Chapter III

Mesotrione combinations in no-till corn (*Zea mays*)

Abstract: Field studies were conducted in 1999, 2000, and 2001 to determine the effectiveness of mesotrione applied preemergence (PRE) and postemergence (POST) in no-till corn. Also of interest was the evaluation of a pre-package mix of mesotrione plus acetochlor (1:11 ratio of mesotrione : acetochlor) in combinations with glyphosate-tms, paraquat, and 2,4-D. Mesotrione PRE at 235 g/ha or greater controlled common lambsquarters, smooth pigweed, and common ragweed at least 80%. POST Mesotrione at 35 g/ha and higher controlled common lambsquarters 91% or greater. Increasing POST mesotrione rates to 140 g/ha controlled smooth pigweed greater than 97%. Common ragweed control from POST mesotrione was 56 to 97% and was inconsistent. PRE and POST applications of mesotrione did not adequately control most annual grasses or cutleaf eveningprimrose. The mesotrione plus acetochlor pre-package mix plus burndown herbicides controlled field pansy and ivyleaf morningglory similar to or better than control by the pre-package mixture of glyphosate-ipa plus atrazine plus acetochlor. However, common ragweed control by mesotrione plus acetochlor plus burndown herbicides was occasionally lower than control by the pre-package mixture of glyphosate-ipa plus atrazine plus acetochlor. Corn injury was generally less than 10% with PRE and POST mesotrione applications. Corn treated with mesotrione generally produced the highest yields.

Nomenclature: Acetochlor; atrazine; 2,4-D; glyphosate-ipa (isopropylamine salt); glyphosate-tms (trimesium salt); mesotrione; paraquat; common lambsquarters, *Chenopodium album* L. #[1] CHEAL; common ragweed, *Ambrosia artemisiifolia* L.# AMBEL; cutleaf eveningprimrose, *Oenothera laciniata* Hill # OEOLA; fall panicum, *Panicum dichotomiflorum* Michx. # PANDI; field pansy, *Viola arvensis* Murr. # VIOAR; giant foxtail, *Setaria faberi* Herrm. # SETFA; goosegrass, *Eleusine indica* (L.) Gaertn # ELEIN; ivyleaf morningglory, *Ipomoea hederacea* (L.)

[1] Letters following this symbol are a WSSA-approved computer code for Composite List of Weeds, Revised in 1989. Available from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

Jacq. # IPOHE; johnsongrass, *Sorghum halepense* (L.) Pers. # SORHA; smooth pigweed, *Amaranthus hybridus* L. # AMACH; corn, *Zea mays* L.

Key words: Bleaching herbicides, burndown, non-selective herbicides, triketone herbicides.

Abbreviations: COC, crop oil concentrate; DAT, days after treatment; PRE, preemergence; POST, postemergence; UAN, urea ammonium nitrate; WAT, weeks after treatment.

INTRODUCTION

Weed management in no-till corn is dependent on control of winter annual weeds with non-selective herbicides and control of summer annual weeds with residual herbicides (Wilson et al. 1985). The non-selective herbicides registered for no-till corn include glyphosate (various salts) and paraquat (Hagood et al. 2001). These non-selective herbicides control various winter annual weed species, but have little to no residual activity (Wilson et al. 1985; Wilson and Worsham 1988; Ahrens 1994). Often 2,4-D is applied with these non-selective herbicides in order to improve control of some winter annual weed species (Hagood et al. 2001; Wilson and Worsham 1988).

The residual herbicides most often included with non-selective herbicides in no-till corn are atrazine plus a chloroacetamide (Ahrens 1994; Anonymous 2001a). However, residual herbicides have reduced control of some winter annual and over-wintering perennial weed species by glyphosate (Selleck et al 1981; Wilson et al 1985). Therefore, new corn herbicides should be evaluated in combinations with non-selective herbicides to determine if similar responses occur.

Tillage may affect residual herbicide activity. Simazine persisted less in no-till corn than in conventional tillage corn (Slack et al 1978). Similarly, atrazine carryover is usually reduced in no-till corn production (Burnside and Wicks 1980). However, Bauman and Ross (1983) found that atrazine residues actually increased over five years in no-till systems in comparison to conventional tillage systems, possibly due to changes in its degradation rate.

