

Comparing the Risks and Benefits of Early Applications of Chlorimuron for Weed Control in Peanut

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ABSTRACT

Chlorimuron is applied from 60 days after peanut (*Arachis hypogaea* L.) emergence (DAE) until 45 days prior to harvest to control Florida beggarweed [*Desmodium tortuosum* (Sw.) DC]. Research trials were conducted in Georgia from 2006 to 2008 to determine whether the benefits of controlling smaller weeds earlier in the season compensate for the potential risk of significant peanut injury from chlorimuron. Chlorimuron at 9 g ai/ha was applied at 21, 35, 49, 63, 77, and 91 DAE. Additionally, flumioxazin (105 g ai/ha) preemergence was included as a treated control, along with a nontreated control. Main plots were split into subplots; weed-free and weeds present. Flumioxazin controlled Florida beggarweed 82%. Chlorimuron controlled Florida beggarweed 38 to 67%, with applications 21 and 35 DAE more efficacious than later applications. With weeds present, peanut treated with chlorimuron at any application timing yielded less than peanut treated with flumioxazin. Weed-free peanut treated with chlorimuron at any application timing yielded less than peanut treated with flumioxazin. These data indicate that chlorimuron applied earlier than 60 DAE provided better Florida beggarweed control with greater peanut yield than when applied at the recommended time intervals. However, Florida beggarweed control and peanut yield from any of the chlorimuron treatments were consistently less than flumioxazin.

Key Words: Chlorimuron, *Desmodium tortuosum*, Florida beggarweed, groundnut, peanut.

Weed control in peanut (*Arachis hypogaea* L.) production relies heavily on herbicides and multiple applications are routine. Intensive herbicide use is due in part to the diversity of troublesome weeds in peanut producing regions of the U. S., slow early season peanut vegetative growth (Cardina and Brecke, 1991), and subterranean fruiting that

increases harvest losses from weeds beyond yield reduction from weed competition (Hauser *et al.*, 1973).

Tall dicot weeds present unique challenges to peanut production. One of the dicot weeds that is a perpetual challenge in the southeastern U. S. is Florida beggarweed [*Desmodium tortuosum* (Sw.) DC]. Florida beggarweed is documented to be among the most common and troublesome weeds in each of the southeastern peanut producing states (Webster, 2005). Florida beggarweed seedlings are often shaded by peanut leaflets and inconspicuous early in the growing season (Hauser *et al.*, 1973). As the season progresses, Florida beggarweed emerges thorough the peanut canopy and some ecotypes eventually reach a height of 3.5 m (Cardina and Brecke, 1989; 1991; Webster and Cardina, 2004). Tall weeds such as Florida beggarweed, sicklepod [*Senna obtusifolia* (L.) H.S. Irwin & Barneby], bristly starbur (*Acanthospermum hispidum* DC.), and *Amaranthus* spp. which escape earlier control tactics intercept fungicides which can lead to foliar disease epidemics (Royal *et al.*, 1997). The woody stems of tall weeds also make peanut digging and vine inversion difficult (Hauser *et al.*, 1973) and are often mowed before harvest to aid in the digging operation. Considering these possible forms of loss, including losses from competition alone, Florida beggarweed at a density of 6 plants/m² reduces peanut yield by 25% (Hauser *et al.*, 1975).

Florida beggarweed can be managed season-long in peanut with individual herbicides and combinations that include metolachlor, paraquat, imazapic, flumioxazin, diclosulam, and chlorimuron (Grey *et al.*, 2003). Chlorimuron is the sole option to control escaped Florida beggarweed during the mid-season, with applications from 60 DAE until 45 days prior to harvest (Anonymous, 2009a). Chlorimuron applications are restricted to this time interval since early-season applications are frequently injurious to peanut (Sims *et al.*, 1987). During the registered mid-season application interval, less chlorimuron is absorbed and translocated by peanut, and more is metabolized to a non-phytotoxic form compared to earlier applications (Wilcut *et al.*, 1989). Even when applied at the appropriate time and rate, chlorimuron temporarily stunts peanut, although the phytotoxic effect has repeatedly been shown to not affect

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peanut yield (Colvin and Brecke, 1988; Johnson *et al.*, 1992; Prostko *et al.*, 2008; Wehtje and Grey, 2004; Wilcut *et al.*, 1989).

