Peanut Cultivar Response to Preemergence Applications of Pyroxasulfone

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ABSTRACT

Pyroxasulfone is a residual herbicide developed for use in several agronomic crops such as corn (*Zea mays* L.), soybean (*Glycine max* L.), wheat (*Triticum aestivum* L.), and sunflower (*Helianthus annuus* L.). Pyroxasulfone provides effective preemergence (PRE) control of annual grasses and broadleaf weeds, but little is known about peanut cultivar tolerance. Therefore, field trials were conducted in Georgia during 2012 and 2013 to evaluate peanut cultivars 'Georgia-06G', 'Georgia Greener', and 'Tifguard' response to pyroxasulfone applied PRE at 0, 120, or 240 g ai/ha. Greater stunting occurred during 2012 than 2013. Peanut stunting 10 days after planting (DAP) during 2012 and 2013 ranged from 38 to 55% and 3 to 11%, respectively. At 10 DAP, greater injury was observed in 'Tifguard' as compared to 'Georgia-06G' with pyroxasulfone at 120 g ai/ha. 'Georgia Greener' was injured more than 'Tifguard' following the 240 g ai/ha rate of pyroxasulfone. By 120 DAP, peanut had recovered substantially from stunting caused by PRE applications of pyroxasulfone with no cultivar interactions. Peanut yield was influenced by pyroxasulfone rate when applied PRE. Peanut yield was 7,140 kg/ha in treatments that did not include pyroxasulfone. Treatments that included pyroxasulfone at 120 g ai/ha yielded similar to treatments without pyroxasulfone. Peanut yield was reduced to 6,750 kg/ha (7%) following pyroxasulfone applied at 240 g ai/ha. When combined over pyroxasulfone rate, 'Georgia-06G' produced greater yields than the other cultivars.

Key Words: KIH-485, crop injury, yield, stunting, height reduction, maturity.

Numerous studies have discussed the negative impact weeds have on peanut production (Buchanan *et al.* 1982; Cardina and Brecke 1989; York and Coble 1977; Young *et al.* 1982; Wilcut *et al.* 1994). Weed control during peanut growth and development is critical to reduce inter-species competition and maintain optimum pod yields (Bridges *et al.* 1992; Burke *et al.* 2007; Cardina and Brecke 1989; Walker *et al.* 1989; York and Coble 1977). Weeds can dramatically inhibit digging and inversion procedures in peanut, leading to harvest losses and harvest inefficiency (Wilcut *et al.* 1994; Young *et al.* 1982). Additionally, weeds may serve as hosts for nematodes and diseases (Bird and Hogger 1973; Clewis *et al.* 2001; Hogger and Bird 1976; Martin 1958).

Growers use a combination of cultural and chemical control tactics to manage weeds; such as, promoting crop health through fertility and crop rotation, as well as preventing weeds from going to seed each year using herbicides or hand-weeding (Buchanan *et al.* 1982). In Georgia, Palmer amaranth (*Amaranthus palmeri* S. Wats) is considered the most troublesome weed in peanut production (Webster *et al.* 2005). Populations of Palmer amaranth exist in Georgia that are resistant to acetyl-lactate synthesis, glycine, and/or triazine herbicides (Heap 2013; Wise *et al.* 2009). Managing the weed seed bank within cropping systems has become challenging due to increased incidence of herbicide resistant Palmer amaranth. Keeley *et al.* (1987) reported that a single female Palmer amaranth can produce up to 600,000 seeds. Weed control failures due to resistance can directly influence weed control in subsequent years due to a buildup of weed seed in the soil (Dieleman *et al.* 1999; Hartzler and Roth 1993; Sparks *et al.* 2003; Webster *et al.* 1998).

Weed management in Georgia peanut production commonly requires a combination of residual and postemergence (POST) herbicides to maintain season long weed control and prevent the production of weed seed (Wilcut *et al.* 1995). Due to fewer hectares of peanut than other row crops, agrichemicals are rarely developed specifically for peanut. Thus, it is critical to evaluate herbicides developed for use in other row crops for their potential use in peanut.

