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ARTICLE

Peanut Response to Pyroxasulfone in Texas and Oklahoma

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ABSTRACT

Field studies were conducted in southwestern Oklahoma (Ft. Cobb), south Texas (Yoakum), and the southern High Plains of Texas (Seminole) during the 2019 and 2020 growing seasons to evaluate peanut cultivar tolerance to pyroxasulfone at 0.09 and 0.12 kg ai/ha applied at peanut cracking (CRACK), early postemergence (EPOST), or mid-postemergence (MPOST). No injury from pyroxasulfone was noted at the Texas locations; however, 0 to 4 % stunting (28 to 32 days after treatment) was noted both years in Oklahoma. Pyroxasulfone rate lowered peanut yield only in 2019 at the High Plains location as the untreated check resulted in higher yield than pyroxasulfone at 0.09 kg/ha. The effect of application timing was only evident at the south Texas location in 2019 when the CRACK application produced higher yield than the MPOST application. Peanut grade (SMK+SS) was not affected by pyroxasulfone rate or application timing at Yoakum or Ft. Cobb. Pyroxasulfone rate and application timing had an occasional effect on peanut yield but did not adversely affect quality and has shown to provide excellent control of problem weeds in peanut.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) production has challenges with weed management. First, most peanut cultivars grown in the U.S. require a fairly long growing season of 140 to 160 d depending on cultivar and geographical region (Grichar *et al.*, 2022; Branch *et al.*, 2021; Lamb *et al.*, 2017). In turn, soil-applied at-plant herbicides do not provide season-long control which may result in mid- to late-season weed problems. Secondly, peanut has a prostrate growth habit with a relatively shallow canopy, and is slow to shade row middles allowing weeds to be more competitive (Wilcut *et al.*, 1995; Walker *et al.*, 1989). Thirdly, peanut fruit develops underground on pegs that originate from stems and grow along the soil surface, and the prostrate growth habit and pattern of fruit development limits cultivation to an early season control option (Wilcut *et al.*, 1995; Brecke and Colvin, 1991).

Pyroxasulfone is a Group 15 herbicide labeled for use in peanut in the U.S. since 2017 (Anonymous, 2017) and is a very long-chain fatty-acid biosynthesis inhibitor, similar to chloroacetamide, oxyacetamide, and tetrazolinone herbicides (Curran and Lingenfelter, 2016; Tanetani *et al.*, 2009). Pyroxasulfone has a low water solubility of 3.49 mg/L at 20 C, and there is a strong correlation between soil binding, reduced herbicide dissipation, and increased soil organic matter content (Westra *et al.*, 2014). Although pyroxasulfone has a similar weed control spectrum as *S*-metolachlor and dimethenamid-P, it has a higher specific activity allowing for use rates approximately eight times lower than dimethenamid-P (Curran and Lingenfelter, 2016).

Application timing is crop specific and pyroxasulfone can be applied from preplant through postemergence in corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanut, soybean (*Glycine max* L.), and wheat (*Triticum aestivum* L.) (Cahoon et al., 2015; Hardwick, 2013; King and Garcia, 2008; Knezevic *et al.*, 2009; Mangin *et al.*, 2017; Tanetani *et al.*, 2009; Tanetani *et al.*, 2011). In peanut, pyroxasulfone may be applied from ground cracking (CRACK) through beginning of pod development stage (Anonymous, 2017). It provides good to excellent control of many weeds in peanut including *Amaranthus* spp., *Lolium* spp, *Urochloa* spp., goosegrass (*Eleusine indica* L.), crowfootgrass (*Dactyloctenium aegyptium* L.), and *Digitaria* spp. (Cahoon *et al.*, 2012; Eure, 2013; Koger *et al.*, 2008; Nurse *et al.*, 2011; Odero and Wright, 2013).

Research has not reported any injury from pyroxasulfone in corn (Mueller and Steckel, 2011). Also, Sikkema *et al.* (2008) reported that pyroxasulfone was safe on several sweet corn hybrids. In other crops, pyroxasulfone was reported to injure pinto and small red Mexican beans (*Phaseolus vulgaris* L.) when applied preplant incorporated (PPI) (Soltani *et al.*, 2008). Peanut has a good crop tolerance to pyroxasulfone; however, pyroxasulfone applied preemergence (PRE) has been documented to cause early-season stunting without any yield loss (Eure *et al.*, 2015).