The complex subtleness of peanut response to chlorimuron is also shown by increased incidence of spotted wilt caused by the tomato spotted wilt *Tospovirus* (TSWV) in chlorimuron treated peanut (Prostko *et al.*, 2008). This phenomenon is reflected in current recommendations for managing spotted wilt that consider the use of chlorimuron as a minor risk factor that can increase incidence of spotted wilt (Brown *et al.*, 2005). Peanut response to chlorimuron is not ignored by growers, who tend to be reluctant to use the herbicide unless escaped Florida beggarweed are numerous.

Florida beggarweed must be controlled the first 4 to 6 weeks (28 to 42 DAE) of the growing season to protect the crop from any yield reduction caused by weed interference (Hauser *et al.*, 1975). It is interesting to note that the chlorimuron application interval (Anonymous, 2009a) is later than the critical period of weed control, meaning that a non-recoverable yield reduction is expected, even if chlorimuron controls the weed. Furthermore, chlorimuron will not consistently control Florida beggarweed taller than 25 cm (Anonymous, 2009a). Cardina and Brecke (1991) monitored Florida beggarweed growth in peanut and determined that it took approximately 45 d for Florida beggarweed height to reach 25 cm. Similarly, by 60 DAE (the earliest permissible time to apply chlorimuron), Florida beggarweed height was greater than 60 cm (Cardina and Brecke, 1991), a size beyond which chlorimuron cannot provide consistent control. In practice, peanut growers frequently apply chlorimuron to Florida beggarweed that are too large for consistent control.

Based on these circumstances, it would be useful for peanut growers to have the option of applying chlorimuron earlier than 60 DAE and presumably to younger and smaller Florida beggarweed. Wehtje and Grey (2004) evaluated the sensitivity of several peanut cultivars to early applications of chlorimuron in weed-free trials. Across all cultivars, they reported no yield response in three of four trials from early applications of chlorimuron, with the earliest application made five weeks after planting (approximately 28 DAE). While these results show that peanut may have acceptable tolerance to chlorimuron applied earlier than what is registered, the earliest labeled application timing remains 60 DAE. Therefore, research trials were initiated to determine whether the benefits of controlling smaller weeds earlier in the season compensate for the potential risk of significant peanut injury from chlorimuron.

Materials and Methods

Irrigated field trials were conducted from 2006 to 2008 near Attapulgus, GA. Soil at the Attapulgus Research Farm was a Lucy loamy sand (loamy, kaolinitic, thermic Arenic Kandiudults); 88% sand, 8% silt, 4% clay, and 0.4% organic matter. Soils at this location are representative of the southeastern U. S. peanut production region.

The experimental design was a split-plot with four replications. Main plots were chlorimuron (9 g ai/ha) applied at 21, 35, 49, 63, 77, and 91 DAE, a treated control of flumioxazin (105 g ai/ha) applied PRE (immediately after seeding peanut), and a nontreated control. A non-ionic surfactant⁴ (0.25% by vol.) was included with all chlorimuron treatments. Main plots were four rows (91 cm spacing) wide by 6.1 m long. Sub-plots were weeds present and weed-free with handweeding. Herbicides were applied with a tractor-mounted CO₂-pressurized plot sprayer or backpack sprayer, calibrated to deliver 234 L/ha at 207 kPa using low-drift Turbo TeeJet[®] spray tips. Sub-plots were two rows wide and 6.1 m long.

Experimental sites were harrowed in March to terminate small grain cover crops, moldboard plowed in mid-April, seedbeds formed and shaped in late-April, and planted to peanut in early May each year. The entire experimental area was treated with pendimethalin applied preplant plant incorporated at 1.1 kg ai/ha to control annual grasses. 'C99R' (Gorbet and Shokes, 2002) peanut were planted in 2006 and 2007, with 'Georgia Green' (Branch, 1996) planted in 2008. Compared to other cultivars, both of these are considered relatively tolerant of chlorimuron (Wehtje and Grey, 2004). Maintenance weed control common to all plots the remainder of the season included one cultivation, clethodim at 0.18 kg ai/ha, and one application of bentazon at 1.1 kg ai/ha plus 2,4-DB at 0.3 kg ai/ha. A crop oil concentrate adjuvant⁵ (1.0% by vol.) was included with both postemergence maintenance herbicide applications. Excluding weed control, cultural practices and pest management decisions for peanut were based on recommendations from the Georgia Cooperative Extension Service (Beasley *et al.*, 1997).

Visual estimates of percent weed control were made one week prior to harvest using a scale of 0 to 100 where 0 = no control and 100 = complete control. Weeds present at mid-season during the study were Florida beggarweed, tropic croton

⁴Chem Nut 80-20[®] non-ionic surfactant-adjuvant, Chem Nut Inc., P. O. Box 3706, Albany, GA 31707.