Pyroxasulfone, formerly KIH-485 is a soil applied herbicide labeled for use in corn (*Zea mays* L.) and soybean (*Glycine max* L.) for the control of annual broadleaf weeds and grasses. Pyroxasulfone applied at rates between 60 and 180 g ai/ha has been documented to control: *Amaranthus* spp., *Lolium* spp., *Urochloa* spp., goosegrass (*Eleusine indica* L.), crowfootgrass (*Dactyloctenium aegyptium* L), and *Digitaria* spp. (Geier *et al.* 2006; Hulting *et al.* 2012; King and Garcia 2008; Koger *et al.* 2008; Knezevic *et al.* 2009; Nurse *et al.* 2011).

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Pyroxasulfone inhibits very long chain fatty acid synthesis similar to chloroacetamide, oxyacetamide, and tetrazolinone herbicides (Tanetani *et al.* 2009). Previous research has determined that peanut is adequately tolerant to pyroxasulfone applied 44 to 51 days after emergence (Prostko *et al.* 2011). Pyroxasulfone applied PRE to peanut has been documented to cause minimal early season stunting but no yield loss (Prostko *et al.* 2011).

Pyroxasulfone use in corn, cotton (*Gossypium hirsutum* L.), soybean, and wheat (*Triticum aestivum* L.) tolerance has been thoroughly described (Cahoon *et al.* 2012; Eure *et al.* 2013; Geier *et al.* 2006; Hulting *et al.* 2012; King and Garcia 2008; Koger *et al.* 2008). However, very little is known concerning peanut response to pyroxasulfone following PRE applications. Previous research indicates differential peanut cultivar response to herbicides (Jordan *et al.* 1998; McLean *et al.* 1994). Therefore, research was conducted to evaluate peanut cultivar response to pyroxasulfone applied PRE.

Materials and Methods

Field experiments were conducted during 2012 and 2013 at the University of Georgia Ponder Research Station near Ty Ty, GA on a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) soil with 93% sand, 3% silt, 4% clay, 1% organic matter, and pH 6.0. Trials were arranged in a split-plot design with main plots consisting of three peanut cultivars ['Georgia-06G'(Branch 2007a), 'TifGuard' (Holbrook *et al.* 2008), and 'Georgia Greener' (Branch 2007b)] and sub-plots consisting of three pyroxasulfone rates (0, 120, or 240 g ai/ha). All treatments were replicated 4 times. Peanut cultivars were planted in freshly tilled seed beds at a rate of 15 plants/m-row, in twin rows spaced 23 cm apart on a 91 cm center. Plots were 1.8 m (two sets of twin rows) wide and 9 m in length. Herbicide treatments were applied immediately following planting using a CO_2-pressurized backpack sprayer calibrated to deliver 140 L/ha at 275 kPa. Immediately following pyroxasulfone application, the trial area was irrigated with 1.3 cm of water using overhead irrigation. Plots were maintained weed-free throughout the season using commonly applied PRE herbicides (pendimethalin plus dimethenamid plus flumioxazin) in combination with cultivation between plots and hand-weeding. Production, irrigation, and pest management practices other than specific treatments were held constant over the entire experiment to optimize peanut growth and development (Anonymous 2013).

Visual estimates of peanut stunting were recorded 10, 80, and 120 d after planting (DAP) using a scale of 0 to 100% where 0 = no stunting and 100 = complete death. Peanut plant density was recorded 20 DAP from 1 meter of twin-rows. Additionally, canopy height was recorded prior to harvest at 120 DAP for 5 plants per plot. To determine treatment effects on peanut maturity, 100 pods per plot were randomly collected immediately after inversion. The hull-scrape method was used to remove the exocarp of the peanut pod. This practice is recommended to determine peanut maturity for harvest timing to ensure optimum peanut pod yield and grade (Johnson 1987; Williams and Drexler 1981). Peanut have indeterminate growth and commonly have pods with varying levels of maturity (Sholar *et al.* 1995). Peanut pod mesocarp darkens as pods mature. Pods with brown or black mesocarps are mature while pod mesocarps that are white, yellow, or orange in color are immature. The distribution of immature and mature peanut pods can serve as an indicator of delayed maturity caused by cultivar, irrigation, fertility, or herbicide injury (Johnson *et al.* 1987; Sholar *et al.* 1995; Mixon and Branch 1985; Mozingo *et al.* 1991). Once pod mesocarps were removed from each sample, pods were grouped by color: black, brown, and other (white, yellow, orange). These data were combined into two groups; immature (white, yellow, orange) and mature (brown and black).

