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Use of Sulfentrazone in a Peanut (*Arachis hypogaea*) Herbicide Program

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ABSTRACT

Field experiments were conducted at two Texas peanut growing locations to study weed control and peanut response to sulfentrazone. Sulfentrazone applied preemergence caused up to 96% peanut stunting when rated 4 weeks after planting. The severity of stunting increased as sulfentrazone rate increased. Eclipta control varied between 89 and 100% while Texas panicum control was never less than 73% regardless of rate. Yellow nutsedge control with sulfentrazone increased as the rate of sulfentrazone increased with control no higher than 81%. Purple nutsedge control varied from 83 to 100% and was not rate dependent. Peanut yields reflect the effect of sulfentrazone injury on plant growth and development as peanut yields decreased as sulfentrazone rate increased.

KEYWORDS: *Arachis hypogaea* L.; *Cyperus esculentus* L.; *Cyperus rotundus* L.; *Eclipta prostrata* L.; *Panicum texanum* Buckl; peanut stunt; preemergence.

INTRODUCTION

Broadleaved weeds such as elipta (*Eclipta prostrata* L.) and pitted morningglory (*Ipomoea lacunosa* L.) are an increasing problem in certain peanut growing regions of the southwestern United States. Dowler (1998) ranks *Ipomoea* spp., Texas panicum (*Panicum texanum* Buckl.), and yellow nutsedge (*Cyperus esculentus* L.) among the ten most common and troublesome weeds in peanut in Texas. These weeds are found in all peanut growing areas of the state (Grichar et al. 1999).

Control of many annual grass and broadleaved weeds in Texas can be achieved with a preplant incorporated (PPI) application of a dinitroaniline herbicide such as trifluralin (Treflan), pendimethalin (Prowl), or ethalfluralin (Sonalan) (Wilcut et al. 1995). However, these herbicides do not adequately control *Ipomoea* or *Cyperus* spp. (Wilcut et al. 1995). Some weeds escape control with the preplant herbicides because of extremely high weed populations, improper soil incorporation, or an inadequate herbicide dose (Grichar and Colburn 1996). Sulfentrazone is a member of the phenyl triazolinone herbicide group (Theodoridis et al. 1992). Herbicides in this family function through inhibition of protoporphyrinogen oxidase (PPO) in the chlorophyll biosynthetic pathway which leads to a buildup of toxic intermediates (Hancock 1995; Matringe et al. 1989; Witkowski and Halling 1989). Unlike other members of this herbicide family, such as the diphenyl ethers, sulfentrazone offers excellent soil activity (Dayan et al. 1996;

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Vidrine et al. 1994). Sulfentrazone is currently registered in the U.S. for weed control in soybean [*Glycine max* L. (Merr.)] as a mixture with chlorimuron (Canopy XL, E.I. du Pont de Nemours and Co., Agricultural Enterprise, Banley Mill Plaza, Wilmington, DE 19898) and in tobacco (*Nicotinia tabacum* L.) it is sold as a single pre-packaged product (Spartan, FMC Corporation, Agricultural Chemical Group, 1735 Market Street, Philadelphia, PA 19103) (Anonymous 2001). Sulfentrazone is primarily absorbed by the roots and causes necrosis and death of emerging weeds after response to light (Anonymous 1995; Wehtje et al. 1997).

The objectives of this research were to determine the spectrum of control with sulfentrazone on various weeds commonly found in peanut fields in Texas and to determine the effect of sulfentrazone on peanut growth and development.

MATERIALS AND METHODS

Field studies were conducted during the 1997 growing season at two locations near Yoakum and Pearsall in the south Texas peanut growing areas. Schedule of events, soil characteristics, and rainfall during the experiment as well as peanut varieties used are shown in Table 1. The experimental design at all locations was a randomized complete block replicated 3 to 4 times depending on location. Plots, two rows 25 ft long spaced 38 in apart, contained natural infestations of eclipta, yellow and purple nutsedge (*Cyperus rotundus* L.), or Texas panicum. Cyperus densities were 6 to 10 plants/ft^2 while eclipta and Texas panicum densities were 2 to 4 plants/ft^2.