Plant residues associated with no-till corn production have decreased the residual activity of some corn herbicides (Erbach and Lovely 1975). Also, residual herbicides applied in no-till corn are most effective when applied closest to the planting date and when multiple herbicide applications are made (Buhler 1991; Johnson et al. 1997). As a result, new corn herbicides should be evaluated in no-till corn with preemergence (PRE) and postemergence (POST) applications made in close proximity to the planting date.

RPA 201772 [5-cyclopropyl-4-(2-methylsulfonyl]-4-trifluoromethylbenzoyl) isoxazoles] (proposed common name isoxaflutole) is a recently introduced PRE herbicide that controls some annual broadleaf and grass weeds in corn (Luscombe et al. 1994; Anonymous 2001b). Potential foliar uptake by weeds and residual soil activity led to investigations of RPA 201772 in no-till corn (Young and Hart 1998). RPA 201772 plus 2,4-D or glyphosate controlled many annual broadleaf and grass weeds (Striegel et al. 1995). Vrabel et al. (1996) reported good foliar activity of RPA 201772 in no-till burndown, with the added benefit of soil residual activity.

Mesotrione is a recently registered herbicide for PRE and POST control of broadleaf weeds in field corn (Anonymous 2001c). This compound is the newest member of the triketone herbicide family, which also includes SC 0051, a herbicide registered in Europe for broadleaf weed control in corn (Beraud et al. 1993). Mesotrione, like other triketones and RPA 210772, functions through inhibition of the enzyme p-hydroxyphenylpyruvate dioxygenase (HPPD, EC1.13.11.27) (Norris et al. 1998; Pallet et al. 1998; Viviani et al. 1998). Currently, little information is available on control of broadleaf weeds by mesotrione applied PRE in no-till corn.

Mesotrione plus acetochlor is a pre-package mixture[2] in a 1:11 ratio that controls selected annual broadleaf weeds and grasses when applied PRE in field corn. This PRE mesotrione plus acetochlor pre-package mix controls several annual broadleaf and grass weeds (Lackey et al. 1999; Ohmes et al. 2000).

[2] Zeneca Ag. Products, 2 Righter Parkway, P.O. Box 15458, Wilmington, DE 19850-5458.

Mesotrione POST has controlled several annual broadleaf weeds, large crabgrass, and barnyardgrass (Sutton et al. 1999; Beckett and Taylor 2000; Armel et al. 2001). POST applications should include 1% v/v crop oil concentrate (COC) and 2.5% v/v urea ammonium nitrate (UAN) (Wichert and Pastushok 2000).

The objective of these studies was to evaluate mesotrione for weed control in no-till corn. Specifically, the first objective was to investigate mesotrione in a tank-mix combination with glyphosate-tms or sequentially following burndown by glyphosate-tms. An additional objective was to evaluate an experimental mesotrione plus acetochlor pre-package mix in tank-mix combinations with glyphosate-tms, paraquat, and 2,4-D.

MATERIALS AND METHODS

Studies were conducted at the Eastern Shore Agricultural Research and Extension Center near Painter, VA in 1999, 2000, and 2001. The soil type was a Bojac sandy loam (Typic Hapludults) with less than 1% organic matter and a pH of 6.1. Fields were planted the previous year with soybean [*Glycine max* (L.) Merr.] and after harvest the land remained fallow the months prior to corn planting. Fertilizer was applied in accordance with current recommendations from Virginia Polytechnic Institute and State University (Donohue and Heckendorn 1994). Corn ('Pioneer 33G26'[3]) was planted without tillage into these fields to a depth of 3.8 cm and a rate of 56,800 seeds/ha on April 29, 1999, April 24, 2000, and April 23, 2001.

Plots established to receive PRE and POST herbicide treatments consisted of four rows spaced 0.76 m apart with a herbicide treated area of 2.5 m by 6.1 m; a 0.9 m untreated buffer was maintained between plots. Herbicides were applied with a tractor-mounted sprayer delivering 235 L/ha at 210 kPa through flat fan nozzles[4]. PRE herbicides were applied May 4, 1999, April 27, 2000, and April 24, 2001. POST herbicides were applied 22, 39, and 35 DAT with PRE

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[3] Pioneer Hi-Bred International, Inc., 400 Locust Street, Suite 800, Des Moines, IA 50306-3453.

