Influence of pH on Carryover of Triketone Herbicides in Missouri No-till Corn and Soybean Rotations

2006-2007 Missouri Fertilizer and Lime Council

Grant Proposal

Investigators:

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Objectives:

It is well known that soil pH extremes can affect the carryover of certain herbicides and in some instances result in injury and/or yield reductions to the rotational crop planted the year following treatment. For example, in research recently funded by the Missouri Fertilizer and Lime Council, atrazine applied to corn in a high pH soil in Missouri resulted in a 5 bu/acre yield loss in the subsequent soybean crop. Conversely, other researchers have observed crop yield losses as a result of herbicide carryover due to low soil pH's. Each of these pH extremes can affect the solubility and breakdown of the herbicide in question, and therefore affect the likelihood of carryover and injury to the subsequent crop.

The triketone herbicides represent the newest class of herbicides that have been introduced onto the market today. Callisto® (mesotrione) was the first of these herbicides released onto the marketplace in 2000 and in a short time span has developed into one of the most popular herbicides used by growers for postemergence broadleaf weed control in corn. Impact® (topramazone) is a similar type of triketone herbicide that was first available for commercial use during the 2006 growing season. Impact® appeared to be used extensively during the 2006 season due to reports that this herbicide performs as well or better than Callisto® and can be purchased at an equivalent or lower cost. Additionally, another triketone herbicide, Laudis® (tembotrione) is currently under development by Bayer CropSciences and is expected to be released for commercial use sometime in the next two to three years. It appears that in the course of the next several growing seasons, each of these triketone herbicides will compete to become the predominant postemergence herbicide used in conventional corn production throughout the U.S. Since the triketone herbicides are the newest class of herbicides released on the market, little is known about the effects of soil pH extremes on the likelihood of carryover injury with these herbicides.

In 2006, at least three separate instances of Callisto® carryover injury onto soybeans were reported to extensions specialists at the University of Missouri. To our knowledge, these were the first cases of Callisto® carryover injury onto soybeans in Missouri since the introduction of this herbicide in 2000. In at least one of these instances, the site in question had an acidic pH ranging from 4.5 to 5. It is not clear whether the other sites in question also had an acidic pH or if pH plays any role in the likelihood of Callisto® carryover. In addition to these reports, some researchers who have been involved in the development of Impact® have speculated that this herbicide is much more likely to carryover than Callisto® due to the chemical properties of this herbicide in comparison to Callisto®. As Impact was just introduced in 2006, this possibility has simply not been explored in experiments conducted by unbiased university researchers. Additionally, little to no information of this nature has been gathered on the experimental herbicide Laudis®, as this herbicide is still a few years away from full commercial release. For all of these reasons, the objectives of these experiments are to determine if variations in soil pH values have an influence on the carryover and persistence of the corn herbicides Callisto®, Impact®, and Laudis® through evaluations of soybean injury and yield conducted the season after treatment.

Procedures:

Replicated field plots that have been established and maintained at the Bradford Research and Extension Center with varying soil pH values will be utilized for all of the experiments conducted in this research. In the first year, one-half of the research area will be no-till planted into corn while the other half of the research area will be no-till planted into soybeans in preparation for a no-till corn rotation during the second year of research. The experiments conducted each year will be arranged in a split-plot design with four replications of four herbicide treatments and five pH levels. Whole plots will be herbicide treatments while subplots will be individual pH levels. Herbicide treatments will consist of postemergence applications of Callisto® at 3 fluid ounces per acre, Impact® at 0.75 fluid ounces per acre, Laudis® at 3 fluid ounces per acre, and an untreated control. Each of these treatments will be applied to plots having soil pH values of 4.8, 5.4, 6.2, 7.0, and 7.6, resulting in a total of 20 individual treatment comparisons. A Roundup Ready® corn hybrid will be utilized in these experiments in order to keep all plots weed-free throughout the season with applications of glyphosate (Roundup®), a nonselective herbicide that has no residual activity or ability to carryover and cause injury to soybeans. At or soon after corn planting, a preemergence application of Dual II Magnum® (*S*-metolachlor) will also be made to reduce early season weed competition and reduce overall weed pressure. Dual II Magnum® is also labeled for use in soybean, thus there is no chance of carryover injury to soybean as a result of applications of this herbicide. Corn will be harvested with a small plot combine and grain yields determined.

