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Potential Stale Seedbed Herbicide Combinations for Cotton

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Abstract

Field experiments were conducted in 1992 and 1993 at Brooksville and Newton, MS to evaluate combinations of the selective herbicides cyanazine, diuron, fluometuron, lactofen, and MSMA with the nonselective herbicides glufosinate, glyphosate, and paraquat for stale seedbed cotton weed control. All herbicide applications were made immediately after planting.

Sicklepod control 2 weeks after treatment (WAT) at Newton was more than 80%, but at Brooksville, control was less than 70% for all nonselective herbicides applied alone. Diuron plus any nonselective herbicide controlled sicklepod more than 80% with no antagonism. MSMA was antagonistic to all nonselective herbicides for sicklepod control both 2 WAT and 4 WAT. At 4 WAT, glyphosate activity was antagonized by most selective herbicides at Brooskville. Diuron antagonized glyphosate at Newton. Diuron in combination with glufosinate controlled sicklepod more than 80%. Pitted morningglory control 2 WAT was antagonized when glyphosate was in combination with any selective herbicide; however, response was additive when paraquat was in combination with a selective herbicide, as was glufosinate in comination with diuron, cyanazine, or MSMA. At 4 WAT, antagonism of pitted mroningglory control occurred for most combinations in 1992; less antagonism occurred in 1993. At each location, a followup postemergence application would be necessary to obtain adequate season-long control of sicklepod and pitted morningglory. Cotton injury at Newton was more than 10% for cyanazine both years of the study, and lactofen injured cotton 23% in 1992. Cotton injury was less than 10% for all selective herbicides at Brooksville.

Introduction

Conservation tillage is defined as any tillage system that has the previous crop's residue or other biomass that maintains at least 30% coverage of the soil after planting (11). Most research has concentrated on establishment of a crop in the previous crop's residue with little or no seedbed preparation. The stale seedbed system requires tillage to reduce or eliminate crop residue and prepare a seedbed suitable for planting, but seedbeds are established several weeks or months before planting (12, 19). Although stale seedbed systems are not effective for erosion control, since little or no residue is left on the soil surface, there is a reduction in tillage compared to a conventional tillage system and, more importantly, no tillage occurs at planting.

This production system has been widely researched in soybean [*Glycine max* (L.) Merr.] production in the Midsouth (4, 5, 12, 13, 14, 16). Stale seedbed-planted cotton (*Gossypium hirsutum* L.) acreage has not grown as rapidly as soybean acreage, but interest is increasing. Considerable research has been conducted on strict no-till cotton (3).

Because of its poor early-season growth rate, an important factor in any reduced-tillage cotton-production system is early-season weed control. Established cover crops or emerged weeds at planting must be controlled (16, 19, 26). Because of the lack of tillage at planting, PPI herbicides are not usually an option in a stale seedbed system. However, when applied at seedbed preparation (13) or through a chemigation system (15), PPI herbicides can be used. The weeds that emerge between seedbed preparation and planting must be controlled with a POST herbicide, and later-germinating weeds need a herbicide with residual activity for control (13, 15, 19). If the existing vegetation is controlled, other pests such as pathogens and insects may also cause less damage to the emerging crop (1, 17, 18, 24, 25).

If nonselective and selective residual soil-applied herbicides are used in a stale seedbed system, combining these herbicides would be preferred. One application would reduce costs, save time, and may broaden the spectrum of weed control, although antagonism has been reported when combining these type herbicides (12, 13, 20, 22, 23, 28). Research has also indicated that some combinations can be used in cotton for control of winter weeds (2, 21, 27).

The objective of these experiments was to determine how combinations of selective and nonselective herbicides control existing weed populations and later germinating weeds in stale seedbed cotton.

Materials and Methods

Field studies were conducted in 1992 and 1993 at the Mississippi Agricultural and Forestry Experiment Station Black Belt Branch Station near Brooksville, Mississippi and the Coastal Plain Branch Station near Newton, Mississippi. Soil types were a Brooksville silty clay (fine, montmorillonitic, thermic Aquic Chromudert) and a Prentiss very fine sandy loam (coarse-loamy, siliceous, thermic Glossic Fragiudult), respectively. The pH and organic matter were 6.8 and 3.0%, respectively, at Brooksville, and 6.4 and 1.0%, respectively, at Newton.

