Peanut Response to Ethalfluralin, Pendimethalin, and Trifluralin Preplant Incorporated[1]

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ABSTRACT

Field experiments were conducted at Yoakum (south Texas) in 1996 and 1997, Comanche (central Texas) in 1998, and Lamesa (west Texas) in 1998 and 1999 to evaluate peanut tolerance to dinitroaniline herbicides. At Lamesa, ethalfluralin at 0.63 or 0.84 kg/ha, pendimethalin at 0.56 or 0.84 kg/ha, and trifluralin at 0.56 or 0.71 kg/ha were applied preplant incorporated (PPI), and at Yoakum and Comanche, ethalfluralin and pendimethalin were applied PPI at 0.67, 0.84, 1.12, and 1.68 kg/ha. There were no differences in stand establishment or yield for any treatment at Lamesa, Comanche, or Yoakum. Similarly, canopy stature was not affected at Lamesa nor was grade affected at Comanche or Yoakum. At Lamesa, yields by herbicide averaged across rates, incorporation methods, and years ranged from 4530 to 4920 kg/ha; by rate averaged across herbicides, incorporation methods, and years was 4600 to 4750 kg/ha; and by incorporation method averaged across herbicides, rates, and years was 4580 to 4770 kg/ha. At Yoakum and Comanche, yields by herbicide were 2640 and 2950 kg/ha, respectively, when averaged across rates; and by rate they ranged from 2630 to 2990 kg/ha when averaged across herbicides. These data indicate peanut has tolerance (safety) to ethalfluralin, pendimethalin, and trifluralin applied PPI in Texas.

Key Words: *Arachis hypogaea* L., groundnut, herbicide injury, peanut injury, yield.

Peanut (*Arachis hypogaea* L.) production has increased from approximately 124,000 planted ha in 1970 to more than 170,000 ha in 2000 (Anon., 2000). Herbicides coupled with

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other cultural practices have resulted in a more than doubling of yield over this period. However, weeds continue to be a major pest problem in all peanut growing regions of the state. Control of many broadleaf and grass weed species can be achieved with a dinitroaniline herbicide such as ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzenamine], pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine], and trifluralin [2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine] applied preplant incorporated (PPI) (Wilcut *et al.*, 1994). If uncontrolled, small-seeded broadleaf weeds such as Palmer amaranth (*Amaranthus palmeri* S. Watts) can reduce peanut yield 60 to 80% through competition and reduced harvest efficiency (Buchanan *et al.*, 1982; Wilcut *et al.*, 1995).

The dinitroaniline herbicides are registered for use in over 40 crops (Anon., 2003). Cotton tolerance to dinitroaniline herbicides was questioned previously; however, long-term studies have shown no adverse affects on cotton growth or yield (Miller *et al.*, 1975; Keeling *et al.*, 1996). In peanut, greenhouse studies showed that ethalfluralin inhibited seedling growth more than pendimethalin at equivalent rates applied PPI; however, injury by these herbicides following preemergence (PRE) applications were similar (Johnson and Mullinix, 1999). In runner peanuts, which are more prone to peg injury compared to spanish peanuts (Merkle, 1975), proper herbicide incorporation was needed to prevent injury (Greer *et al.*, 1969). Merkle (1975) stated that sporadic injury to runner peanut from trifluralin was due to the failure to properly incorporate the herbicide. Buchanan *et al.* (1978) found that trifluralin at rates as high as 4.5 kg/ha did not reduce stands of Florunner, Florigiant, or GK-3 peanut cultivars. No differences were observed in a 3 yr study examining the yield and grade affects in five runner cultivars (Grichar and Colburn, 1993). In Florida, ethalfluralin did not cause peanut injury at any rate or application timing (Brecke and Currey, 1980). Dinitroaniline injury on peanut includes swollen hypocotyl, abnormal lateral root growth, and stunted plants (Greer *et al.*, 1969; Buchanan *et al.*, 1978).