Peanut were inverted and harvested 3 days later using commercial equipment. Peanut yields were recorded and adjusted to 10% moisture. Data for all parameters were analyzed as a split-plot design and subjected to ANOVA using the PROC MIXED procedure in SAS (SAS Institute Inc., Cary, NC 27513) with peanut cultivar and pyroxasulfone rate as fixed affects and years and replications as random effects. Means of significant main effects and interactions were separated using Fisher's Protected LSD test at $P \leq 0.05$.

Results and Discussion

Plant Density and Stunting

Peanut density was not influenced by the interaction of year, cultivar, and pyroxasulfone rate ($P=0.7783$). Peanut plant density range from 14.3 to 14.4 plants per m of row and was not influenced by the main effect of pyroxasulfone rate ($P=0.3677$) or peanut cultivar ($P=0.5590$) (data not shown). Peanut stunting 10 DAP was influenced by the interaction of year, cultivar, and pyroxasulfone rate (Table 1). Greater stunting

Table 1. Peanut stunting 10 days after planting (DAP) as influence by peanut cultivar, pyroxasulfone rate, and experiment.[a]

Cultivar	Pyroxasulfone rate	Stunting 10 DAP	
		2012	2013
	g ai/ha	%	
Georgia-06G	120	38 c	8 de
	240	50 ab	5 de
Georgia Greener	120	40 c	3 e
	240	55 a	8 de
Tifguard	120	50 ab	5 de
	240	44 bc	11 d

[a]Means followed by the same letter are not significantly different according to Fisher's Protected LSD ($p \leq 0.05$).

occurred during 2012 than in 2013. Peanut stunting 10 DAP during 2012 and 2013 ranged from 38 to 55% and 3 to 11%, respectively. During 2012, greater injury was observed in 'Tifguard' following 120 g ai/ha of pyroxasulfone applied PRE than in 'Georgia-06G'. 'Georgia Greener' had greater stunting following 240 g ai/ha of pyroxasulfone applied PRE than in 'Tifguard'. During 2013, pyroxasulfone applied at 240 g ai/ha resulted in greater stunting in 'Tifguard' than in 'Georgia-06G'. Prostko *et al.* (2011) documented transient peanut stunting at one of two locations following pyroxasulfone applied PRE. Additionally, differential peanut cultivar response to herbicides has been observed in Virginia- and runner-type peanut cultivars (Jordan *et al.* 1998; McLean *et al.* 1994).

Several factors may have played a role in the differences observed in regards to early season peanut response to pyroxasulfone applied PRE. More rainfall occurred during peanut cracking in 2012 compared to 2013 (5 cm vs. 2.5 cm). Increased peanut stunting has been observed following application of PRE herbicide applications under cool, wet conditions (Grichar *et al.* 2004). Other research has shown that significant peanut injury from soil applied herbicides may occur if peanut emergence coincides with rain events (Johnson *et al.* 2006; Jordan 2007; Prostko 2013). Soil type can influence crop tolerance to pyroxasulfone (Anonymous 2012; Cahoon *et al.* 2012; Koger *et al.* 2008; Nurse *et al.* 2011; Odero and Wright 2013). Research in other crops has shown greater crop injury from pyroxasulfone applied PRE on course-textured soils than on fine-textured or organic soils (Cahoon *et al.* 2012; Eure *et al.* 2013; Nurse *et al.* 2011; Koger *et al.* 2008; Odero and Wright 2013). Sweet corn injury has been documented to be greater than 10% following pyroxasulfone applied at 250 g ai/ha on soil with 82% sand (Nurse *et al.* 2011). Pyroxasulfone applied PRE to sweet corn on soils high in organic matter has shown no visible injury (Odero and Wright 2013). In cotton, Koger *et al.* (2008) reported only transient injury on a silt loam soil following pyroxasulfone applied PRE. Others have reported significant cotton injury and stand loss following PRE application of pyroxasulfone on sandy soils (Cahoon *et al.* 2012; Eure *et al.* 2013).