[4] Teejet 8003 flat fan nozzle. Spraying Systems Company, North Avenue, Wheaton, IL 60188.

herbicides on May 26, 1999, June 5, 2000, and May 29, 2001. All POST mesotrione treatments included 1% v/v COC[5] and 2.5% v/v UAN.

The first study, entitled "Mesotrione rate response" was conducted in 1999, 2000, and 2001 to evaluate mesotrione applied PRE at 78, 157, 235, and 314 g ai/ha in combination with glyphosate-tms at 1120 g ai/ha. Additional treatments included POST mesotrione at 35, 70, 105, and 140 g/ha. In these POST mesotrione treatments, glyphosate-tms was applied at 1120 g /ha on the same date the PRE mesotrione treatments were applied to control winter annual weed species prior to POST mesotrione applications.

A second study, entitled "Mesotrione pre-package mix combinations" was conducted in 1999 and 2001 to evaluate mesotrione at 202 g/ha plus acetochlor at 2240 g ai/ha as a pre-package mix in combination with paraquat at 700 g ai/ha or glyphosate-tms at 840 g/ha. These mesotrione plus acetochlor plus non-selective herbicide treatments were evaluated with or without 526 g ai/ha of 2,4-D. A commercial standard of 840 g ai/ha glyphosate-ipa plus 1680 g ai/ha atrazine plus 2240 g/ha of acetochlor[6] was included for comparison. Paraquat at 700 g/ha and glyphosate-tms at 840 g/ha were also applied alone for comparison.

Weed species varied with year and studies, but each was present in at least two years. Weed heights for PRE burdown applications were generally similar over years although some differences occurred. Heights of the winter annual weeds cutleaf eveningprimrose (*Oenothera laciniata* Hill) and field pansy (*Viola arvensis* Murr.) were 10 to 25 cm tall at the time of PRE burndown applications and generally increased little in height during the 3 to 5 weeks between PRE and POST herbicide applications. Furthermore, field pansy was usually flowering at POST applications. In general, summer annual weed species were not present at the time of PRE burndown applications. Common ragweed (*Ambrosia artemisiifolia* L.) was 15 to 20 cm at POST applications in 2000 and 2001. Common lambsquarters was 5 to 8 cm at POST

[5] Agridex, a mixture of 83% paraffinic mineral oil and 17% polyoxyethylene sorbitan fatty acid ester, Helena Chemical Company, 5100 Poplar Avenue, Memphis TN 38137.

[6] Field Master™ herbicide. Monsanto Company. 800 N. Lindbergh Blvd, St. Louis, MO 63167.

application in 2000, but was about 23 cm tall in 2001. Smooth pigweed (*Amaranthus hybridus* L.) was 5 to10 cm tall in 2000, but did not germinate until after POST applications in 2001. Annual grasses were a combination of giant foxtail, goosegrass [*Eleusine indica* (L.) Gaertn], fall panicum (*Panicum dichotomiflorum* Michx.), and seedling johnsongrass. Most of these grasses germinated after POST applications, with the exception of johnsongrass. Corn height was approximately 15 cm tall in 1999 and in the V3 to V4 stage of growth. In 2000 and 2001, corn was approximately 46 and 61 cm in height, respectively and in the V9 to V11 growth stages.

Treatments in both studies were replicated three times and arranged in a randomized complete block design. Corn injury and weed control were visually rated on a scale of 0 to 100% where 0 = no injury or weed control and 100 = crop death or complete weed control. Injury was generally rated 3 wk after treatment (WAT) with PRE herbicides and again 1 WAT with POST herbicides.

In the first study, visual control ratings of all weed species were made 4 WAT with POST herbicides. However, in the second study control of field pansy was evaluated 3 WAT with PRE herbicides, while common ragweed and ivyleaf morningglory were rated 12 WAT with PRE herbicides. Corn yields were determined by harvesting grain from the center two rows of each plot with a commercial combine modified for small plots and adjusting weight to 15.5% moisture prior to analysis. However, corn was not harvested in 1999 due to high johnsongrass populations. Data were subjected to analysis of variance (ANOVA) and means were separated using Fisher's Protected LSD test at the $\alpha = 0.05$ significance level. When ANOVA revealed no significant year by treatment interaction, data were pooled over years.