The dinitroaniline herbicides were applied to 83% of the 128,000 ha in Texas and Oklahoma peanut in 1997 (Smith *et al.*, 1998). Injury to peanut with dinitroaniline herbicides is a concern to many growers in this region. There is debate if differences in injury occur from the dinitroaniline herbicides. Therefore, the objective of this research was to evaluate the effects of dinitroaniline herbicide selection, rate, and incorporation method on peanut for injury and yield in south, central, and west Texas.

Materials and Methods

Field experiments were conducted in Texas at the Texas Agricultural Experiment Station farm located near Yoakum (south Texas) in 1996 and 1997, in a producers field at Comanche (central Texas) in 1998, and at the Agricultural Complex for Research and Extension Center (AG-CARES) at Lamesa (west Texas) in 1998 and 1999. At Yoakum, the soil was a Tremona loamy fine sand (clayey, mixed, active, thermic Aquic Arenic Paleustalf; 0.8% organic matter; pH 7.7). Runner peanut cultivar, seeding rate, and planting and harvest dates for each experiment are given in Table 1. The soil at Comanche was a Chaney loamy sand (fine, mixed, active, thermic Oxyaquic Paleustalf; 0.4% organic matter; pH 6.6); and at Lamesa, the soil was an Amarillo fine sandy loam (fine-loamy, mixed, superactive, thermic Aridic Paleustalf; 0.4% organic matter; pH 7.8). At Yoakum and Comanche, ethalfluralin and pendimethalin were applied preplant at 0.67, 0.84, 1.12, and 1.68 kg/ha and incorporated 3 to 5 cm with a stalk cutter (Comanche) or 6 cm with a power take-off (PTO)-driven power tiller (Yoakum) prior to planting. At Lamesa, ethalfluralin at 0.63 and 0.84 kg/ha, pendimethalin at 0.56 and 0.84 kg/ha, and trifluralin at 0.56 and 0.71 kg/ha were applied preplant and incorporated 5 to 8 cm with a field cultivator or 3 to 5 cm with a rolling cultivator prior to planting. Rates were chosen based on the minimum and maximum labeled rates according to soil type. Individual plot size was 2 by 8 m at Yoakum, 2 by 15 m at Comanche, and 4 by 15 m at Lamesa. Seasonal rainfall plus irrigation at Yoakum totaled 59 and 62 cm in 1996 and 1997, respectively. At Lamesa, seasonal irrigation plus rainfall (April through Oct.) totaled 67 cm in 1998 and 89 cm in 1999. At Comanche in 1998, center pivot irrigation was used throughout the season and soil moisture was never limiting. Traditional production practices were used to maximize peanut growth, development, and yield. All plots were cultivated and hand-weeded throughout the growing season to maintain weed-free conditions. No insecticides were needed at any location in any year.

Table 1. Peanut variety, seeding rate, and planting date at each location.

Site location	Year	Planting date	Cultivar	Seeding rate	Row spacing	Harvest date
				kg/ha	cm	
Comanche	1998	8 May	Tamrun 96	101	97	1 Oct.
Lamesa	1998	30 April	AT 120	90	102	29 Oct.
Lamesa	1999	5 May	Tamrun 88	90	102	4 Nov.
Yoakum	1996	17 May	GK-7	101	91	5 Oct.
Yoakum	1997	16 June	GK-7	101	91	4 Nov.