Herbicide treatments included sulfentrazone (Authority 4E, FMC Corp.) alone at 0.25, 0.31, or 0.37 lb ai/A applied preemergence (PRE) or in sequence with ethalfluralin (Sonalan HFP, Dow AgroSciences) at 0.75 lb ai/A applied preplant incorporated (PPI) followed by sulfentrazone at the above mentioned rates applied PRE. Ethalfluralin alone at 0.75 lb/A applied PPI or ethalfluralin followed by imazapic (Cadre 70 DG, BASF Corp.) applied postemergence (POST) were used as comparisons and an untreated check was included at each location. Applications of ethalfluralin PPI were made 2 to 3 in deep with a tractor-driven power tiller one to two hours prior to peanut planting. Sulfentrazone was applied PRE within 3 h of peanut planting. Applications of imazapic POST were applied when weeds were 6 to 8 in tall (approximately 4 wk after planting [WAP]) and included a non-ionic surfactant (Kinetic, Helena Chemical Co.). Herbicides were applied with a CO_2 pressurized backpack sprayer using Teejet 11002 flat fan nozzles (Spraying Systems Corporation, Wheaton, IL 60188) which delivered a spray volume of 20 gal/A at 30 PSI. Peanut stunting and weed control were estimated visually 4 and 12 WAP, respectively, using a scale of 0 (no peanut stunting or weed control) to 100 (complete crop death or weed control), relative to the untreated check. Weed control data were transformed by the arscine square root function and data means were separated using Fisher's Protected LSD test at P=0.05. Non-transformed data for weed control are presented since arcsine transformation did not affect conclusions.

Peanut yields were determined at Pearsall by digging the pods, air drying in the field for 6 to 8 d, and harvesting individual plots with a combine. Weights were recorded after soil and trash were removed from the samples. Peanut yield means were separated using Fisher's Protected LSD test at P=0.05. Yields were not obtained at Yoakum due to severe crow (*Corvus corax*) damage which occurred several days after peanuts were dug.

Table 1. Schedule of events, peanut varieties, soil characteristics, and rainfall for conducting peanut herbicide study at two Texas locations,1997.

	Location	
Events, other parameters[a]	Pearsall	Yoakum
Planting date	June 4	May 14
PPI application	June 4	May 14
PRE application	June 4	May 14
Variety	GK-7	GK-7
Soil type		
Sand (%)	78	96
Silt (%)	10	2
Clay (%)	12	2
CEC	6.5	2.6
pH	7.3	6.8
Organic matter	1.0	0.2
Rainfall (inch)		
June	4.5	6.0
July	1.2	7.51
August	1.6	1.12

[a]Abbreviations: CEC, cation exchange capacity; PPI, preplant incorporated; PRE, preemergence.

RESULTS AND DISCUSSION

Peanut injury. Although peanut plants exhibited chlorosis and some necrosis after sulfentrazone was applied, only peanut stunting will be discussed because those symptoms lasted season-long and had the most effect on peanut yield. Field and weather conditions were different at each test location; therefore, peanut stunting data was analyzed separately by location. At both locations, peanut stunting with sulfentrazone was visible when rated 4 WAP; however, peanut stunting was greater at the Pearsall, Texas location (Table 2). Imazapic caused no peanut stunting at either location. At Pearsall, Texas sulfentrazone at 0.25 lb/A resulted in 73% peanut stunting and peanut stunting was at least 90% with rates greater than 0.25 lb/A. Peanut stunting was 10% with sulfentrazone alone at 0.25 lb/A at Yoakum, Texas and increased as the rate of sulfentrazone increased. When sulfentrazone was applied PRE following ethalfluralin applied PPI, peanut stunting was similar to or greater than sulfentrazone alone. At both locations, peanuts never recovered fully from the sulfentrazone stunting throughout the growing season (data not shown).