RESULTS AND DISCUSSION

Rainfall during the 28 days after treatment (DAT) with PRE herbicides differed between years. In 1999, 0.2 cm of rainfall was received during the first 14 DAT and an additional 1.2 cm occurred during the following 2 wk. In 2000, rainfall during the 14 DAT was 0.1 cm, but an additional 5.8 cm of rain was received during the next 2 wk. In 2001, 1.2 cm of rain occurred during the first 7 DAT and a total of 5.4 cm occurred during the next 3 wk.

Mesotrione rate response. No year by treatment interaction occurred for control of cutleaf eveningprimrose and annual grass, or for corn yields, therefore these data were pooled. Since cutleaf eveningprimrose is a winter annual weed, PRE and POST herbicide applications were considered POST to this weed species. Glyphosate controlled cutleaf eveningprimrose only 20% (Table 3.1). Additions of 78 to 235 g/ha of mesotrione to glyphosate improved control to 43 to 61%. Mesotrione at 314 g/ha plus glyphosate controlled cutleaf eveningprimrose 71%. Glyphosate fb 35 to 140 g/ha of POST mesotrione controlled cutleaf eveningprimrose 35 to 50%. The tank-mixtures of mesotrione plus glyphosate likely provided greater control of cutleaf eveningprimrose than POST mesotrione because higher rates of mesotrione were applied at the PRE timing than at POST applications. Other researchers have previously reported difficulty in controlling cutleaf eveningprimrose in no-till crops (Reynolds et al. 2000).

Control of common lambsquarters, common ragweed, and smooth pigweed by mesotrione PRE was rate dependent and varied somewhat among species. Common lambsquarters control by 78 g/ha mesotrione PRE in 2000 was only 59%. However, common lambsquarters control was greater than 87% by mesotrione at 157 g/ha and above (Tables 3.1). Common ragweed control by mesotrione at 235 and 314 g/ha was 80 to 89% and smooth pigweed control at these rates was 83 to 91% (Tables 1 and 2). Control of both species was frequently lower at 78 and 157 g/ha mesotrione. In previous studies in conventional tillage corn, mesotrione PRE at 157 and 210 g/ha did not control common lambsquarters or smooth pigweed better than 62% and common ragweed control was low and variable (Armel 2002). Similarly, other PRE herbicides have frequently controlled certain weed species better in no-till than in conventional tillage systems (Fuqua et al. 1988).

Mesotrione POST controlled both common lambsquarters and smooth pigweed (Table 3.1). Common lambsquarters control was greater than 90% with 35 to 140 g/ha mesotrione and control did not differ between rates. However, smooth pigweed control with mesotrione POST was 98 to 99% at all rates in 2000 but was 65 to 97% with 35 to 140 g/ha mesotrione in 2001. This difference in smooth pigweed control between years likely results from the fact that smooth pigweed did not emerge in 2001 until after POST mesotrione was applied. As a result, low POST mesotrione rates were not sufficient to provide PRE control of smooth pigweed.

Common ragweed control with mesotrione POST at 35 to 140 g/ha was 82 to 97% in 2000 and 56 to 82% in 2001 (Table 3.2). In these studies, common ragweed control with mesotrione was more consistent with PRE applications than with POST applications. In previous studies (Armel 2002), common ragweed control was most consistent with combinations of preemergence herbicides followed by POST mesotrione treatments.

Mesotrione controlled annual grass species 19 to 63% (Table 3.2). Mesotrione was generally more active on goosegrass and seedling johnsongrass than on fall panicum and giant foxtail (data not presented). Seedling johnsongrass exhibited pronounced bleaching symptoms from POST mesotrione applications, but most plants eventually recovered. PRE mesotrione applications controlled annual grasses less than 44%, while POST applications controlled annual grasses less than 63% (Table 3.2). Similarly, Ohmes et al. (2000) reported mesotrione did not control giant foxtail or johnsongrass.