Peanut stunting 80 and 120 DAP was not influenced by the interaction of cultivar, pyroxasulfone rate, and year. However, peanut stunting at 80 DAP was influenced by the main effect of pyroxasulfone rate (Table 2). When pooled over cultivars and years, pyroxasulfone applied at 120 or 240 g ai/ha caused 8 and 14% stunting, respectively. By 120 DAP, peanut stunting ranged from 6 to 8% regardless of pyroxasulfone rate or cultivar (Table 2). Plant height was not influenced by the interaction of cultivar, pyroxasulfone rate, and year. The main effect of pyroxasulfone rate and cultivar did influence plant height 120 DAP. At this time, plant height was reduced from 35 cm in the non-treated control to 33 cm when pyroxasulfone was applied PRE (Table 2). When pooled over years and pyroxasulfone rates, 'Georgia-06G' and 'Tifguard' were 5 and 4 cm taller than 'Georgia Greener', respectively (Table 3).

Maturity and Yield

Peanut maturity and yield were not influenced by the interaction of cultivar, pyroxasulfone rate, and yield. Additionally, peanut maturity was not influenced by cultivar or pyroxasulfone rate (Tables 2 and 3). Peanut yield was influenced by the main effect of pyroxasulfone rate and cultivar. Yield was reduced following pyroxasulfone applied PRE at the 240 g ai/ha but not at the 120 g ai/ha rate (Table 2). When pooled over cultivars and trials, peanut yield was 7,140 kg/ha in treatments that did not include pyroxasulfone. Treatments that included pyroxasulfone applied at 120 g ai/ha yielded similar to treatments without pyroxasulfone. Pyroxasulfone applied at 240 g ai/ha reduced yield to 6,640 kg/ha (7%) as compared to the non-treated control. Previously, Prostko *et al.* (2011) did not

Table 2. Influence of pyroxasulfone rate applied preemergence to peanut on stunting 80 and 120 days after planting (DAP), plant height 120 DAP, and yield.[a,b]

	Stunting		Plant height	Pod maturity		
Pyroxasulfone rate	80 DAP	120 DAP[c]	120 DAP	Immature[d]	Mature[e]	Yield
g ai/ha	%		cm	%		kg/ha
0	-	-	35 a	62	38	7140 a
120	8 b	6	33 b	59	41	6750 ab
240	14 a	8	33 b	58	42	6640 b

[a]Data combined over 3 peanut cultivars and 2 locations.
[b]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($p \leq 0.05$).
[c]P = 0.3452
[d]P = 0.2370.

Table 3. Influence of cultivar on plant height 120 days after planting (DAP), pod maturity, and yield.[a,b]

		Pod maturity		
Cultivar	Plant height	Immature[c]	Mature[d]	Yield
	cm	%		kg/ha
Georgia-06G	35 a	61	39	7260 a
Georgia Greener	30 b	59	41	6635 b
Tifguard	34 a	59	41	6630 b

[a]Data combined over 3 pyroxasulfone rates and 2 locations.
[b]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($p \leq 0.05$).
[c]P = 0.5835.
[d]P = 0.5579.

observe yield loss following PRE application of pyroxasulfone in peanut. Peanut cultivar did influence peanut yield. 'Georgia-06G' yield was 630 to 635 kg/ha greater than 'Georgia Greener' and 'Tifguard' (Table 3). 'Georgia-06G' has historically produced greater pod yield than 'Georgia Greener' and 'Tifguard' (Branch 2012). Due to high yield potential, 'Georgia-06G' was planted on 77% of acreage in Georgia during 2012 (Beasley 2013).

In one of two trials, differential peanut cultivar tolerance was observed for stunting 10 DAP. 'Tifguard' was less tolerant to a 1x rate of pyroxasulfone than 'Georgia Greener' and 'Georgia-06G'. Although peanut yield was not reduced following a 1x rate of pyroxasulfone applied PRE, the potential for early season stunting and less than a 2x safety margin on yield is concerning. Additionally, these trials were conducted under optimum conditions for plants to recover from early season herbicide injury. Results may have been different if late season conditions were not conducive for peanut recovery. Future research should be conducted to understand the influence of soil type and rainfall or irrigation timing on peanut injury from PRE applied pyroxasulfone.

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