. Maxwell. 1998. Weed management in glyphosate resistant corn, Urbana, Illinois, 1998. NCWSS Res. Rep. 55:170-171.
1998-11. Kapusta, G., E.S. Chadbourne, and J.L. Matthews. 1998. Glyphosate-resistant corn weed control systems. NCWSS Res. Rep. 55:173-176.
1998-12. Mickelson, J.A., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1998. Wild-proso millet control in imidazolinone-tolerant field corn studies. NCWSS Res. Rep. 55:178-182.
1998-13. Harvey, R.G., J.W. Albright, and T.M. Anthon. 1998. Weed management in imidazolinone-resistant field corn study. NCWSS Res. Rep. 55:186-187.
1998-14. Geier, P.W. and P.W. Stahlman. 1998. Weed control with sulfonylurea herbicides in corn. NCWSS Res. Rep. 55:198-199.
1998-15. Spotanski, J.J., A.R. Martin, and J.T. Krumm. 1998. Weed control with pre and post herbicides in corn at Lincoln, NE in 1998. NCWSS Res. Rep. 55:210-211.
1998-16. Spotanski, J.J., A.R. Martin, and J.T. Krumm. 1998. Annual weed control systems in corn at Lincoln, NE in 1998. NCWSS Res. Rep. 55:238-239.
1998-17. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1998. Annual weed control in field corn studies. NCWSS Res. Rep. 55:243-247.
1998-18. Hoverstad, T.R., J.L. Gunsolus, and J.K. Getting. 1998. Herbicide performance in corn at Waseca, MN in 1998. NCWSS Res. Rep. 55:248-249.
1998-19. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1998. Long-term field corn herbicide benefit study #1 (yr.2). NCWSS Res. Rep. 55:250-251.
1998-20. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1998. Long-term field corn herbicide benefit study #2 (yr.1). NCWSS Res. Rep. 55:252-253.
1998-21. Harvey, R.G., D.W. Fischer, and T.M. Anthon. 1998. Long-term weed management study – Caledonia (yr.2). NCWSS Res. Rep. 55:254-255.
1998-22. Wax, L.M. and D.J. Maxwell. 1998. Weed control with ZA 1296 in corn, Urbana, Illinois, 1998. NCWSS Res. Rep. 55:260-261.
1998-23. Harvey, R.G., J.W. Albright, T.M. Anthon, and J.L. Kutil. 1998. Field corn herbicide studies. NCWSS Res. Rep. 55:262-274.
1998-24. Getting, J.K., J.L. Gunsolus, and T.R. Hoverstad. 1998. Herbicide performance in corn at Lamberton, MN in 1998. NCWSS Res. Rep. 55:278-279.
1998-25. Krausz, R.F. and G. Kapusta. 1998. Tillage by herbicide study in glufosinate-resistant corn. NCWSS Res. Rep. 55:411-413.
1998-26. Krumm, J.T. and A.R. Martin. 1998. Weed control in no-till corn at Lincoln, NE in 1998. NCWSS Res. Rep. 55:414-416.

1999 Studies

1999-1. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 1999. Weed management systems comparison study in field corn with woolly cupgrass. NCWSS Res. Rep. 56:137-140.

1999-2. Fischer, D.W., R.G. Harvey, J.W. Albright, and T. M. Anthon. 1999. Field corn herbicide studies. NCWSS Res. Rep. 56:147-153.

1999-3. Hoverstad, T.R., J.L. Gunsolus, and J.K. Getting. 1999. Herbicide performance in corn at Waseca, MN in 1999. NCWSS Res. Rep. 56:169-171.

1999-4. Getting, J.K., J.L. Gunsolus, and T.R. Hoverstad. 1999. Herbicide performance in corn at Lamberton, MN in 1999. NCWSS Res. Rep. 56:176-177.

1999-5. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 1999. Weed management systems comparison in field corn with heavy weed pressure. NCWSS Res. Rep. 56:180-184.

1999-6. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 1999. Weed management systems comparison in field corn with light weed pressure. NCWSS Res. Rep. 56:185-189.

1999-7. Fischer, D.W., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1999. Long-term field corn herbicide benefit study #1 (yr.3). NCWSS Res. Rep. 56:206-207.

1999-8. Young, B.H. and J.L. Matthews. 1999. Preemergence weed control with RPA 201772 in corn. NCWSS Res. Rep. 56:208.

1999-9. Sprague, C.L., D.J. Maxwell, and L.M. Wax. 1999. Comparisons of ZA-1296 and RPA 201772 for weed control in corn, Urbana, IL, 1999. NCWSS Res. Rep. 56:223-224.

1999-10. Young, B.G., B.C. Johnson, and J.L. Matthews. 1999. Preemergence and sequential weed control with ZA 1296 in conventional corn. NCWSS Res. Rep. 56:226-227.

1999-11. Waltz, A.L., A.R. Martin, and J.J. Spotanski, 1999. Weed control with ZA-1296 in field corn at Lincoln, NE in 1999. NCWSS Res. Rep. 56:228-230.

1999-12. Johnson, B.C., B.G. Young, and J.L. Matthews. 1999. Influence of application timing and atrazine on the postemergence broadleaf activity of ZA 1296. NCWSS Res. Rep. 56:230-231.

1999-13. Harvey, R.G., D.E. Stoltenberg, J.W. Albright, and T.M. Anthon. 1999. Management of weed species shifts in glyphosate-resistant cropping systems – (year 2). NCWSS Res. Rep. 56:236-238.

1999-14. Harvey, R.G., D.E. Stoltenberg, J.W. Albright, and T.M. Anthon. 1999. Management of weed species shifts in glyphosate-tolerant cropping systems – Caledonia (year 2). NCWSS Res. Rep. 56:239-242.

1999-15. Getting, J.K. and B.D. Potter. 1999. Herbicide performance in glyphosate resistant corn at Lamberton, MN in 1999. NCWSS Res. Rep. 56:245-246.

1999-16. Maxwell, D.J., L.M. Wax, and C.L. Sprague. 1999. Residual herbicides for weed control in glyphosate resistant corn, Urbana, Illinois, 1999. NCWSS Res. Rep. 56:247-248.

1999-17. Fischer, D.W., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1999. Annual weed control in glyphosate resistant field corn. NCWSS Res. Rep. 56:249-251.

1999-18. Krausz, R.F. and B.G. Young. 1999. Weed control in glyphosate-resistant corn. NCWSS Res. Rep. 56:263-265.

1999-19. Fischer, D.W., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1999. Annual weed control in field corn study – glufosinate and imidazolinone resistant. NCWSS Res. Rep. 56:268-270.

1999-20. Nolte, S.A., B.G. Young, and J.L. Matthews. 1999. Weed management systems in conventional and herbicide resistant corn. NCWSS Res. Rep. 56:276-277.

1999-21. Geier, P.W. and P.W. Stahlman. 1999. Carfentrazone in tank mixtures for postemergence weed control in no-till corn. NCWSS Res. Rep. 56:401-402.

1999-22. Fischer, D.W., R.G. Harvey, J.W. Albright, and T.M. Anthon. 1999. Weed management systems comparison in no-till field corn. NCWSS Res. Rep. 56:403-407.

1999-23. Geier, P.W. and P.W. Stahlman. 1999. Evaluation of ZA 1296 in dryland no-till corn. NCWSS Res. Rep. 56:418-419.

2000 Studies

2000-1. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control in N4640 BT field corn. NCWSS Res. Rep. 57:84-85.

2000-2. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems comparison in field corn with wild-proso millet. NCWSS Res. Rep. 57:96-99.

2000-3. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control in field corn with wild-proso millet. NCWSS Res. Rep. 57:100-101.

2000-4. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems comparison in field corn with woolly cupgrass. NCWSS Res. Rep. 57:106-109.

2000-5. Owen, M.D.K., J.F. Lux, D.D. Franzenburg, and J.M. Lee. 2000. Evaluation of postemergence applied atrazine & 2,4-D amine, PCC196 and V-10064 herbicides for weed control in corn, Ames, Iowa, 2000. NCWSS Res. Rep. 57:114-117.

2000-6. Maxwell, D.J. and L.M. Wax. 2000. Evaluation of ZA 1296 and other herbicides in corn, Urbana, Illinois, 2000. NCWSS Res. Rep. 57:120-122.

2000-7. Johnson, B.C., B.H. Young, and J.L. Matthews. 2000. Postemergence ZA 1296 tank-mix partners. NCWSS Res. Rep. 57:123-124.

2000-8. Krausz, R.F. and B.G. Young. 2000. Weed control in glyphosate-resistant corn. NCWSS Res. Rep. 57:153-155.

2000-9. Hasty, R.F. and C.L. Sprague. 2000. Weed control in glyphosate resistant corn, Dekalb, Illinois, 2000. NCWSS Res. Rep. 57:156-157.

2000-10. Harvey, R.G., D.E. Stoltenberg, J.W. Albright, and T.M. Anthon. 2000. Management of weed species shifts in glyphosate-tolerant cropping systems – Caledonia (year 3). NCWSS Res. Rep. 57:163-166.

2000-11. Harvey, R.G., D.E. Stoltenberg, J.W. Albright, and T.M. Anthon. 2000. Management of weed species shifts in glyphosate-resistant cropping systems – (year 3). NCWSS Res. Rep. 57:167-169.

2000-12. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control in glyphosate resistant field corn. NCWSS Res. Rep. 57:170-171.

2000-13. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control in glufosinate resistant field corn. NCWSS Res. Rep. 57:179-180.

2000-14. Getting, J.K. 2000. Glufosinate resistant corn yield trial at Lamberton, MN in 2000. NCWSS Res. Rep. 57:181-182.

2000-15. Getting J.K. 2000. Weed control in glufosinate resistant corn at Lamberton, MN in 2000. NCWSS Res. Rep. 57:183-184.

2000-16. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control study in imidazolinone resistant field corn. NCWSS Res. Rep. 57:185-186.

2000-17. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems in field corn near Baraboo, Wisconsin. NCWSS Res. Rep. 57:197-200.

2000-18. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems comparison in field corn near Deforest, Wisconsin. NCWSS Res. Rep. 57:201-204.

2000-19. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems comparison in field corn with heavy weed pressure. NCWSS Res. Rep. 57:205-208.

2000-20. Nolte, S.A., B.G. Young, and J.L. Matthews. 2000. Weed management in conventional and herbicide resistant corn. NCWSS Res. Rep. 57:214-217.

2000-21. Hoverstad, T.R. and J.L. Gunsolus. 2000. Herbicide performance in corn at Waseca, MN in 2000. NCWSS Res. Rep. 57:235-237.

2000-22. Harvey, R.G., J.W. Albright, and T.M. Anthon. 2000. Annual weed control in field corn. NCWSS Res. Rep. 57:238-242.

2000-23. Fischer, D.W., R.G. Harvey, and T.M. Anthon. 2000. Long-term weed management study – Caledonia (yr. 4). NCWSS Res. Rep. 57:243-245.

2000-24. Owen, M.D.K., J.F. Lux, D.D. Franzenburg, and J.M. Lee, 2000. ICIA-5676 & ZA 1296 with ICIA-0224 and paraquat for burndown and residual weed control in no tillage corn, Ames, Iowa, 2000. NCWSS Res. Rep. 57:376-377.

2000-25. Owen, M.D.K., J.F. Lux, D.D. Franzenburg, and J.M. Lee. 2000. Evaluation of FOE 5043 & metribuzin, FOE 5043 & metribuzin & atrazine, and FOE 5043 & RPA 201772 alone or in tank-mix combinations for weed control in no tillage corn, Ames, Iowa, 2000. NCWSS Res. Rep. 57:380-382.

2000-26. Bauman, T.T., M.D. White, and D.E. Hillger. 2000. Burndown and residual control with RPA 201772 in corn. NCWSS Res. Rep. 57:389-390.

2000-27. Fischer, D.W., R.G. Harvey, J.G. Lauer, J.W. Albright, and T.M. Anthon. 2000. Weed management systems comparison in no-till corn. NCWSS Res. Rep. 57:409-412.

2001 Studies

2001-1. Wrage, L.J., D.L. Deneke, D.A. Vos, and S.A. Wagner. 2001. Woolly cupgrass control in corn. NCWSS Res. Rep. 58:105-106.

2001-2. Young, B.G. and S.A. Nolte, 2001. Comparison of corn soil-applied herbicides for control of common waterhemp. NCWSS Res. Rep. 58:129.

2001-3. Krausz, R.F., B.G. Young, and J.L. Matthews. 2001. Postemergence waterhemp control in corn. NCWSS Res. Rep. 58:130-131.

2001-4. Sprague, C.L. and D.J. Maxwell. 2001. AEF 130360 sequential systems for weed control in corn, Urbana, Illinois, 2001. NCWSS Res. Rep. 58:137-139.

2001-5. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2001. Preemergence S-metolachlor & CGA-154281 plus ZA 1296 and S-metolachlor & CGA-154281 followed by ZA 1296 postemergence in corn, Nashua, IA, 2001. NCWSS Res. Rep. 58:168-171.

2001-6. Young, B.G., A.J. Hoskins, and J.L. Matthews. 2001. Preemergence comparison of RPA 201772 and ZA 1296. NCWSS Res. Rep. 58:172-173.

2001-7. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2001. Preemergence S-metolachlor & CGA-154281 plus ZA 1296 and S-metolachlor & CGA-154281 followed by ZA 1296 postemergence in corn, Ames, IA 2001. NCWSS Res. Rep. 58:176-179.

2001-8. Hager, A.G., R.F. Hasty, and D.J. Maxwell. 2001. Weed control systems in herbicide resistant corn, Urbana, Illinois, 2001. NCWSS Res. Rep. 58:185-188.

2001-9. Hoverstad, T.R. and J.L. Gunsolus. 2001. Herbicide performance in corn at Waseca, MN, common ragweed site in 2001. NCWSS Res. Rep. 58:212-213.

2001-10. Hoverstad, T.R. and J.L. Gunsolus. 2001. Herbicide performance in corn at Waseca, MN, common cocklebur site in 2001. NCWSS Res. Rep. 58:214-215.

2001-11. Getting, J.K., J.L. Gunsolus, and T.R. Hoverstad. 2001. Herbicide performance in corn at Lamberton, MN in 2001. NCWSS Res. Rep. 58:230-231.

2002 Studies

2002-1. Hoverstad, T.R. and J.L. Gunsolus. 2002. Herbicide performance in corn at Waseca, MN tall waterhemp site in 2002. NCWSS Res. Rep. 59:70-71.
2002-2. Krausz, R.F. and B.G. Young. 2002. Effect of nitrogen on common waterhemp control in corn. NCWSS Res. Rep. 59:72-74.
2002-3. Hoverstad, T.R. and J.L. Gunsolus. 2002. Herbicide performance in corn at Waseca, MN common cocklebur site in 2002. NCWSS Res. Rep. 59:75-76.
2002-4. Hoverstad, T.R. and J.L. Gunsolus. 2002. Herbicide performance in corn at Waseca, MN common ragweed site in 2002. NCWSS Res. Rep. 59:77-78.
2002-5. Bunting, J.A., D.J. Maxwell, and C.L. Sprague. 2002. AE F 130360 01 combinations for weed control in corn. Urbana, Illinois, 2002. NCWSS Res. Rep. 59:97-99.
2002-6. Wax, L.M., D.J. Maxwell, and A.G. Hager. 2002. Weed control systems for weed control in glyphosate resistant corn. Urbana, Illinois, 2002. NCWSS Res. Rep. 59:135-138.
2002-7. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2002. Evaluation of weed control with preemergence applied herbicide combinations including imazethapyr & imazapyr, dicamba & San 1269H, mesotrione and others. Ames, IA, 2002. NCWSS Res. Rep. 59:147-150.
2002-8. Schaufler, K.L., F.R. Breitenbach, and L.M. Behnken. 2002. Evaluation of glufosinate and mesotrione weed management systems in corn at Rochester, MN in 2002. NCWSS Res. Rep. 59:155-156.
2002-9. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2002. Evaluation of crop phytotoxicity and weed control from preemergence and postemergence applied herbicides, Nashua, IA, 2002. NCWSS Res. Rep. 59:168-172.
2002-10. Getting, J.K., J.L. Gunsolus, and T.R. Hoverstad. 2002. Herbicide performances in corn at Luverne, MN in 2002. NCWSS Res. Rep. 59:175-176.
2002-11. Soderholm, C.L., F.R. Breitenbach, and L.M. Behnken. 2002. Herbicide performance in corn at Rochester, MN in 2002. NCWSS Res. Rep. 59:177-178.
2002-12. Krausz, R.F. and B.G. Young. 2002. Long-term tillage by herbicide study in a transgenic corn and soybean rotation. NCWSS Res. Rep. 59:241-245.

2003 Studies

2003-1. Getting, J.K. and B.D. Potter. 2003. Weed control with soil applied atrazine tank mixes in corn at Lamberton, MN in 2003. NCWSS Res. Rep. 60:73-74.
2003-2. Behnken, L.M., F.R. Breitenbach, K.R. Griffin, and K.L. Schaufler. 2003. Evaluation of isoxaflutole, s-metolachlor & mesotrione & CGA-154281, and s-metolachlor & atrazine & mesotrione & CGA-154281 for weed control in corn at Rochester, MN in 2003. NCWSS Res. Rep. 60:83-84.
2003-3. Hoverstad, T.R. and J.L. Gunsolus. 2003. Herbicide performance in corn at Waseca, MN common ragweed site in 2003. NCWSS Res. Rep. 60:85-86.
2003-4. Hoverstad, T.R. and J.L. Gunsolus. 2003. Herbicide performance in corn at Waseca, MN tall waterhemp site in 2003. NCWSS Res. Rep. 60:87-88.
2003-5. Hoverstad, T.R. and J.L. Gunsolus. 2003. Herbicide performance in corn at Waseca, MN common cocklebur site in 2003. NCWSS Res. Rep. 60:89-90.
2003-6. Getting, J.K., J.L. Gunsolus, and T.R. Hoverstad. 2003. Herbicide performance in corn at Lamberton, MN in 2003. NCWSS Res. Rep. 60:93-94.
2003-7. Breitenbach, F.R., L.M. Behnken, A.R. Sheehan, and K.L. Schaufler. 2003. Comparison of single pass and two-pass sequential weed management systems for weed control in corn at Potsdam, MN in 2003. NCWSS Res. Rep. 60:95-96.

2003-8. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2003. Evaluation of two-pass versus single-pass corn herbicide programs for crop phytoxicity and weed control, Ames, IA, 2003. NCWSS Res. Rep. 60:97-100.

2003-9. Behnken, L.M., F.R. Breitenbach, A.R. Sheehan, and A.L. Plank. 2003. Comparison of the performance of foramsulfuron and foramsulfuron & iodosulfuron alone and in combination with other herbicides for weed control in corn at Rochester, MN in 2003. NCWSS Res. Rep. 60:113-114.

2003-10. Getting, J.K. and B.D. Potter. 2003. Weed control with POST applied [nicosulfuron & rimsulfuron] tank mixes in corn at Lamberton, MN in 2003. NCWSS Res. Rep. 60:121-122.

2003-11. Hager, A.G., D.J. Maxwell, and D.E. Norby. 2003. Postemergence herbicide programs for weed control in corn, Urbana, Illinois, 2003. NCWSS Res. Rep. 60:123-125.

2003-12. Getting, J.K. and B.D. Potter. 2003. Weed control with glyphosate tank mixed with dicamba and [dicamba & San 1269H] in glyphosate-resistant corn at Lamberton, MN in 2003. NCWSS Res. Rep. 60:136-137.

2003-13. Krausz, R.F. and B.G. Young. 2003. Common cocklebur and giant foxtail control in glyphosate-resistant corn. NCWSS Res. Rep. 60:150-151.