Soybeans were grown at each location prior to the spring of 1992, and disked twice with a tandem disk-harrow immediately following harvest to incorporate crop stubble. The final tillage operations were May 8, 1992 and April 30, 1993 at Brooksville, and April 25, 1992 and April 20, 1993 at Newton. The final tillage operation was accomplished with two passes in opposite directions with a two-way bed conditioner equipped with rolling baskets and S-tine harrows set to operate at a 2.3-inch depth. 'DES 119' cotton was planted on flat beds at both locations. In Brooksville, the planting dates were June 16, 1992 and June 3, 1993 and in Newton on June 1, 1992 and May 28, 1993.

The experimental design was a randomized complete block with a factorial arrangement of treatments. The first factor was five selective herbicide treatments applied PRE to cotton at planting: 1.8 lb ai/A cyanazine; 1.5 lb ai/A fluometuron; 2.0 lb ai/A MSMA; 1.5 lb ai/A diuron; 0.20 lb ai/A lactofen; and no herbicide.

The second factor was three nonselective herbicides applied PRE to cotton at planting: 0.50 lb ai/A glyphosate; 0.47 lb ai/A paraquat; 0.75 lb ai/A glufosinate; and no herbicide.

All herbicides of each factor were applied alone or as combinations. Plots were four 30-inch rows 25 feet long. Herbicides were applied to plots with a tractor-mounted compressed-air sprayer calibrated to deliver a volume of 20 gpa at planting. A nonionic surfactant (X-77, a mixture of alkylaryl-polyoxyethylene glycols, free fatty acids, and isopropanol; Valent USA Corp., 575 Market St., San Francisco CA) was used at 1.0% (v/v) with glyphosate, and at 0.50% with all other herbicides.

At planting, sicklepod [*Senna obtusifolia* (L.) Irwin and Barnaby] was in the cotyledon to 6-leaf stage with a density of 1-2 plants/ft^2. Pitted morningglory (*Ipomea lacunosa* L.) was in the cotyledon to 10-leaf stage with densities of 0.5-1 plants/ft^2. Quizalofop at 0.063 lb ai/A plus 1.25% (v/v) crop oil concentrate (Agri-Dex, a heavy range paraffin-base petroleum oil polyol fatty acid esters and polyethoxylated derivatives thereof; Helena Chemical Co., 6075 Poplar Ave., Suite 500, Memphis, TN) was applied POST to all experiments in late July to control unwanted grass weeds.

Weed control, based on biomass reduction, was visually estimated 2 and 4 WAT based on a scale of 0 to 100% where 0 = no weed control and 100% = death of all plants. Cotton injury was visually estimated at 2 weeks after treatment (WAT) at Newton and 4 WAT at Brooksville. Cotton injury was based on a scale of 0 = no injury and 100% = plant death. Cotton was not taken to yield because of heavy late-season weed infestations. Data tables were constructed according to the significant interactions present. Treatment means herein were compared by weighted Fisher's Protected LSD at the 0.05 level of probability to compare all combination means.

Interactions between herbicide combinations were calculated by the mathematical method described by Colby (9). An expected value was calculated as follows: the product of the percent reduction provided by the two herbicides applied individually was divided by 100; this value was then subtracted from the sum of the control obtained with the two herbicides applied alone. Expected and observed values were compared by Fisher's protected LSD at the 5% level of significance. If the observed response for the herbicide combination were significantly greater than the expected value, the combination was declared synergistic; if significantly less than the expected value, the combination was declared antagonistic; the combination was additive when there was not a significant difference between the observed and the expected responses.

Results and Discussion

Sicklepod control 2 WAT had a location by selective herbicide by nonselective herbicide interaction; thus, data are only averaged over years (Table 1). At Newton, all nonselective herbicides applied alone controlled sicklepod greater than 80%; however, at Brooksville control was less than 70%. Similar results were observed with selective herbicides. All selective herbicides except lactofen controlled sicklepod 80% or greater, but at Brooksville control was less than 70%, except for 80% control with diuron. Diuron plus any nonselective herbicide was the only combination that controlled sicklepod more than 80%. There was no antagonism at either location. Antagonism occurred with MSMA and all nonselective herbicides. The higher control at Newton was because of more sicklepod emergence at the time of application, allowing the nonselective herbicides to control more emerged sicklepod.

At 4 WAT, there was a year by location by selective herbicide by non-selective herbicide interaction for sicklepod control (Table 2). At Brooksville, all of the nonselective herbicides controlled more sicklepod in 1992 than 1993. Glyphosate alone gave variable control from year to year. In 1992, sicklepod was controlled 80%, compared to only 48% in 1993. All of the selective herbicides except cyanazine antagonized control from glyphosate both years. Others have also noted antagonism when glyphosate was in combination with selective herbicides (12, 13, 23, 28). Antagonism with MSMA continued with all POST herbicides in 1992 and 1993. However, lactofen in 1992 and fluometuron in 1993 in combination with paraquat produced a synergistic response for sicklepod control.

