Annoying Trends in Strip-Tillage Weed Control in Peanut: What are Our Options?

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ABSTRACT

Controlling Texas panicum in peanut has been troublesome to growers attempting to implement strip-tillage production practices. Studies were conducted from 1999 to 2001 in Georgia to develop Texas panicum management systems in strip-tillage peanut production. The experimental design was a split-plot with four replications. Main plots were preemergence (PRE) herbicides for annual grass control; ethalfluralin (Sonalan®) (0.75 lbs a.i. acre-1), pendimethalin (Prowl®)(1.0 lbs a.i. acre-1), metolachlor (Dual®) (2.0 lbs a.i. acre-1), alachlor (Lasso Microtech®) (3.0 lbs a.i. acre-1), dimethenamid (Frontier®) (1.2 lbs a.i. acre-1), and a nontreated PRE control. All plots were irrigated immediately after PRE applications to activate herbicides. Sub-plots were postemergence (POST) graminicides applied 28 days after peanut emergence; sethoxydim (Poast Plus®) (0.20 lbs a.i. acre-1), clethodim (Select®) (0.09 lbs a.i. acre-1), and a nontreated POST control. None of the PRE herbicides alone adequately controlled Texas panicum in strip-till peanut production, even with optimum activation with irrigation. Both sethoxydim and clethodim consistently controlled Texas panicum, regardless of PRE treatments. While POST graminicides effectively controlled Texas panicum in strip-till peanut production, their use to the exclusion of PRE herbicides would leave small-seeded dicot weeds, such as Florida pusley, uncontrolled. Growers who choose to use irrigated strip-till peanut production need to use a properly timed POST graminicide for Texas panicum control in addition to traditional dinitroaniline herbicides. This additional cost needs to be factored into crop production budgets.

KEYWORDS

Panicum texanum, pre-eemergence,herbicides, post emergence herbidides, herbicide injury

INTRODUCTION

Texas panicum (*Panicum texanum* Buckl.) is among the most common and troublesome weeds of southeastern peanut (*Arachis hypogaea* L.) (Webster 2001). Texas panicum is also considered to be among the most costly weeds in peanut (Buchanan *et al*. 1982), with losses primarily due to yield reductions from competition, excessive harvest losses, and costs of control.

Ethalfluralin and pendimethalin are the two dinitroaniline herbicides registered for use on peanut grown in the southeastern U. S. and are the primary means to control annual grasses in conventional tillage peanut production (Brecke and Currey 1980; Chamblee *et al*. 1982; Grichar 1991; Grichar *et al*. 1994; Prostko *et al*. 2001). Traditionally, both are applied preplant incorporated (PPI), although registrations have been recently amended to allow preemergence (PRE) applications, activated with sprinkler irrigation (Anonymous 2001a, 2001b). Ethalfluralin and pendimethalin applied PPI or PRE effectively control Texas panicum in conventional tillage systems and neither herbicide is overly injurious to peanut (Grichar and Colburn 1993; Johnson and Mullinix 1999; Johnson *et al*. 1997).

Peanut production in the U. S. using conservation tillage practices has recently increased (Sholar *et al*. 1995). Conservation tillage minimizes water and wind erosion which can be significant in the southeastern peanut producing region. Conservation tillage is also attractive because conventional tillage requires multiple tillage operations in rapid succession, which can be complicated by skilled labor shortages, weather delays, and logistical complications. In contrast, conservation tillage offers growers significant time and labor savings in the spring planting season by rescheduling tasks to other times year. Furthermore, recent trials have shown incidence of spotted wilt disease (tomato spotted wilt tospovirus) in peanut is significantly less in conservation tillage than in conventional tillage (Johnson *et al*. 2001), adding further incentive for growers to alter their peanut production strategy.

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The most common conservation tillage variant in the southeastern peanut production region is strip-tillage into a small grain cover crop such as rye (*Secale cereale* L.). The seedbed preparation implement has in-row subsoil shanks, multiple gangs of fluted coulters to cut cover-crop debris, and ground-driven crumblers that till a band approximately 12 in wide. Crops are seeded with planter units tandem-mounted on the tillage implement or as a separate operation.

With the widespread acceptance of strip-tillage peanut production come new questions regarding Texas panicum control. Grichar and Boswell (1987) showed that one of the limiting factors to profitable strip-tillage peanut production was annual grass control. Similarly, Wilcut *et al*. (1990) were not able to adequately control Texas panicum in non-irrigated conservation-tillage peanut production using dinitroaniline herbicides alone. Adequate control in their trials came with either paraquat or sethoxydim POST following dinitroaniline herbicides applied PRE. It is plausible that the lack of timely rainfall or irrigation for herbicide activation may have reduced activity of the dinitroaniline herbicides evaluated in their trials. Grichar *et al*. (1994) evaluated several herbicides for overall weed management in irrigated strip-tillage peanut and determined that pendimethalin applied in a band and crudely incorporated with crumblers on the strip-tillage implement did not adequately control Texas panicum. Chloracetamide herbicides used in their study were ineffective in controlling Texas panicum. POST graminicides are highly efficacious in controlling Texas panicum and other annual grasses (Prostko *et al*. 2001), but neither provide residual control of grasses nor control small-seeded dicot weeds.