In the second year of research, all corn plots will be rotated into soybeans. A Roundup Ready® soybean variety will be no-till planted into the first-year corn plots and early-season soybean stunting and injury in response to the previous corn herbicide treatments and pH levels will be evaluated. All soybean plots will be maintained weed-free throughout the season and soybeans will be harvested with a small plot combine. Conversely, corn will be no-till planted into the area previously planted with soybeans during the second year of research and the same four herbicide treatments will be applied to plots having soil pH values of 4.8, 5.4, 6.2, 7.0, and 7.6. As in the first year experiments, corn will be harvested and grain yields determined.

In the third and final year of the research, a Roundup Ready® soybean variety will be no-till planted into the area that had previously been in corn during the second year of research. These soybeans will also be monitored for early-season symptoms of carryover injury due to the previous corn treatments and yields will also be determined. This will provide two years of data pertaining to the effects of these herbicide treatments and soil pH levels on carryover to soybean from standard postemergence applications of Callisto®, Impact®, and Laudis® made in the previous corn crop.

Current Status/Importance of Research Area:

In 2005, Missouri ranked 5th in the nation in soybean production and well over half of these acres follow corn in a traditional corn-soybean rotation. If the triketone herbicides utilized in corn production caused only a 5 bushel yield reduction on 1% (~50,000) of the soybean acres in Missouri, this would result in $1.5 million in lost income to Missouri farmers each year. With the current costs and restraints of soybean production systems, yield must be maximized in order to also maximize profitability.

As discussed previously, it is likely that at least one of the triketone herbicides will become the predominant method of postemergence weed control used in corn production during the next several years. Currently, Callisto® leads this group of herbicides but it may eventually be replaced by either Impact® or Laudis®. Little is know about the carryover potential of either of these herbicides therefore the results from this research may help growers to prevent a problem before significant yield losses are incurred.

Timetable for Proposed Research:

The first year of research will begin in April of 2007 at the time of corn planting and this research will continue through three years until the time of the final soybean harvest in 2009.

Strategy for Application/Transfer of Knowledge:

Results from this research will be presented at local, regional, and national meetings, and plots at the BREC will be utilized during each year of the research for training in the annual crop injury and diagnostic clinic. Results will also be published in scientific journal articles and used to update Missouri weed control recommendations and Extension publications.

Budget:

Category	Year 1	Year 2	Year 3	Total
Salary				
Research Associate (20% in years 1 & 2, 10% in year 3)	12,000	12,000	6,000	30,000
Fringe Benefits (31%)	3,720	3,720	1,860	9,300
Materials and Supplies (seed, stakes, herbicides, etc.)	1,000	1,000	500	2,500
Soil Analyses	800	800	800	2,400
Total	$17,520	$17,520	$9,160	$44,200

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EDUCATION:

Ph. D. Plant Pathology, Physiology, and Weed Science, 2000, Virginia Tech
B. S. Agriculture, 1995, Ferrum College

PROFESSIONAL EXPERIENCE:

2003-Present	Assistant Professor of Agronomy and State Extension Weed Scientist, Dept. of Agronomy, University of Missouri
2000-2003	Postdoctoral Research Associate, Dept. of Plant Pathology, Physiology, and Weed Science, Virginia Tech
1995-2000	Graduate Research Assistant, Dept. of Plant Pathology, Physiology, and Weed Science, Virginia Tech

PRIMARY RESEARCH / EXTENSION RESPONSIBILITIES:

Project director for research and extension projects in the area of weed management in corn, soybean, wheat, pastures, and forages. Primary extension objectives are to: 1) develop cost-effective and environmentally sound weed management systems for use in agronomic crops and forages, and 2) to provide timely and accurate weed control information and recommendations to regional Extension specialists, agribusiness representatives, and growers throughout Missouri. Specific extension activities include presentations at field days and grower meetings, writing newsletter articles on topics of recent concern, answering questions at weekly teleconferences, and conducting weed and herbicide training sessions. In addition to evaluating new herbicides and weed management techniques, applied research programs focus on the development of weed management programs for use in conventional and herbicide-tolerant crop and forage systems, and on the interactions that occur between weeds, insects, and diseases.