Corn injury from PRE and POST mesotrione applications was generally less than 10% (data not presented). Injury was generally stunting that dissipated within 2 to 3 WAT. Yield of corn receiving tank-mix combinations of glyphosate-tms plus mesotrione or glyphosate-tms fb mesotrione POST were higher than corn treated with glyphosate-tms only (Table 3.2). Further, corn treated with mesotrione PRE produced yields of 7.53 to 8.99 Mg/ha and corn treated with mesotrione POST produced yields of 7.31 to 9.26 Mg/ha.

Mesotrione pre-package mix combinations. No year by treatment interaction occurred with control ratings for field pansy, therefore these data were pooled over years. Field pansy control was 89 to 98% among all treatments (Table 3.3). However, field pansy control with the mesotrione plus acetochlor pre-package mix was higher in combination with paraquat (98%) than with glyphosate-tms (89%). Glyphosate-tms and paraquat alone effectively controlled field pansy 94 and 90%, respectively. The addition of 2,4-D to combinations of the pre-package mix of mesotrione plus acetochlor with either glyphosate-tms or paraquat did not improve control of field pansy.

Common ragweed control was similar among treatments with residual herbicides. In 1999, mesotrione plus acetochlor combinations controlled common ragweed 82 to 99% (Table 3.3). These same treatments controlled common ragweed 73 to 94% in 2001. Glyphosate-ipa plus atrazine plus acetochlor controlled common ragweed 84 and 98% in 2000 and 2001, respectively. In 2001, this standard pre-package mix gave better control of common ragweed than the mesotrione plus acetochlor pre-package mix in combinations with either paraquat plus 2,4-D or glyphosate-tms. Common ragweed control from the pre-package mix of mesotrione plus acetochlor has been variable in previous studies (Armel 2002). PRE atrazine has been recommended for common ragweed control (Hagood et al. 2000).

Ivyleaf morningglory control was variable. In 1999, the pre-package mix of mesotrione plus acetochlor controlled morningglory species 53 to 67% and the glyphosate plus atrazine plus acetochlor standard controlled morningglory 47% (Table 3.3). However, in 2001 the mesotrione plus acetochlor pre-package mix combinations controlled ivyleaf morningglory 78 to 89% and control from the glyphosate-ipa plus atrazine plus acetochlor pre-package mix was 99%. Increased control in 2001 could be due to differences in rainfall after PRE applications. In 2001, 1.2 cm of rainfall was received by 1 WAT, while only 0.1 cm was received in the same time period in 1999.

Corn injury was generally less than 10% with PRE mesotrione plus acetochlor treatments and was reflected as transient stunting (data not presented). Corn yields were generally higher in 2001 than 1999 due to higher amounts of rain. In 1999, corn yields were 3.38 to 5.19 Mg/ha and treatments with residual herbicides were not greater than burndown treatments applied alone (Table 3.3). In 2001, all treatments with residual herbicides produced higher corn yields than paraquat or glyphosate applied alone. Further, corn treated with the glyphosate-ipa plus atrazine plus acetochlor pre-package mix produced a grain yield of 8.45 Mg/ha and this yield was higher than yields from corn treated with the mesotrione plus acetochlor pre-package mix in combination with paraquat treatments. This difference in yield cannot be readily explained by weed control or corn injury.

Based on these studies, mesotrione can provide control of weeds in no-till corn on the Coastal Plain soils of eastern Virginia. PRE mesotrione rates of 235 or 314 g/ha controlled common lambsquarters, smooth pigweed, and common ragweed at least 80%. The mesotrione pre-package mix with acetochlor plus burndown herbicides controlled field pansy and ivyleaf morningglory similar to control with glyphosate-ipa plus atrazine plus acetochlor pre-package mix. However, this mesotrione plus acetochlor pre-mix was not always effective against common ragweed. Mesotrione POST at 35 to 140 g/ha controlled common lambsquarters 90% or greater. Increasing POST mesotrione rates to 105 to 140 g/ha consistently controlled smooth pigweed. Common ragweed control from POST mesotrione applications was not consistent (56 to 97%). Similarly, Beckett and Taylor (2000) also reported that POST mesotrione controlled smooth pigweed and common lambsquarters, but our studies did not exhibit adequate common ragweed control as they reported. Also, mesotrione applications were not adequate for control of cutleaf eveningprimrose or annual grasses present in these studies.

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LITERATURE CITED

Ahrens, W. H., ed. 1994. Herbicide Handbook. 7^{th} ed. Champaign, IL: Weed Sci. Soc. of Amer. 352 p.