2004 Studies

2004-1. Behnken, L.M., F.R. Breitenbach, A.L. White, and K.R. Griffin. 2004. Comparison of single-pass and two-pass sequential management systems for weed control in field corn at Rochester, MN in 2004. NCWSS Res. Rep. 61:39-40.

2004-2. Hoverstad, T.R. and J.L. Gunsolus. 2004. Herbicide performance in corn at Waseca, MN common cocklebur site in 2004. NCWSS Res. Rep. 61:41-42.

2004-3. Hoverstad, T.R. and J.L. Gunsolus. 2004. Herbicide performance in corn at Waseca, MN tall waterhemp site in 2004. NCWSS Res. Rep. 61:43-44.

2004-4. Hoverstad, T.R. and J.L. Gunsolus. 2004. Herbicide performance in corn at Waseca, MN giant ragweed site in 2004. NCWSS Res. Rep. 61:45-46.

2004-5 Hoverstad, T.R. and J.L. Gunsolus. 2004. Herbicide performance in corn at Waseca, MN common ragweed site in 2004. NCWSS Res. Rep. 61:47-48.

2004-6. Waddington, M.A., B.G. Young, J.M.Young, and S.D. Nettleton. 2004. Postemergence application timing in glyphosate-resistant corn. NCWSS Res. Rep. 61:77-78.

2005 Studies

2005-1. Breitenbach, F.R., L.M. Behnken, T.R. Hoverstad, and J.L. Gunsolus. 2005. Evaluation of weed management systems in field corn at Rochester, MN in 2005. NCWSS Res. Rep. 62:46-48.

2005-2. Breitenbach, F.R., L.M. Behnken, C.W. Stever, and K.M. Sheehan. 2005. Evaluation of application timings of mesotrione and glyphosate based systems in field corn at Rochester, MN in 2005. NCWSS Res. Rep. 62:62-64.

2005-3. Owen, M.D.K., J.F. Lux, and D.D. Franzenburg. 2005. Postemergence applications of nicosulfuron & rimsulfuron, topramezone, atrazine, mesotrione, foramsulfuron and others for weed control in corn, Ames, IA, 2005. NCWSS Res. Rep. 62:65-68.

2005-4. Horky, K.T. and A.R. Martin. 2005. Weed control in glufosinate resistant corn. NCWSS Res. Rep. 62:69-72.

2005-5. Horky, K.T. and A.R. Martin. 2005. Evaluation of glyphosate programs in corn. NCWSS Res. Rep. 62:75-77.

2005-6. Hoverstad, T.R. 2005. Topramezone for weed control in corn at Waseca, MN in 2005. NCWSS Res. Rep. 62:91-92.

2005-7. Horky, K.T. and A.R. Martin. 2005. Evaluation of topramezone in corn. NCWSS Res. Rep. 62:93-95.
2005-8. Hoverstad, T.R. and J.L. Gunsolus. 2005. Herbicide performance in corn at Waseca, MN tall waterhemp site in 2005. NCWSS Res. Rep. 62:114-115.
2005-9. Hoverstad, T.R. and J.L. Gunsolus. 2005. Herbicide performance in corn at Waseca, Mn giant ragweed site in 2005. NCWSS Res. Rep. 62:116-117.
2005-10. Hoverstad, T.R. and J.L. Gunsolus. 2005. Herbicide performance in corn at Waseca, MN common ragweed site in 2005. NCWSS Res. Rep. 62:118-119.
2005-11. Hoverstad, T.R. and J.L. Gunsolus. 2005. Herbicide performance in corn at Waseca, MN common cocklebur site in 2005. NCWSS Res. Rep. 62:120-121.

KNOWLEDGE, PERCEPTIONS AND ATTITUDES OF ORGANIC FARMERS ABOUT WEED CONTROL. Elizabeth Canales, Jason Parker, Robyn Wilson, Mark Tucker and Doug Doohan, Research Assistant, Post Doctoral Associate, Assistant Professor, and Associate Professor, The Ohio State University, Columbus, OH 44691, Associate Professor, Purdue University, West Lafayette, IN 47907.

Previous research has shown that organic farmers rely on non-traditional sources of agricultural production knowledge. Networks of like-minded individuals willing to share knowledge are preferred over programming provided by land grant universities. Moreover a strong emphasis upon heuristic approaches has been identified. A predictable outcome of such preferences is belief in concepts not yet supported by scientific evidence. The objective of this research was to identify key concepts and attitudes held by organic farmers about weeds and weed control and determine how they differed from those held by conventional farmers. Methodology included development of an expert model that described key concepts about how weeds are introduced and spread in the agro-ecosystem, management strategies and techniques, and their positive and negative impacts. Fourteen organic farmers from central and northern Ohio were selected for interviews using an open-ended survey instrument that was based on the expert model. Most interviews were conducted in-person and lasted approximately 90 minutes. Interviews were transcribed and key concepts were coded and mapped into an influence diagram. This process provided for the development of a mental model (i.e., conceptual map) describing the deeply held knowledge, perceptions and attitudes of this cohort. Similarities and contrasts with a mental model previously completed for conventional farmers were identified and characterized. The long-term goal of this research is to identify and develop new education and research opportunities that are more appropriate to the needs of organic farming.

GLYPHOSATE INFLUENCE ON SUGARBEET PRODUCTION AND CONTROL OF ABUTILON THEOPHRASTI, CHENOPODIUM ALBUM, AND AMARANTHUS SPECIES USING WEED GROWTH STAGE AND GROWING DEGREE DAYS. Mark W. Bredehoeft*, Mark W. Bloomquist, Chris C. Dunsmore, and Cody W. Bakker, Southern Minn. Beet Sugar Coop., 83550 County Rd 21, Renville, MN 56284.

Weed control in sugarbeets has been a challenge since the inception of sugarbeet production. Conventional sugarbeet weed control has seen many modifications to optimize the efficacy of these products. Weed control with conventional products has been managed by growth stage of sugarbeet and weeds and more recently by growing degree days. In 2008 a significant part of the sugarbeet growing regions in the United States seeded some percentage of their sugarbeet production acres to a biotech variety with the Glyphosate tolerant trait. Sugarbeet growers need to be given information to best manage Glyphosate for weed control in sugarbeet. A study was established in 2008 in Southern Minnesota to evaluate application of Glyphosate for control of Abutilon theophrasti, Chenopodium album and Amaranthus species using weed growth stage or growing degree days. A base of 34 degrees Fahrenheit was used to calculate GDD. One treatment with Glyphosate gave 54, 69 and 83 percent control of Abutilon theophrasti, Amaranthus species and Chenopodium album. All other Glyphosate treatments gave weed control with of 90% or greater. Sugarbeet production was best with Glyphosate applied at 200 and 400 GDD and one application prior to row closure. The application at 200 GDD tended to be the most important when an application one week prior to row closure was conducted. Glyphosate application at 1, 2, 4, and 6 inch weeds was best for weed control and sugarbeet production with Glyphosate applied at 32 oz. per acre compared to 22 oz. per acre.

WEED CONTROL IN GLYPOSATE-RESISTANT SUGAR BEETS. Jeff M. Stachler, Alan G. Dexter, and John L. Luecke, Assistant Professor, Professor, and Research Specialist, Department of Plant Sciences, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050.

Glyphosate-resistant sugar beet was commercially available for the first time in 2008 in North Dakota and Minnesota. Glyphosate-resistant canola, corn, and soybean can be weed problems in glyphosate-resistant sugar beet, requiring the use of conventional sugar beet herbicides for control. Glyphosate-resistant and tolerant weeds will be difficult to control in glyphosate-resistant sugar beet, requiring the use of conventional sugar beet herbicides to obtain control. Two small-plot field research studies were conducted. Glyphosate-resistant sugar beets were not planted at either location. At Prosper, ND, glyphosate-resistant canola, corn, and soybean were planted in rows perpendicular to the treated plot length to establish plants for evaluation. At this location, triflusulfuron at 9 g ai/ha, clopyralid at 34 g ae/ha and 78 g ae/ha, clethodim (Select Max) at 34 and 78 g ai/ha, clethodim (2EC) at 34 and 78 g ai/h, quizalofop at 34 and 78 g ai/ha, and desmedipham plus phenmedipham plus ethofumesate (Progress) at 370 g ai/ha plus triflusulfuron at 9 g/ha were applied in combination with glyphosate at 1.1 kg ae/ha plus AMS 2.8 kg/ha. A non-ionic surfactant, a MSO, and a high surfactant (methylated) oil were added to each of the lowest rate conventional sugar beet herbicides, with the exception of quizalofop and clethodim (2EC). All treatments were applied on June 19, 2008 and again on July 1st.

At 20 days after the last application, clopyralid controlled greater than 94% of the glyphosate-resistant soybean regardless of rate or adjuvant. Triflusulfuron plus the oils and Progress plus triflusulfuron plus the oils controlled 71 to 79% of the glyphosate-resistant soybean. No other herbicide combination provided greater than 70% control of glyphosate-resistant soybean. Only Progress plus triflusulfuron plus oils or with no adjuvant controlled 43 to 48% of glyphosate-resistant canola. All other treatment combinations provided less than 29% control. Quizalofop, clethodim (2EC), and Select Max at any rate plus any adjuvant controlled greater than 92% of the glyphosate-resistant corn with the exception of clethodim (2EC) at 34 g/ha plus no adjuvant and plus non-ionic surfactant. Triflusulfuron plus oils and Progress plus triflusulfuron plus oils controlled 60 to 69% of glyphosate-resistant corn. No other treatments provided greater than 55% control of glyphosate-resistant corn.

The second study was established at Kindred, ND in a 2007 sugar beet field having ladysthumb, wild buckwheat, Powell amaranth, and redroot pigweed. Several treatments were investigated. The treatments of interest included ethofumesate applied PRE at 4.2 kg ai/ha followed by Progress at 135 g/ha plus triflusulfuron at 4.5 g/ha plus clopyralid at 34 g/ha plus Select Max at 34 g/ha plus MSO at 1.5%v/v on May 22, 2008 followed by Progress at 179 g/ha plus previous products applied on May 29th and June 17th followed by Progress at 280 g/ha plus previous products applied on June 24th. All treatments containing glyphosate were applied at 1.1 kg/ha plus AMS at 2.8 kg/ha. Glyphosate was applied on May 22 and June 17th, May 22nd and June 24th, May 29th and June 24th, May 29th and July 1st, and May 22, June 17th, and July 1st. Ethofumesate at 4.2 kg/ha plus glyphosate was applied on May 22nd followed by glyphosate on June 24th. Glyphosate was applied on May 22nd followed by glyphosate plus dimethenamid at 1.1 kg ai/ha on June 17th. Glyphosate plus triflusulfuron at 9 g/ha and glyphosate plus clopyralid were applied on May 29th and June 24th.

At 28 days after the July 1st application, the conventional herbicide treatment provided more effective control of ladysthumb, wild buckwheat, Powell amaranth, and redroot pigweed, than glyphosate applied on May 22nd and June 17. Glyphosate followed by glyphosate plus dimethanamid controlled 87% of ladystumb compared to glyphosate applied on May 22nd and June 17th. Glyphosate applied on May 29th and July 1st provided the most effective control of ladysthumb at 94%. The conventional herbicide treatment controlled 89% of wild buckwheat compared to the two sequential glyphosate applications last sprayed on June 24th. Glyphosate plus triflusulfuron followed by glyphosate plus triflusulfuron controlled 83% of wild buckwheat compared to glyphosate applied on May 29th and June 24th. The conventional herbicide treatment, ethofumesate plus glyphosate followed by glyphosate, glyphosate followed by glyphosate plus dimethenamid, and sequential applications of glyphosate plus triflusulfuron controlled 87, 66, 83, and 80% of Powell amaranth and redroot pigweed compared to the sequential glyphosate treatments last applied on June 17th and 24th ranging from 28 to 53%.

For maximum control of glyphosate-resistant crops in glyphosate-resistant sugarbeet, three different herbicides/combinations will be necessary. However, with additional research it may be possible to control all glyphosate-resistant crops with a single herbicide, triflusulfuron. The proper timing and combination of conventional sugar beet herbicides can improve weed control compared to early-season sequential glyphosate applications and provide similar control to late-season sequential glyphosate applications. The addition of dimethenamid and triflusulfuron to glyphosate improved control of Powell amaranth and redroot pigweed and ladysthumb for demethenamid and wild buckwheat for triflusulfuron at the Kindred location.

PRODUCT INTEGRITY – A COMPREHENSIVE PROGRAM USED TO PREVENT CROSS-CONTAMINATION INCIDENTS AT DOW AGROSCIENCES. David G. Ouse, Research Biologist and Jim Gifford Senior Technician, Crop Protection Research and Development, Dow AgroSciences, 9330 Zionsville Road, Indianapolis, IN 46268.

It is common in the agriculture industry to share equipment in the manufacture of agrichemicals as the volumes of many products do not justify the expense of having dedicated equipment. Therefore, a Product Integrity program has been developed at Dow AgroSciences to manage the change-over from one product to another in our manufacturing process. The central focus of our Product Integrity Policy states that our products will not contain extraneous ingredients at levels that could cause regulatory or performance issues.

In order to effectively manage the production of our products a series of Product Integrity Requirements have been developed to define processes that effectively manage this risk. Dow AgroSciences’ Product Integrity Requirements do not allow the sharing of process equipment between insecticides or fungicides with herbicides. Additionally, herbicide and insecticide or fungicide production is required to be separated by a solid wall in order to avoid any mix ups or misidentification of ingredients. The clean out of equipment from one product to another is required to ensure that the preceding active ingredient will not cause issues in the following product. In order to determine what level to clean the equipment an acceptable cleaning level (ACL) is calculated. The ACL is calculated by using the no-observable effect level (NOEL) of the preceding active ingredient on the most sensitive crop the following product is labeled for use on. This NOEL is divided by a safety factor and also divided by the maximum use rate of the next product. Thus, an ACL is a biological value that if exceeded could cause crop injury. Additionally, EPA has established maximum levels at which extraneous ingredients can be present in another product in USEPA Pesticide Regulation Notice 96-8. At Dow AgroSciences’ we use the lowest value either the calculated biological ACL or the EPA default level.

Dow AgroSciences also periodically assesses our internal and external contract facilities for alignment with our Product Integrity Requirements in order to ensure compliance with our Product Integrity Program. Collectively, our processes and assessment program enables us to effectively manage risk and prevent cross-contamination from preceding products in equipment that is shared.

PERFORMANCE OF GOLDSKY HERBICIDE ON GRASS AND BROADLEAF WEEDS IN SPRING WHEAT. Roger E. Gast, Brett M. Oemichen, Monte R. Weimer, and Marcin D. Dzikowski, Dow AgroSciences LLC, Indianapolis, IN 46268.

Pyroxsulam is a new triazolopyrimidine sulfonamide herbicide that provides broad spectrum postemergence grass and broadleaf weed control in wheat. The control spectrum includes key annual grasses occurring across the global wheat markets such as blackgrass (*Alopecurus sp.*), windgrass (*Apera spica-venti*), wild oat (*Avena sp.*), annual bromes (*Bromus sp*.), ryegrass (*Lolium sp*). and canarygrass (*Phalaris sp.*), and certain broadleaf species. GoldSky™ herbicide is an oil dispersion premix formulation (coded GF-1848) containing pyroxsulam, florasulam and fluroxypyr-meptyl designed to deliver full spectrum control of key annual weeds in the U.S. spring wheat market. The label use rate of one pint formulated product A^{-1} delivers 15 + 2.5 + 100 gae ha^{-1} of each component, respectively.

Replicated field research trials were conducted in 2007 and 2008 at 29 locations across the northern spring wheat states of North Dakota, Montana and Idaho to determine the relative performance of GF-1848 compared to current standard grass and broadleaf herbicide tank mix treatments. GF-1848 was applied at the labeled rate with a non-ionic surfactant at 0.5% v/v plus ammonium sulfate fertilizer at a rate of 1.7 kg ha^{-1}. Comparison grass herbicide treatments included clodinafop, fenoxaprop, pinoxaden, flucarbazone, and the premix of mesosulfuron plus propoxycarbazone, all applied at typical label rates.

GF-1848 provided 91% mean late season control of wild oats over 12 locations, similar to the clodinafop (92%) and pinoxaden (94%) treatments. Wild oat control with other comparision treatments was lower. Fenoxaprop control ranged from 62% to 86% and mesosulfuron plus propoxycarbazone 83% to 87% depending on tank mix partners, and flucarbazone plus 2,4-D averaged 82%. Yellow foxtail late season control with GF-1848 was 92%, comparable to pinoxaden (94%), and was higher than all other comparison treatments. Green foxtail control with GF-1848 was 76%, similar to clodinafop and flucarbazone at 81% and 71%, respectively. Both treatments provided less green foxtail control than pinoxaden or fenoxaprop treatments.

GF-1848 provided excellent control of key broadleaf weeds such as kochia (92%), Russian thistle (88%), wild mustard (98%), wild buckwheat (90%), redroot pigweed (99%) and common lambsquarters (92%). Spring wheat tolerance to GF-1848, up to the double label rate, was excellent in all weed free trials with no significant yield losses observed. Rotational studies conducted on the key rotational crops indicate that all tested crops can be planted the season following application of GF-1848. The results of these trials indicate that GoldSky provides unique one pass, cross-spectrum control of key weeds in spring wheat delivered in a single formulation.

™ Trademark of Dow AgroSciences LLC

EFFECT OF TIMING AND ADJUVANTS ON WEED CONTROL WITH PYROXSULAM IN WINTER WHEAT. Gary A. Finn, Monte R. Weimer, Brett M. Oemichen, Harvey A. Yoshida, and D. Chad Cummings, Dow AgroSciences, Indianapolis, IN 46268.

Field research was conducted in multiple locations across the central and western winter wheat belt to determine the effect of application timing on the control of downy brome and true cheat with pyroxsulam versus competitive standards. The impact of ammonium sulfate or urea ammonium nitrate on the efficacy of pyroxsulam on downy brome was also investigated. A total of 12 trials were conducted in 2008 in Kansas, Colorado, Montana, Idaho, Oregon, and Washington. In the application timing study, pyroxsulam (18.4 g ha^{-1}) was compared against propoxycarbazone (44 g ha^{-1}), sulfosulfuron (35 g ha^{-1}), and the premix (Olympus Flex) propoxycarbazone-sodium + mesosulfuron-methyl (25 g ha^{-1}). The four application timings were fall, early winter, late winter/early spring, and normal spring. The five treatments in the adjuvant study were pyroxsulam (18.4 g ha^{-1}) + nonionic surfactant (0.5% v/v), pyroxsulam (18.4 g ha^{-1}) + nonionic surfactant (0.5% v/v) + ammonium sulfate (1.7 kg ha^{-1}), pyroxsulam (18.4 g ha^{-1}) + nonionic surfactant (0.5% v/v) + urea ammonium nitrate (4.68 l ha^{-1}), propoxycarbazone (44 g ha^{-1}) + nonionic surfactant (0.5% v/v), and Olympus Flex (25 gai/ha) + nonionic surfactant (0.5% v/v) + ammonium sulfate (1.7 kg ha^{-1}). In the adjuvant study, applications were made in the fall or in the spring to winter wheat.

