Texas Panicum (*Panicum texanum*) Control in Strip-Tillage Peanut (*Arachis hypogaea*) Production

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ABSTRACT

Studies were conducted from 1999 through 2001 in Georgia to develop Texas panicum management systems in strip-tillage peanut production into a killed rye cover crop. The experimental design was a split-plot with four replications. Main plots were preemergence (PRE) herbicides for annual grass control—ethalfluralin, pendimethalin, metolachlor, alachlor, dimethenamid, and a nontreated PRE control. All plots were irrigated immediately after PRE applications to activate herbicides. Subplots were postemergence (POST) graminicides applied 28 d after peanut emergence—sethoxydim, clethodim, and a nontreated POST control. POST graminicides were applied with a crop oil concentrate. None of the PRE herbicides alone adequately controlled Texas panicum in strip-till peanut production, even with optimum activation with irrigation. Sethoxydim and clethodim controlled Texas panicum at least 91%, regardless of PRE treatments. Peanut yields were greater where ethalfluralin or pendimethalin PRE were applied sequentially with a POST graminicides, compared to PRE herbicides or POST graminicides alone. This suggests that, while POST graminicides effectively control Texas panicum, the reduced efficacy of dinitroaniline herbicides is still beneficial. The additional cost of a POST graminicide needs to be factored into production budgets for strip-tillage peanut production.

Key Words: Alachlor, clethodim, dimethenamid, ethalfluralin, integrated weed management, metolachlor, pendimethalin, reduced tillage, sethoxydim.

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

Dinitroaniline herbicides are the primary soil-applied herbicides used 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). Ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzenamine] and

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pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] are the two dinitroaniline herbicides registered for use on peanut grown in the Southeastern U.S. Traditionally, both are applied preplant incorporated (PPI), although registrations have been amended recently to allow preemergence (PRE) applications, activated with sprinkler irrigation (Anon., 2001a,b). Ethalfluralin and pendimethalin applied PPI or PRE effectively control Texas panicum in conventional tillage systems without causing significant injury to peanut (Grichar and Colburn, 1993; Johnson *et al.*, 1997; Johnson and Mullinix, 1999).

Peanut production in the U.S. using conservation tillage practices has recently increased (Sholar *et al.*, 1995). The increase in conservation tillage is due primarily to time and labor savings during the spring. Peanut in the Southeastern U.S. is often strip-tilled into a killed rye (*Secale cereale* L.) cover crop. Seedbeds are prepared with an implement that has in-row subsoil shanks, multiple gangs of fluted coulters to cut cover-crop debris, and ground-driven crumblers that till a band approximately 30 cm wide. Crops are seeded with planter units tandem-mounted on the tillage implement or as a separate operation. Conventional tillage requires multiple tillage operations in rapid succession, which can be complicated by weather delays and shortages in skilled agricultural labor. Conservation tillage either eliminates tillage operations or reschedules tasks easing logistical complications. Conservation tillage also minimizes water and wind erosion, which can be significant in the Southeastern U.S. 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.

With the increased acceptance of strip-tillage peanut production come new questions regarding weed control. Grichar and Boswell (1987) showed that one of the limiting factors to profitable strip-tillage peanut production was annual grass control, including Texas panicum. Nationwide, dinitroaniline herbicides normally are not used in conservation tillage systems in other crops, with grass control provided by chloracetamide herbicides and postemergence (POST) graminicides. Chloracetamides are less susceptible to volatility loss and adsorption by organic matter than dinitroaniline herbicides (Ross and Lembi, 1985). However, Grichar *et al.* (1994) found chloracetamide herbicides were ineffective in controlling Texas panicum. Dinitroaniline herbicides alone were not able to adequately control Texas panicum in nonirrigated conservation-tillage peanut production (Wilcut *et al.*, 1990). Adequate control in their trials came with either paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) or sethoxydim {2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} following dinitroaniline herbicides applied PRE. Grichar *et al.* (1994) evaluated several herbicides for overall weed management in irrigated strip-tillage peanut. They determined that pendimethalin applied in a band and incorporated with crumblers on the strip-tillage implement did not adequately control Texas panicum.

With the increasing acceptance of strip-tillage peanut production, effective and reliable systems need to be developed for Texas panicum control. Therefore, trials were initiated in 1999 to develop integrated systems for Texas panicum control in irrigated strip-tillage peanut production.

