Peanut Tolerance to Pyroxasulfone

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ABSTRACT

Due to limited hectares and production in comparison to field corn, soybean, and wheat, commercial research and development efforts by major manufacturers for potential new peanut herbicides are minimal. Therefore, new herbicides developed for large hectare crops should be evaluated for potential use in peanut. Field trials were conducted in Ty Ty and Plains Georgia in 2007 and 2008 to evaluate the tolerance of peanut to PRE and POST applications of pyroxasulfone at five rates (0, 120, 240, 360, and 480 g ai/ha). Pyroxasulfone did not cause significant peanut injury at the Ty Ty location. In Plains, PRE applications of pyroxasulfone caused significant crop stunting, particularly at the 360 and 480 g/ha rates. In Ty Ty, PRE applications of pyroxasulfone also resulted in greater expression of tomato spotted wilt virus than POST applications. Peanut yields were not reduced by any rate or timing of pyroxasulfone. These results suggest that pyroxasulfone may have some potential to be utilized in peanut.

Key Words: crop injury, tomato spotted wilt virus, yield.

In 2010, peanut was planted on 522,000 ha in the U.S. (Anonymous 2011). In contrast, field corn, soybean, and wheat were planted on 36,000,000, 31,000,000, and 22,000,000 ha, respectively (Anonymous 2011). Consequently, commercial research and development efforts for new herbicides are focused in these crops and not in peanut. The most recent registrations for herbicides in U.S. peanut were granted to diclosulam (2000), fluazifop (2009), flumioxazin (2001), and lactofen (2005).

Pyroxasulfone, formerly KIH-485, is a new broad-spectrum herbicide being developed for preemergence (PRE) use in field corn (*Zea mays* L.), soybean [*Glycine max* (L.) Merr.] and wheat (*Triticum aestivum* L.). Anticipated use rates of pyroxasulfone in these crops range between 60 and 120 g ai/ha. Pyroxasulfone is effective on many annual weed species including field sandbur (*Cenchrus spinifex* Cav.), green foxtail [*Setaria viridis* (L.) Beauv.], kochia [*Kochia scoparia* (L.) Schrad.], large crabgrass [*Digitaria sanguinalis* (L.) Scop.], Palmer amaranth (*Amaranthus palmeri* S. Wats.), shattercane [*Sorghum bicolor* (L.)], Texas millet [*Urochloa texana* (Buckl.) R. Webster], and velvetleaf (*Abutilon theophrasti* Medik.) (King and Garcia 2008; King *et al.* 2007; Geier *et al.* 2006; Knezevic *et al.* 2009; and Steele *et al.* 2005). From this list, Palmer amaranth and Texas millet are of particular interest since these are two of the most common and troublesome weeds of peanut (Webster 2009).

Pyroxasulfone is an inhibitor of very-long-chain-fatty acids and should be categorized within the K3 group of herbicides (Tanetani *et al.* 2009). Other common K3 herbicides include acetochlor, alachlor, butachlor, dimethenamid-p, flufenacet, *S*-metolachlor, and propachlor (Senseman 2007). S-metolachlor is frequently used in peanut for the control of various weeds including yellow nutsedge (*Cyperus esculentus* L.) and Benghal dayflower (*Commelina benghalensis* L.) (Grichar *et al.* 2001; Grichar *et al.* 2008; Prostko *et al.* 2005).

Little information about the tolerance of legume crops to pyroxasulfone has been published in the literature. Although pyroxasulfone was initially targeted for PRE weed control in corn, soybean has shown good tolerance (Porpiglia *et al.* 2005). Generally, PRE applications of pyroxasulfone at 125 to 314 g ai/ha in soybean have provided similar weed control and crop response as *S*-metolachlor (Young and Young 2005; Moody *et al.* 2005). In dry bean (*Phaseolus vulgaris* L.), PRE applications of pyroxasulfone at 210 and 420 g ai/ha caused unacceptable crop injury and yield loss in some market classes (Sikkema *et al.* 2007). Pinto and small red Mexican beans (*Phaseolus vulgaris* L.) were not tolerant of pyroxasulfone when applied preplant incorporated (PPI) at 209 or 418 g ai/ha (Soltani *et al.* 2008). Preliminary pyroxasulfone field trials in peanut have shown promise (Prostko and Grey 2008). Since research about the selectivity of pyroxasulfone in peanut is limited, the objective of these studies was to evaluate the tolerance of peanut to PRE and postemergence (POST) applications of pyroxasulfone.