In the application timing study, pyroxsulam control of downy brome, when applied in the fall was equal to the competitive standards (>80% control). Applications in the fall provided greater downy brome control versus the spring applications for pyroxsulam, propoxycarbazone, sulfosulfuron, and Olympus Flex. The ranking of the application timings relative to downy brome control were: fall application > normal spring application > winter or early spring (before green-up) applications. Winter dormancy resulted in reduced downy brome control in the winter early spring applications for all the herbicide treatments in the Hays, Kansas and Huntley, Montana locations. Pyroxsulam provided better control of true cheat than downy brome at all application timings. Application timing of pyroxsulam did not affect the control of true cheat, resulting in 95-100% control across all application timings. In the adjuvant study, the addition of ammonium sulfate or urea ammonium nitrate contributed to an increase in downy brome control in adverse growing environments with low moisture and low relative humidity in the Montana, Colorado, and Idaho trials. Pyroxsulam downy brome control was increased 9-14 % in the fall applications and 5-7 % with the spring applications with the addition of ammonium sulfate or urea ammonium nitrate to the spray mixture. The addition of ammonium sulfate or urea ammonium nitrate resulted in little to no effect on downy brome control with pyroxsulam in the Kansas, Washington, and Oregon trial locations. In these locations, growing conditions were more favorable to good plant growth (low moisture stress, actively growing downy brome, and good winter wheat crop competition) resulting in excellent winter wheat growth and good overall weed control. Ammonium sulfate and urea ammonium nitrate were roughly equal in their effect at increasing downy brome control with pyroxsulam with the fall and spring applications. These studies indicate that downy brome control with pyroxsulam is best achieved when applied to actively growing plants < 2 tillers in size. Control of downy brome was reduced when pyroxsulam was applied to winter or drought dormant plants. The results of the adjuvant study support the addition of ammonium sulfate or urea ammonium nitrate to pyroxsulam spray solutions for optimal control of downy brome under adverse growing conditions.

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

Wolverine™ herbicide is a new postemergence grass and broadleaf herbicide that has been developed by Bayer CropScience for use in spring wheat, durum, winter wheat, and barley. Wolverine has a very favorable ecological, ecotoxicological, and environmental profile with low acute mammalian toxicity and no genotoxic, mutagenic or oncogenic properties noted. Wolverine is a pre-formulated mixture containing the novel active ingredient, pyrasulfotole, with bromoxynil, fenoxaprop p-ethyl and the highly effective herbicide safener, mefenpyr-diethyl. This unique combination of active ingredients provides consistent broad spectrum grass and broadleaf weed control with excellent crop tolerance. Rapid microbial degradation is the primary degradation pathway for pyrasulfotole in the soil environment, with no soil activity from fenoxaprop and bromoxynil. Therefore, Wolverine has an excellent crop rotation profile, allowing re-cropping to all of the major crops grown in the northern cereal production area.

Wolverine is specially formulated as an emulsifiable concentrate for easy handling and optimized for grass and broadleaf weed control. Apply Wolverine after the cereal crop has emerged and before flag leaf emergence. Grass weeds should be treated with Wolverine between the 1 leaf and 2 tiller stage of growth and broadleaf weeds should be treated with Wolverine between the 1 - 8 leaf stage of growth depending on weed species.

Wolverine will be labeled on 63 different weed species with many of them common in the northern cereal production area of the United States. Wolverine provides excellent control of key grass and broadleaf weeds such as wild oat, yellow foxtail, green foxtail, kochia, pigweed sp., wild buckwheat, common lambsquarters, mustard sp., Russian thistle, field pennycress, prickly lettuce, common waterhemp, white cockle, and nightshade sp. Excellent control of sulfonylurea resistant weeds such as kochia, prickly lettuce and Russian thistle biotypes has been confirmed with Wolverine in field trials. Wolverine has been tested on spring wheat, durum wheat, and barley varieties and crop tolerance was excellent on all varieties tested. Broad spectrum weed control across a wide range of grass and broadleaf weeds, excellent crop safety, and very favorable toxicological, ecotoxicological and environmental properties make Wolverine a safe and easy to use tool for cereal grain farmers.

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

Huskie™ is a new broad spectrum postemergence broadleaf herbicide that was introduced in 2008 by Bayer CropScience. Huskie is registered for use in spring wheat, durum, winter wheat, barley and triticale. Huskie is a mixture of pyrasulfotole, bromoxynil, and mefenpyr-diethyl, the highly effective cereal herbicide safener. The inclusion of two different modes of action, an HPPD and PSII inhibitor provides a product with unique resistance management characteristics. Huskie is a consistent broad spectrum broadleaf herbicide with excellent crop tolerance. Rapid degradation of Huskie in the soil provides an excellent crop rotation profile allowing re-cropping to all of the major crops grown in the northern cereal production area. Additionally, Huskie can inhibit second flushes of select weeds, such as redroot pigweed, kochia, and common lambsquarters.

Huskie is formulated as an emulsifiable concentrate for easy mixing and handling by the customer. Apply Huskie at 11-15 oz/ac after the cereal crop has emerged but before flag leaf emergence. For optimum control of broadleaf weeds and maximum yield, apply Huskie between the 1 - 8 leaf stage of growth, depending on weed species. Huskie can be tank mixed with selected fungicides and insecticides. When Huskie is applied alone it can be mixed with AMS at 0.5 lb/ac or 28% UAN at 1 qt/ac.

Huskie has been tested on more than 50 broadleaf weed species at many locations in numerous field experiments in the northern cereal production area of the United States. Huskie controls key broadleaf weeds such as kochia, pigweed sp., wild buckwheat, common lambsquarters, mustard sp., Russian thistle, field pennycress, prickly lettuce, common waterhemp, white cockle and nightshade sp. Huskie also controls sulfonylurea resistant weeds such as kochia, prickly lettuce and Russian thistle. Crop tolerance with Huskie has been excellent when tested on several different varieties of spring wheat, durum wheat, and barley.

Huskie provided excellent broadleaf weed control in both research trials and commercial production fields in 2008. Huskie was commercially applied on 3.3 plus million acres of cereals in the United States in 2008. Applications of Huskie were successfully made with several different types of commercial application equipment. Overall weed control and crop tolerance with Huskie was excellent in spite of being applied during some challenging environmental conditions. Grower satisfaction with Huskie was very high with a high level of re-use intentions for 2009. The excellent weed control and crop safety combined with a favorable crop rotation profile makes Huskie a valuable tool for wheat, barley and triticale producers.

RESPONSE OF WHEAT TO AE F130060 AND NITROGEN FERTILIZER APPLICATIONS. James R. Martin, Charles R. Tutt, and Dorothy L. Call, Extension Professor, Research Specialist, and Technician, Department of Plant and Soil Sciences, University of Kentucky, Princeton, KY 42445-0469.

AE F130060 (proposed common name mesosulfuron methyl) is a foliar-applied herbicide used to manage weedy gasses after wheat emergence. It is an Acetolactate Synthase (ALS) inhibitor that can injure wheat; consequently, it is formulated with the safener, mefenpyr diethyl. There have been isolated cases in Kentucky where AE F130060 injured wheat, particularly when it was applied near the time of topdressing nitrogen fertilizer. The herbicide label for AE F130060 cautions against making applications within 14 days of topdressing ammonium nitrogen fertilizer due to the risk of crop injury.

This research was conducted over a two-year period during the 2006-2007 and 2007-2008 growing seasons to evaluate wheat response when nitrogen fertilizer was topdressed at different times relative to spring application of AE F130060. Liquid nitrogen was applied with stream bars at 120 units/A. The commercial formulation of AE F130060 with the safener was applied in mid-March at a rate of 0.21 oz ai/A plus surfactant, plus 28% liquid nitrogen at 1 qt/A in water at spray volume of 20 GPA with 8003 flat fan tips. The timing for topdressing nitrogen in the first study occurred over a period of five weeks at weekly intervals designated as -14, -7, 0, + 7, and +14 days relative to timing of AE F130060. The timings for the second study also included -21 and + 21 days, consequently topdressing timings occurred over a period of seven weeks. Each nitrogen treatment that was associated with AE F130060, had the same nitrogen fertilizer treatment but without AE F130060.

Wheat injury in the form of yellow or necrotic leaves and stunted plants tended to be greatest where AE F130060 and 28% liquid nitrogen were applied the same day. Wheat plants usually recovered from discoloration within 4 to 5 weeks after the herbicide was applied. Wheat plants were numerically shorter than the non-treated checks within one week after AE F130060 in both studies. The amount of stunting was usually greater when nitrogen fertilizer was topdressed the same day as spraying AE F130060 (i.e. 0-day timing of N fertilizer). AE F130060 tended to cause stunting for all timings through 6 weeks after application. Freezing temperatures during April 6 -10 caused substantial freeze damage to plants that were rapidly growing and not injured from the AE F130060. By the time wheat matured in 2007, the plants that were initially injured from AE F130060 tended to be taller than the plants that did not receive AE F130060. It is likely that the initial injury from the herbicide delayed the development of wheat; consequently these plants were able to tolerate the freezing temperatures that occurred during early April. In the second study the herbicide-treated plants were numerically shorter than the non-treated checks and were statistically significant when nitrogen was topdressed at -14 days, the same day, and +14 days.

The unexpected higher yield in the first study where plants were injured the greatest from AE F130060, compared with plants that did not receive AE F130060, is attributed to the unusual freezing temperatures in early April in the first study. Plants that were injured from the March application of AEF 130060 were delayed in growth and less prone to the freezing temperatures in early April. AE F130060-treated plants were able to recover more quickly from the freeze injury and yielded better than plants that did not receive the herbicide. Herbicide injury in the second study limited wheat yield by 8.3 and 9.6 bu/A when liquid nitrogen was topdressed the same day as AE F130060 and seven days after AE F130060, respectively. In spite of herbicide injury, the best overall wheat yield in the second study occurred for nitrogen topdressed February 21 or 14 days before Osprey.

In summary, AE F130060 caused wheat to be stunted and have yellow or necrotic leaves. The plants recovered from discoloration by 5 weeks after the herbicide was applied; however, stunting occurred up to maturity for some treatments in the second study. The only treatments where AE F130060 limited wheat yield was in the second study when nitrogen was topdressed the same day as AE F130060 and seven days after the herbicide.

2008 North Central Weed Science Society Proc. 63:146.

PINOXADEN + FLORASULAM: A NEW PREMIX FOR GRASS AND BROADLEAF WEED CONTROL IN WHEAT AND BARLEY. Peter C. Forster*, Donald J. Porter and Jason C. Sanders, Syngenta Crop Protection Inc., Greensboro, NC 27419.

Pinoxaden + florasulam premix is a new Syngenta selective postemergence herbicide for the US market that will provide control of a broad spectrum of troublesome grass and broadleaf weeds in wheat and barley. The premix combines two active ingredients: pinoxaden, which provides grass weed control by inhibiting acetyl-CoA carboxylase (ACCase) and florasulam, which provides broadleaf weed control by inhibiting acetolactate synthase (ALS). At the recommended use rate of 8.85 fl. oz/A + Adigor adjuvant at 9.6 fl. oz/A, the premix will provide excellent broad spectrum grass control as well as a solid foundation for control of broadleaf weeds. Additional broadleaf herbicides may be tank mixed with the premix to broaden the spectrum of weed control. The premix provides excellent crop safety and rotational crop flexibility and may be applied to all varieties of spring wheat (excluding durum), winter wheat and barley.

PREPLANT APPLICATION OF SAFLUFENACIL FOR BROADLEAF WEED CONTROL IN CEREALS. Siyuan Tan, Mark Oostlander, Leo Charvat, Glen Forster, Lyle Drew, John O'Barr and Sam Willingham, Biologists, BASF Corporation, Research Triangle Park, NC 27709, USA and BASF Canada Inc., Missisauga, ON L5R 4H1, Canada.

The efficacy of a new developmental herbicide, saflufenacil, was tested in combination with glyphosate as a preplant treatment prior to cereal crops and as a chemfallow treatment. Trials were conducted from 2004 to 2008 in all the major ecozones of Western Canada, and across the cereal growing regions of the United States. Saflufenacil applied at rates from 18 to 50 g ai/ha, in combination with glyphosate at 450 or 840 g ae/ha provided excellent control of broadleaf weeds, including glyphosate tolerant species, in a preplant and chemfallow use pattern. Saflufenacil at the lower rate of 18 g ai/ha + glyphosate provided excellent burndown control of all evaluated broadleaf weeds. Increasing the rate to 50 g ai/ha provided residual activity on species such as wild mustard (*Sinapis arvensis*) and wild buckwheat (*Polygonum convolvulus*). Cereal tolerance to saflufenacil was assessed at rates from 18 to 100 g ai/ha over a wide range of climates and soil conditions. Cereals (bread wheat, durum wheat, barley, oats) showed excellent tolerance to saflufenacil at rates up to 100 g/ha.

POTENTIAL OF SAFLUFENACIL FOR PREHARVEST DESICCATION OF SUNFLOWER. Kirk A. Howatt, Brian M. Jenks, Phillip W. Stahlman, and Michael Moechnig, Associate Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050, Associate Professor, North Central Research and Extension Center, North Dakota State University, Minot, ND 58701-7645, Professor, Kansas State University Agricultural Research Center, Hays, KS 67601-9228, and Assistant Professor, South Dakota State University, Brookings, SD 57007.

Experiments were established near Minot and Fargo, ND; Brookings, SD; and Hays, KS, to evaluate the response of sunflower to herbicides applied at three desiccation stages. The treatment list included a control and a factorial arrangement of three application timings, 50%, 40%, and 30% seed moisture, and four desiccants, paraquat at 420 g ai/ha plus non-ionic surfactant at 0.25% vol/vol, saflufenacil at 50 g ai/ha plus methylated seed oil at 1% vol/vol and ammonium sulfate at 1600 g ai/ha, glyphosate at 840 g ae/ha plus ammonium sulfate at 1600 g/ha, and glyphosate at 840 g/ha plus saflufenacil at 25 g/ha with methylated seed oil at 1% vol/vol and ammonium sulfate at 1600 g/ha. Paraquat was applied in 180 L/ha spray volume while other desiccant treatments were applied in 90 L/ha spray volume. Visible necrosis overestimated the actual desiccation and drying effect of each treatment. The receptacle moisture content was the most restrictive based on desired moistures at harvest of 15% seed moisture and 40% receptacle moisture. More benefit to using a desiccant was documented in Minot and Fargo than Brookings and Hays. Herbicide application at 30% moisture allowed earlier harvest in Minot and Fargo by about 5 to 8 d, but the choice of herbicide did not substantially affect the date of harvest. Sunflower treated with saflufenacil at 40% seed moisture reached 40% receptacle moisture 27 d earlier than untreated sunflower in Minot but only 5 d earlier in Hays, illustrating the effect of fall weather. Treatment, even at 50% moisture, did not affect yield or test weight relative to the untreated. Likewise, treatments did not affect oil composition. Herbicide application at 50% moisture caused slightly lower oil content compared with the control but values were still above minimum values to avoid discounts. Choice of herbicide did not affect oil content.

ENVIRONMENTAL INFLUENCE ON IRRIGATED POTATO RECOVERY FROM GLYPHOSATE SIMULATED DRIFT. Harlene M. Hatterman-Valenti and Collin P. Auwarter, Professor and Research Specialist, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105

Field research was conducted at the Northern Plains Potato Grower's Association Irrigation Research site near Tappen, ND to evaluate Russet Burbank growth the same year glyphosate simulated drift occurred to irrigated potatoes. In 2007 and 2008, glyphosate was applied at rates one-third, one-sixth, and-twelfth, and one-twenty-forth the standard use rate (0.25, 0.125, 0.0625, and 0.0313 lb ae/A) at the tuber hooking (TH) - 0.25 lb ae/A only, tuber initiation (TI), early tuber bulking (EB), and late tuber bulking stage (LB).

In 2007, total yield from potatoes treated with glyphosate at the TH stage was significantly lower than any other treatment (88 cwt/A). This was followed by potatoes treated with 0.25 lb/A glyphosate at the TI stage (187 cwt/A). All other treatments had total yields similar to the untreated. Only plants treated with 0.25 lb/A glyphosate at the TH, TI, and LB stages or with 0.125 lb/A glyphosate at the TI stage yielded less marketable tubers than the untreated. Glyphosate caused an increase in cull tubers when potatoes were treated with 0.25 or 0.125 lb/A at TI in comparison to the untreated. Glyphosate also depressed tuber growth. Fewer 4 to 6 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH stage. Likewise, fewer 6 to 10 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH and TI stages. Large tuber production (>10 oz) was decreased when plants were treated with 0.25 lb/A glyphosate at the TH, TI, or LB stages, or when treated with 0.125 lb/A glyphosate at the TI stage.

In 2008, total yield from plants treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages or with 0.125 lb/A glyphosate at the TI and EB stages were significantly lower than any other treatment, except 0.063 lb/A glyphosate at the TI stage. Results were similar for marketable tubers except that plants treated with 0.063 lb/A glyphosate at the TI stage also had significantly less marketable tubers. Glyphosate caused an increase in cull tubers when potatoes were treated with 0.25 or 0.125 lb/A at TI in comparison to the untreated. Glyphosate also depressed tuber growth. Fewer 4 to 6 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages. Likewise, fewer 6 to 10 oz tubers were produced when potatoes were treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages, or with 0.125 lb/A glyphosate at the TI and EB stages, or with 0.063 lb/A glyphosate at the TI stage. Large tuber production (>10 oz) was decreased when plants were treated with 0.25 lb/A glyphosate at the TH, TI, or LB stages, or when treated with 0.125 lb/A glyphosate at the TI and EB stages, or when treated with 0.063 lb/A glyphosate at the TI stage.

The negative tuber yield effect from simulated glyphosate drift was most severe at the TH stage in 2007 whereas the TH, TI, and EB stages were equally sensitive to simulated glyphosate drift in 2008. However, total and marketable yield was reduced 5.6X and 8.8X when plants were treated with 0.25 lb/A glyphosate at the TH stage, respectively compared to the untreated in 2007. In contrast, total yield was reduced 2X, 2X, and 1.9X, respectively, when plants were treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages, and marketable yield was reduced 2.7X, 4X, and 3.4X, respectively, when plant were treated with 0.25 lb/A glyphosate at the TH, TI, and EB stages, compared to the untreated in 2008. It was concluded that the effect of air temperature on vine growth and tuber production contributed to the differences between years.

VARIETY-SPECIFIC WEED MANAGEMENT IN POTATOES. Jed B. Colquhoun and Richard A. Rittmeyer, Associate Professor and Research Associate, Department of Horticulture, University of Wisconsin, Madison, WI 53706.

Potato varieties differ greatly in plant emergence, early season growth, and canopy closure rates. In previous research, differences among varieties in the ability to tolerate or suppress weeds were observed and attributed to differences in early season growth characteristics. With this in mind, the objective of this study was to develop variety-specific weed management strategies based on early-season competitive ability, with the overall goal of reducing the reliance on herbicides as the primary means of weed control. The study was arranged in a split-plot design with potato variety (Bannock Russet or Russet Burbank) as the main plot factor and weed control program as the sub-plot factor. Weed control programs included a conventional broadcast preemergence application of s-metolachlor and metribuzin at potato hilling, the same program applied in a band over the potato row combined with inter-row cultivation, rimsulfuron and metribuzin broadcast postemergence, rimsulfuron and metribuzin banded postemergence over the potato row combined with cultivation, glyphosate banded postemergence between the potato row, and cultivation alone. Russet Burbank emerged earlier and established a full crop canopy prior to Bannock Russet. In both varieties, in-row weed control was greater where herbicides were applied compared to cultivation alone. In-row weed biomass in Russet Burbank was similar when herbicides were broadcast, banded, or applied only postemergence. In Bannock Russet, banding herbicides or using exclusively postemergence herbicides resulted in poor in-row weed control. Between-row weed biomass was minimal in Russet Burbank and no differences were observed among weed control programs. In Bannock Russet, between-row weed biomass was greatest where preemergence herbicides were applied broadcast or banded. Marketable potato yield was similar between programs involving herbicides and cultivation alone in Russet Burbank. Yield was greater when herbicides were broadcast preemergence compared to when they were banded at a similar timing. In Bannock Russet, yield was reduced when cultivation was used alone compared to programs including herbicides. Potato yield was greatest in the conventional preemergence broadcast s-metolachlor and metribuzin program. Bannock Russet yield was lowest where postemergence herbicides were banded or cultivation was used alone.