Materials and Methods

Irrigated field studies were conducted at the Attapulgus Research Farm near Bainbridge, GA (1999 and 2001) and at the Coastal Plain Exp. Sta. Ponder Farm near Tifton, GA (2000). Soil at Attapulgus was a Lucy loamy sand (loamy, kaolinitic, thermic Arenic Kandiudults). A Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) was 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 (0.8 kg ai/ha), pendimethalin (1.1 kg ai/ha), metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] (2.2 kg ai/ha), alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)acetamide] (3.4 kg ai/ha), dimethenamid [2-chloro-*N*-(2,4-dimethyl-3-thienyl)-*N*-(2-methoxy-1-methylethyl)acetamide] (1.3 kg ai/ha), and a nontreated PRE control. Chloracetamide herbicides were included in the trial since they are widely used in peanut and conservation tillage systems in other crops. PRE herbicides were applied immediately after planting peanut and irrigated (1.2 cm) with a center-pivot within 12 hr of application. Subplots were POST graminicides; sethoxydim (0.22 kg ai/ha), clethodim{(E,E)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} (0.10 kg ai/ha), and a nontreated POST control. POST graminicides were applied 28 d 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 [Agri-Dex®; 83% paraffin base petroleum oil and 17% polyoxyethylated polyol fatty acid and polyol fatty acid ester (Helena Chemical Co., Memphis, TN] was included with all POST graminicides at 1.0% (v/v). Herbicides were applied with a tractor-mounted CO_2 plot sprayer calibrated to deliver 234 L/ha at 207 kPa using flat fan nozzle tips. Plots were two rows (91 cm spacing) wide by 6.1 m long.

Plots were seeded with rye at 63 kg/ha using a grain drill (18 cm spacing) in the fall after the preceding crop harvest. In early April, the rye cover was killed with glyphosate [*N*-(phosphono-methyl)glycine] at 1.1 kg ai/ha. Seedbeds were formed with a two-row strip-tillage implement (Kelley Manufacturing Co., Tifton, GA) that prepared a 30-cm seedbed and planted to peanut with a vacuum planter (ATI., Inc., Lenexa, KS) 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 112 kg/ha. After seeding peanut, the entire experimental area was treated with paraquat (0.6 kg ai/ha) to control emerged weeds. This treatment was not tank mixed with any PRE herbicides. Plots were maintained free of dicot weeds throughout the season with one POST application of pyridate [O-(6-chloro-3-phenyl-4-pyridazinol) S-octylcarbonothioate] (1.0 kg ai/ha) plus 2,4-DB [4-(2,4-dichlorophenoxy)butanoic acid] (0.3 kg ai/ha) and handweeding as needed. Pest and crop management practices were held constant over the experiment and based on Georgia Coop. Ext. Serv. recommendations.

Visual estimates of percent Texas panicum control and peanut injury compared to the nontreated control were recorded 90 d after planting, based on a percentage scale of 0 (no crop injury or weed control) to 100 (crop death or complete weed control). Texas panicum densities were high in 1999 and 2001 (> 10 plants/m^2) and extraordinarily high in 2000 (> 20/m^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. Final yield is reported as cleaned farmer stock peanut.

Data for percent Texas panicum control, peanut injury, and yield were subjected to analysis of variance with partitioning appropriate for the factorial treatment arrangement. Means for significant main effects and interactions were separated using Fisher's protected LSD at $P \leq 05$. Arcsine transformations of visual injury and weed control ratings did not change the results of the analysis of variance; therefore, nontransformed data were used for analysis and presentation.

Results and Discussion

Texas Panicum Control. Analysis of variance indicated no significant interactions between PRE herbicides and POST graminicides for Texas panicum control. Therefore, only the main effect means are presented. Pooled over POST treatments, 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 season long (Prostko et. al., 2001). Although PRE herbicides were activated with irrigation within 12 hr of application in these trials, Texas panicum control was not adequate. Wilcut *et al.* (1990) found sequential applications of either paraquat or sethoxydim following dinitroaniline herbicides were needed for adequate Texas panicum control in nonirrigated strip-tillage trials. In our trials, neither ethalfluralin nor pendimethalin PRE in strip-tillage peanut adequately controlled 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).

Table 1. Texas panicum control in strip-tillage peanut production with preemergence herbicides from 1999 to 2001.[a]

PRE herbicide	Herbicide rate	Texas panicum control
	kg/ha	%
Ethalfluralin	0.8	70
Pendimethalin	1.1	75
Metolachlor	2.2	67
Alachlor	3.4	71
Dimethenamid	1.3	66
Nontreated PRE	----	58
LSD (0.05)		14

[a]Data are pooled over POST graminicide treatments and years.