With the increasing acceptance of strip-tillage peanut production in the southeastern coastal plain, systems need to be developed for Texas panicum control. Therefore, trials were initiated in 1999 to develop systems for Texas panicum control in strip-tillage peanut production.

MATERIALS AND METHODS

Irrigated field studies were conducted at the Attapulgus Research Farm near Bainbridge, GA (1999 and 2001) and the Coastal Plain Experiment Station Ponder Farm near Tifton, GA (2000), both units of the University of Georgia - Tifton Campus. Soils at Attapulgus were a Lucy loamy sand (loamy, kaolinitic, thermic Arenic Kandiudults) and a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) at the Ponder Farm. Soils at Attapulgus were 88% sand, 8% silt, 4% clay, and 0.9% organic matter and 88% sand, 6% silt, 6% clay, and 0.5% organic matter in 1999 and 2001, respectively. Soil at the Ponder Farm was 90% sand, 6% silt, 4% clay, and 0.7% organic matter. Soils at both locations were representative of soils in the southeastern U. S. peanut production region.

The experimental design was a split-plot with treatments replicated four times. Main plots were residual herbicides applied PRE; ethalfluralin (0.75 lbs a.i. acre-1), pendimethalin (1.0 lbs a.i. acre-1), metolachlor (2.0 lbs a.i. acre-1), alachlor (3.0 lbs a.i. acre-1), dimethenamid (1.2 lbs a.i. acre-1), and a nontreated PRE control. Chloracetamide herbicides were included in the trial since they are widely used for grass control in conservation tillage systems in other crops. All PRE herbicides were applied immediately after planting and irrigated (1.2 cm) with a center-pivot within twelve hours of application. Sub-plots were POST graminicides; sethoxydim (0.20 lbs a.i. acre-1), clethodim (0.09 lbs a.i. acre-1), and a nontreated POST control. POST graminicides were applied 28 days after emergence (DAE), with an additional application made 42 DAE in 2000. The additional applications were made in 2000 due an unusually large density of Texas panicum. A crop oil concentrate adjuvant was included with all POST graminicides at 1.0% by vol. Herbicides were applied with a tractor-mounted CO_2 plot sprayer calibrated to deliver 25 gal acre-1 at 30 lbs per inch^2 with flat fan nozzle tips. Plots were two rows wide by 20 ft long, with rows spaced 36 in apart.

Plots were seeded with rye at 56 lbs acre-1 using a grain drill in the fall after the preceeding crop harvest. In early April, the rye cover was killed with glyphosate (Roundup Ultra®) (1.0 lbs a.i. acre-1). Seedbeds were formed with a two-row strip-tillage implement (Kelley Manufacturing Company; 80 Vernon Drive; Tifton, GA 31794) that prepared a 12 in seedbed and planted to peanut with a vacuum planter (ATI., Inc.; 17135 West 116th St.; Lenexa, KS 66219) in a separate operation. Georgia Green (1999 and 2000) and C-99R (2001) peanut were seeded in early May each year at a rate of 100 lbs acre-1. After seeding peanut, the entire experimental area was treated with paraquat (0.5 lbs a.i. acre-1) to control emerged weeds. This treatment was not tank mixed with any PRE herbicides. All plots were maintained free of dicot weeds throughout the season with one POST application of pyridate (Tough®) (0.9 lbs a.i. acre-1) plus 2,4-DB (Butoxone®) (0.25 lbs a.i. acre-1) and handweeding as needed.

Parameters measured were visual estimates of Texas panicum control and peanut injury compared to the nontreated control taken 90 days after planting and peanut yield. Visual ratings are based on a percentage scale from 0 (no crop injury or weed control) to 100 (crop death or complete weed control). Texas panicum densities were high in 1999 and 2001 (>1 plant per foot^2) and extraordinarily high in 2000 (>2 plants per foot^2). Peanut yields were measured by digging, inverting, air curing, and combining peanut using commercial two-row equipment. Yield samples were mechanically cleaned to remove foreign material, with yields reported as cleaned farmer stock peanut.

All data were subjected to analysis of variance, with means separated using Fisher's protected LSD (P = 0.05). Arcsine transformations of visual injury and weed control ratings did not change the results of the analysis of variance, therefore nontransformed data are presented.