SAFLUFENACIL TOLERANCE IN VEGETABLES. Darren E. Robinson and Peter H. Sikkema, Assistant and Associate Professors, Department of Plant Agriculture, University of Guelph, Ridgetown Campus, Ridgetown, ON, N0P 2C0.

Trials were established in 2007 and 2008 in Ontario to determine the effect of saflufenacil applied pre-transplant to pepper, tomato, broccoli, cabbage and cauliflower and pre-emergent to potato. Saflufenacil was applied at rates of 25, 50 and 100 g a.i. ha^{-1}, and visual injury, plant dry weight at 42 days after emergence or transplanting, and marketable crop yield were measured under weed-free conditions. Saflufenacil caused commercially unacceptable (>10%) visual injury to broccoli and cauliflower at 100 g a.i. ha^{-1}, but injury was less than 10% at both 25 and 50 g a.i. ha^{-1}. Injury included stunting and leaf necrosis. Saflufenacil did not cause a reduction in dry weight, or head size of broccoli, cabbage or cauliflower, but cauliflower yield was reduced at the 100 g a.i. ha^{-1} rate. Saflufenacil caused commercially unacceptable (>10%) visual injury, and reductions in dry weight of pepper and tomato at 50 and 100 g a.i. ha^{-1}. Despite these reductions in dry weight of both crops, only pepper yield was less than the untreated check at the 100 g a.i. ha^{-1} rate of saflufenacil. Visual injury was less than 5% visual injury to potato, even at the 100 g a.i. ha^{-1} rate of saflufenacil and plant dry weight and yield were not less than the untreated check in any of the herbicide treatments. Saflufenacil tolerance in cole crops may be sufficient to justify further evaluation at the lower rates studied in the trial, however there is limited information on varietal differences and environmental conditions, which may affect cole crop tolerance to the herbicide. Pepper and tomato showed little tolerance to pre-transplant applications of saflufenacil. Potato showed good tolerance at rates of saflufenacil from 25 to 100 g a.i. ha^{-1}, but again further study on different varieties, soil types and environments are needed to establish the crop's full range of tolerance to saflufenacil.

THE EFFECT OF POSTEMERGENCE THIFENSULFURON-METHYL ON COMMERCIAL PROCESSING TOMATO CULTIVARS IN A TWO YEAR STUDY. Stephen C. Weller, Greg R. Kruger, William G. Johnson, Timothy A. Koch, and Doug Doohan, Professor, Department of Horticulture and Landscape Architecture, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, Research Assistant, Associate Professor, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH 44691.

Experiments in Ohio and Indiana in 2007 and 2008 evaluated the safety of postemeregence applications of thifensulfuron-methyl on several commercially grown processing tomato cultivars. In Ohio, cultivars evaluated were: TR12, 818, 611, 9704, 401, 7983, 46TJ, and 331 in 2007 and cultivars 818, 611, 9704, 331, 3402, and TSH4 in 2008. In Indiana, cultivars 818, 611, 9704, 401, 7983, and 331 were evaluated in 2007 and 2008. Treatments of 0, 8, or 16 g/ha of thifensulfuron-methyl + 0.25% v/v of a non-ionic surfactant were applied to tomatoes approximately four weeks after transplanting. Evaluations on visual injury based on a scale of 0 to 100 (where 0 = no injury and 100 was completely dead plants) and yield were collected. Results were generally similar at both locations, but injury was more prevalent on some cultivars tested in Ohio. Cultivars exhibited some initial chlorosis after application, but injury was mild and most cultivars quickly recovered. The exception was cultivar TR12 which was susceptible and did not recover as quickly as other cultivars and it had a significant yield loss. Over all cultivars, except TR-12, thifensulfuron-methyl did not reduce yields and appears to be a good candidate for postemergence broadleaf weed control for most commercial processing tomato cultivars.

A TWO YEAR STUDY ON THE RESPONSE OF COMMERCIAL PROCESSING TOMATOES TO SIMULATED DICAMBA DRIFT. Greg R. Kruger, William G. Johnson, Doug Doohan, Timothy A. Koch, and Stephen C. Weller, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Purdue University, Associate Professor, Research Assistant, Department of Horticulture and Crop Science, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH 44691, Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907.

Herbicide drift onto processing tomatoes is a major concern for growers in Indiana and Ohio on the 5,828 ha grown annually. Several studies have shown that auxin herbicides can cause injury symptoms on tomatoes, but there is little quantitative evidence of the impact of drift on yields. With the future planned release of dicamba resistant soybean, it is possible that dicamba use during the soybean growing season will become more common and the potential for off-target drift, volatility or tank contamination will increase. The purpose of this study conducted in Lafayette, IN in 2007 and 2008 and in Wooster, OH in 2008 was to determine injury potential to processing tomato from dicamba drift. . The experiment was established as a dose response study with two application timings: either at the early vegetative stage (2 weeks after transplanting) or at the early bloom stage (~ 5 weeks after transplanting). Simulated drift rates of dicamba were 1/3rd, 1/10th, 1/30th, 1/100th, 1/300th, and 1/1000th based on an X rate of 0.56 kg ae/ha of dicamba. Treatments were applied with a backpack sprayer delivering 140 l/ha at 117.2 kPa of pressure. Spray solutions contained 2.8 kg/ha of AMS and 0.25%v/v NIS with the dicamba. Crop injury, yield (both red fruit and green fruit), and flower loss were evaluated. Data were analyzed using non-linear log-logistic modeling in R and combined across locations, years, and cultivars. A 25% estimated flower loss occurred at 0.0133 kg ae/ha (~1/42nd of 0.56 kg ae/ha) at the first application timing, and 0.0064 kg ae/ha (~1/88th of 0.56 kg ae/ha) for the second application timing. A 25% reduction in red fruit weight occurred at 0.0119 kg ae/ha (~1/47th of 0.56 kg ae/ha) at the first application timing, but it occurred at 0.0075 kg ae/ha (~1/75th of 0.56 kg ae/ha) for the second application timing. Injury and yield loss increased as rate of drift increased. This study showed that even at low dicamba rates (1/80th of 0.56 kg ae/ha) its drift can significantly impact processing tomato yields.

A TWO YEAR STUDY ON THE RESPONSE OF COMMERCIAL PROCESSING TOMATOES TO SIMULATED GLYPHOSATE DRIFT. Greg R. Kruger, William G. Johnson, and Stephen C. Weller, Graduate Research Assistant, Associate Professor, Department of Botany and Plant Pathology, Professor, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN 47907.

Herbicide drift on vegetable crops is a major concern for vegetable growers. In Indiana 3,250 ha of processing tomatoes are grown annually and they often are located near glyphosate resistant corn or soybean fields. Because of the widespread use of glyphosate for post-emergence weed control, it is important to understand how glyphosate drift impacts tomato growth, development, and yield. The purpose of this study was to determine the effect of glyphosate drift on processing tomato yields. The dose response study was conducted in Lafayette, IN in 2007 and 2008 with two tomato cultivars (331 and 611) and two timings of glyphosate application (2 weeks and approximately 5 weeks after transplanting). The simulated drift rates of glyphosate were 1/3rd, 1/10th, 1/30th, 1/100th, 1/300th, and 1/1000th based on an X rate of 0.64 kg ae/ha of glyphosate. Treatments were applied with a backpack sprayer delivering 140 l/ha at 117.2 kPa of pressure. Spray solutions contained 2.8 kg/ha of AMS and 0.25%v/v NIS with the glyphosate. Crop injury, yield (both red fruit and green fruit), and flower loss were evaluated. Data were analyzed using non-linear log-logistic modeling in R and pooled across years and cultivars. There were significant differences between the first herbicide timing and the second timing for flower loss, red fruit yield, and total fruit yield. A 25% flower loss occurred at 0.0511 kg ae/ha (~1/12th of 0.64 kg ae/ha) at the first timing and at 0.0075 kg ae/ha (~1/85th of 0.64 kg ae/ha) for the second timing. A 25% reduction in red fruit weight occurred at 0.0439 kg ae/ha (~1/15th of 0.64 kg ae/ha) for the first timing and at 0.0085 kg ae/ha (~1/75th of 0.64 kg ae/ha) for the second n timing. Glyphosate drift at the early bloom (approximately 5 weeks after transplanting) lead to greater fruit loss than drift onto tomato plants in the vegetative stage (2 weeks after transplanting). Glyphosate drift delayed fruit ripening even at very low drift rates (approximately 1/8th of 0.64 kg ae/ha for the first timing and 1/91st of 0.64 kg ae/ha for the second timing) indicating that tomatoes are very sensitive to glyphosate.

HERBICIDE TREATED MULCHES IMPROVE WEED CONTROL, SUPPRESS SCION ROOTING AND PREVENT WINTER INJURY IN VINIFERA VINEYARD. Linjian Jiang, Imed Dami, Hannah Mathers and Doug Doohan, Graduate Student, Assistant Professor, Associate Professor and Associate Professor, Department of Horticulture and Crop Science, The Ohio State University/Ohio Agricultural Research and Development Center, Wooster, OH 44691.

The grape species *Vitis vinifera* is extensively grown for wine production in the US. Roots of *vinifera* grapes are susceptible to a soil insect, phylloxera. Grafting to a resistant grape root stock is widely used to prevent damage by this pest. However, the graft union may be damaged by extreme winter temperature. Grape growers in cold regions mound soil over the graft union in autumn to protect the scion from winter injury. In the following spring, the soil hills are removed to prevent *vinifera* scion rooting and the susceptibility to phylloxera that would result from that event. This annual tillage practice, called “winter hilling”, often results in severe soil erosion, chemical run-off and increased weed problems. In this study, we proposed that herbicide-treated mulches could be an alternative method for weed management, winter protection and soil conservation in *vinifera* vineyards. Trials were conducted in two vineyards to test weed management by simazine treated soil, straw and bark. Scion rooting number was also recorded when the soil or mulch was removed in June. The degree of winter protection was determined by temperature loggers buried under soil and different mulches. Weed density data were recorded for each identified species and applied to a SAS ANOVA model. Mulches significantly suppressed most weeds in both vineyards. Mulches also significantly reduced scion rooting, and provided as good winter protection as soil. In conclusion, herbicide-treated mulches provided an alternative method for the management of weeds, winter protection, scion rooting and soil erosion problems in *vinifera* vineyards.

FALL AND/OR SPRING APPLICATIONS OF GRANULAR DITHIOPYR AND PRODIAMINE FOR CRABGRASS CONTROL IN TURFGRASS. Michael W. Melichar, Daniel L. Loughner, Zachary J. Reicher, Daniel V. Weisenberger, and Jeff A. Borger, Field Scientist, Dow AgroSciences, Indianapolis, In 46268, Field Scientist, Dow AgroSciences, Huntingdon Valley, PA 19006, Professor, Purdue University, West Lafayette, IN 47907, Research Agronomist, Purdue University, West Lafayette, IN 47907 and Research Agronomist, The Pennsylvania State University, State College, PA, 16801.

Three field trials were conducted in Indiana (2006-2007 and 2007-2008) and Pennsylvania (2007-2008) to evaluate fall and spring applications of granular dithiopyr and granular prodiamine for control of crabgrass (*Digitaria* species) in turfgrass. For each trial, five foot by five foot plots were replicated three times for each individual treatment. Shaker bottles or shaker tables were used to uniformly spread the granular treatments over the treated plots. Treatments were applied to individual plots in October, November, November followed by May, March, April, May, or June. The turf plots were maintained with regular mowing and watering and received no fertilization. Percent crabgrass control evaluations were made in July (Indiana 2007) and August (Indiana 2008 and Pennsylvania 2008).

Fall applications (October and November) of dithiopyr @ 560 gms a.i./ha and fall application followed by spring application (November-May) of dithiopyr @ 560 + 280 gms a.i./ha provided acceptable crabgrass control. Fall applications (October and November) of prodiamine @ 730 gms a.i./ha did not provide acceptable crabgrass control. Fall application followed by spring application (November-May) of prodiamine @ 730 + 280 gms a.i./ha provided acceptable crabgrass control. March, April, and May applications of dithiopyr @ 430 or 560 gms a.i./ha provided acceptable crabgrass control while June applications did not. March and April applications of prodiamine @ 730 gms a.i./ha provided acceptable crabgrass control while May and June applications did not. March, April, May, and June applications of dithiopyr @ 430 gms a.i./ha and prodiamine @ 730 gms a.i./ha were not significantly different in crabgrass control.

2008 North Central Weed Science Society Proc. 63:157.

DUPONT HERBICIDES WITH MULTIPLE MODES OF ACTION AND FLEXIBLE UTILITY FOR USE ON OPTIUMUM® GAT® CORN AND SOYBEAN. David W. Saunders, Kevin L. Hahn, Larry, H. Hageman, Helen A. Flanigan, Mick F. Holm and Wayne J. Schumacher, Product Development, DuPont Crop Protection, Dallas Center, IA 50063.

Corn hybrids and soybean varieties containing the Optimum® GAT® trait will be tolerant to applications of glyphosate as well as a wide range of ALS-inhibitor herbicides. This broad herbicide tolerance will allow the development of new DuPont herbicide blends designed to meet changing weed control needs in row crops. Data will be presented supporting the development of DuPont™ Diligent™, Instigate™ and Trigate™ herbicides that will deliver broader-spectrum weed control, soil-residual activity plus additional herbicidal modes-of-action for difficult-to control weeds and many herbicide resistant weeds. Weed control data will also be presented which supports the development of DuPont™ Traverse™ and Freestyle™ herbicides. These herbicides will provide additional broader spectrum weed control while maintaining crop rotation and expanded application flexibility. Seed products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® Gat® trait are not currently registered for sale or use in the United States.

2008 UNIVERSITY TRIALS WITH HERBICIDES DESIGNED FOR USE ON OPTIMUM® GAT® CORN AND SOYBEAN CROPS. Susan K. Rick, Michael T. Edwards, James D. Harbour and David W. Saunders. Product Development. DuPont Crop Protection, Wilmington, DE 19880.

Weed control programs designed for use on corn and soybean crops containing the Optimum® GAT® trait are under development. Integrated herbicide programs making use of preemergence, postemergence and 2-pass weed control strategies were evaluated by 25 universities in 2008. Data will be presented supporting the use of Optimum® GAT® trait crops as new tools for managing weed control needs across the United States. Seed products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® GAT® trait are not currently registered for sale or use in the United States.

OPTUMUM GAT HERBICIDE PROGRAMS AS TOOLS FOR MANAGING ALS AND/OR GLYPHOSATE RESISTANT WEEDS. D. Raymond Forney, David W. Saunders, John Beitler and Stephen D. Strachan, Product Development, DuPont Crop Protection, Wilmington, DE 19880.

As new herbicide tolerance traits are commercialized in row crops, a broader range of herbicide tools for managing resistant weeds will be possible. Improved management tools from DuPont will allow for: a) the choice of the most efficacious active ingredients within an herbicide family independent of native crop tolerance; b) the introduction of new herbicidal modes-of-action not presently available for use on a particular weed problem; and c) the development of new herbicide programs that will integrate multiple herbicide families and sequential application timings to fit local agronomic practices. Weed control strategies developed for managing weed resistance problems in crops containing the Optimum® GAT® trait are founded on three simple fundamentals: 1) use an effective alternate mode-of-action (MOA) herbicide in addition to ALS and/or glyphosate to control known herbicide-resistant weeds; 2) include an effective alternate MOA at least every-other year for "at-risk" weeds (per local University experts); and3) scout fields to monitor effectiveness of the herbicide program. Products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® GAT® trait are not currently registered for sale or use in the United States.

KIXOR™ HERBICIDE (SAFLUFENACIL) PERFORMANCE PROFILE IN 2008 UNIVERSITY CORN TRIALS. Dan E. Westberg, Brady F. Kappler, Mark A. Storr, Duane P. Rathmann, Garfield G. Thomas, and Caren A. Judge, BASF Corporation, Research Triangle Park, NC, 27709.

Kixor (saflufenacil) is a new herbicide active ingredient under development for preplant, preplant incorporated, and preemergence broadleaf weed control in corn. Kixor demonstrated excellent residual control on key broadleaf species including common cocklebur (*Xanthium strumarium*), common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), common sunflower (*Helianthus annuus*), giant ragweed (*Ambrosia trifida*), horseweed (*Conyza canadensis*), morningglory spp. (*Ipomoea* spp.), nightshade spp. (*Solanum* spp.), and pigweed/waterhemp spp. (*Amaranthus* spp.).

The lead formulation evaluated in 39 university trials was a premix of Kixor + dimethenamid-p, Integrity™ Herbicide, at the target use rate range of 614 to 1228 g ai/ha; rates were adjusted based on soil texture. Integrity provided broad spectrum broadleaf and grass control whether it was used at full rates as a one-pass preemergence treatment or at reduced rates (2/3X) as a set-up for an in-crop postemergence application of glyphosate.

Federal registration is projected during the 3rd quarter of 2009.

BURNDOWN CONTROL OF FALL GERMINATING WEEDS WITH BAS 800H AS INFLUENCED BY THE TYPE OF ADJUVANT. Stevan Z. Knezevic, and Jon Scott. Associate Professor and Technologist, Haskell Ag. Lab., Univ. of Nebraska, Concord, NE; Leo Charvat, BASF Corporation, Lincoln, NE.

BAS 800H is a new herbicide under development for broadleaf weed control in various crops. Field studies were conducted in the Fall of 2005 and 2006 with the objective to describe dose-response curves of BAS 800H applied POST on 10-15 cm tall weeds. A total of six BAS-800H rates, ranging from 0 to 100 g ai/ha, were used alone or tank mixed with glyphosate (870 g ae/ha), NIS (0.25 % v/v), COC (1% v/v), or MSO (1% v/v). An effective dose (ED) that provided 90% control (e.g., ED90) was determined for each weed species using R software and drc package. In general, preliminary data suggested that MSO provided the most enhancement of BAS 800H. The ED90 values for common dandelion (*Taraxacum officinale*) at 14 DAT were 54, 96, 48, 40, and 99 g /ha of BAS 800H applied tank mixed with glyphosate, NIS, COC, or MSO, and BAS 800H applied alone, respectively. The ED90 values for henbit (*Lamium amplexicaule*) were 41, 87, 45, 32, and 95 g /ha of BAS 800H tank mixed with glyphosate, NIS, COC, MSO, and BAS 800H alone, respectively. Similar trends in ED90 values were observed for field bindweed (*Convolvulus arvensis*), prickly lettuce (*Lactuca serriola*), and shepherd's-purse (*Capsella bursa-pastoris*), suggesting potential use of this new compound for fall control of many broadleaf weeds.

GRAIN SORGHUM RESPONSE TO SAFLUFENACIL. Phillip W. Stahlman, John C. Frihauf, Patrick W. Geier and Loretta Serafin, Professor, Graduate Research Assistant, and Assistant Scientist, Kansas State University Agricultural Research Center, Hays, KS 67601 and District Agronomist, New South Wales Department of Primary Industries, Calala NSW 2340.