Studies in other crops have reported some yield reductions when using pyroxasulfone and results can vary by crop (Boydston *et al.*, 2012; Hulting *et al.*, 2012; Soltani *et al.*, 2012; Mahoney *et al.*, 2014; McNaughton *et al.*, 2014; Tidemann *et al.*, 2014). Winter wheat showed minimal injury or yield reductions at doses up to 0.15 kg/ha (Hulting *et al.*, 2012). Potato (*Solanum tuberosum* L.) also exhibited tolerance to pyroxasulfone at rates up to 0.15 kg/ha with minor yield reduction and quality losses (Boydston et al., 2012). Pyroxasulfone at 0.125 kg/ha caused unacceptable yield losses in barley (*Hordeum vulgare* L.) as well as durum wheat (*Triticum durum* L.) and oats (*Avena sativa* L.) (Soltani *et al.*, 2012). Sunflower (*Helianthus annus* L.) has shown acceptable tolerance to pyroxasulfone up to 0.33 kg/ha although injury (but not yield loss) did occur at locations with heavy precipitation events shortly after application (Olsen et al., 2011).

To further document peanut variety tolerance to pyroxasulfone, field studies were conducted at two rates (0.09 and 0.12 kg/ha) and three application timings, peanut ground cracking (CRACK), early postemergence (EPOST), and mid-postemergence (MPOST), in the southwestern Oklahoma and south and southern High Plains of Texas peanut growing regions.

MATERIALS AND METHODS

Peanut tolerance studies were conducted during the 2019 and 2020 growing seasons at the Oklahoma State University Caddo Research Station near Ft. Cobb, a commercial field near Seminole, TX and the Texas A&M AgriLife Research site near Yoakum. Soils at Ft. Cobb were a Cobb fine sandy loam (fine-loamy, mixed, active, thermic Typic Haplustalfs) with less than 1% organic matter and a pH 7.3. Soils at the Seminole location were a Patricia loamy fine sand (fine-loamy, mixed, superactive, thermic Aridic Paleustalfs) with 1.4% organic matter and a pH 7.9. Soils at Yoakum were a Denhawken sandy clay loam (fine, smectitic, hyperthermic, Vertic Haplustepts) with less than 1.0 % organic matter and pH 7.6.

Treatments consisted of a factorial arrangement of two pyroxasulfone rates (0.09 or 0.012 kg ai/ha) and three application timings, CRACK, EPOST, or MPOST. The CRACK applications were applied 8 to 15 days after planting (DAP), EPOST applications were applied 17 to 30 DAP, and MPOST applications were applied 34 to 58 DAP, depending on location. This is within the application timing suggested on the pyroxasulfone label for it use on peanut (Anonymous, 2017). Herbicides were applied using water as a carrier with a CO_2-pressurized backpack sprayer. An untreated weed-free check was included in each study and each treatment was replicated three to four times depending on location. Other specifics of each study can be seen in Table 1.

Peanut cultivars evaluated were those grown in each production area. In south Texas and the Texas High Plains, the runner type peanut, 'Georgia-09B' was planted (Branch, 2010) while in Oklahoma the Virginia type peanut, 'Wynne' (Roberson, 2013) was grown. Georgia-09B has been grown extensively in Texas for a number of years and is a high-oleic and low-linoleic fatty acid composition with partial resistance to the Tomato Spotted Wilt (TSW) caused by the *Tomato spotted wilt virus* (Anonymous, 2024). Wynne yields on the average 68% jumbo and 21% fancy and also has a high oleic fatty acid composition with partial resistance to early leaf spot caused by *Passalora arachidicola* (syn. *Cercospora arachidicola* Hori.), Cylindrocladium black rot (CBR) caused by *Cylindocladium crotalaria* (Loos) Bell & Sobers, Sclerotinia blight caused by *Sclerotinia minor* Jagger, and TSWV (Anonymous, 2016).