Herbicides were applied using water as a carrier with a tractor-mounted compressed air sprayer using Teejet 80015 flat fan nozzles (Spraying Systems, Co., Wheaton, IL) that delivered 140 L/ha at 207 kPa (Lamesa), a compressed-air bicycle sprayer using Teejet 11002 flat fan nozzles that delivered 190 L/ha at 180 kPa (Yoakum), or with a CO_2-pressurized backpack sprayer using 8003 XR flat fan nozzles that delivered 187 L/ha at 103 kPa (Comanche). Peanut injury was estimated visually throughout the growing season (approximately 3, 6, 10, and 20 wk after planting) at each location using a scale of 0 (no injury) to 100 (peanut death). Canopy height and width were recorded 177 d after planting (DAP) at Lamesa and 30 and 74 DAP at Comanche in 1998. Peanut yield was determined by digging the pods based on maturity of control plots, air-drying in the field for 6 to 10 d, and harvesting individual plots with a small-plot thresher. Yield samples were cleaned and adjusted to 10% moisture. Pod, shell, and peanut kernal weight were determined from each sample. Grades were determined for a 200 g pod sample from each plot following procedures described by the Federal-State Inspection Service (USDA, 1986).

At each location, the experimental design was a randomized complete block with treatments replicated three times. Data were subjected to an analysis of variance with partitioning appropriate for the factorial arrangement. At Lamesa, no year by herbicide by rate by incorporation interaction or any two- or three-way interaction was observed; therefore, only main effects were compared. Data from Comanche and Yoakum were analyzed over locations. No location by herbicide by rate interaction or any two-way interactions were observed; therefore, only main effects were compared. Main effect means were compared using Fisher's Protected LSD test at $P \leq 0.05$.

Results and Discussion

Peanut stand, visual injury, and canopy stature. At Lamesa, peanut stand varied by year when averaged across treatments (data not shown). This was attributed to the larger seed size of Tamrun 88 compared to AT 120, which resulted in a lower seeding density in the 2nd yr of this experiment. No differences in stand were observed as a result of dinitroaniline treatment (data not shown). Buchanan *et al.* (1978) reported that peanut stands were not reduced by dinitroaniline herbicides to rates up to 3.36 kg/ha. Visual injury (stunting) was noted at 40 DAP following pendimethalin application; however, no injury was observed at 62 DAP (data not shown). Buchanan *et al.* (1978) reported peanut injury (visible phytotoxicity symptoms) from applications of trifluralin and pendimethalin and Greer (1969) noted visible injury from trifluralin and benefin. No reduction in peanut canopy stature (height and width) were observed at harvest (data not shown).

There was no reduction in peanut stand at 30 DAP at Comanche (Table 2). Canopy height and width were not affected by pendimethalin or ethalfluralin when averaged across rates (Table 3). However, height at 74 DAP was reduced by the 1.12 kg/ha rate when averaged across herbicides (Table 2). Less than 5% visual injury (stunting) was noted 80 DAP (Tables 2 and 3). No visual plant growth reduction was noted with any herbicide at Yoakum (data not shown).

Table 2. Peanut stand, height, width, stunting (Comanche), yield, and grade (Comanche and Yoakum) as affected by pendimethalin and ethalfluralin rates averaged over herbicides.

Rate	Stand	Height		Width	Stunt.	Yield	Grade
	--30 DAP[b]--		--74 DAP--		80 DAP		
	plts/m	--------cm--------			%	kg/ha	%
0.56	9	7	42	90	1	2990	63
0.84	7	7	36	84	2	2920	64
1.12	8	7	33	82	3	2650	61
1.68	8	6	38	89	3	2630	60
Weed-free check	7	6	38	82	0	3380	64
LSD ($P \leq 0.05$)	NS	NS	6	NS	NS	NS	NS

[a]DAP = days after planting.

Table 3. Peanut stand, height, width, stunting (at Comanche), yield, and grade (Comanche and Yoakum) as affected by pendimethalin and ethalfluralin averaged over rates.

Treatment[a]	Stand	Height		Width	Stunt.	Yield	Grade
	--30 DAP[b]--		--74 DAP--		80 DAP		
	plts/m	--------cm--------			%	kg/ha	%
Ethalfluralin	8	7	36	87	2	2950	63
Pendimethalin	8	7	38	85	2	2640	61
Weed-free check	7	6	38	82	0	3380	64
LSD ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS	NS

[a]All plots including the weed-free check were cultivated and hand-weeded to maintain weed-free conditions.