RESULTS AND DISCUSSION

Analysis of variance indicated no significant interactions between PRE herbicides and POST graminicides for Texas panicum control, and only main effect means are presented. However, there was a significant interaction between PRE herbicides and POST graminicides for peanut yield. In addition, there was no year by treatment interactions for any of the parameters, therefore all data were pooled across years.

Texas panicum control

Less than 76% control of Texas panicum was noted with dinitroaniline and chloracetamide herbicides in strip-tillage peanut production (Table 1). This is in contrast to previous research in conventional tillage systems where ethalfluralin and pendimethalin applied PPI or PRE effectively controlled Texas panicum (Prostko et. al. 2001). In this current study, PRE herbicides were activated with irrigation within twelve hours of application and still failed to adequately control Texas panicum. Wilcut *et al*. (1990) found sequential applications of either paraquat or sethoxydim POST following dinitroaniline herbicides applied PRE were needed for adequate Texas panicum control in their non-irrigated strip-tillage trials. In our trials, neither ethalfluralin nor pendimethalin PRE in strip-tillage peanut adequately control Texas panicum, despite activating PRE herbicides with irrigation. Previous research supports the inability of chloracetamide herbicides to adequately control Texas panicum in strip-tillage peanut production (Grichar *et al*. 1994).

Marginal control of Texas panicum is unacceptable in peanut production. Peanut has a long growing season and subterranean fruiting which complicates harvest and any Texas panicum escaping control will likely cause significant harvest losses. While there has been no research on Texas panicum interference with peanut to quantify yield losses, it is widely felt that annual grasses escaping initial control efforts significantly reduce yield (Chamblee *et al*. 1982). Accordingly, neither dinitroaniline nor chloracetamide herbicides should be recommended as the sole means for Texas panicum control in strip-tillage peanut due to their poor efficacy.

Sethoxydim and clethodim effectively controlled Texas panicum when applied 28 DAE (Table 2). The lack of significant interaction between PRE herbicides and POST graminicides shows that properly used POST graminicides alone are fully capable of adequately controlling Texas panicum, which is consistent with other research (Grichar *et al*. 1994; Prostko *et al*. 2001; Wilcut *et al*. 1990). However, there are disadvantages to relying exclusively on POST graminicides for Texas panicum control to the exclusion of dinitroaniline herbicides. Dinitroaniline and chloracetamide herbicides control an array of small seeded dicot weeds, including Florida pusley (*Richardia scabra* L.), and POST graminicides will not control dicot weeds. In addition, POST graminicides at the rates registered for use on peanut will not provide residual control of annual grasses, including Texas panicum. Furthermore, sequential applications may be needed to control later emerging weeds or escapes from extremely heavy infestations, which occurred in the 2000 trial. Sequential applications add to the cost of peanut production, which is contradictory to the current urgency to reduce production costs. Logically, it is prudent to have complimentary management options for potentially devas-

Table 1. Texas panicum control in strip-tillage peanut production with preemergence herbicides; 1999 to 2001. Data pooled over POST graminicide treatments and years.

PRE herbicide	Rate	Control
	lbs ai acre^{-1}	----- % ------
Ethalfluralin	0.75	70
Pendimethalin	1.0	75
Metolachlor	2.0	67
Alachlor	3.0	71
Dimethenamid	1.2	66
Nontreated PRE	–	58
$LSD_{0.05}$		14

Table 2. Texas panicum control in strip-tillage peanut production with postemergence graminicides; 1999 to 2001. Data pooled over PRE graminicide treatments and years.

PRE herbicide	Rate	Control
	lbs ai acre^{-1}	----- % ------
Sethoxydim	0.20	90
Clethodim	0.09	91
Nontreated POST	–	22
$LSD_{0.05}$		26

tating weeds like Texas panicum, instead of relying on only a single herbicide that may fail.

A possible explanation for the poor control of Texas panicum with ethalfluralin and pendimethalin PRE in strip-tillage peanut production is the presence of germinated, but non-emerged, Texas panicum seedlings at the time of treatment. Uptake of dinitroaniline herbicides is primarily through roots and emerging shoots (Appleby and Valverde 1989; Ashton and Crafts 1981). However, Parker (1966) showed that trifluralin was more inhibitory to grain sorghum [*Sorghum bicolor* (L.) Moench] when absorbed through roots than emerging shoots. Dinitroaniline herbicides are generally considered to be immobile in the soil (Weber 1990). In a strip-tillage system, dinitroaniline herbicides will be concentrated in the extreme upper portions of the soil profile and Texas panicum, a large seeded annual grass, may be able to germinate below the zone where dinitroaniline herbicides are located. In this case, emerging shoots pass through treated soil, whereas developing roots would be below the herbicide treated soil. In contrast, conventional tillage systems would have freshly tilled soil from incorporation that mechanically controls emerging Texas panicum and disperses the herbicide deeper in the soil profile where roots, as well as emerging shoots, absorb the herbicide. This theory is also the basis on which direct-seeded cucurbit crops are more tolerant of dinitroaniline herbicides applied PRE than PPI (Grey *et al*. 2000a, 2000b).