Anonymous. 2001a. Crop production and agricultural chemical usage in field crops. Agricultural statistics board, NASS and USDA. Online. Internet. September 20, 2001. Available **http://www.usda.gov/nass/**.

Anonymous. 2001b. Balance® herbicide product label. Aventis Crop Protection. Crop Protection Reference. C&P Press 17^{th} edition. pp. 24-27.

Anonymous. 2001c. Callisto™ herbicide label. Syngenta Crop Protection, Inc. Greensboro, NC.

Armel, G. R., H. P. Wilson, R. R. Richardson, and T. E. Hines. 2001. ZA 1296 combinations for control of grasses in corn. Weed Sci. Soc. Am. Abstr. 41:84.

Armel, G. R., H. P. Wilson, and T. E. Hines. 2002. Investigations of mesotrione for weed management in corn. Virginia Polytech. Inst. and State Univ., Blacksburg. Chap. 1.

Bauman, T. T. and M. A. Ross. 1983. Effect of three tillage systems on the persistence of atrazine. Weed Sci. 31:423-426.

Beckett, T. H. and S. E. Taylor. 2000. Postemergence performance of mesotrione in weed control programs. Proc. N. Cent. Weed Sci. Soc. 55:81.

Beraud, M., J. Claument, and A. Montury. 1993. ICIA 0051, A new herbicide for control of annual weeds in maize. Proc. Br. Crop. Prot. Conf. Weeds 51-56.

Buhler, D. D. 1988. Factors influencing fluorochloridone activity in no-till corn. Weed Sci. 36:207-214.

Buhler, D. D. 1991. Early preplant atrazine and metolachlor in conservation tillage corn (*Zea mays*). Weed Technol. 5:66-71

Burnside, O. C. and G. A Wicks. 1980. Atrazine carryover in soil in a reduced tillage crop production system. Weed Sci. 28:661-666.

Donohue, S. J. and S. E. Heckendorn. 1994. Soil test recommendations for Virginia. Virginia Coop. Ext. Serv. Publ. 834. Blacksburg: Virginia Polytech. Inst. and State Univ.

Erbach, D. C. and W. G. Lovely. 1975. Effect of plant residue on herbicide performance in no-tillage corn. Weed Sci. 23:512-515.

Fuqua, M. A., G. N. Rhodes, R. M. Hayes, and W. A. Krueger. 1988. Effects of tillage on activity of preemergence herbicides in soybeans. Proc. South. Weed Sci. Soc. 41:59.

Hagood, E. S., C. W. Swann, H. P. Wilson, R. L. Ritter, B. A. Majek, W. S. Curran, and R. Chandran. 2001. Pest Management Guide: Field Crops. Grain crops, soybeans and forages. Virginia Coop. Ext. Serv. Publ. 456-016. Blacksburg: Virginia Polytech. Inst. and State Univ.

Johnson, W. G., M. S. Defelice, and C. S. Holman. 1997. Application timing affects weed control with metolachlor plus atrazine in no-till corn (*Zea mays*). Weed Technol. 11:207-211.

Lackey, B. A. T. H. Beckett, S. Dennis, and K. Brownell. 1999. ZA 1296: A versatile preemergence and postemergence broadleaf herbicide for corn. Proc. Northeast. Weed Sci. Soc. 53:116.

Luscombe, B. M., T. E. Vrabel, M. D. Paulsgrove, S. Cramp, P. Cain, A. Gamblin, and J. C. Millet. 1994. RPA 201772 a new broad spectrum preemergence herbicide for corn. Proc. N. Cent. Weed Sci. Soc. 49:47.

Norris, S. R., X. Shen, and D. DellaPenna. 1998. Complementation of the arabidopsis *pds1* mutant with the gene encoding p-hydroxyphenylpyruvate dioxygenase. Plant Physiol. 117:1317-1323.

Ohmes, G. A., J. A. Kendig, R. L. Barham, and P. M. Ezell. 2000. Efficacy of ZA 1296 in corn. Proc. South. Weed Sci. Soc. 53:225.