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Table 1. Peanut varieties, planting dates, application dates, inverting, harvesting dates and May/June rainfall for the pyroxasulfone/peanut tolerance studies in Georgia, 2007–2008.

	Ty Ty		Plains	
	2007	2008	2007	2008
Variety	AP-3	AP-3	Georgia Green	Georgia Green
Planting Date	May 8	May 12	May 8	May 13
PRE	May 10	May 13	May 8	May 14
POST	June 21	June 25	June 28	June 25
Inverting	Sept. 17	Sept. 26	Sept. 17	Oct. 3
Harvesting	Sept. 26	Sept. 29	Sept. 25	Oct. 7
Rainfall (cm)				
May	0.13	1.80	4.55	0.00
June	9.53	5.95	13.43	7.32

Materials and Methods

Field trials were conducted in 2007 and 2008 at the University of Georgia Ponder Research Station, near Ty Ty, GA, (Latitude 31.50911; Longitude −83.64813) and the Southwest Georgia Branch Experiment Station near Plains, GA (Latitude 32.04675; Longitude −84.37102). The soil type at the Ponder Research Station was a Tifton sand with 96% sand, 2% silt, 2% clay, 1.2% organic matter, and pH 6.0. The soil type at the Southwest Experiment Station was a Greenville sandy loam with 71% sand, 13% silt, 16% clay, 1% organic matter, and pH 6.0. Cultivars, planting dates, inverting, and harvest dates are presented in Table 1. Common production practices and Cooperative Extension recommendations were used at all times. Supplemental irrigation was applied as needed.

Herbicide treatments were arranged in a factorial design that included two application timings (PRE or POST) and five pyroxasulfone rates (0, 120, 240, 360, and 480 g ai/ha). All treatments were replicated four times. PRE treatments were activated with irrigation within 48 hours of application. POST treatments of pyroxasulfone were applied between 44 and 51 days after peanut planting and included a non-ionic surfactant (80/20, United Agri Products, Inc., P.O. Box 1286, Greely, CO 80632-1286) at 0.25% v/v. At the time of the POST applications, the peanut plants were in the R1 to R2 stage of growth (Boote 1982). Treatments were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L/ha at 220 to 275 kPa. The plot areas were maintained weed-free using a combination of mechanical cultivation, hand-weeding, and commonly used preemergence herbicides (diclosulam, flumioxazin, and pendimethalin).

Visual estimates of crop injury (stunting) were obtained 10 to 15 days after the POST treatments using a scale of 0–100% where 0 = no injury and 100% = complete plant death. At the Ty Ty location only, incidence of tomato spotted wilt virus (TSWV) was measured just prior to peanut inverting by counting the number of disease loci per linear row in 31 cm sections and transforming the data to percentage infection based upon total row length. Peanut yield data were obtained using commercial inverting and harvesting equipment. Peanut yields were adjusted to 10% moisture.

Data were subjected to a mixed model ANOVA with pyroxasulfone rates, application methods and locations as fixed effects and years and interactions as random effects. Where appropriate, data were regressed on pyroxasulfone rate and a sigmoid regression model was fit to the data using SigmaPlot (Version 11, Systat Software Inc., 1735 Technology Drive, Suite 430, San Jose, CA 95110).