It is also possible that the presence of cover debris adsorbs dinitroaniline herbicides, reducing efficacy. Dinitroaniline herbicides are readily adsorbed by organic matter, which has traditionally limited their use to mineral soils (Weber *et al*. 1990). It is possible that the presence of rye straw mulch, although not finely pulverized by mowing or decay, intercepts and adsorbs ethalfluralin and pendimethalin reducing efficacy in strip-tillage peanut production.

Visible injury

Peanut exhibited no visible injury symptoms from any of the herbicide treatments throughout the study (data not shown). Similarly, time of peanut emergence was not affected by PRE herbicide treatments. These results are in agreement with previous research that showed dinitroaniline herbicides applied PRE are not overly injurious to peanut (Johnson and Mullinix 1999; Johnson *et al*. 1997).

Peanut yield

Peanut yield response to Texas panicum control in strip-tillage systems generally mirrored the Texas panicum control data (Table 3). Peanut yields were greater in plots that relied on PRE herbicides followed sequentially by POST graminicides for Texas panicum control than those using PRE herbicides alone. Relying exclusively on PRE herbicides in strip-tillage peanut production for Texas panicum control reduced yields by allowing escaped Texas panicum to interfere with peanut growth and yield. Exclusive use of POST graminicides protected peanut yield loss due to Texas panicum interference. However, maintenance weed control, including handweeding, prevented the confounding presence of uncontrolled small seeded broadleaf weeds in these trials. If peanut producers using strip-tillage

Table 3. Effects of Texas panicum management in strip-tillage peanut production on yield; 1999-2001.

PRE herbicide	POST herbicide	Yield
		lbs acre^{-1}
Ethalfluralin		
	Sethoxydim	2570
	Clethodim	2970
	Nontreated POST	1940
Pendimethalin		
	Sethoxydim	3100
	Clethodim	3210
	Nontreated POST	2280
Metolachlor		
	Sethoxydim	3100
	Clethodim	3340
	Nontreated POST	1780
Alachlor		
	Sethoxydim	3080
	Clethodim	3090
	Nontreated POST	2000
Dimethenamid		
	Sethoxydim	2840
	Clethodim	2740
	Nontreated POST	1870
Nontreated PRE		
	Sethoxydim	2420
	Clethodim	2420
	Nontreated POST	1510
$LSD_{0.05}$		710

choose to rely exclusively on POST graminicides for Texas panicum control they should also plan control of dicot weeds with other facets of their weed management system.

These results show the potential for serious difficulties in managing Texas panicum in irrigated strip-tillage peanut production. Dinitroaniline herbicides, the traditional means to control Texas panicum in conventional tillage systems, do not adequately control the annual grass in strip-tillage peanut production, despite irrigation to activate the herbicides. POST graminicides effectively control Texas panicum, but their exclusive use will not control small seeded dicot weeds that are controlled by PRE herbicides, perhaps complicating the overall weed management system. The most effective system to control Texas panicum in strip-tillage peanut will feature either ethalfluralin or pendimethalin PRE, followed by a POST application of either sethoxydim or clethodim. The additional cost of the seemingly obligatory POST graminicide treatment in strip-tillage peanut production should be factored into any decision that a grower makes when deciding on the type of tillage system.

Despite the reduction in efficacy of dinitroaniline herbicides in strip-tillage peanut production, these herbicides still have a clear niche and should not be overlooked by growers. While dinitroaniline herbicides do not adequately control Texas panicum in strip-tillage production systems, they control many small seeded broadleaf weeds (W. C. Johnson, III, unpublished data). Furthermore, ethalfluralin and pendimethalin cost approximately $5.70 and $4.70 per acre, respectively, which are among the least costly herbicide inputs in peanut production (E. P. Prostko, unpublished data). In contrast, cost of alternatives such as the chloracetamides, are much greater, ranging from $11.70 to $15.80 per acre. Despite the reduced efficacy in strip-tillage systems, the inexpensive cost of dinitroaniline herbicides insures their continued use in irrigated strip-tillage peanut production.

FUTURE RESEARCH

Field trials were initiated in 2002 to determine if seeding rate of the rye cover crop affects efficacy of residual and postemergence herbicides used in strip-tillage peanut. It has been speculated that the rye cover crop may adsorb some preemergence herbicides. It has also been observed that very heavy densities of rye shields weeds from postemergence herbicides. These trials will possibly indicate the optimum cover crop seeding rate from a weed management perspective. Complimentary greenhouse and plant growth chamber trials will be initiated to quantify the adsorption of preemergence herbicides by rye straw and effects on emergence of weed seedlings.

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