Pallett, K. E., J. P. Little, M. Sheekey, and P. Veerasekaran. 1998. The mode of action of isoxaflutole. I. Physiological effects, metabolism, and selectivity. Pestic. Biochem. Physiol. 62:113-124.

Reynolds, D., S. Crawford, and D. Jordan. 2000. Cutleaf eveningprimrose control with preplant burndown herbicide combinations in cotton. J. Cotton Sci. 4:124-129.

Ryan, G.F. 1970. Resistance of common groundsel to simazine and atrazine. Weed Sci. 18:614-616.

Selleck, G. W. and D. D. Baird. 1981. Antagonism with glyphosate and residual herbicide combinations. Weed Sci. 29:185-190.

Slack, C. H., R. L. Blevins, and C. F. Rieck. 1978. Effect of soil pH and tillage on persistence of simazine. Weed Sci. 26:145-147.

Striegel, W. L., W. Duckworth, J. P. Carter, and D. P. Veilleux. 1995. Efficacy of EXP 31130A tank mixtures as a burndown treatment in no-till corn. Proc. N. Cent. Weed Sci. Soc. 50:22.

Sutton, P. B., G. A. Foxon, J. M. Beraud, J. Anderdon, and R. Wichert. 1999. Integrated weed management systems for maize using mesotrione, nicosulfuron, and acetochlor. Proc. Br. Crop Prot. Conf. Weeds 225-230.

Viviani, F., J. P. Little, and K. E. Pallett. 1998. The mode of action of isoxaflutole. II. Characterization of the inhibition of carrot 4-hydroxyphenylpyruvate dioxygenase by the diketonitrile derivative of RPA 201772. Pestic. Biochem. Physiol. 62:125-134.

Vrabel, T. E., W. L. Streigel, and J. D. Lavoy. 1996. Efficacy of isoxaflutole as a burndown treatment in no-till corn. Proc. North Cent. Weed Sci. Soc. 51:67.

Wichert, R. A. and G. Pastushok. 2000. Mesotrione- weed control with different adjuvant systems. Proc. N. Cent. Weed Sci. Soc. 55:81.

Wilson, H. P., T. E. Hines, R. R. Bellinder, and J. A. Grande. 1985. Comparison of HOE-39866, SC-0224, paraquat, and glyphosate in no-till corn (*Zea mays*). Weed Sci. 33:531-536.

Wilson, J. S. and A. D. Worsham. 1988. Combinations of nonselective herbicides for difficult to control weeds in no-till corn, *Zea mays*, and Soybeans, *Glycine max*. Weed Sci. 36:648-652.

Young, B. G. and S. E. Hart. 1998. Optimizing foliar activity of RPA 201772 on giant foxtail (*Setaria faberi*) with various adjuvants. Weed Sci. 46:397-402.

Table 3.1. Cutleaf eveningprimrose, smooth pigweed, and common lambsquarters control with preemergence and postemergence mesotrione in no-till corn in 1999, 2000, and 2001. [a]

			Weed control[b]				
			Cutleaf eveningprimrose	Smooth pigweed		Common lambsquarters	
Herbicide treatment[c]	Application timing	Rate	1999 + 2001[c]	2000	2001	2000	2001
		— g ai/ha —	%				
Glyphosate + mesotrione	PRE	1120 + 78	43	63	55	85	59
Glyphosate + mesotrione	PRE	1120 + 157	44	82	68	88	93
Glyphosate + mesotrione	PRE	1120 + 235	61	91	83	96	95
Glyphosate + mesotrione	PRE	1120 + 314	71	90	84	93	96
Glyphosate	PRE	1120	35	98	65	91	94
fb mesotrione[d]	POST	35					
Glyphosate	PRE	1120	45	99	80	98	98
fb mesotrione	POST	70					
Glyphosate	PRE	1120	50	99	83	99	90
fb mesotrione	POST	105					
Glyphosate	PRE	1120	45	99	97	99	96
fb mesotrione	POST	140					
Glyphosate	PRE	1120	20	1	32	0	27
untreated check[e]			0	0	0	0	0
$LSD_{0.05}$			20	12	16	11	20

[a] Abbreviations: PRE, preemergence; POST, postemergence; fb, followed by.
[b] Weed control ratings were made 4 weeks after postemergence herbicide applications.
[c] No year by treatment interaction occurred with cutleaf eveningprimrose control, therefore these data are pooled over 1999 and 2001.
[d] Glyphosate was applied as its trimesium salt.
[d] All postemergence treatments included 1% v/v crop oil concentrate plus 2.5% v/v urea ammonium nitrate.
[e] Untreated check not included in the statistical analysis.