Field experiments were conducted near Hays, Colby, and St. John, KS in 2007 and 2008 and near Somerton, NSW Australia in 2007 to evaluate weed control effectiveness (six experiments) and grain sorghum tolerance (eight experiments) to soil-applied saflufenacil (BAS 800H) alone and in mixture with dimethanamid-P. The two herbicides were tank mixed at ratios of 1:8.8 in 2007, but a prepackaged mixture in the same ratio (BAS 781H) was used in 2008. Soil types ranged from fine sandy loam with <1% organic matter to silty clay loam with ~2.5% organic matter. Herbicide use rates generally ranged from 188 to 250 g ha^{-1} of saflufenacil to 1650 to 2200 g ha^{-1} of dimethenamid-P. Rates were adjusted for soil texture and organic matter content. In addition to comparing herbicide use rates, most experiments in 2007 also compared 7-10 day preplant and preemergence application timings, whereas treatments in weed-free crop tolerance experiments in 2008 were applied only preemergence. Greater visible crop injury (foliar necrosis, reddish stripes, and planting stunting) occurred on coarse-textured, low organic matter soils than on medium or fine textured soils when rainfall was received preceding or at the time of crop emergence. Few or no foliar symptoms or plant stunting were observed following gentle to moderate rainfall within a few days after crop emergence, especially on medium and fine textures soils. Often, injury was limited to a few individual plants growing next to unaffected plants. Most injured plants eventually recovered completely and produced grain. Crop yields seldom were reduced. Weed control usually exceeded 90% at mid-season and often was slightly higher for preemergence application compared to 7-10 day preplant applications. Grass weed control generally declined earlier than broadleaf weed control. The results of these experiments indicate promising potential for the use of saflufenacil and dimethenamid-P mixtures in grain sorghum.

WEED CONTROL IN SORGHUM WITH HUSKIE HERBICIDE. Kevin K. Watteyne*, Charles P. Hicks, Greg W. Hudec, Mary D. Paulsgrove, Russ R. Perkins, Gary Schwarzlose, Michael Weber and Amy M. Wyman. Technical Service and Field Development Representatives, Product Development Manager, Bayer CropScience, Research Triangle Park, NC 27709.

Huskie herbicide has been used extensively in wheat, barley, and triticale for broadleaf control. Huskie offers the first significant new mode of action for the above mentioned crops in more than 20 years meaning fewer resistant weeds. Huskie has shown good to excellent control of the toughest cereal weeds, including kochia, Russian thistle, and wild buckwheat.

In the major grain sorghum growing states, growers have seen weed resistance problems develop to the point where they are currently battling widespread resistance issues. Weed failures have been common with current herbicides used for broadleaf control in grain sorghum. This includes ALD-inhibitors, Roundup, and Photosystem II Inhibitors.

Pyrasulfotole, the active ingredient in Huskie, offers a new mode of action in grain sorghum for major broadleaf control. Huskie includes the Bayer CropScience proprietary safener, which works by accelerating the metabolism of the herbicide in the crop, but not in susceptible weed species.

Studies were conducted in 2007 and 2008 by Bayer CropScience and all major Midwestern universities in major grain sorghum growing states. Huskie at 4-15 fl oz/acre + AMS w/wo 1 pt/A atrazine were tested in both years. Commercial targeted rates are: 11-15 fl oz/acre. Weed control has been good to excellent on hard to control weeds and resistant weeds: palmer amaranth, pigweed, puncturevine, velvetleaf, Russian thistle, ivyleaf morningglory, and tall waterhemp. Numerous adjuvant systems have been researched and no decision has been made on final recommendations to be used with Huskie herbicide.

Huskie is not currently registered for use in grain sorghum.

RESIDUAL AND NON-RESIDUAL HERBICIDE APPLICATION TIMING EFFECTS ON WEED CONTROL AND CORN YIELD. Wesley J. Everman, Andrew J. Chomas, and James J. Kells, Assistant Professor, Research Technician, and Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

Timing of weed control is an important consideration in any weed management program, and with the increased adoption of postemergence only herbicide programs in corn, greater importance is placed on application timing. Studies were established at the Michigan State University Agronomy Farm in East Lansing, MI each year from 2004 to 2008 to investigate the effects of herbicide application timing on weed control and yields in corn. Treatments were arranged in a randomized complete block with POST herbicide application timings based upon weed heights of 3, 6, and 9 inches. Herbicide treatments consisted of POST applications of glyphosate at 0.75 lb a.e./A or glufosinate at 0.42 lb a.e./A applied either alone or in combination with acetochlor at 1.4 lb a.i./A, as well as following PRE applications of acetochlor at 1.4 lb a.i./A. Weed control ratings were taken 2 and 4 weeks after the late POST with yields determined at the end of the season. Weed control was greatest where acetochlor was applied with glyphosate or glufosinate, regardless of timing. Excellent weed control was achieved when POST treatments were applied before weeds reached 9 inches in height. Yields decreased as herbicide application was delayed from a weed height of 3 inches to a weed height of 9 inches. These studies show the importance of timely herbicide applications and residual herbicides in a POST only weed management program to preserve yields.

HERBICIDE TANK MIXES FOR CONTROL OF GLYPHOSATE-RECALCITRANT KOCHIA.
Randall S. Currie, Phillip W. Stahlman, and Patrick W. Geier, Associate Professor, Kansas State University, Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846, and Professor and Assistant Scientist, Kansas State University, Agricultural Research Center-Hays, 1232 240th Ave., Hays, KS 67601.

Kochia is becoming more difficult to control with glyphosate in western Kansas. Elsewhere in these proceedings, Thompson presents evidence that glyphosate-resistant kochia has developed in this region. We strongly suspect the kochia populations discussed here are resistant to glyphosate but have not confirmed this. Therefore, we refer to them as glyphosate-recalcitrant. Our objective was to test herbicide tank mixes to control these kochia populations. The test site was a field approximately 6 km north of Ingalls, KS, that had been in glyphosate-resistant crops for 4 of the last 5 yr. At this site in 2007, the producer had difficulty controlling kochia in glyphosate-resistant soybeans with repeated applications of glyphosate. Two studies (PRE and POST) were conducted at this site the entire plot area was treated with paraquat applied at 0.6 kg/ha 11 d prior to planting. At planting, kochia had recovered form the paraquat treatment. Corn was planted no till into soybean stubble. Studies were arranged in a randomized complete block design with four blocks. The PRE study had 0.83 kg/ha glyphosate tank mixed with the following treatments applied 3 d after planting (DAP): S-metolachlor atrazine at 1 + 2 kg/ha; S-metolachlor + mesotrione + atrazine at 1.8 + 0.18 + 0.7 kg/ha; acetochlor + atrazine at 2.6 + 1 kg/ha; acetocholor 1.5 kg/ha; acetochlor + isoxaflutole at 1.5 + .03 kg/ha; acetochlor + isoxaflutole at 1.5 + .05 kg/ha; acetochlor + topramezone at 1.5 + 0.12 kg/ha; pendimethalin + atrazine at 0.9 + 1.1 kg/ha; isoxaflutole at 0.03 lb/ai PRE followed by a POST application of topramezone at 0.018 kg/ha with 1% v/v coc and 2% v/v ams; or isoxaflutole at 0.03 kg/ha PRE followed by a POST application of dicamba at 0.28 kg/ha + 0.25% v/v nis. In the POST test, the entire plot area received an application of acetochlor + glyphosate at 1.9 + 0.83 kg/ha 2 d prior to corn emergence. The following POST treatments were applied 16 DAP: topramezone at 0.018 kg/ha with 1% v/v coc and 2% v/v ams; topramezone + glyphosate at 0.018 + 0.83 kg/ha with 1% v/v coc and 2% v/v ams; topramezone + glyphosate at 0.018 + 0.83 kg/ha with 2% v/v ams; dicamba + diflufenzopyr at 0.2 + 0.08 kg/ha plus 2% v/v ams; dicamba + diflufenzopyr + glyphosate at 0.2 + 0.08 + 0.83 kg/ha with 2% v/v ams; fluroxypyr + atrazine at 0.14 + 0.6 kg/ha; fluroxypyr + atrazine + glyphosate at 0.14 + 0.6 + 0.83 kg/ha with 2% v/v ams; bromoxynil + atrazine at 0.28 + 0.6 kg/ha; bromoxynil + atrazine at 0.4 + 0.83 kg/ha; bromoxynil + atrazine + glyhposate at 0.28 + 0.6 + 0.83 kg/ha; dicamba at 0.28 kg/ha with 0.25% v/v nis; dicamba at 0.6 kg/ha with 0.25% v/v nis; dicamba + glyphosate at 0.28 + 0.83 kg/ha with 0.25% v/v nis; or bromoxynil + atrazine + fluroxypyr at 0.28 + 0.6 + .07 kg/ha. Later POST treatments were dicamba + diflufenzopyr at 0.27 + 0.1kg/ha with 0.25 % v/v nis and 2% v/v ams or dicamba + diflufenzopyr + glyphosate at 0.27 + 0.1 + 0.83 kg/ha with 2% v/v ams applied 22 DAP. In the pre test single applications of glyphosate tank mixed with acetochlor alone or acetocholor in combination with topramezone or isoxaflutole failed to provide 90% control. All other tank mixes with glyphosate provided greater than 90% control. In the POST study, kochia survived the first glyphosate treatment. Topramezone alone or tank mixed with glyhposate with out COC or glyhposate tank mixed with less than 0.6 kg/ha dicamba failed to provide 90% control of these escaped kochia. Second applications of a glyhposate tank mixed with all other treatments 16 to 22 DAP provided greater than 93 % control.

RESPONSE OF CORN HYBRIDS TO GLYPHOSATE APPLICATION TIMINGS. Kelly A. Nelson and Clinton G. Meinhardt, Associate Professor and Research Specialist, Division of Plant Sciences, University of Missouri, Novelty, MO 63460.

No-till corn plant establishment is difficult in claypan soils. Concerns related to burndown herbicide selection and corn hybrid response had been expressed on soils with low pH. Sites with a low soil test pH were selected in 2007 and 2008 to evaluate corn hybrid response to glyphosate application timings (21, 14, and 0 days before planting) and rates (0, 860 and 1730 g ae/ha). There was no interaction between corn hybrid selection and glyphosate application timing or rate. Harvested plant population and yield differences between hybrids were detected, but no effect of glyphosate application timings and rates was observed.

EFFECT OF TIME OF DAY OF APPLICATION ON HERBICIDE EFFICACY IN CORN. Peter H. Sikkema,[1] Nader Soltani[1], and Robert E. Nurse[2]. [1]University of Guelph Ridgetown Campus, Ridgetown, Ontario, Canada, N0P 2C0; [2]Agriculture and Agri-Food Canada, Harrow, ON.

Field trials were conducted from 2005 to 2007 at two locations in southwestern Ontario to investigate how the timing of herbicide applications throughout the day affects weed control in corn. Weed control following the application of six postemergence (POST) herbicides (atrazine, bromoxynil, dicamba/diflufenzopyr, glyphosate, glufosinate, and nicosulfuron) at 600, 900, 1200, 1500, 1800, 2100 and 2400 hours was assessed. For many weed species herbicide efficacy was reduced when applications were made at 600, 2100, 2400 hours. Velvetleaf was the most sensitive to the time of day effect, followed by common ragweed, common lambsquarters and redroot pigweed. Annual grasses were not as sensitive to application timing; however, control of barnyardgrass and green foxtail was reduced in some environments at 600 hours and after 2100 hours. Only in the most severe cases was the grain yield of corn reduced due to reduced weed control. Changes in air temperature, relative humidity and light intensity throughout the day that cause species-specific physiological changes may account for the variation in weed control throughout the day. The results of this research suggest that there is a strong species-specific influence of ambient air temperature, light intensity and leaf orientation on the efficacy of POST herbicides. It is hoped that the results of this research will aid growers to apply herbicides when they are most efficacious, thus reducing costs associated with weed escapes.

INTRODUCTION OF “INTEGRATED WEED MANAGEMENT: FINE TUNING THE SYSTEM” AND THE SYMPOSIUM. Erin C. Taylor, Karen A. Renner, and Christy L. Sprague, Research Associate, Professor, and Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

“Integrated Weed Management: Fine Tuning the System” (E-3065) is a new 136-page, all color bulletin from Michigan State University Extension. This new publication compliments “Integrated Weed Management: One Year’s Seeding…” (E-2931), released in February 2005. The chapters in the new bulletin include: complex crop rotations, cover crop systems, manure and compost, flaming, grazing and other biological controls, weed thresholds, on-farm weed management trials, and 14 new weed profiles. Our goal was to compile information on each of these topics from researchers, extension personnel, and experienced growers to create easily digestible information regarding sustainable weed management. During this introduction opportunities and ideas for incorporating information from the bulletin into extension programs and classroom teaching will be presented.

DIVERSE CROP ROTATIONS AND WEED MANAGEMENT. Karen A. Renner and Christy L. Sprague, Professor and Associate Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

Crop rotations are essential to all farming systems to manage nutrients and pests, control soil erosion, increase soil organic matter, and improve soil quality. Complex crop rotations that include a variety of crops and planting dates usually improve weed management. When cultural practices are varied in a crop rotation, weed species are less likely to establish in the ever-changing niches. Many experiments have provided evidence that a complex crop rotation reduces weed populations compared with continuous production of one crop. This discussion period will examine the crop rotations of several field crop and vegetable farmers in Michigan and the surrounding states. Tillage, cover crop, and nutrient management practices provide insight into why these rotations work on these farms. Audience members will be encouraged to share their experiences with the effect of crop rotations on weed management.

CANADA THISTLE CONTROL WITH SUDANGRASS COVER CROPS. Abram J. Bicksler and John B. Masiunas, Graduate Research Assistant and Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, 1201 West Gregory Drive, Urbana, IL 61801.

Canada thistle (*Cirsium arvense*) is a vigorous, perennial weed that readily spreads by broad, creeping underground roots. The effects of summer annual cover crops and defoliation on Canada thistle growth and survival were investigated in field experiments from 2006-2008 at the Cruse Tract Vegetable Crops Research Farm. Both three months and one year after initiation of experiments, thistle shoot densities were reduced after sudangrass or sudangrass-cowpea (MIX) treatments. The MIX treatment was predominately sudangrass. By fifteen months after initiation of experiments, thistle shoot densities were lowest after sudangrass or MIX mowed once or twice. Biomass per individual thistle shoot was not reduced three months after initiation of the experiments by cover crops or mowing, but it was reduced one year after sudangrass or MIX treatments. Sudangrass and MIX treatments produced the greatest amount of cover crop biomass, regrowth following mowing, and mowed mulch. Fifteen months after the initiation of experiments, soybeans had the greatest biomass when planted into former once and twice-mowed cover crop plots. Canada thistle was suppressed in sudangrass or sudangrass-cowpea treatments, owing to the cover crop's competitiveness and regrowth potential. Mowing is more important for continued thistle control in the second than first season. We recommend a sudangrass cover crop with multiple mowing as part of a sustainable Canada thistle management strategy.

MUSTARDS AS BIOFUMIGANTS: CURRENT STATUS AND FUTURE PROSPECTS. Daniel Anderson, John B. Masiunas, Stephen Bossu, and Mosbah Kushad, Research Associate, Associate Professor, Undergraduate Research Assistant and Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, 1201 West Gregory Drive, Urbana, IL 61801.

Mustards (*Brassica* sp.) are being recommended as biofumigants for control of nematodes and some soil borne diseases. Mustard residues also suppress weeds, although their effectiveness varies depending on factors such as biomass, residue placement, maceration, environment, species, and cultivar. The primary mechanism for pest suppression by mustard residues is hydrolysis by myrosinase of glucosinolates to D-glucose, sulfates, and a number of active allelochemicals such as isothiocyanates (ITCs), nitriles, and thiocyanates. In living Brassica tissues, myrosinase is held in myrosin cells, separated from glucosinolates, but when cells are damaged, myrosinase is released, causing the breakdown of different glucosinolates into their corresponding bioactive forms. Our research objective is to determine the factors influencing activity of the glucosinolate – myrosinase – ITC system on weeds. In research with “Tilney” yellow (white) mustard (*Sinapis alba* syn. *Brassica hirta*) and “Florida Broadleaf” brown (Indian) mustard (*B. juncea*) we found that weed suppression was greater on a sandy soil than a silty clay loam but varied depending on weed species. For examples, in a sandy soil both species reduced longspine sandbur (*Cenchrus longispinus*) and large crabgrass (*Digitaria sanguinalis*) populations more than pigweed (*Amaranthus* spp) and eastern black nightshade (*Solanum ptycanthum*). Complete maceration of mustard shoot tissue and placement of residues in the upper 1.5 cm of soil where the majority of weeds emerge is critical for maximum activity. We are currently evaluating the mustard germplasm for their glucosinolate profile, myrosinase activity, and weed suppression. Further research will provide a biorational approach for including mustard biofumigants crops in sustainable weed management systems.

EVALUATION OF A NO-TILL ORGANIC SOYBENA SYSTEM IN MICHIGAN. Dale R. Mutch, Extension Specialist and Coordinator, Kellogg Biological Station, Michigan State University, Hickory Corners, MI 49060.

Michigan's largest organic acreage is planted to soybeans. Currently, these soybean farmers use up to 10 tillage treatments to control weeds. The increase in fuel costs has caused farmers to reevaluate current weed control practices to reduce these tillage trips.

Developing a biosuppressant cover crop system for soybeans will reduce tillage trips. Cover crops suppress weeds by competing for light, water and nutrients. The Michigan State University Extension Cover Crop Program has been evaluating a no-till organic soybean system for five years. Cereal rye is planted in the fall and crimped and rolled in the late spring. Soybeans are no-till drilled in 7.5 inch spacing following crimping and rolling of the rye. No additional weed control practices are used throughout the growing season.

We have had mixed results with this practice. In 2004 we had excellent yields and excellent weed control. In 2005 we crimped/rolled the rye too early resulting in lower yields. In 2006 we had very good yields and excellent weed control. In 2007 we had a drought that resulted in poor yields and weedy plots. I believe we need more research on this practice, as the potential benefits definitely make it worth the effort.

EFFECT OF FLAMING TIME ON WEED CONTROL. Erin Taylor, Research Associate, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824-1325.

High relative humidity or the presence of dew are thought to buffer the intensity of heat reaching the leaf surface of weeds during flaming and thus reduce the level of control. We measured the effectiveness of flaming at four different times throughout the day (8 a.m., noon, 4 p.m., and 8 p.m.) at two sites in 2007 and one site in 2008. In general, air temperature was the lowest and relative humidity was the highest at the 8 a.m. treatment time. Broadleaf and grass weed heights at the time of flaming ranged from 0.4 to 3.8 cm and 0.4 to 8.9 cm, respectively. Weed counts were taken in permanent quadrats before and five days after flaming. Flaming reduced broadleaf, but not grassy weed populations in all three site years. At both sites in 2007, broadleaf weed control was reduced at the 8 p.m. treatment time (average 44% control) compared with the other three treatment times (average 89% control). In 2008, there were no differences in broadleaf weed control among treatment timings. The differences in broadleaf weed control among flaming times in 2007 could not be explained by differences in temperature, relative humidity, or the presence/absence of dew.

WEED FLAMING: AN ENGINEERING APPROACH. Chris A. Bruening and George Gogos, Santiago Ulloa and Stevan Knezevic, Graduate student and Professor, Department of Mechanical Engineering, University of Nebraska, Lincoln, NE 68588, Graduate Student and Associate Professor, Haskell Ag Lab, University of Nebraska, Concord, NE 68728.

Weed flaming is a thermal weed control technique which has been proven to be very effective in several crops. Propane is the typical fuel source and its combustion in presence of air can produce flame and gas temperatures approaching 2000°C. These high temperatures are behind the principle of weed flaming, which is to boil the water in the plant cells, resulting in cell wall leakage and fatal damage to the targeted weed. From an engineering viewpoint, heat must be carefully controlled to maximize its effectiveness and to guarantee only weeds are being killed during flaming treatment. We have developed an improved heat control method that yielded in a higher quality treatment. Through the use of computational fluid dynamics and experimental measurements, a hood/torch device has been designed and compared to an open flame torch currently on the market. Both temperature measurements and field testing have been conducted in the comparison. Temperature measurements showed that the hood/torch device concentrated the heat of combustion, producing a larger high temperature core than the open torch. This also resulted in a longer exposure time to high temperature gases. Results from field tests showed the hood/torch device has the potential to reduce the propane consumption rate by 30-50% and to provide much greater control of flames in windy field conditions.