REFEREED JOURNAL ARTICLES

Bradley, K. W. and S. P. Conley. 2006. Influence of imazamox rate and tank-mix combinations on winter annual broadleaf weed control and yield in imidazolinone-resistant wheat. Online. Crop Management doi:10.1094/CM-2006-0523-01-RS.

Bradley, K. W. 2006. A review of the effects of row spacing on weed management in corn and soybean. Online. Crop Management doi:10.1094/CM-2006-0227-02-RV.

Bradley, K. W., E. S. Hagood, Jr, K. P. Love, and R. D. Heidel. 2004. Response of biennial and perennial weeds to selected herbicides and prepackaged herbicide combinations in grass pastures and hay fields. Weed Technol. 18:795-800.

Bradley, K. W., E. S. Hagood, Jr., and P. H. Davis. 2004. Trumpetcreeper (*Campsis radicans*) control in double-crop glyphosate-resistant soybean (*Glycine max*) with glyphosate and conventional herbicide systems. Weed Technol. 18:298-303.

Bradley, K. W., E. S. Hagood, Jr., and P. Davis. 2004. Evaluation of postemergence herbicide combinations for long-term trumpetcreeper (*Campsis radicans*) control in corn (*Zea mays*). Weed Technol. 17:718-723.

King, S. R. E. S. Hagood, Jr., **K. W. Bradley**, and K. K. Hatzios. 2003. Absorption, translocation, and metabolism of AEF 130060 03 in wheat, barley, and Italian ryegrass (*Lolium multiflorum*) with or without dicamba. Weed Sci. 51: 509-514.

Bailey, W. A., K. K. Hatzios, **K. W. Bradley**, and H. P. Wilson. 2003. Absorption, translocation, and metabolism of sulfentrazone in potato (*Solanum tuberosum*) and selected weed species. Weed Sci. 51:32-36.

Bradley, K. W. and E. S. Hagood, Jr. 2002. Influence of sequential herbicide treatment, herbicide application timing, and mowing on mugwort (*Artemisia vulgaris*) control. Weed Technol. 16:346-352.

Bradley, K. W. and E. S. Hagood, Jr. 2002. Evaluations of selected herbicides and rates for long-term mugwort (*Artemisia vulgaris*) control. Weed Technol. 16:164-170.

Bradley, K. W. and E. S. Hagood, Jr. 2001. Identification of a johnsongrass (*Sorghum halepense*) biotype resistant to aryloxyphenoxypropionate and cyclohexanedione herbicides in Virginia. Weed Technol. 15:623-627.

Bradley, K. W., J. Wu, K. K. Hatzios, and E. S. Hagood, Jr. 2001. The mechanism of resistance to aryloxyphenoxypropionate and cyclohexanediones herbicides in a johnsongrass biotype. Weed Sci. 49:477-484.

·······Peter Clifton Scharf

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Research and Extension education interests

- developing, evaluating, and promoting tools to predict crop N needs, including variable-rate N management
- minimizing environmental impacts of agricultural nutrients
- optimizing nutrient and lime management for crop production
- tailoring nutrient recommendations to account for soil properties

Education

Degree	*Date*	*Institution*	*Major*
Ph.D.	May 1993	Virginia Polytechnic Inst. and State University	Crop & Soil Environmental Sciences
M.S.	July 1988	Virginia Polytechnic Inst. and State University	Agronomy
B.S.	August 1982	University of Wisconsin	Biochemistry, Genetics

Selected Research Publications

Scharf, P.C., N.R. Kitchen, K.A. Sudduth, and J.G. Davis. 2006. Spatially variable corn yield is a weak predictor of optimal nitrogen rate. Soil Sci. Soc. Am. J. 70:2154-2160.