Table 3.2. Common ragweed and annual grass control and corn yields with preemergence and postemergence mesotrione in no-till corn in 1999, 2000, and 2001.[a]

			Weed control[b]			
			Common ragweed		Annual grasses	Corn yield
Herbicide treatment[d]	Application timing	Rate	2000	2001	1999 + 2001[c]	1999 + 2000 + 2001[c]
		— g ai/ha —	—	%	—	— Mg/ha —
Glyphosate + mesotrione	PRE	1120 + 78	75	61	19	7.62
Glyphosate + mesotrione	PRE	1120 + 157	79	68	28	7.53
Glyphosate + mesotrione	PRE	1120 + 235	89	81	44	8.66
Glyphosate + mesotrione	PRE	1120 + 314	86	80	43	8.99
Glyphosate	PRE	1120	82	56	19	7.31
fb mesotrione[e]	POST	35				
Glyphosate	PRE	1120	93	66	38	8.50
fb mesotrione	POST	70				
Glyphosate	PRE	1120	93	82	58	9.14
fb mesotrione	POST	105				
Glyphosate	PRE	1120	97	75	63	9.26
fb mesotrione	POST	140				
Glyphosate	PRE	1120	3	38	15	2.44
Untreated check[f]			0	0	0	1.20
$LSD_{0.05}$			10	25	14	1.69

[a] Abbreviations: PRE, preemergence; POST, postemergence; fb, followed by.
[b] Weed control ratings were made 4 weeks after postemergence herbicide applications.
[c] No year by treatment interaction occurred with annual grass control or corn yields, therefore these data are pooled over years.
[d] Glyphosate was applied as its trimesium salt.
[e] All postemergence treatments included 1% v/v crop oil concentrate plus 2.5% v/v urea ammonium nitrate.
[f] Untreated check not included in the statistical analysis.

Table 3.3. Evaluation of the mesotrione plus acetochlor pre-package mix applied preemergence for the control of field pansy, common ragweed, and ivyleaf morningglory and corn yields in no-till corn in 1999 and 2001.[a]

		Weed control[b]						
		Field pansy	Common ragweed		Ivyleaf morningglory		Corn yield	
Herbicide treatment	Rate	1999 + 2001[c]	1999	2001	1999	2001	1999	2001
	— g ai/ha —	— % —					— Mg/ha —	
Glyphosate-tms + mesotrione + acetochlor[d]	840 + 202 + 2240	89	89	74	62	78	3.81	7.76
Glyphosate-tms + mesotrione + acetochlor + 2,4-D[d]	840 + 202 + 2240+ 526	92	82	80	67	88	5.19	5.92
Paraquat + mesotrione + acetochlor[e]	700 + 202 + 2240	98	96	94	53	89	3.26	5.68
Paraquat + mesotrione + acetochlor + 2,4-D[e]	700 + 202 + 2240 + 526	97	99	73	66	83	4.49	5.69
Glyphosate-ipa + atrazine + acetochlor[d]	840 + 1680 + 2240	94	84	98	47	99	4.81	8.45
Glyphosate-tms[d]	840	94	3	23	10	7	3.38	2.05
Paraquat[e]	700	90	19	43	20	30	3.70	2.51
Untreated check[f]		0	0	0	0	0	2.88	0.29
$LSD_{0.05}$		5	21	23	18	24	NS	2.59

[a] Abbreviations: Glyphosate-tms, the trimesium salt of glyphosate; Glyphosate-ipa, the isopropylamine salt of glyphosate; NS, not significant.

[b] Field pansy ratings were made 3 weeks after treatment; common ragweed and ivyleaf morningglory were rated 12 weeks after treatment.

[c] No year by treatment interaction occurred for field pansy control, therefore these data are pooled over 1999 and 2001.

[d] Contained 4.76 kg/ha of ammonium sulfate.

[e] Contained 0.25% v/v non-ionic surfactant.

[f] Untreated check not included in the statistical analysis.