Table 2. Peanut injury (4 weeks after planting), weed control (12 weeks after planting), and peanut yield with sulfentrazone at two Texas locations.

Herbicide	Rate/A	Appl timing[a]	Peanut injury		Weed control[b,c]					Yield[d]
			Pears	Yoak	CYPES	CYPRO	ECLAL	PANTE Pears	PANTE Yoak	
	Lbs ai		%							Lbs/A
Check	-	-	0	0	0	0	0	0	0	2294
Ethalfluralin	0.75	PPI	0	0	0	0	0	100	100	2980
Sulfentrazone	0.25	PRE	73	10	48	100	89	73	83	2163
Sulfentrazone	0.31	PRE	90	34	63	84	93	89	81	1501
Sulfentrazone	0.37	PRE	96	53	81	96	100	100	78	218
Ethalfluralin+ sulfentrazone	0.75 0.25	PPI PRE	80	29	41	94	96	100	88	1597
Ethalfluralin+ sulfentrazone	0.75 0.31	PPI PRE	90	93	50	95	98	100	75	1162
Ethalfluralin+ sulfentrazone	0.75 0.37	PPI PRE	93	43	68	83	95	100	75	1016
Ethalfluralin+ imazapic	0.75 0.06	PPI POST	0	0	70	100	44	100	99	2813
LSD (0.05)			6	12	28	21	24	9	12	931

[a]Abbreviations: Pears, Pearsall; PPI, preplant incorporated; PRE, preemergence; Yoak, Yoakum.
[b]Bayer Code for weeds: CYPES, yellow nutsedge; CYPRO, purple nutsedge; ECLAL, eclipta; PANTE, Texas panicum.
[c]Yellow nutsedge and eclipta were present at the Yoakum location while purple nutsedge was present at Pearsall.
[d]Yield from the Pearsall location only.

Sulfentrazone has been reported to injure soybean (Li et al. 1999; Taylor-Lovell et al. 2001). Injury symptoms on soybean include chlorosis, discoloration of veins, and reduced internode length (Taylor-Lowell et al. 2001). Hulting et al. (1997) reported significant differences in soybean tolerance to sulfentrazone and found that soybean height was found to be a good indicator of susceptibility. Variation in soybean response may be due to differential tolerance to the peroxidative stress from the herbicide because no differences in either uptake or translocation have been demonstrated (Dayan et al. 1997). Differential variety responses with sulfentrazone have also been observed in potato (*Solanum tuberosum* L.) (Kazarian et al. 2000; Wilson et al. 2002). Grichar et al. (2003) noted 10% or less potato stunting with sulfentrazone at 0.10 and 0.12 lb ai/A. However, when sulfentrazone rate increased to 0.19 lb ai/A or greater, potato stunting was at least 25% at one location. This increase in potato stunting was attributed to the irrigation that was applied 48 h after the PRE application and to the coarse soil (91% sand) at that location (Grichar et al. 2003).

Other research also has shown an increase in sulfentrazone injury when a significant rainfall event moved the herbicide into the crop root zone (Taylor-Lovell et al. 2001). Grey et al. (1997) reported that the availability of sulfentrazone increased with higher pH and coarser textured soil resulting in increased crop injury potential. Also, sulfentrazone injury to soybean was more likely in soils low in organic matter content and under conditions of high moisture (Wehtje et al. 1997). At both locations, total rainfall during the month of planting (May-Yoakum; June-Pearsall) was at least 4.5 inch with an organic matter content of both soils 1.0% or less (Table 1).

Yellow nutsedge control.

At 12 WAT, sulfentrazone alone applied PRE at 0.37 lb/A controlled yellow nutsedge 81% while all other rates controlled 63% or less (Table 2). Ethalfluralin plus imazapic controlled only 70% yellow nutsedge. Lack of yellow nutsedge control may be attributed to high populations (6 to 10 plants/ft^2) and continuous emergence from planting to harvest due to frequent irrigations which provided environmental conditions conducive for yellow nutsedge growth. Other studies have reported at least 90% control of yellow nutsedge with sulfentrazone (Krausz et al. 1998; Niekamp et al. 1999).