Results and Discussion

Crop Injury (stunting). Peanut stunting at the Ty Ty location did not exceed 5% from any rate or

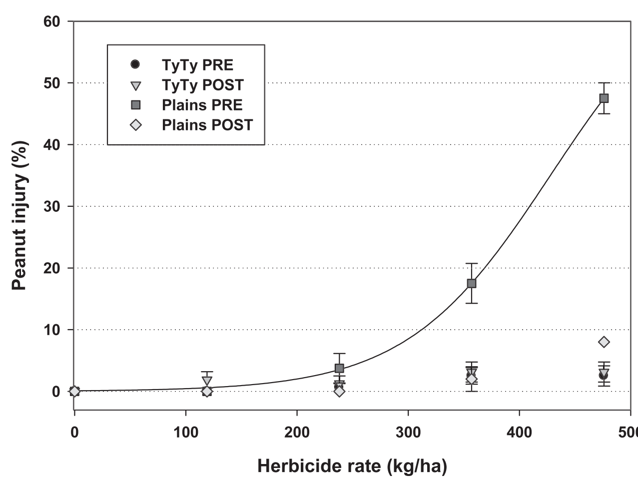

Fig. 1. The effect of pyroxasulfone rate and application timing on peanut injury (stunting) at two locations in Georgia, 2007–2008. There was a sigmoidal relation between peanut injury and rate of pyroxasulfone when applied PRE at Plains.

Table 2. The influence of pyroxasulfone application timing on tomato spotted wilt virus in peanut ('AP-3'), Ty Ty, Georgia, 2007-2008.[a]

Application Timing[b]	Tomato Spotted Wilt Virus Incidence[c]
	%
PRE	24
POST	19

[a]Pooled over two years and five pyroxasulfone rates (0, 120, 240, 360, and 480 g ai/ha).
[b]PRE = preemergence; POST = postemergence.
[c]P = 0.0126.

timing of pyroxasulfone (Figure 1). At the Plains location, there was a sigmoidal relationship between peanut stunting and pyroxasulfone rate when applied PRE ($p<0.0001$). Pyroxasulfone applied PRE at 240 g/ha or less caused less than 5% crop stunting. However, significant crop stunting occurred at 360 g/ha (18% injury) and 480 g/ha (48% injury). This contrast in crop response between locations may be explained due to the differences in soil type, environment, and cultivars. At Plains, soil silt and clay contents were 11 to 14% higher than at Ty Ty. Additionally, combined May + June rainfall totals were greater at the Plains location (Table 1). Crop injury symptoms may be enhanced when residual herbicides are applied to heavier, more adsorptive soils that receive higher rainfall amounts. When compared to AP-3, Georgia Green is considered to be a small-seeded peanut cultivar (Branch 1996; Gorbett 2007). Previous research concluded that smaller-seeded market classes of dry bean were more sensitive to PRE applications of pyroxasulfone than dry beans with larger seeds (Sikkema *et al.* 2007). In soybean, it has been speculated that plants developing from larger seeds could survive lethal herbicide doses better than plants developing from smaller seeds because they could survive on more cotyledonary food reserves until the herbicide dosage reaches a non-lethal level (Anderson 1970). Additional pyroxasulfone/peanut cultivar tolerance research is needed due to the fact that the cultivars used in these studies have been replaced by larger-seeded, superior disease resistant, and higher yielding cultivars such as Georgia-06G (Branch 2007).

Peanut injury from POST applications of pyroxasulfone was less than 10% in these studies. Pyroxasulfone provides no POST weed control activity. However, in other crops, the inclusion of pyroxasulfone in combination with POST herbicides is a strategy to enhance the residual control of susceptible weeds (King *et al.* 2007; King and Garcia 2008). In peanut, this POST use pattern could be an effective means for controlling weeds with season-long emergence patterns, especially