LIVESTOCK, AN IMPORTANT PIECE OF THE WEED CONTROL PUZZLE. Gary Reding, Langeland Farms, Inc., Greensburg, IN 47240.

Gary Reding was a conventional farmer but is now transitioning 600 acres to organic production at Langeland Farms in SE Indiana. Sir Albert Howard said, “Mother Nature never attempts to farm without livestock.” Learn how this statement encouraged Gary to mimic nature in his weed management strategies. Livestock have played a major role in controlling weeds during and after the transition in several ways. To begin, Gary intensively grazes cattle and goats on short-term pastures in his rotation; a practice which disrupts the lifecycle of key weeds such as giant ragweed and Canada thistle. Also, fall grazing of corn stover minimizes the volunteer corn issues in his popcorn, soybean, small grains and hay rotation. And furthermore, buffer areas around crop fields are grazed/baled for hay to keep forbs and fescue from creeping into the high value organic grain fields. In addition to weed control, Gary will briefly discuss meat sales and the increased organic matter observed when forages are added to the crop rotation as other ways in which livestock add value to the overall farm operation.

WEED MANAGEMENT STRATEGIES IN SUSTAINABLE PASTURE SYSTEMS. Richard Leep, Forage Agronomist, Department of Crop and Soil Sciences, Michigan State University, Hickory Corners, MI 49060.

Almost 90 percent of weed control in pasture systems can be accomplished by good pasture management. Management practices which can be used to control weeds in pastures include grazing, clipping, preventing perennial weeds from reaching the reproductive stage of growth, proper soil fertility, and maintaining thick stands of grasses and legumes. Many weed species are opportunistic and when combined with poor practices such as over grazing, these species can compete with perennial and annual forage species in a pasture. The 10 percent of weeds that may need to be controlled in pastures can be troublesome and may need to be treated with an appropriate herbicide. Most often, these weed patches can be controlled with spot treatments. Knowing the biology of the target weed species will help in control measures.

IS WEED COMPETITION FOR NITROGEN IMPORTANT? Chris M. Boerboom, Professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Knowledge of weed crop interactions can help to guide weed management and other crop production decisions. Nitrogen is one of the three major resources that may become limiting in non-legume crops such as corn and the recent dramatic surge in the price of nitrogen fertilizers has increased the importance of optimizing nitrogen rates. Based on an experiment evaluating optimal nitrogen rates in corn with different durations of weed competition, it can be argued that weed competition for nitrogen may be more significant than competition for water or light. In the experiment, weeds were controlled preemergence or were allowed to compete until they were 10 or 30 cm tall before being controlled with glyphosate. At the economic optimum nitrogen rate, corn yield was significantly reduced when weeds were allowed to compete until they were 30 cm tall. It is reasonable to speculate that the yield loss from this duration of weed growth was caused by competition for water. However, with high nitrogen rates (100 kg/ha or more than the economic optimum nitrogen rate), corn yields with weed competition were equal to the weed-free corn. This suggests that nitrogen was no longer limiting with high rates and that early competition for water was not yield limiting. Although additional nitrogen could compensate for early-season weed competition, high nitrogen prices should preclude over application of nitrogen to manage the risk of weed competition. Partial budgets even suggest that preemergence herbicide programs that are twice as expensive as postemergence programs can have equal or greater profit at nitrogen optimizing rates. Although these results have implications for growers using inorganic nitrogen sources, growers using legumes or manure as nitrogen sources should also be aware of these relationships as nitrogen availability can be limited in these cropping systems.

WEED SEED SURVIVAL IN LIVESTOCK MANURE HANDLING SYSTEMS. Roger Becker and Jeanie Katovich and Jerry Doll, Professor and Senior Scientist, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108 and Professor Emeritus, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Manure is an important soil amendment and valuable resource. In addition to providing nutrients, manure enriches the microbial population and diversity and adds organic matter to the soil. Many assume manure is often rich in weed seeds. The opposite is probably the case as most of our harvested forage is relatively free of weed seeds. Exceptions obviously exist. There is no simple method to extract weed seeds from feed or manure and to then test them for viability. So our best advice is to understand current knowledge about weed seeds in manure and how they may spread weed infestations. Key factors that determine the potential for weed seed problems: feed sources, type of animals, and type of feed and manure handling systems, will be discussed in the context of weed seed survival and dispersal.

INFLUENCE OF SPRING AND SUMMER HERBICIDE APPLICATIONS ON WEED CONTROL, TOTAL FORAGE YIELD AND TOTAL FORAGE QUALITY IN TALL FESCUE PASTURES IN MISSOURI. Kristin K. Payne*, Eric B. Riley, Jimmy D. Wait, Kevin W. Bradley, Graduate Research Assistant, Research Specialist, Research Associate and Assistant Professor, University of Missouri, Columbia, MO 65211.

Field experiments were conducted in 2007 and 2008 at two pasture sites in Boone and Moniteau County, Missouri to evaluate the effect of various herbicides and herbicide combinations on weed control, total forage yield and total forage quality. Both sites consisted of tall fescue (*Festuca arundinacea* Schreb.) pastures that contained natural infestations of common ragweed (*Ambrosia artemisiifolia* L.) and tall ironweed (*Vernonia gigantea* (Walt.) Trel). At both locations, 2,4-D, metsulfuron, aminopyralid, 2,4-D plus dicamba, 2,4-D plus picloram, aminopyralid plus 2,4-D, and 2,4-D plus dicamba plus metsulfuron were applied at a spring and summer application timing and evaluated for tall fescue injury and visual weed control. One month after the spring application timing, metsulfuron and 2,4-D plus dicamba plus metsulfuron resulted in 18 to 48% tall fescue injury, while all other herbicide treatments caused less than 10% tall fescue injury. One month after the summer application timing, all treatments caused less than 5% tall fescue injury. Application timing influenced common ragweed density one year after treatment (1YAT) at the Moniteau County but not the Boone County location. At the Boone County site, common ragweed density 1YAT ranged from 59 to 77 plants/m^2 and was similar among herbicide-treated and untreated plots. At the Moniteau County location, spring applications of metsulfuron and aminopyralid plus 2,4-D resulted in highest common ragweed densities 1YAT while no herbicide treatment decreased common ragweed density compared to the untreated control at the summer application timing. Application timing did not influence tall ironweed density 1YAT at either location. All herbicide treatments except metsulfuron and 2,4-D plus dicamba plus metsulfuron reduced tall ironweed density 1YAT compared to the untreated control at the Moniteau County research location. At the Boone County location, 2,4-D was the only treatment that decreased tall ironweed density 1YAT compared to the untreated control.

When averaged across all herbicide treatments applied in the spring, total annual forage yields at the Moniteau County location were greater than the untreated control. However, when averaged across all treatments applied in the summer, total annual forage yields were less than the untreated control. At the Boone County location, there were no differences in total annual forage yields between herbicide-treated and untreated plots, regardless of application timing. Few differences in total forage quality were observed at either the Boone or Moniteau County location in response to herbicide applications. One YAT, crude protein (CP) content was higher and acid detergent fiber (ADF) and neutral detergent fiber (NDF) content was lower in untreated compared to herbicide-treated forage at the Moniteau County location. ADF and NDF content was also lower in untreated compared to herbicide-treated forage 1YAT at the Boone County location, but CP content was similar between herbicide-treated and untreated forage. Pure samples of common ragweed and tall ironweed collected at the time of the spring 2007 and 2008 forage harvests were higher in forage quality than pure samples of tall fescue. Therefore, the poorer forage quality in herbicide-treated compared to untreated forage may be at least partially explained by the removal of common ragweed or tall ironweed with herbicide treatments. Results from these experiments indicate that the removal of common ragweed and tall ironweed with herbicides may increase total forage yields but is not likely to increase total forage quality.

ESTABLISHMENT AND PRODUCTIVITY OF FORAGE LEGUMES FOLLOWING FALL HERBICIDE APPLICATIONS. Mark J. Renz and John W. Albright, Professor and Research Program Manager, University of Wisconsin, Madison, WI 53706.

Previous research in Wisconsin has shown that herbicide applications with aminopyralid at 0.087 to 0.122 kg ae ha^{-1}, metsulfuron at 0.042 kg ha^{-1}, and imazapic at 0.21 kg ha^{-1} during the fall reduced establishment of forage legumes the following spring 7 months after treatment (MAT). Experiments were continued at two locations in Arlington and Lancaster Wisconsin to evaluate establishment of a range of legume forages established in the fall, 11 MAT, and the resulting yield of forage legumes planted at both timings 20 and 22 MAT. Treatments in this experiment included aminopyralid (0.054, 0.087 and 0.122 kg ae ha^{-1}), clopyralid (0.420 kg ae ha^{-1}), metsulfuron (0.042 kg ha^{-1}), imazapic (0.210 kg ha^{-1}), 2,4-D + dicamba (0.560 + 1.57 kg ae ha^{-1}) and an untreated control. Plots were treated on October 25th and 20th 2006 and then forage species planted 7 MAT on May 16th and 18th and 11 MAT on September 9th and 12th at Arlington and Lancaster respectively. Legume species planted included alfalfa, red clover, and white clover. Frequency of species planted in the fall was counted in 12 locations within each plot on October 31st at Arlington and November 7th at Lancaster. Resulting biomass for each species was harvested 20 MAT for the spring planted legumes and 22 MAT for the late summer planted legumes. Frequency and biomass was divided by untreated controls and data were analyzed by ANOVA for each species separately.

Significant differences ($p<0.05$) between establishment of alfalfa 11 MAT was only observed for clopyralid treatments at the Arlington site. All other treatments resulted in no reduction in establishment of any legume at both sites. Aboveground biomass of legumes, however only differed in spring plantings that were treated with metsulfuron at 0.042 kg ha^{-1}. This treatment resulted in 93-100% reductions in alfalfa, red and white clover biomass compared to untreated plots 20 MAT. In contrast, no reductions in biomass harvested 22 MAT were detected in summer plantings 11 MAT with any treatment across both sites.

This research demonstrates that while legumes can be established 7 MAT in Wisconsin, treatments of aminopyralid, metsulfuron, clopyralid, and imazapic have the potential to reduce establishment of legumes. Although our research only found reductions in biomass from treatments containing metsulfuron, the potential exists to reduce biomass if establishment is reduced enough. Unless this risk is acceptable, we recommend waiting a minimum of 11 MAT after using aminopyralid, metsulfuron, clopyralid, and imazapic before planting legumes as this will minimize the risk of yield loss from these herbicides.

EFFECT OF WEED CONTROL AND CUTTING SYSTEM ON ROUNDUP READY ALFALFA STAND LONGEVITY. Calvin Glaspie, Andrew Chomas, Timothy Dietz, James Kells and Wesley Everman, Graduate Research Assistant, Research Technician, Research Technician, Professor, Assistant Professor, Department of Crop and Soil Sciences Michigan State University, East Lansing MI 48864.

Glyphosate resistant alfalfa offers growers options for weed control in alfalfa. Weed management systems which utilize glyphosate as the main method of control could have potential benefits not previously observed with traditional practices. One proposed benefit of using glyphosate resistant alfalfa is increased longevity of an alfalfa stand under heavy harvest management. It is hypothesized that a stand of glyphosate resistant alfalfa will have a greater longevity due to effective control of weeds with minimal injury to the crop often seen with commonly used herbicides used. To test glyphosate resistant alfalfa persistence and yield potential, a field trial was established in August of 2003 on a capac loam soil with a pH of 7.4 at the Michigan State University Agronomy Farm in East Lansing, Michigan. Glyphosate resistant alfalfa was planted at a rate of 18 lbs/A at a 6” spacing and managed according to commercial production practices in Michigan. Treatments were arranged in a split plot design with cutting frequency as the whole plot and herbicide treatment as the sub plot. Whole plots were managed either as an intensive management system or as a moderate management system based on number of cuttings in a season. Herbicide treatments consisted of no herbicide applied, glyphosate at 0.75 lb ae/A or hexazinone at 0.5 lb ai/A as needed based on visual observation of weed pressure. Cuttings were taken each year after establishment at 750/850 growing degree days base 42 starting March 1st and subsequent cuttings at 28/35 day intervals for the intensive and moderate management systems, respectively. Dry biomass yield, forage quality and stand population data were collected percent. Weed and alfalfa percent dry biomass were calculated from hand separation data. Initial results indicate no significant differences between treatments when averaged across management blocks for yield, forage quality, weed control and stand persistence from 2004-2007. Data in 2008 shows segregation in treatment effects on weed biomass. A higher proportion of dry matter (DM) yield per acre in the untreated was weeds (1.7832 DM tons/a) compared to the hexazinone and glyphosate treatments (0.676 and 0.6529 DM tons/a respectively) across cutting blocks. The study is ongoing with an expected conclusion date in 2010.

EVALUATION OF GLUFOSINATE IN BURNDOWN APPLICATIONS. R. Darren Unland, Matthew J. Mahoney, Jayla R. Allen, and Michael Weber, Bayer CropScience, RTP, NC 27709.

As glyphosate resistant weeds are becoming more common and the in-crop use of glyphosate in corn and soybean production continues to increase, growers are seeking alternative solutions for controlling emerged weeds at or prior to planting in no-till situations. Glufosinate has been successfully used for several years as a burndown herbicide for cotton to control winter annual and perennial weeds in the spring. A new formulation of glufosinate for use in glufosinate-tolerant canola, corn, and soybean will soon be available for burndown and in-crop applications. Trials were conducted by Bayer CropScience and universities across the Midwest and Northeastern United States to evaluate weed control by glufosinate alone or in tankmixes with other herbicides prior to planting soybean. Glufosinate provided excellent postemergent control of most weeds including glyphosate-resistant horseweed (*Conyza canadensis*). The recently added labeled use of glufosinate as a burndown application offers non-selective weed control with a new mode of action for soybeans.

WEED CONTROL IN GLUFOSINATE RESISTANT SOYBEANS. Michael Weber* and Jayla Allen, Bayer CropScience, Research Triangle Park, NC. (184)

Glufosinate resistant soybeans are expected to gain full commercialization by early 2009. Glufosinate resistant soybeans will be a limited launch in the US and gradually increase in concurrent years. The total acres of soybeans have been estimated to be about one million for soybean growing areas. Soybean maturity ranges are expected to be from 0.5 through 4.8 groups; ranging from the Dakotas through Arkansas. Glufosinate has a unique mode of action that can provide an alternative control measure for weeds resistant to glyphosate. A new formulation of glufosinate has been labeled for use in glufosinate-resistant crops.

Weed control trials for glufosinate resistant soybeans were conducted by Bayer CropScience and universities. Trials evaluated the use of glufosinate in glufosinate resistant soybeans for general weed efficacy across a broad spectrum of grass and broadleaf weeds. Weed control was influenced by a preemergence herbicide when used following a glufosinate application versus without the use of a preemergence herbicide.

COMPARISON OF WEED MANAGEMENT STRATEGIES IN GLUFOSINATE, GLYPHOSATE, AND CONVENTIONAL SOYBEAN VARIETIES. Dean M. Grossnickle, James F. Lux, Damian D. Franzenburg, and Micheal D. K. Owen, Ag Research Specialists, and Professor, Agronomy Department, Iowa State University, Ames, IA 50011.

Field experiments were established to compare weed management tactics in glufosinate, glyphosate, and conventional soybean varieties in the spring, 2008. Strategies evaluated included several herbicide application timings and the use of a residual herbicide as part of a weed control program. Experiments were established at the Ames, Lewis, and Nashua Iowa State University research farms. Experiments were randomized complete block design with four replications. Plots measured 3.05 by 7.62 m and studies were established under minimum tillage conditions. Soybean varieties included ‘ML2566’ (glufosinate resistant), ‘AG2802’ (glyphosate resistant), and a conventional cultivar ‘PB253N’. Soybeans were seeded 3.18 cm deep using a 76.20 cm row cone planter at 370,500 seeds per ha.

Treatments included three application timings; early postemergence (EPOST) at V3, mid-postemergence (MPOST) at V5, and late postemergence (LPOST) at R2. Sequential application timings included preemergence (PRE) followed by (FB) MPOST, EPOST FB LPOST, and PRE FB EPOST and LPOST. One conventional program (PRE FB EPOST) was also included. Herbicides included glufosinate, glyphosate, pendimethalin, acifluorfen, bentazon, and sethoxydim. All PRE treatments were pendimethalin at 1.06 kg ai ha^{-1}. Glufosinate was applied at 0.44 kg ai ha^{-1} with 3.85 kg ammonium sulfate (AMS) per 378 l of carrier volume and applied to the ‘ML2566’ soybeans. Glyphosate was 0.86 kg ae ha^{-1} with 3.85 kg of AMS per 378 l of carrier volume and applied to the ‘AG2802’ soybeans. Conventional EPOST treatments included acifluorfen at 0.19 kg ai ha^{-1}, bentazon at 0.83 kg ai ha^{-1}, sethoxydim at 0.21 kg ai ha^{-1}, and crop oil concentrate at 2.32 l ha^{-1}. All herbicide applications were made at 187 l ha^{-1}.

Soybeans were evaluated for herbicide injury 7 days after the EPOST and MPOST applications and percent weed control was evaluated 15 days after EPOST, MPOST, and LPOST applications. Weeds evaluated included foxtail spp., velvetleaf, common waterhemp, and common lambsquarters. Woolly cupgrass was evaluated at Lewis.

Significant soybean injury ranging from 16 to 76% was observed across the three locations for the conventional herbicide program. Across the three locations, glufosinate treatments resulted in 0 to 10% soybean injury, while glyphosate treatments resulted in 0 to 7% injury.

In Ames, control of foxtail spp. ranged 92 to 99% across all herbicide treatments and application timings. Glyphosate controlled foxtail spp. 4 to 7% better than glufosinate at the 15 day evaluation rating for EPOST and MPOST application timings. The conventional program controlled foxtail spp. 4% better than the EPOST glufosinate. Glyphosate had 8% better velvetleaf control than glufosinate and the conventional program for the EPOST application timing and control ranged 90 to 99%. All herbicides and application timings controlled common waterhemp 90 to 98%. Glyphosate applied MPOST controlled common waterhemp 6% better than glufosinate. Glyphosate and the conventional program had 8% better control than glufosinate for common waterhemp EPOST. No differences between glyphosate, glufosinate, and conventional program were seen for the control of common lambsquarters for EPOST application timing. The MPOST timing of glyphosate and glufosinate had similar control of common lambsquarters and ranged from 95 to 99%. No differences in control between LPOST glyphosate and glufosinate regardless of weed species.

At Lewis, woolly cupgrass control ranged from 87 to 99%. Glyphosate and glufosinate EPOST controlled woolly cupgrass 12% better when compared to the conventional program EPOST. Glyphosate and glufosinate were similar for woolly cupgrass control when applied EPOST, MPOST, and LPOST. Glyphosate controlled velvetleaf 5% better than glufosinate at the MPOST timing.

Glufosinate and the conventional program controlled velvetleaf 3% better than glyphosate EPOST. No differences for common waterhemp and common lambsquarters were observed. No differences between glyphosate and glufosinate LPOST were observed and control was 98 to 99%.

At Nashua, glyphosate controlled velvetleaf 9 to 14% better than glufosinate at the EPOST and MPOST timings, respectively. The conventional program controlled velvetleaf 14% better than EPOST glufosinate. Comparing the MPOST application timing, glyphosate controlled common waterhemp and common lambsquarters 7% better than glufosinate. Glyphosate, glufosinate, and the conventional program controlled common lambsquarters and common waterhemp EPOST equally and control ranged from 91 to 99%. No differences for herbicide treatments were observed for foxtail spp. control. Glyphosate and glufosinate LPOST provided 98 to 99% weed control.