Each plot consisted of two rows spaced 91 cm apart and 7.6 m long at Ft. Cobb, four rows spaced 102 cm apart and 9.1 m long at the Seminole location, and 97 cm apart and 7.6 m long at Yoakum. At Seminole only the center two rows were treated. Traditional production practices as recommended by the Texas A&M AgriLife Extension Service (Baughman et al., 2012) and the Oklahoma Cooperative Extension Service (Godsey et al., 2011) were used to maximize peanut growth, development, and yield at all locations. Plots were maintained weed-free with the use of POST herbicides such as clethodim or 2,4-DB and/or hand-weeding.

At Yoakum, lateral hand moved irrigation lines were used while at the Lubbock and Ft. Cobb locations, a center pivot irrigation system was used. Irrigation was applied throughout the growing season as needed.

Peanut stunting was based on visual subjective estimates using a scale of 0 to 100 (0 = no peanut stunting, 100 = peanut death) (Frans, et al., 1986). Peanut yield was determined by digging the pods based on maturity of the untreated check plots, air-drying in the field for 6 to 10 d, and harvesting with a 2-row combine. Yield samples were cleaned and adjusted to 10% moisture. Pod, shell, and peanut kernel weight were determined from each sample. Grades [percent sound mature kernels (SMK) plus sound splits (SS)] were determined for a 200-g pod sample from each plot following procedures described by the Federal-State Inspection Service (Anonymous, 2019). Grade data were collected both years at Yoakum and in 2019 at Ft. Cobb.

Since arscine transformation did not affect interpretation of the data, original means are presented. Data were subjected to ANOVA and analyzed using the SAS PROC MIXED procedure 23, version 9.2 (SAS 9, 2019). Treatment means were separated using Fisher's Protected LSD at $P < 0.05$.

Table 1. Variables associated with the pyroxasulfone study in Texas and Oklahoma.[a]

	South Texas		Texas High Plains		Oklahoma	
Variable	2019	2020	2019	2020	2019	2020
Location	Yoakum	Yoakum	Seminole	Seminole	Ft. Cobb	Ft. Cobb
Coordinates	29.2785° N 97.1245° W	29.2770° N 97.1240° W	32.7324° N 102.8767° W	32.7521° N 102.7872° W	35.0910° N 98.2745° W	35.0910° N 98.2745° W
Planting date	June 19	June 17	April 30	April 28	May 15	May 6
Variety	Georgia-09B	Georgia-09B	Georgia-09B	Georgia-09B	Wynne	Wynne
Application						
Sprayer type	CO2 backpack	CO2 backpack	CO2 backpack	CO2 backpack	CO2 backpack	CO2 backpack
Spray pressure (kPa)	180	180	198	180	168	168
Nozzle type	Flat fan	Flat fan	Flat fan	Flat fan	Flat fan	Flat fan
Nozzles tips	DG 11002	Teejet 11002	Teejet 11002	Teejet 11002	TTI 110015	TTI 110015
Spray volume (L ha^{-1})	187	187	140	140	112	112
CRACK[a]	July 1	June 30	May 13	May 6	May 30	May 19
EPOST	July 15	July 7	May 30	May 27	June 11	June 4
MPOST	July 29	July 21	June 10	June 10	June 25	July 2

[a]Abbreviations: CRACK, peanut cracking; EPOST, early postemergence; MPOST, mid postemergence.

RESULTS AND DISCUSSION

Peanut injury (stunting) was estimated visually throughout the growing season at all locations; however, only the 28 to 32 days after planting (DAP) evaluations are presented since injury symptoms were most apparent during this time-frame (Table 2).

Stunting

Stunting was not observed in either year at the Yoakum or Seminole locations. The south Texas (Yoakum) results are similar to that seen in a previous study with no stunting due to pyroxasulfone (Grichar *et al.*, 2019). In the High Plains area, pyroxasulfone has resulted in some peanut stunting but was not consistent over years (Dotray *et al.*, 2018).