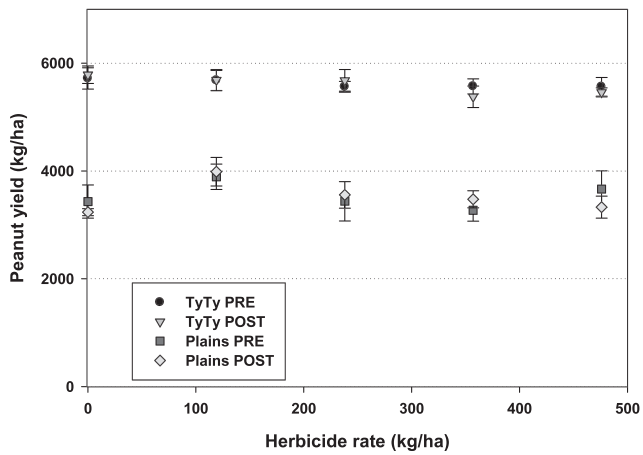

Fig. 2. Influence of pyroxasulfone rate and application timing on peanut yield at two locations in Georgia, 2007–2008.

species that are difficult to control with other management tools such as Benghal dayflower and ALS-resistant Palmer amaranth.

Tomato Spotted Wilt Virus (TSWV). Due to lack of significant interactions, data were combined over years and pyroxasulfone rates. There was a significant effect of pyroxasulfone application timing on the incidence of TSWV. Pyroxasulfone applied PRE resulted in higher incidences of TSWV than POST applications (Table 2). This was unexpected since AP-3 is considered to have excellent resistance to TSWV (Gorbet 2007). In previous research, only POST applications of chlorimuron had an influence on the incidence of TSWV in peanut (Prostko *et al.* 2009). In other peanut research, applications of diclosulam (PPI), flumioxazin (PRE), imazapic (POST), paraquat (POST), and 2,4-DB (POST) did not affect the incidence of TSWV (Bailey *et al.* 2000; Faircloth and Prostko 2010; Tubbs *et al.* 2010; Wilcut *et al.* 2001). The mechanism of how certain herbicides influence TSWV in peanut has not yet been discovered.

Yield. There were no significant effects of pyroxasulfone rates or application timings on peanut yield (Figure 2). In other legume crops, PPI or PRE applications of pyroxasulfone at rates $\geq$ 209 g ai/ha caused significant yield reductions (Soltani *et al.* 2008; Sikkema *et al.* 2007). While there was significant crop injury (stunting) from pyroxasulfone applied PRE at Plains, there was no correlation between this injury and peanut yield for application timing at either location (Figure 3).

Summary and Conclusions

These results suggest that pyroxasulfone may have some potential to be utilized in peanut.

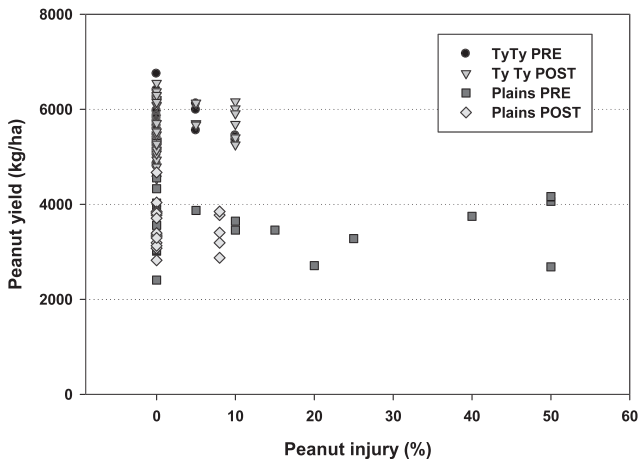

Fig. 3. Influence of pyroxasulfone injury (stunting) on peanut yield at two locations in Georgia, 2007–2008.

However, the crop injury (stunting) and TSWV increases associated with the PRE applications of pyroxasulfone are of some concern. Based upon these results and observations from earlier unpublished exploratory trials, peanut tolerance to PRE applications of pyroxasulfone needs further investigation. Additionally, future research on the potential use of pyroxasulfone in peanut should focus on co-applications with POST herbicides such as paraquat or imazapic.

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