Scharf, P.C., S.M. Brouder, and R.G. Hoeft. 2006. Chlorophyll meter readings can predict nitrogen need and yield response of corn in the north-central U.S. Agron. J. 98:655-665.

Cromley, S.M., W.J. Wiebold, P.C. Scharf, and S.P. Conley. 2006. Hybrid and planting date effects on corn response to starter fertilizer. Online. Crop Management doi:10.1094/CM-2006-0906-01-RS.

Scharf, Peter C., Newell R. Kitchen, Kenneth A. Sudduth, J. Glenn Davis, Victoria C. Hubbard, and John A. Lory. 2005. Field-scale variability in optimal N fertilizer rate for corn. Agron. J. 97:452-461.

Scharf, Peter C. and William J. Wiebold. Soybean yield responds minimally to nitrogen applications in Missouri. 2003. Online. Crop Management doi:10.1094/CM-2003-1117-01-RS.

Lory, John A. and Peter C. Scharf. 2003. Yield goal versus delta yield for predicting fertilizer nitrogen need in corn. Agron. J. 95:994-999.

Scharf, Peter C., John P. Schmidt, Newell R. Kitchen, Kenneth A. Sudduth, S. Young Hong, John A. Lory, and J. Glenn Davis. 2002. Remote sensing for nitrogen management. J. Soil Water Cons. 57:518-524.

Scharf, Peter C. and John A. Lory. 2002. Calibrating corn color from aerial photographs to predict sidedress N need. Agron. J. 94:397-404.

Scharf, Peter C., William J. Wiebold, and John A. Lory. 2002. Corn yield response to nitrogen fertilizer timing and deficiency level. Agron. J. 94:435-441.

Hellwig, K. B., W. G. Johnson, and P. C. Scharf. 2002. Grass weed interference and nitrogen accumulation in no-tillage corn. Weed Sci. 50:757-762.

Selected Extension Publications

Scharf, Peter and John Lory. 2006. Best Management Practices for nitrogen fertilizer in Missouri. 12-page manual. MU Extension publication IPM1027.

Scharf, Peter. 2006. Color of corn leaf shows needed nitrogen for crop. MidAmerica Farmer Grower, June 30, 2006, p. 8-9.

Scharf, Peter. 2006. Fertilizer efficiency–What's the limit? Integrated Pest & Crop Management 16:30-31.

Scharf, Peter and Harlan Palm. 2005. The color of green: sensors cast light on how corn growers can use less nitrogen. Press release through MU Extension & Ag Information.

Houghton, Dean. 2005. Rescue N: When? The Furrow, summer 2005 p. 7-8. Using information from Peter Scharf.

Scharf, Peter and Larry Mueller. 2005. Fall-applied N may be lost. Integrated Pest & Crop Management 15:35-36.

Wehrspann, Jodie. 2004. Spend fertilizer dollars wisely. Farm Industry News, Oct. 2004. Using information from Peter Scharf.

Scharf, Peter. 2004. Rain and nitrogen: a bad combination. Integrated Pest & Crop Management 14:70.

Scharf, Peter. 2004. Nitrogen carryover after low-yielding corn. Integrated Pest & Crop Management 14:25.

Scharf, Peter. 2004. Early urea applications. Integrated Pest & Crop Management 14:14,16.

Scharf, Peter. 2004. Changes in the nitrogen fertilizer industry: higher prices, more imports, more urea, and more UAN solution. Integrated Pest & Crop Management 14:17.

Scharf, Peter. 2004. Proper soil pH reduces atrazine carryover in no-till rotations. Missouri CCA News, January 2004 p. 3-4.

Reichenberger, Larry. 2004. An eye for nitrogen. Successful Farming, Feb. 2004. Using information from Peter Scharf.