GLYPHOSATE-RESISTANT AND CONVENTIONAL SOYBEAN RESPONSE TO FOLIAR MANGANESE FERTILIZER. Mark L. Bernards, Lucas Perim and Irvin L Schleufer. Assistant Professor, Undergraduate Research Assistant and Research Technologist, Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE 68583.

Recent reports suggest that glyphosate-resistant soybean varieties may be more responsive to manganese (Mn) fertilizer applications than conventional soybean varieties. In some studies this research was conducted on soils that were deficient or marginally sufficient for plant available Mn. Our objectives in this research were 1) to evaluate the response of conventional and glyphosate-resistant soybean varieties to foliar applications of Mn on silt loam soils with sufficient plant available Mn, and 2) to measure the interaction of Mn and glyphosate applications on glyphosate-resistant varieties. Experiments were conducted in 2007 and 2008 at the South Central Agricultural Laboratory (SCAL) near Clay Center, NE, and at the Lincoln Agronomy Farm in Lincoln, NE. Eight soybean varieties (four conventional and four glyphosate-resistant) were planted in 30-in rows at 150,000 seeds/A in. Preemergence herbicides were applied to control weeds. Manganese sulfate (0.33 lb Mn/A) was applied foliarly at V3-V4, V7-V8, and the R1-R2 growth stages. Glyphosate was applied at the V5-V6 to select treatments. Grain was harvested using combines and yields were calculated. There was no yield difference in response to Mn fertilizer application between the glyphosate-resistant and the conventional varieties (each classification represented the average of 4 varieties). Manganese application had an inconsistent effect on yield (averaged across all 8 varieties). It was higher (1.8 bu/A) in one site year, lower (1.6 bu/A) in one site year, and not different in two site years. Manganese application did not affect the yield of individual varieties within a year, with two exceptions. Glyphosate applications to the glyphosate-resistant soybeans also had an inconsistent effect. It reduced yield (2.2 bu/A) in one site year, increased it (2.3 bu/A) in one site year, and had no effect in two site years. There was no interaction between glyphosate and Mn applications on soybean yield.

EVALUTION OF SOYBEAN YIELDS BETWEEN GLUFOSINATE AND GLYPHOSATE RESISTANT SOYBEANS. Michael Weber* and Jayla Allen, Bayer CropScience, Research Triangle Park, NC. (187)

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

Glufosinate resistant soybeans are expected to gain full commercialization by early 2009. Glufosinate resistant soybeans will be a limited launch in the US and gradually increase in concurrent years. The total acres of soybeans have been estimated to be about one million for soybean growing areas. Soybean maturity ranges are expected to be from 0.5 through 4.8 groups; ranging from the Dakotas through Arkansas. Glufosinate has a unique mode of action that can provide an alternative control measure for weeds resistant to glyphosate. A new formulation of glufosinate has been labeled for use in glufosinate-resistant crops.

Yield trials for glufosinate and glyphosate resistant soybeans were conducted by universities. Trials evaluated yield along with the use of glufosinate in glufosinate resistant soybeans comparing to glyphosate in glyphosate resistant soybeans for general weed efficacy under a broad spectrum of grass and broadleaf weeds.

KIXOR™ HERBICIDE (SAFLUFENACIL) PERFORMANCE PROFILE IN 2008 UNIVERSITY SOYBEAN TRIALS. Dan E. Westberg, Paul M. Vassalotti, Gery R. Welker, Dennis W. Belcher, and Adam C. Hixson, BASF Corporation, Research Triangle Park, NC, 27709.

Kixor (saflufenacil) is a new herbicide active ingredient under development for preplant to preemergence burndown of broadleaf weeds in soybean. Kixor demonstrated rapid burndown as well as preemergence activity on most broadleaf species including common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), common sunflower (*Helianthus annuus*), giant ragweed (*Ambrosia trifida*), horseweed (*Conyza canadensis*), morningglory spp. (*Ipomoea* spp.), and pigweed/waterhemp spp. (*Amaranthus* spp.). Glyphosate resistant horseweed was present at a few locations; Kixor provided effective control of these populations. Control of emerged grasses with glyphosate was unaffected by the addition of Kixor.

Two formulations were evaluated in 31 university trials: 1) a solo product, Sharpen™ Herbicide, at the target use rate of 25 g ai/ha, and 2) a premix of Kixor + imazethapyr, OpTill™ Herbicide, at the target use rate of 95 g/ha. Both formulations provided excellent broadleaf weed burndown and reduced early season broadleaf weed competition with their residual activity. OpTill provided additional residual broadleaf activity and significant grass residual. The residual activity provided by the formulations was effective as a set-up treatment for an in-crop postemergence application of glyphosate.

Federal registration is projected during the 3rd quarter of 2009.

INFLUENCE OF HORSEWEED HEIGHT ON THE FOLIAR EFFICACY OF SAFLUFENACIL. Tracy G. Mellendorf, Bryan G. Young, and Joseph L. Matthews, Graduate Research Assistant, Professor, and Researcher, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL 62901.

Field studies were conducted in 2007 and 2008 near Murphysboro, Illinois to evaluate the influence of horseweed plant height on the foliar efficacy of saflufenacil. The horseweed population was comprised of at least 90% glyphosate-resistant horseweed as determined by previous research at this site. Herbicide treatments included six rates of saflufenacil (0, 25, 50, 75, 100, and 125 g ai/ha) applied alone and in combination with glyphosate (840 g ae/ha). Glyphosate (840 g/ha) and paraquat (840 g ai/ha) were included as standards for comparison. The formulation of glyphosate used in this research did not include a full load of activator adjuvant. Crop oil concentrate (1 % v/v) was included in each treatment and liquid ammonium sulfate (5 % v/v) was added to every treatment except paraquat. Plot size was 3 by 9 meters with four replications arranged in a randomized complete block design. Prior to herbicide application 12 and 18 horseweed plants, in 2007 and 2008 respectively, were flagged per plot and original height was recorded. Plant height was categorized into four groups: <15, 15 to 30, 30.5 to 45, and >45 cm. Visual evaluations of control for individual plants and the entire plot were recorded at 7 and 14 days after treatment (DAT). Horseweed plant shoots were harvested at the end of season and dry weights were determined.

Control of horseweed with glyphosate applied alone was less than 30%, further confirming the presence of glyphosate-resistant plants. At 7 DAT all treatments with saflufenacil and paraquat provided at least 90% control. At 14 DAT saflufenacil applied alone at the lowest rate of 25 g/ha provided less control than all other treatments that included saflufenacil. Saflufenacil applied at 50 g/ha or greater resulted in at least 97% control, regardless of horseweed height at application. Herbicide efficacy was slightly reduced as horseweed height increased for saflufenacil at 25 g/ha applied alone. The addition of glyphosate to saflufenacil did not improve herbicide efficacy for rates of saflufenacil 50 g/ha or greater. Control of horseweed from paraquat declined over time due to plant regrowth from the apical meristems. The extent of horseweed regrowth from applications of saflufenacil alone was less than paraquat and even less frequent for saflufenacil and glyphosate tank-mixtures.

ROTATIONAL CROP SENSITIVITY TO FALL-APPLIED BAS 800H. Brian M. Jenks, Gary P. Willoughby, and Shanna A. Mazurek, North Dakota State University, Minot, ND 58701; Phillip W. Stahlman and Patrick W. Geier, Kansas State University Agricultural Research Center, Hays, KS 67601; and Leo D. Charvat, BASF Corporation, Lincoln, NE 68523.

Studies were conducted in ND, KS, and NE to determine rotational crop sensitivity to fall-applied BAS 800H (saflufenacil). At Minot, ND, studies were conducted in 2007 and 2008. BAS 800H was applied September 1, 2006 into wheat stubble at 25, 38, and 50 g/ha. Canola, flax, and lentil were direct-seeded into the treated area May 1, 2007. No visible crop injury was observed with any treatment. The soil was a loam with pH 5.4 and 3.4% OM.

In a separate study at Minot, BAS 800H was applied September 11, 2007 to wheat stubble at 25, 38, 50, 75, 100, and 200 g/ha. Sunflower, safflower, and lentil were planted May 15-20, 2008. BAS 800H caused severe crop injury including significant reductions in sunflower and safflower density and height. However, lentil injury was above 10% only at 100 g or higher. The study was conducted in a loam soil with pH 4.8 and 3.3% OM.

At Hays, KS, BAS 800H was applied September 2, 2007 at 25, 38, 50, 75, 100, and 200 g/ha onto bare soil in a non-replicated study. Alfalfa was seeded October 1, 2007. Canola and alfalfa were also seeded the following spring on April 2, 2008. There was no biomass reduction or visible crop injury to fall-seeded alfalfa or spring-seeded canola or alfalfa.

Also at Hays, KS, BAS 800H was applied September 2, 2007 at 25, 38, 50, 75, 100, and 200 g/ha onto bare soil that had been in fallow in 2007. In spring 2008, the plot area was tilled about 5 cm-deep and firmed with a Brillion seeder prior to seeding spring crops. Canola and alfalfa were seeded April 2, 2008. Sunflower and cotton were seeded June 5, 2008. There were no differences in crop density or biomass with any treatment. There was no visible injury to any crop. The soil at Hays was a silt loam with pH 7.8 and 1.5% OM.

At Lincoln, NE, BAS 800H was applied at 25, 38, and 50 g/ha to winter wheat stubble August 3, 2007. Canola and alfalfa were planted the following spring on March 28, 2008. Two maturities of RR soybeans and one sunflower were planted May 5, 2008. Stand counts were similar between treated and untreated plots and there was no visible injury to any crop. Thus, rotational spring crops of canola, alfalfa, soybean, and sunflower were not affected by a post-harvest application of BAS 800H, when planted in a normal rotation, in a no-till planting the following year. This study was conducted in a silty clay loam soil with pH 6.5 and 2.5% OM.

In a separate study at Lincoln, NE, BAS 800H was applied at 25, 38, 50, 75, 100, and 200 g/ha to winter wheat stubble September 12, 2007. An additional 25 g of BAS 800H was applied to the back 10 feet of each treatment on April 21, 2008. Canola and alfalfa were planted the following spring on March 28, 2008. Two maturities of RR soybeans and one sunflower were planted May 5, 2008 in the fall and fall plus spring application areas. Stand counts were similar between treated and untreated plots with no visible injury to canola, alfalfa, or soybeans. Canola stand counts were slightly lower at 200 g, but not significant. There was no stand reduction or visible injury to sunflower from the fall-applied treatments; however, sunflower stands were reduced where BAS 800H at 25 g was applied in the spring. The soil in this study was a silty loam with pH 4.7 and 2.7% OM.

FOMESAFEN + GLYPHOSATE: A NEW PREMIX FOR MANAGING GLYPHOSATE RESISTANT WEEDS IN SOYBEANS. Dain E. Bruns, Thomas H. Beckett, and Donald J. Porter, Research and Development Scientist, Research and Development Scientist, and Technical Brand Manager, Syngenta Crop Protection, Inc., Greensboro, NC 27409.

Fomesafen + glyphosate is a pre-package mixture of two proven soybean herbicides from Syngenta Crop Protection, Inc. This new mixture was developed for postemergence use in glyphosate tolerant soybean where the addition of a second mode of action could be useful in resistance management or where the presence of glyphosate resistant dicot weeds will require an additional tank mix partner for commercial control. Fomesafen + glyphosate premix controls velvetleaf, pigweed species, waterhemp species, common lambsquarters, common ragweed, jimsonweed, nightshade species, Pennsylvania smartweed, foxtail species, barnyardgrass, fall panicum, broadleaf signalgrass, and crabgrass, including glyphosate resistant Palmer amaranth and tall waterhemp. The fomesafen + glyphosate premix provides similar level of weed control as protoporphyrinogen oxidase herbicides mixed with glyphosate, however, the premix provides a significant improvement in soybean crop safety compared to the tank mixes. The market introduction of this new fomesafen + glyphosate premix will help sustain the glyphosate tolerant soybean production system.

TANK MIXES WITH GLYPHOSATE FOR DIFFICULT TO CONTROL WEEDS IN SOYBEAN.
Dawn Refsell, Bryan Young, and Gordon Roskamp, Extension Specialist, University of Illinois, Urbana, IL 61801, Professor, University of Southern Illinois, Carbondale, IL 62901, and Professor, Western Illinois University, Macomb, IL 61455.

The onset of glyphosate-resistant weed species is leaving growers with the question of how to manage these suspected resistant weeds. The incorporation of a preemergence herbicide and the use of tank-mixes are commonly noted at the top two ways to manage these weeds. Many times a quick remedy is also needed for a rescue treatment to control weeds which have escaped earlier weed management tactics. Field Studies were conducted in 2008 at seven locations throughout Illinois to determine the effectiveness of herbicides tank-mixed with glyphosate for control of common waterhemp (*Amaranthus rudis*), morningglory (*Ipomea* spp.), giant ragweed (*Ambrosia trifida*), and common lambsquarters (*Chenopodium album*) in soybean (*Glycine max*). These tank mixes were applied at early postemergence and late postemergence and at full and reduced rates and were compared with four glyphosate alone combinations and a preemergence followed by postemergence treatment. Soybean injury was evaluated 7 and 14 DAT, weed control was evaluated at 14, 28, and 56 DAT, and yield was collected at all but one location at the end of the season.

The Desota, IL location contained suspected glyphosate-resistant common waterhemp and was evaluated separately from the other trials. Only nine late postemergence treatments were evaluated and soybean injury was observed. Soybean injury 7 and 14 DAT was the greatest at 12 and 15%, respectively for the glyphosate+lactofen (high rate) treatment. 10% soybean injury was also observed in the glyphosate+lactofen (low rate) and the glyphosate+fomesafen (high rate) treatments 7 and 14 DAT. Glyphosate-resistant common waterhemp control 14 DAT ranged from 0 to 60%. Only three treatments provided greater than 50% 14 DAT and these being the glyphosate+lactofen (high and low rates) and glyphosate+fomesafen (high rate). Control of glyphosate-resistant common waterhemp 28 DAT was not greater than 52% for any treatment. Yield was not recorded at this location due to lack of weed control.

Common waterhemp control was evaluated at five other locations, morningglory over four locations, giant ragweed over three locations, and common lambsquarters at one location. Control of common waterhemp 14DAT did not differ significantly; however, at 28 DAT three of the twenty-nine treatments had reduced control (less than 85%). Control 56 DAT was greater than 85% for all but three treatments which included glyphosate alone (EPOST), glyphosate+imazethapyr (EPOST), and glyphosate+chlorimuron+thifensulfuron (EPOST). There were no differences in giant ragweed control regardless of rate and application timing at 7 and 14 DAT. Giant ragweed control was only 76% in the glyphosate+lactofen (LPOST) treatment 56 DAT, proving to be the only treatment with significantly less control. Morningglory control varied greatly 7 DAT with the highest level of control being 82%. Eleven tank-mix combinations provided greater than 81% control 14 DAT, with only one treatment with less than 80% control 56 DAT. Control of morningglory by glyphosate alone (EPOST) was significantly less at each evaluation timing. Common lambsquarters control ranged from 95 to 100% control for all treatments at 7 and 14 DAT (no evaluation at 56 DAT).

Soybean injury was the greatest regardless of application timing at rate for the glyphosate+lactofen treatment where soybean injury was as high as 25%. Injury was also observed at levels greater than 10% for the glyphosate+flumiclorac and glyphosate+fomesafen treatments at early postemergence timing. Soybean yield did not differ significantly by treatment except for the untreated control where yield was 1267 kg/ha. All other treatments yielded from 2840 to 3360 kg/ha.

2008 North Central Weed Science Society Proc. 63:192.

HOW NOVEL ARE THE CHEMICAL WEAPONS OF GARLIC MUSTARD IN NORTH AMERICA? Don Cipollini*, Stephanie Enright, and E. Kathryn Barto, Professor, technician, and graduate student, Department of Biological Sciences, Wright State University, Dayton, OH 45435

The novel weapons hypothesis posits that invasive plant species gain an advantage in invaded habitats by possessing novel biochemical traits toward which naive native species from many taxonomic groups lack tolerance. The invasiveness of garlic mustard in North America has been associated with the possession of novel weapons, but the chemistry of the native community has not been examined sufficiently to know whether the putatively bioactive molecules of garlic mustard are not already present in the native community. We compared the HPLC profile of flavonoids and glucosinolates, activities of trypsin inhibitors, and concentrations of cyanide in leaves of bolting garlic mustard plants with that found in equivalent leaves of four North American mustard species that occupy forest understories where garlic mustard invades. While profiles varied among North American *Arabis* and *Cardamine* species, no native mustard examined shared the same profile of glucosinolates or flavonoids in leaves with garlic mustard. Trypsin inhibitor levels were lower in undamaged leaves of garlic mustard than in the native species, which differed from each other, but these proteins are known to be highly inducible in garlic mustard. Among species, significant concentrations of cyanide were only found in the leaves of garlic mustard. Among the species examined here, the putatively bioactive chemistry of garlic mustard was distinct, supporting assertions of the novelty of the chemical weapons of garlic mustard in North America.

APPLICATION TIMING AFFECTS CONTROL OF WILD PARSNIP [*Pastinaca sativa* (L)] AND WILD CARROT [*Daucus carota* (L)] WITH HERBICIDES. Byron Sleugh[1], Mark Renz[2], and Mary Halstvedt[1]. [1]Dow AgroSciences LLC, 9330 Zionsville Rd., Indianapolis, IN 46268, [2]University of Wisconsin, Madison.

Wild parsnip (*Pastinaca sativa* (L) and *Daucus carota* (L)are two biennial invasive and noxious species that often occur in non crop sites such as ditch banks, road side rights of ways, Conservation Reserve Program (CRP) areas, wildlife habitat and others areas including pastures throughout the USA Midwest and Great Plains. While many herbicides are registered for use on these sites, little information is available about herbicides that provide long-term control of these weeds and appropriate timing to apply these treatments. Trials were established in CRP sites in Iowa and Wisconsin and herbicide applications were made in the autumn and spring. The experiment was designed as a randomized complete block with 3 to 4 replications. Treatments included (65, 87, 108, and 130 g ae ha^{-1}) of a premix formulation of aminopyralid + metsulfuron methyl (61.95% WG), methsulfuron methyl (13 g ae ha^{-1}), aminopyralid (120 g ae ha^{-1}) [WI only], 2,4-D amine (2240 g ae ha^{-1}), aminopyralid + 2,4-D (ForeFront® R&P) (120 + 972 g ae ha^{-1}), and metsulfuron methyl + dicamba + 2,4-D (11+ 140+ 402 g ae ha^{-1}) [IA only]. A nonionic surfactant was included with all treatments at 0.25% v/v. Control (% visual) of wild parsnip and wild carrot was evaluated as well as wild parsnip seedling count and ground cover at the Wisconsin trial site. There were no differences between fall applied treatments for control of established wild parsnip and wild carrot rosettes, but there was a difference in number of new seedlings the following spring among treatments. The premix formulation of aminopyralid + metsulfuron (130 g ae ha^{-1}) provided the best control of new seedlings with a 57% reduction for wild parsnip at the Wisconsin site. Aminopyralid + metsulfuron could be an effective treatment to manage wild parsnip populations. When applied in the spring, all treatments provided excellent control of both wild parsnip and wild carrot (except 2,4-D amine) at 96 days after treatment (DAT) in Iowa and 55 DAT in Wisconsin. Based on these results, a fall herbicide application is not recommended for the control of wild parsnip and wild carrot unless the management strategy also calls for a follow up application in the spring to control the emerging seedlings. Spring herbicide applications were much more effective at controlling both existing rosettes and emerging seedlings.