Purple nutsedge control.

Sulfentrazone, with and without etalfluralin, control of purple nutsedge varied from 83 to 100% while ethalfluralin plus imazapic controlled purple nutsedge completely (Table 2). Grichar et al. (2003) reported that sulfentrazone at rates lower than 0.15 lb ai/A provided variable purple nutsedge control while rates above 0.2 lb/A provided greater than 80% control when applied PRE. Wehtje et al. (1997) reported sulfentrazone was more effective when placed in the root zone at a higher pH relative to a lower pH. They speculated that better control at the higher pH may be relative to the ionization of sulfentrazone. Sulfentrazone has a pKa of 6.6. Both anionic and molecular (uncharged) forms would be present at a pH 6.2 and the molecular form would be predominant at pH 4.2. The anionic form may be preferentially absorbed by roots of purple nutsedge or less subject to absorption by soil colloids (Wehtje et al. 1997).

Eclipta control.

Sulfentazone alone or in combination with ethalfluralin controlled eclipta no less than 89% while ethalfluralin plus imazapic controlled eclipta 44% (Table 2). Ethalfluralin alone did not control eclipta. Sulfentrazone provides excellent control of many broadleaved weeds including common waterhemp (*Amaranthus rudis* Sauer) and morninglory species but somewhat inconsistent control of common ragweed (*Ambrosia artemisiifolia* L.) and common cocklebur (*Xanthium strumarium* L.) (Krausz et al. 1998; Niekamp et al. 1999; Vidrine et al. 1996). Krausz and Young (2003) reported that sulfentrazone at 0.25 lb/A controlled ivyleaf morningglory (*Ipomoea hederacea* L.) 100%.

Texas panicum control.

At Pearsall, sulfentrazone alone at 0.25 lb/A controlled 73% Texas panicum, but when the rate of sulfentrazone was increased to 0.37 lb/A or ethalfluralin was applied PPI followed by sulfentrazone applied PRE, Texas panicum control was 100%. Bailey et al. (2002) reported that sulfentrazone applied PRE at 0.1 to 0.2 lb ai/A controlled goosegrass

(*Eleusine indica* L.) and large crabgrass (*Digitaria sanguinalis* L.) no more than 47%. However, when sulfentrazone dose was increased to 0.25 lb ai/A, control of these annual grasses increased to 76%. They reported that increasing doses of sulfentrazone PRE correlated to linear increases in annual grass control. Other research indicated adequate control of several grass species with the use of sulfentrazone at higher doses (Hancock 1995).

At Yoakum, ethalfluralin alone or ethalfluralin followed by imazapic applied POST controlled Texas panicum at least 99% (Table 2). Sulfentrazone alone or following ethalfluralin applied PPI controlled 75 to 88% Texas panicum. In other research, Grichar et al. (2006) reported that sulfentrazone at 0.2 lb ai/A failed to control Texas panicum when rated 12 WAT. They found early season Texas panicum control with sulfentrazone was less than 40% and did not improve during the growing season.

Peanut yield.

Ethalfluralin followed by imazapic produced a yield of 2813 lb/A while the untreated check yielded 2294 lb/A (Table 2). Peanut yields with sulfentrazone reflect the effect of herbicide injury on peanut growth and development. As sulfentrazone rate increased, peanut yield decreased. These data are in contrast to the work in the southeastern U.S. where sulfentrazone could be applied either PPI or PRE with little or no risk to peanut (Grey et al. 2004).

CONCLUSIONS

Although sulfentrazone provided control of eclipta, Texas panicum, and purple nutsedge in peanut, the severe peanut stunting and subsequent yield reduction noted with sulfentrazone is too great for its use as an effective herbicide. The chance of peanut injury is high under the coarse sands normally reserved for peanut production in the southwestern U.S.

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