Marginal control of Texas panicum may be acceptable in some cropping systems where cost-effective control options do not exist or the crop is competitive with Texas panicum. However, peanut has a long growing season and subterranean fruiting which complicates harvest. Escaped Texas panicum will likely cause significant losses. While there has been no research on Texas panicum interference with peanut to quantify yield losses, it is widely accepted that annual grasses escaping initial control efforts can cause losses (Chamblee *et al.*, 1982). Therefore, neither dinitroaniline nor chloracetamide herbicides should be recommended as the sole means for Texas panicum control in strip-tillage peanut.

Sethoxydim and clethodim effectively controlled Texas panicum when applied 28 DAE (Table 2). Lack of significant interaction between PRE herbicides and POST graminicides shows that properly timed POST graminicides alone are fully capable of controlling Texas panicum, which is consistent with other research (Wilcut *et al.*, 1990; Grichar *et al.*, 1994; Prostko *et al.*, 2001). 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. POST graminicides do not control dicot weeds. Additionally, POST graminicides at the rates registered for use on peanut will not provide residual control of Texas panicum and other annual grasses. Sequential applications may be needed to control later emerging weeds or escapes from extremely heavy infestations, which occurred in the 2000 trial, adding to the cost of peanut production.

Table 2. Texas panicum control in strip-tillage peanut production with postemergence graminicides from 1999 to 2001.[a]

POST herbicide	Herbicide rate	Texas panicum control
	kg/ha	%
Sethoxydim	0.22	90
Clethodim	0.1	91
Nontreated POST	----	22
LSD (0.05)		26

[a]Data are pooled over PRE treatments and years.

There are two possible reasons for reduced efficacy of ethalfluralin and pendimethalin PRE for Texas panicum control in strip-tillage peanut production. One possibility is the presence of germinated, but nonemerged, Texas panicum seedlings at the time of herbicide application. Uptake of dinitroaniline herbicides is primarily through roots and emerging shoots (Ashton and Crafts, 1981; Appleby and Valverde, 1989). However, Parker (1966) showed that trifluralin[2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine] was more inhibitory to grain sorghum [*Sorghum bicolor* (L.) Moench] when absorbed through roots than emerging shoots. Dinitroaniline herbicides generally are considered to be immobile in the soil (Weber, 1990). It is possible that 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,b). Cover debris adsorb dinitroaniline herbicides which may reduce efficacy (Weber, 1990). Dinitroaniline herbicides are readily adsorbed by organic matter, which traditionally has limited their use to mineral soils. 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.

Visual Injury. Peanut exhibited no visual 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 *et al.*, 1997; Johnson and Mullinix, 1999).

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

Table 3. Interactive effects of Texas panicum management in strip-tillage peanut production on yield from 1999-2001.

PRE herbicide	POST herbicide	Peanut yield
		kg/ha
Ethalfluralin	Sethoxydim	2880
	Clethodim	3330
	Nontreated POST	2170
Pendimethalin	Sethoxydim	3470
	Clethodim	3590
	Nontreated POST	2550
Metolachlor	Sethoxydim	3470
	Clethodim	3740
	Nontreated POST	1990
Alachlor	Sethoxydim	3450
	Clethodim	3460
	Nontreated POST	2240
Dimethenamid	Sethoxydim	3180
	Clethodim	3070
	Nontreated POST	2090
Nontreated PRE	Sethoxydim	2710
	Clethodim	2710
	Nontreated POST	1690
LSD (0.05)		790

These results show the potential for inadequate Texas panicum control in irrigated, strip-tillage peanut production with soil-applied herbicides. 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. The most effective system to control Texas panicum in strip-tillage peanut will feature either ethalfluralin or pendimethalin PRE, followed by either sethoxydim or clethodim POST. Logically, it is prudent to have complimentary management options for potentially devastating weeds like Texas panicum, instead of relying on only a single tactic that may be prone to failure. The additional cost of a 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 in peanut (W.C. JohnsonINDEX respectively, which are among the least costly herbicide inputs in peanut production (E.P. Prostko, unpubl. data). In contrast, cost of alternatives such as the chloracetamides are much greater and range from $29.00 to $39.00/ha. Despite the reduced efficacy in strip-tillage systems, the inexpensive cost of dinitroaniline herbicides insures their continued use in irrigated strip-tillage peanut production.

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