At Newton 4 WAT, all selective and nonselective herbicides applied alone controlled sicklepod less than 80% (Table 2). Fluometuron or diuron in combination with all nonselective herbicides controlled sicklepod greater than 80% with no antagonism in 1992, except diuron in combination with glyphosate, which resulted in antagonism and 64% control. In 1993, diuron plus glufosinate was the only combination that controlled sicklepod above 80%. MSMA continued to be antagonistic with all POST herbicides 4 WAT at Newton in 1992 and 1993.

Sicklepod control was not evaluated later in the season because of heavy weed reinfestations. Sicklepod has the ability to germinate over a wide range of temperatures (8), soil pH (7), and under drought stress (10), causing a serious problem throughout the growing season. Sicklepod requires a POST herbicide if emerged at application. A selective herbicide that has residual activity is necessary to extend control, and these data indicate additional POST treatments are necessary to maintain season-long sicklepod control. Glufosinate resulted in initial control of sicklepod; however, a selective herbicide such as fluometuron, diuron, and cyanazine was needed for controlling later-germinating sicklepod. In general, antagonism occurred less frequently when selective herbicides were in combination with glufosinate.

Pitted morningglory control was evaluated at Brooksville in 1992 and 1993, and a selective herbicide by nonselective herbicide interaction occurred 2 WAT; thus, data are averaged over years (Table 3). Glyphosate and glufosinate applied alone controlled pitted morningglory 91 and 87%, respectively, but paraquat controlled only pitted morningglory 63%. Fluometuron and cyanazine controlled pitted morningglory 80% or more, and all other selective herbicides controlled pitted morningglory less than 80%. Antagonism occurred with all combinations containing glyphosate. An additive response occurred with all paraquat combinations, resulting in control of pitted morningglory above 85%. Similar results were observed with glufosinate in combination with diuron, cyanazine, and MSMA.

At 4 WAT, a year by selective herbicide by nonselective herbicide interaction occurred for pitted morningglory control (Table 4). All selective and non-selective herbicides alone controlled pitted morningglory less than 65% in 1992 and 1993. In 1992, all nonselective and selective herbicide combinations antagonized pitted morningglory control except fluometuron plus glyphosate or glufosinate, which resulted in additive responses. However, control was below 75% for all combinations. In 1993, antagonism was not as severe. Fluometuron and MSMA in combination with glufosinate resulted in a synergistic response; however, control was no more than 60%. MSMA is less likely to be antagonistic with non-selective herbicides, since it also has POST activity on pitted morningglory. All combinations controlled pitted morningglory less than 75% in 1993.

Pitted morningglory must be controlled early in stale seedbed. In order to obtain adequate control a nonselective application would be required. As with sicklepod, a nonselective treatment is needed to control emerged weeds, and a selective herbicide is needed for residual control. Diuron plus glufosinate or glyphosate are effective for early-season pitted morningglory control; however, results from this and previous research (12, 13, 23, 28) indicate antagonism may be a problem with either of these nonselective herbicides.

At Newton, a selective herbicide by year interaction occurred for cotton injury 2 WAT; thus, data are averaged over nonselective herbicides (Table 5). Injury was not evaluated 4 WAT because of heavy weed pressure that affected cotton stand and growth. In 1992, when no selective herbicide was used, injury was 3%; this was less than cyanazine, diuron, or lactofen averaged across nonselective herbicides. Cyanazine and diuron injured cotton 10 and 11%, respectively, and lactofen injured cotton 23%. In 1993, injury was below 10% for all selective herbicides except cyanazine, which injured cotton 13%. Cyanazine and diuron caused more injury than when no selective herbicide was used.

At Brooksville, a selective by nonselective herbicide interaction occurred for cotton injury 4 WAT, thus data are averaged over years (Table 6). Injury was not evaluated 2 WAT due to delayed and reduced stand establishment and emergence. Cotton injury was below 10% for all treatments. This indicates that on the heavier soils at Brooksville injury is less of a problem than on the lighter-textured soils at Newton.

A nonselective herbicide in a combination with a selective herbicide was necessary for stale seedbed cotton production. However, none of these treatments provided the necessary 8-week weed-free period for maximum cotton yield (6). Adequate control may be obtained in the early season, but a followup POST application will be needed to achieve acceptable season-long control. Diuron as a selective herbicide had the most consistent control and, when in combination with glufosinate, weed control generally increased. However, injury may be a problem with diuron, and antagonism may occur with certain species. Research must be conducted to determine if application timing and rate ranges may affect stale seedbed weed control.

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