⁵Chem Nut Agri-Oil[®] crop oil concentrate adjuvant, Chem Nut Inc., P. O. Box 3706, Albany, GA 31707.

Table 1. Effect of chlorimuron times of application on dicot weed control in peanut at Attapulcus, GA from 2006 to 2008.

Herbicide treatment ^a	Florida beggarweed	Tropic croton	Sicklepod	Bristly starbur
	Visual control (%) ^b			
Flumioxazin ^c	82 a	86 a	66 a	78 a
Chlorimuron ^d 21 DAE	67 b	45 bc	70 a	50 b
Chlorimuron 35 DAE	66 b	62 b	61 ab	20 cd
Chlorimuron 49 DAE	51 c	48 bc	52 ab	39 bc
Chlorimuron 63 DAE	50 c	49 bc	43 bc	30 bcd
Chlorimuron 77 DAE	44 c	40 c	49 bc	25 cd
Chlorimuron 91 DAE	38 c	38 c	34 c	20 cd
Nontreated	0 d	0 d	0 d	0 e

^aAbbreviations: DAE, days after peanut emergence; PRE, preemergence.

^bMeans in a column followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$.

^cFlumioxazin applied at 105 g/ha immediately after seeding peanut. Flumioxazin was included as a weed control standard for comparison.

^dChlorimuron applied at 9 g/ha plus non-ionic surfactant at 0.25% by vol.

(*Croton glandulosus* var. *septentrionalis* Muell.-Arg.), sicklepod, and bristly starbur originating from natural infestations. Florida beggarweed were present at densities ≤ 5 plants/m², tropic croton at ≤ 5 plants/m², sicklepod at ≤ 2 plants/m², and bristly starbur at ≤ 2 plants/m².

Immediately prior to harvest, plots were mowed to remove the upper portion of tall weeds to facilitate more efficient digging and vine inversion. Peanut were dug at optimum maturity, inverted, and later combined with commercial-scale equipment, modified for small plot use. Pod samples were cleaned to remove foreign material contaminants, including weeds. A 500g sub-sample was collected for each plot to determine the percentage of total sound mature kernels (TSMK).

Data for percent weed control and peanut yield were subjected to analysis of variance with partitioning appropriate for the split-plot experimental design. Means for significant main effects and interactions were separated using Fisher's Protected LSD at $P \leq 0.05$. Arcsine transformations of weed control ratings did not change the results of the analysis of variance; therefore, non-transformed data were used for analysis and presentation.

Results and Discussion

Analysis of variance indicated nonsignificant year by treatment interaction for weed control, peanut yield, and grade. Therefore, data were combined over years for presentation. There was a significant interaction between herbicide treatments and weediness for peanut yield and grade, and these data are presented as interactive means.

Flumioxazin controlled Florida beggarweed more effectively than chlorimuron regardless of

application (Table 1). Among chlorimuron treatments, herbicide applications at either 21 or 35 DAE controlled Florida beggarweed 66 to 67% and were more effective than later applications of chlorimuron (38 to 51% control). Florida beggarweed height ranged from 90 to 120 cm at the earliest labeled application timing (60 DAE), which is considerably larger than the 25 cm maximum height allowance on the chlorimuron label (Anonymous, 2009a). Florida beggarweed were greater than 2 m tall when chlorimuron was applied 91 DAE and the applicators had to hold the spray boom at full extension above their head to achieve adequate spray coverage of the weed.

Flumioxazin was the only treatment that effectively controlled tropic croton in peanut (Table 1). Overall, chlorimuron did not effectively control tropic croton in these trials. Of the application timings evaluated, chlorimuron applied at 35 DAE was the most effective in controlling tropic croton (62%), which was less than control with flumioxazin (86%). Chlorimuron is not registered for tropic croton control (Anonymous, 2009a).

None of the treatments effectively controlled sicklepod (Table 1). Of the treatments evaluated, flumioxazin and chlorimuron applied from 21 through 49 DAE were the most effective (52 to 70% control). Lack of effective sicklepod control with flumioxazin is not surprising since the herbicide is not registered for sicklepod control in peanut (Anonymous, 2009b). Chlorimuron is used for sicklepod control in soybean [*Glycine max* (L.) Merr.] (Anonymous, 2009a). However, applications are made early-season to seedling sicklepod and often at rates greater than those applied to peanut.