TECHNICAL INTRODUCTION OF DUPONT'S NEW VEGETATION MANAGEMENT HERBICIDE AMINOCYCLOPYRACHLOR. Ronnie G. Turner, Jon S. Claus, Mark J. Holliday and Edison Hidalgo, US Product Development Manager, DuPont Crop Protection, Memphis, TN 38125, Global Product Development Manager, Six Sigma Project Manager and Research Biologist, DuPont Crop Protection, Wilmington, DE 19805.

Aminocyclopyrachlor, a new active ingredient herbicide from DuPont, is currently under development for use in non-crop markets including rights-of-way, bareground, roadsides and invasive weed management.

Aminocyclopyrachlor is a novel pyrimidine carboxylic acid herbicide which provides both postemergent and soil residual activity in controlling many annual and perennial broadleaf weeds and brush species. This low use rate auxin-type herbicide provides broad-spectrum control of many broadleaf weeds including Asteraceae, Fabaceae, Chenopodiaceae, Convolvulaceae, Solanaceae and Euphorbiaceae, and a number of woody plant species, such as, *Acer rubrum*, *Acer negundo, Celtis occidentalis*, *Salix alba*, *Nyssa sylvatica*, *Prosopis juliflora* and *Ulmus americana*. Aminocyclopyrachlor also controls important ALS, PPO, triazine and glyphosate resistant weeds such as, *Amaranthus spp.*, *Kochia scoparia*, *Conyza canadensis*, *Ambrosia* spp., and *Salsola iberica*. Aminocyclopyrachlor has a very favorable toxicological (*acute and subchronic toxicity testing complete*) and environmental safety profile. Aminocyclopyrachlor will provide new standard for broadleaf and woody plant weed control in the roadside, invasive weed management, rights-of-way and bareground markets.

BIOLOGY REVIEW OF AMINOCYCLOPYRACHLOR. Susan K. Rick, Ronnie G. Turner and Jeff H. Meredith, Product Development, DuPont Crop Protection, Memphis, TN 38125

Aminocyclopyrachlor is a new herbicide candidate under development by DuPont Crop Protection. Aminocyclopyrachlor has a potential fit in many markets including fine turf, vegetation management and rangeland and pasture. Field testing of aminocyclopyrachlor began in 2004 and it has been tested under the DuPont codes DPX-KJM44 and DPX-MAT28. Aminocyclopyrachlor has both foliar and residual activity on a broad spectrum of broadleaf weeds, shrubs and brush species.
Aminocyclopyrachlor is taken up by leaves, stems and roots. Effects can be seen in hours to a few days however death may require weeks or months. Initial control symptoms include bending or twisting of stems and leaves, while advanced symptoms include stem thickening, growth stunting, leaf cupping, severe necrosis and death. Tank mixtures with various sulfonylureas increases the spectrum of species controlled and will be beneficial in controlling or delaying the onset of ALS resistant species.

AMINOCYCLOPYRACHLOR FOR INVASIVE WEED MANAGEMENT AND RESTORATION GRASS SAFETY IN THE CENTRAL GREAT PLAINS. Philip Westra, Scott Nissen, Todd Gaines, Bekir Bekun, Brad Lindenmayer, and Dale Shaner, Professor, Professor, Graduate Student, Visiting Scientist, Graduate Student, and Professor. Colorado State University and USDA/ARS, Fort Collins, CO 80523

Aminocyclopyrachlor is a new non-ALS herbicide under development by Dupont for initial use in non-cropland settings for invasive weed and tree control. Use rates to date in field research projects have ranged from 35 to 280 grams active ingredient per hectare. Most sensitive perennial weeds are well controlled at 70 – 100 grams per hectare. This new herbicide has both foliar and soil activity on susceptible species. Central great plains research shows that leafy spurge, Canada thistle, Scotch thistle, Russian knapweed, field bindweed, common milkweed, salt cedar, and Russian olive all exhibit excellent (> 90%) 1 year after treatment (YAT) control with aminocyclopyrachlor. Weeds in the mustard family are not well controlled by this herbicide. Soil binding is soil dependent; this herbicide shows good residual soil activity in different soils, but by 2 YAT most agronomic crops show no injury effects. Use of a good adjuvant enhances foliar activity of aminocyclopyrachlor. 2008 field research evaluated the pre and post response of 18 cool and warm season grasses to aminocyclopyrachlor.

ASSESSMENT OF CONSERVATION RESERVE PROGRAM (CRP) MID-MANAGEMENT OPTIONS FOR SUPPRESSION OF SMOOTH BROME. Marie L. Schmidt*, Richard T. Proost, Mark J. Renz, Graduate Research Assistant, Outreach Specialist, and Professor, University of Wisconsin, Madison, WI 53706.

The Conservation Reserve Program (CRP) was initially established as a cropland set-aside program offered by the United States Department of Agriculture in the 1985 Farm Bill. Over the past twenty years priorities for this program shifted to support wildlife habitat, specifically nesting habitat, food and cover for upland birds. Due to this shift, many fields that were planted in a monoculture of cool season grass such as smooth brome are now considered improper habitat for this program. Recently, the Farm Service Agency has required owners of these properties to suppress cool season grasses and diversify the plant species present by inter-seeding the fields with desirable forbs. This management is intended to enhance wildlife habitat by increasing plant species and structural diversity as well as remove duff and control woody vegetation. While options for management are provided by National Resource Conservation Service, limited information exists on the effectiveness of herbicides and tillage in suppressing cool season grasses, establishing desirable forbs, and how these treatments can affect soil loss. Experiments were conducted near New Glarus and Horicon Wisconsin to evaluate the effectiveness of glyphosate at 0.56, 0.84 and 1.12 kg ha^{-1}, sethoxydim at 0.11, 0.21 and 0.32 kg $ha^{-1}$and fluazifop at 0.21, 0.28 and 0.42 kg ha^{-1} in suppressing smooth brome dominated fields compared to tillage and untreated plots. Herbicides and tillage were applied in the spring on 4/29/08 and 5/12/08 at each site respectively. At the New Glarus site, plots were inter-seeded with alfalfa using a no-till drill 1 day after treatments (DAT) were applied.

Suppression of smooth brome and other cool season grasses was observed with treatments containing glyphosate and fluazifop at both sites during the summer. Percent control was 75-85% and 88-94% for treatments containing glyphosate and 48-58% and 84-91% for treatments containing fluazifop 97 DAT and 77 DAT at the New Glarus and Horicon site respectively. Suppression did diminish with time, and at the New Glarus site, only treatments containing glyphosate were able to maintain suppression of smooth brome 127 DAT, with glyphosate at 0.56, 0.84 and 1.12 kg ha^{-1} reducing cover of smooth brome by 84, 89, and 91 percent respectively. At the Horicon site, smooth brome remained suppressed 106 DAT with fluazifop, glyphosate, sethoxydim and tillage. Fluazifop at 0.21, 0.28 and 0.42 kg ha^{-1} reduced cover by 57, 82 and 83% compared to the UTC respectively, while glyphosate at 0.56 and 0.84 kg ha^{-1} and sethoxydim at 0.32 kg ha^{-1} reduced smooth brome cover 73, 60 and 51% respectively. Differences in suppression between sites may have been due to large populations of goldenrod species at the Horicon site in combination with no inter-seeding. Establishment of alfalfa was successful at the New Glarus site with all treatments, but only enhanced with glyphosate treatments. Cover of alfalfa 127 DAT with these treatments were 34-55% compared to 2% in untreated plots.

Although all methods were effective in establishing a more diverse plant community, the use of glyphosate was more effective at suppressing populations and allowing for establishment of alfalfa while also suppressing other undesirable broadleaf weeds. While disking suppressed smooth brome, results did not persist throughout the year as cover was only reduced at the Horicon site 39% 106 DAT. These data in combination with the potential for increased soil loss on highly erodable land should cause land managers to hesitate in recommending disking for mid contract management of cool season grasses.

AMINOPYRALID PLUS TRICLOPYR EFFICACY ON PROBLEMATIC VEGETATION IN RIGHTS-OF-WAY SITES. David E. Hillger, Vanelle F. Peterson, William N. Kline, Vernon B. Langston and Patrick L. Burch, Senior Biologist, Lead Research Specialist and Senior Research Specialists, Dow AgroSciences LLC, Indianapolis, IN 46268

Aminopyralid + triclopyr amine (Milestone® VM Plus specialty herbicide) is a herbicide developed by Dow AgroSciences for rights-of-way vegetation management. Trials conducted in 2006 through 2008 provided excellent control of several herbaceous broadleaf plants including yellow starthistle (*Centaurea solstitialis*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), horseweed (*Conyza canadensis)*, ragweed species, (*Ambrosia spp.*), woolly croton (*Croton capitalus*), sericea lespedeza (*Lespedeza cuneata*), poison hemlock (*Conium maculatum*), wild carrot (*Daucus carota*) and giant hogweed (*Heracleum mantegazzianum*). Aminopyralid + triclopyr amine also controls brushy rights-of-way weed species including Scotch broom (*Cytisus scoparius*), French broom (*Teline monspessulana*) and Himalaya blackberry (*Rubis discolor*). Aminopyralid + triclopyr amine has an excellent fit in rights-of-way vegetation management systems where glyphosate resistant species like *Conyza* spp. and *Ambrosia trifida* are present or where selective broadleaf control is desirable.

HIGH VOLUME FOLIAR HERBICIDE TREATMENTS FOR LATE SEASON ASIAN BUSH HONEYSUCKLE CONTROL. Ronald A. Rathfon, Department of Forestry and Natural Resources, Purdue University, Dubois, IN 47527.

Amur honeysuckle phenology provides important windows of opportunity for effecting targeted control in high quality native plant communities. It leafs out in early spring, well in advance of most native vegetation and retains its foliage late into the fall, after most native plants have gone dormant. This study tested seven different high volume foliar herbicide treatments as late fall controls for Amur honeysuckle in southern Indiana.

Treatments included:

Herbicide Type and Concentration

1. 1% glyphosate (3 lb ae/100 gal) as GlyproPlus®
2. 2% glyphosate (6 lb ae/100 gal)
3. 4% glyphosate (12 lb ae/100 gal)
4. 0.125% imazapyr (0.25 lb ae/100 gal) as Arsenal®
5. 0.25% imazapyr (0.5 lb ae/100 gal)
6. 0.5% imazapyr (1 lb ae/100 gal)
7. 1% glyphosate + 0.125% imazapyr

Application Timing

1. 7 Nov
2. 14 Nov
3. 21 Nov

Three replications of each herbicide x treatment timing combination were each randomly assigned to 25 ft. x 100 ft. plots containing a dense stand of Amur honeysuckle. Plots averaged 4730 shrubs/acre with shrub heights ranging from <1 ft. to 15 ft. The treatment plots were located within forest edge habitat where forest and pasture interface. Treated shrubs were tallied by height classes: <4.5 ft., 4.5 – 8 ft., and >8 ft. Herbicide was applied using a 50 gal., 3-point hitch mounted sprayer with a PTO-driven 6-roller pump. Foliage was sprayed to the point of runoff to achieve complete coverage.

For purposes of this study, control is defined as complete mortality of the above ground portion of the shrub with no resprouting two years following treatment. In the week of Nov. 7, all the glyphosate alone treatments achieved almost 100% control. Among imazapyr treatments, only the 0.5% concentration achieved >90% control, with 0.25% imazapyr controlling 87% of treated shrubs. Adding imazapyr to glyphosate provided 90% control and could not improve on using glyphosate alone at this date. However, it provided more control than 0.125% imazapyr treatment (66%). The week of Nov. 14, 1% glyphosate control dropped precipitously to only 30%. 2% glyphosate achieved over 85% control, while 4% glyphosate was still able to control 100% of treated shrubs. Because of rainy conditions, the imazapyr alone treatments were not applied the week of Nov. 14. The 1% glyphosate + 0.125% imazapyr treatment only provided 47% control. The week of Nov. 21, none of the treatments achieved satisfactory control. The 2% glyphosate and 0.5% imazapyr treatments achieved the highest level of control, approaching 70%. 4% glyphosate controlled only 52% of shrubs. Shrub size did not affect the performance of any glyphosate treatments the week of Nov 7. The larger the shrubs, the lower the control rates where imazapyr was appled on Nov 7, except for the highest rate, 0.5%. By Nov 21, all herbicide treatments were decreasingly effective as shrub size increased.

1% glyphosate can provide 100% control as a foliar treatment for controlling Amur honeysuckle when applied in the fall, as late as the first week in November in southern Indiana. Glyphosate can remain effective as a foliar treatment for controlling Amur honeysuckle through the second week in Nov in southern Indiana when applied at higher concentrations (2% - 4%). Foliar herbicide applications for controlling Asian bush honeysuckle are unreliable when applied after the 2nd week in Nov in southern Indiana, regardless of herbicide product or concentration. Imazapyr foliar treatments only achieve high rates of Amur honeysuckle control at a minimum 0.5% concentration rate applied in early Nov. Lower concentration rates of imazapyr may be applied at this time when most shrubs are in smaller size classes. Amur honeysuckle susceptibility to foliar herbicide treatment will vary in Indiana by latitude, with effective treatments being applied later in the fall the further south you go in normal weather years. Weather in September and October will cause variation in bush honeysuckle phenology and thus susceptibility to foliar herbicide treatments from year-to-year.

INVASIVE PLANTS IN FORESTS INFESTED BY EMERALD ASH BORER: HOW SCIENTISTS AND MANAGERS WORKED TOGETHER TO DESIGN A USEFUL RESEARCH PROGRAM. Kathleen S. Knight, John Cardina, Catherine P. Herms, Kamal J.K. Gandhi, Annemarie Smith, Robert P. Long, and Daniel A. Herms, Research Ecologist, US Forest Service Northern Research Station, Delaware, OH 43015, Professor, Department of Horticulture and Crop Science, Ohio State University, Wooster, Ohio 44691, Research Associate, Department of Horticulture and Crop Science, Ohio State University, Wooster, Ohio 44691, Assistant Professor, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602, Invasive Species Forester, 360 E State St. Athens, OH 45707, Research Plant Pathologist, US Forest Service Northern Research Station, Delaware, OH 43015, and Associate Professor and Associate Chair, Department of Entomology, Ohio State University, Wooster, Ohio 44691.

Emerald ash borer (EAB) (*Agrilus planipennis*), an introduced beetle, has already killed millions of ash (*Fraxinus spp*.) trees in Michigan and Ohio and threatens all North American ash species. Ash species are the dominant tree species in some riparian and swamp ecosystems, as well as an important component in many upland hardwood forest ecosystems. Ash mortality due to EAB may cause a cascade of effects in these ecosystems. We began our research with a discussion with managers experiencing EAB infestation in their parks to identify research questions of importance to them. We have continued to meet with this group of managers to update them on our results and to gather suggestions for outreach to other managers and to the public.

To understand the effects of EAB on forest ecosystems, a network of 254 plots in forested areas were established in Ohio and Michigan, representing a gradient of infestation by EAB. Thus far, our research has focused on rates and patterns of ash decline and mortality due to EAB and the response of invasive plants to this disturbance. We have created a model to predict the yearly mortality of ash trees in infested forests. We will identify species of invasive plants likely to become problematic in different ash ecosystems, as well as circumstances, including ash density and invasive species density thresholds, in which the invasive plants may become dominant. Using the tools we create, managers will be able to plan the timing of removal of hazard trees, control of invasive plants, pre-emptive harvests, and restoration activities.

EFFECT OF REMOVAL OF DAME'S ROCKET (*HESPERIS MATRONALIS*) ON FOREST UNDERSTORY VEGETATION IN NW INDIANA. Noel B. Pavlovic, Stacey Leicht-Young, Krystal Frohnapple, and Ralph Grundel, Ecologist, Ecologist, Biological Technician, and Ecologist, U.S. Geological Survey, Great Lakes Science Center, 1100 N. Mineral Springs Rd., Porter, IN 46304

Invasive exotic plants may often negatively affect native plant species. One approach to determining the potential effect of a given invasive species is by removing this species from the community. We used this removal approach to quantify the response of a mesic woodland plant community to the removal of the invasive plant, *Hesperis matronalis* (dame's rocket). We established ten paired treatment plots in which one plot had *H. matronalis* removed and the other with *H. matronalis* retained as a control. In each of these plots we measured cover for each plant species present. Sampling was done twice each year, once in the spring and once in late summer for three years. We began each survey by evaluating the cover of the plant species present, and then pulling all *H. matronalis* from the treatment plots. Cover of *H. matronalis* did not differ between control and treatment plots prior to removal, declined in the removal plots and remained significantly lower in cover compared to the control plots. Total vegetation cover, however, was not significantly different between treatment and control plots. Removal did not significantly affect species richness and species diversity (evenness, Shannon, and Simpson) at the plot scale but did increase species richness across all treatment plots in the summer of the last sampling year, when compared to control plots. Ordination analysis indicated a significant compositional change in the spring plant composition of plots over the three years, reflecting an increase in the cover of exotic woody species. Exotic woody plants, especially *Rosa multiflora* and *Euonymus alatus,* significantly increased in cover in response to *H. matronalis* removal. In the three years, neither native nor exotic forbs, nor native woody plants, significantly responded to the removal of *H. matronalis*. The apparent positive response of woody invasive plants from the removal of *H. matronalis* shows that removal of one invasive may cause increases in other invasives during restoration of degraded communities.

2008 North Central Weed Science Society Proc. 63:211.

A BIOLOGICAL CONTROL PROGRAM FOR COMMON TANSY (*TANACETUM VULGARE*) IN CANADA AND THE UNITED STATES. Alec McClay[1], Monika Chandler[2], André Gassmann[3], Vera Wolf[4], John Gaskin[5], [1]McClay Ecoscience, 15 Greenbriar Crescent, Sherwood Park, Alberta, Canada T8H 1H8 biocontrol@mcclay-ecoscience.com, [2]Minnesota Dept of Agriculture, 601 Robert Street North, Saint Paul, MN 55155, USA 651-201-6468, Monika.Chandler@state.mn.us, [3]CABI Europe - Switzerland, 1 Rue des Grillons, Delémont CH-2800, Switzerland a.gassmann@cabi.org, [4]CABI and University of Bielefeld, Universitätsstraße 25, D-33615 Bielefeld, Germany v.wolf@cabi.org, [5]USDA-ARS Northern Plains Agricultural Research Laboratory, 1500 N. Central Ave. Sidney, MT 59270, USA JGaskin@sidney.ars.usda.gov

Common tansy (*Tanacetum vulgare* L., Asteraceae) is an aromatic herbaceous perennial native to Europe, which was introduced into North America as a culinary and medicinal herb. Now widely naturalized in pastures, roadsides, waste places, and riparian areas across Canada and the northern USA, tansy is also spreading in forested areas. It contains several compounds toxic to humans and livestock, such as α-thujone. Tansy reduces the productivity of pastures, displaces native vegetation in natural areas, and can be a problem in regeneration of logged areas. It is listed as a noxious weed in several states and provinces. Common tansy is a good target for biological control, as it is a perennial plant growing in stable habitats, and has few native North American congeners. A biological control program for common tansy is being funded and coordinated by a Canadian-US consortium led by the Alberta Invasive Plants Council and the Minnesota Department of Agriculture. CABI Europe - Switzerland is identifying and testing potential agents for efficacy and host specificity, including the stem-mining weevil *Microplontus millefolii*, the leaf-feeding beetle *Cassida stigmatica*, the rhizome-mining moths *Isophrictis striatella* and *Dichrorampha* spp., and the root-feeding flea beetle *Longitarsus noricus*. Several of these species are now in culture at CABI, and preliminary host specificity testing is under way. A test plant list has been developed and is under review by the Canadian Biological Control Review Committee and the US Technical Advisory Group.