[a]DAP = days after planting.

Peanut grade and yield. For each herbicide, no yield differences were observed as a result of rate or incorporation method. At Lamesa, peanut yield was not affected by herbicides averaged across rates, incorporation methods, and years (Table 4). Treatment yield ranged from 4530 to 4920 kg/ha and was not affected by rates averaged across herbicides, incorporation methods, and years (Table 5) or by incorporation method averaged across herbicides, rates, and years (Table 6). At the Comanche and Yoakum locations, yield and grade were not affected by herbicide averaged across rates (Table 3) or by rate averaged across herbicides (Table 2). Peanut yield and grade did vary by location averaged across herbicides and rates (data not shown). Grichar and Colburn (1993) previously reported that pendimethalin at 1.12 kg/ha reduced peanut grade when compared with ethalfluralin, benefin [N-butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine], and trifluralin. Buchanan *et al.* (1978) reported that pendimethalin and trifluralin did not affect peanut yield when used at their normal use rate. No differences in yield or grade for runner peanuts with the dinitroaniline herbicides were observed. Problems associ-

Table 4. Peanut yield by herbicide averaged across rates, incorporation methods, and years at Lamesa[a].

Herbicide	Yield
	kg/ha
Ethalfluralin	4580
Pendimethalin	4530
Trifluralin	4920
Weed-free check	5120
LSD ($P \leq 0.05$)	NS

[a]Since no year by dinitroaniline herbicide by rate by incorporation interaction or any two- or three-way interaction was observed, main effects such as dinitroaniline herbicide were compared.

Table 5. Peanut yield by rate averaged across herbicides, incorporation methods, and years at Lamesa[a].

Herbicide rate	Yield
	kg/ha
Low[b]	4600
High[c]	4750
Weed-free check	5120
LSD ($P \leq 0.05$)	NS

[a]Since no year by dinitroaniline herbicide by rate by incorporation interaction or any two- or three-way interaction was observed, main effects such as rate were compared.

[b]The low rate of ethalfluralin, pendimethalin, and trifluralin was 0.63, 0.56, and 0.56 kg/ha, respectively.

[c]The high rate of ethalfluralin, pendimethalin, and trifluralin was 0.84, 0.84, and 0.71 kg/ha, respectively.

Table 6. Peanut yield by incorporation method averaged across herbicides, rates, and years at Lamesa[a].

Incorporation method	Yield
	kg/ha
Field cultivator	4770
Rolling cultivator	4580
Weed-free check	5120
LSD ($P \leq 0.05$)	NS

[a]Since no year by dinitroaniline herbicide by rate by incorporation interaction or any two- or three-way interactions were observed, main effects such as incorporation were compared.

ated with these herbicides may be due to other factors, as noted by Greer *et al.* (1969), who stated that proper incorporation of trifluralin was very important to avoid injury to spanish peanut. Any type of incorporation equipment which is not properly adjusted can result in uneven herbicide distribution, resulting in concentrated zones within the soil profile which may inhibit lateral root development (Boswell *et al.*, 1969). Greer *et al.* (1969) reported that correct seed placement within the incorporated zone was very important. Peanut seed planted in the upper levels of the incorporation zone generally extend roots through the treated zone. Any factor which causes a slower rate of growth could result in stunting. Annual grass control in reduced tillage systems where ethalfluralin and pendimethalin were surface applied and water incorporated was effective, and excellent peanut tolerance was noted (Prostko *et al.*, 2001).

Conclusions

These experiments indicate that ethalfluralin, pendimethalin, and trifluralin herbicides can be applied in Texas on peanut with little to no injury expected. Tolerance can be achieved regardless of the ethalfluralin, pendimethalin, or trifluralin herbicide, labeled rate, and type of mechanical incorporation utilized.

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