At Ft. Cobb, there was a pyroxasulfone rate by application timing interaction. When evaluated 28 to 32 days after pyroxasulfone application, stunting was seen with pyroxasulfone at 0.09 kg ai/ha in both years (Table 2). In 2019, pyroxasulfone at 0.09 kg/ha applied CRACK resulted in 3% stunting; however, no stunting was noted with any other application timing or rate. In 2020, stunting was noted with pyroxasulfone at the 0.09 kg/ha rate regardless of application timing. Pyroxasulfone at 0.12 kg/ha applied CRACK or EPOST resulted in stunting; however, the MPOST application resulted in no stunting. When evaluated late-season prior to harvest, stunting was < 1% with pyroxasulfone at either rate or application timing (data not shown). In previous work with pyroxasulfone in Oklahoma, peanut stunting was observed with PPI and PRE treatments with injury ranging from 4 to 13% (Baughman *et al.*, 2018).

In Georgia, Eure *et al.* (2015) reported peanut stunting during the two test years with pyroxasulfone ranged from 3 to 11% in one year and 38 to 55% in another, depending on peanut cultivar. They reported several factors played a role in the differences observed between the two years. More rainfall occurred through the EPOST application in the year with greater injury than in the year with lesser injury (50.8 mm vs. 25.4 mm). At Ft. Cobb in 2019, high rainfall amounts were noted in May (Table 3) which may have been a factor with pyroxasulfone stunting at 0.09 kg/ha. However, in 2020 rainfall totals were not extremely high (Table 3) and therefore would not appear to be a factor in the peanut stunting with pyroxasulfone. In contrast, the Yoakum location had high rainfall amounts in May of both 2019 and 2020 (Table 3) and this did not affect peanut growth after the application of pyroxasulfone (data not shown).

Enhanced peanut stunting has been observed following the application of PRE herbicides under cool, wet conditions (Grichar *et al.*, 2004). In previous research, Prostko (2013) documented transient peanut stunting at one of two locations following pyroxasulfone applied PRE.

Table 2. Early-season stunting 28 to 32 days after pyroxasulfone application in Oklahoma.[a]

Treatment	Rate	Application timing	2019	2020
	kg/ha		%	
Untreated			0	0
Pyroxasulfone	0.09	CRACK	3	3
		EPOST	0	3
		MPOST	0	1
Pyroxasulfone	0.12	CRACK	0	4
		EPOST	0	1
		MPOST	0	0
LSD (0.05)			1	1

[a]Abbreviations: CRACK, peanut cracking; EPOST, early postemergence; MPOST, mid postemergence.

Research in other crops has shown greater crop injury from pyroxasulfone applied PRE on coarse-textured soils than on fine-textured or organic soils (Cahoon *et al.*, 2012; Eure, 2013; Koger *et al.*, 2008; Nurse *et al.*, 2011; Odero and Wright, 2013). Sweet corn injury has been documented to be greater than 10% following pyroxasulfone at 0.25 kg/ha on soils with 82% sand (Nurse *et al.*, 2011) while no injury has been observed on soils high in organic matter (Odero and Wright, 2013). In cotton, Koger *et al.* (2008) reported only transient injury on a silt loam soil following pyroxasulfone applied PRE while Cahoon *et. al.* (2015) observed injury and stand reductions on loamy sand and sandy loam soils.

Table 3. Monthly rainfall at Ft. Cobb, Seminole, and Yoakum during the 2019 and 2020 growing seasons.

Month	Ft. Cobb		Seminole		Yoakum	
	2019	2020	2019	2020	2019	2020
	mm					
May	278.1	86.6	21.8	0.8	147.0	205.5
June	73.9	29.2	63.2	0.5	115.6	132.3
July	40.9	91.9	57.2	44.7	27.7	103.6
August	119.4	21.6	0	8.6	12.9	21.1
September	122.9	118.1	68.6	20.6	55.1	105.9
October	40.1	56.1	1.0	7.6	160.5	4.6
November	36.6	23.4	82.8	1.3	27.2	60.5

Yield

The effect of pyroxasulfone rate on peanut yield was only seen at the Seminole location in 2019 (Table 4). In that year, the untreated check resulted in an 11% yield increase over pyroxasulfone at 0.09 kg/ha while there was not a difference in yield between the untreated check and pyroxasulfone at 0.12 kg/ha. The rainfall pattern in 2019 at the Seminole location indicates that May rainfall was actually lower (21.8 mm) while June (63.2 mm) and July (57.2 mm) rainfall was slightly above the 23-year average. Averages for May are 45.7 mm while June and July averages are 45.7 and 43.2 mm, respectively (Anonymous, 2025). Therefore, the different observed levels of moisture did not appear to be a factor in the yield differences.

Table 4. Peanut response to pyroxasulfone rate in Texas and Oklahoma.[a,b,c]

Herbicide	Rate	Yoakum		Seminole		Ft. Cobb	
				2019	2020		2019
		Yield	Grade	Yield		Yield	Grade
	kg/ha	kg/ha	%	kg/ha		kg/ha	%
Untreated	-	3041	66.2	8658	4271	5990	70.5
Pyroxasulfone	0.09	3200	65.5	7791	4392	6065	71.5
	0.12	3074	65.9	7954	4097	6022	71.2
LSD (0.05)		NS	NS	754	NS	NS	NS

[a] Grade: sound mature kernels (SMK) + sound splits (SS).

[b] There was no pyroxasulfone rate by year interaction for yield or grade at Yoakum or yield at Ft. Cobb; therefore, data are combined over years.

[c] Grade was collected at Ft. Cobb only in 2019.

The effect of pyroxasulfone application timing on yield was only seen at the Yoakum location in 2019 (Table 5). Pyroxasulfone applied at CRACK produced a 21% higher yield than pyroxasulfone applied MPOST. No other application timing differences were noted. No explanation for the higher yield with the CRACK application or the lower yield with the MPOST application can be provided.

Table 5. Peanut response to pyroxasulfone application timing in Texas and Oklahoma.[a,b,c,d]

Application timing	Yoakum			Seminole		Ft. Cobb	
	2019	2020		2019	2020		2019
	Yield		Grade	Yield		Yield	Grade
	kg/ha		%	kg/ha		kg/ha	%
Untreated	3273	2808	66.2	8658	4271	5990	70.5
CRACK	3604	3086	65.9	8184	4271	6161	71.6
EPOST	3275	2931	64.9	7633	4118	6003	71.5
MPOST	2853	3070	66.2	7801	4347	5970	71.1
LSD (0.05)	500	NS	NS	NS	NS	NS	NS

[a] Abbreviations: CRACK, peanut cracking; EPOST, early postemergence; MPOST, mid postemergence; NS, not significant at the 0.05 level of significance.

[b] Grade: sound mature kernels (SMK) + sound splits (SS).

[c] There was no application timing by year interaction for grade at Yoakum or yield at Ft. Cobb.

[d] Grade was collected at Ft. Cobb only in 2019.

In a previous two-year herbicide efficacy study in Oklahoma, in one year there was no difference in yield between the untreated check and any pyroxasulfone treatment and the authors attributed this to the lack of adequate *U. texana* control with any herbicide treatment (Baughman et al., 2018). High populations of *U. texana* in peanut can reduce yield due to competition for nutrients, moisture, and sunlight (Wilcut *et al.*, 1995; Brecke and Colvin, 1991). Also, *U. texana* can reduce peanut yield through reduced harvest efficiency. The tight fibrous root system of this weed becomes intertwined with the peanut plant, causing peanut pods to be stripped from the vine during digging (Buchanan *et al.*, 1982; Henning *et al.*, 1982; Wilcut *et al.*, 1995). Peanuts that become detached from the plant remain unharvested in or on the soil (Buchanan *et al.*, 1982). In another year, with lower *U. texana* populations, all herbicide systems yielded more than the untreated check. The herbicide system that included pyroxasulfone at 0.06 kg/ha applied PRE and late postemergence (LPOST) provided the greatest yield.

Grade

Since there was not a peanut grade by year interaction at Yoakum, grade was combined over years. Grade was not influenced by pyroxasulfone rate (Table 4) or application timing (Table 5) at Yoakum or Ft. Cobb. No other research could be found reporting on peanut grade response when using pyroxasulfone.

CONCLUSION

The results of these studies indicate that pyroxasulfone is safe to use on peanut in Texas and Oklahoma. Peanut injury was less than 5%, and yield was only reduced in one out of 6 site years and was not consistent over the two pyroxasulfone rates. Additional research is needed on peanut cultivars that have not been evaluated to make sure they are compatible with pyroxasulfone at the different rates and application timings.

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