Flumioxazin controlled bristly starbur better (78%) than chlorimuron, regardless of application

Table 2. Interactive effects of chlorimuron and weediness on peanut yield and grade at Attapulcus, GA; 2006 to 2008.

Herbicide treatment ^a	Peanut yield (kg/ha) ^b		Total sound mature kernels (%) ^b	
	Weeds present	Weed-free	Weeds present	Weed-free
Flumioxazin ^c	3970 a	4570 a	73 ab	72 c
Chlorimuron ^d 21 DAE	2770 b	4070 b	72 ab	73 ab
Chlorimuron 35 DAE	2610 bc	4000 bc	72 ab	73 ab
Chlorimuron 49 DAE	2390 bcd	4010 bc	72 ab	73 ab
Chlorimuron 63 DAE	2220 bcd	3560 cd	72 b	73 abc
Chlorimuron 77 DAE	2020 d	4280 ab	73 ab	73 abc
Chlorimuron 91 DAE	2140 cd	4090 ab	74 a	72 bc
Nontreated	2160 cd	3910 bc	72 ab	74 a

^aAbbreviations: DAE, days after peanut emergence; PRE, preemergence.

^bMeans in a column followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$.

^cFlumioxazin applied at 105 g ai/ha immediately after seeding peanut. Flumioxazin was included as a weed control standard for comparison.

^dChlorimuron applied at 9 g ai/ha plus non-ionic surfactant at 0.25% by vol.

timing (Table 1). Bristly starbur control by chlorimuron varied from 20 to 50%, with control generally less with later chlorimuron applications. While flumioxazin is not registered for bristly starbur control, suppression is often obtained (Anonymous, 2009b) and this is generally consistent with our results. Chlorimuron is also registered to suppress bristly starbur in peanut (Anonymous, 2009a). However, in our trials bristly starbur control by chlorimuron was poor, with control ranging from 20 to 30% at the registered application timings.

Greatest peanut yield occurred with flumioxazin in both weedy and weed-free plots (Table 2). In weedy plots, peanut treated with chlorimuron at 21 DAE yielded more than the nontreated control, while peanut treated with chlorimuron from 35 to 91 DAE yielded the same as the nontreated weedy control. Based on peanut yield response in the presence of weeds, chlorimuron applied at 21 DAE controlled dicot weeds and protected peanut yields better than later applications. However, none of the chlorimuron treatments protected peanut yield as effectively as flumioxazin.

In weed-free plots, there were no differences in peanut yield among peanut treated with chlorimuron at any application timing, excluding 63 DAE, which we consider an anomaly in the data. In absence of weeds, peanut treated with chlorimuron earlier than permitted generally yielded the same as those treated with chlorimuron at the allowed time interval. This indicates that peanut has acceptable tolerance to chlorimuron applied earlier than permissible.

Chlorimuron did not affect TSMK, regardless of the presence of weeds (Table 2). Factors that severely stunt peanut can delay maturity and reduce grade if harvested too soon. This possible

effect on peanut grade was not observed and is further evidence that early applications of chlorimuron are not injurious enough to significantly affect peanut growth. Weed-free peanut treated with flumioxazin and chlorimuron at 91 DAE had lower grade than nontreated peanut. There was neither significant visual injury (data not shown) nor yield reduction from these treatments, thus no obvious explanation why grades were reduced from these treatments.

These results indicate there is little reason for peanut growers to apply chlorimuron for weed control in peanut, regardless of the time of application, but especially as the label presently permits. This is in agreement with Wehtje *et al.* (2000) who showed reduced net returns from peanut production when chlorimuron was applied late-season and integrated into an overall weed management system. They attributed these results to weed control too late in the season to protect yields and subtle peanut injury from which there was incomplete recovery. Chlorimuron is registered for control of one weed species in peanut, Florida beggarweed, which further limits the utility of this herbicide. Grey and Bridges (2005) applied chlorimuron 49 or 63 DAE and neither application consistently controlled Florida beggarweed or increased peanut yield over the weed-free control. In our trials, chlorimuron applied 21 DAE was more efficacious than chlorimuron applied at later applications, but Florida beggarweed control was still less than flumioxazin. Furthermore, flumioxazin controlled Florida beggarweed, tropic croton, and bristly starbur more effectively than chlorimuron at any application timing.

Our trials were structured such that there was minimal dicot weed control other than from the experimental treatments. In practice, chlorimuron

is used to control Florida beggarweed that escaped control from earlier treatments. Perhaps early season herbicides would control, stunt, or weaken Florida beggarweed and give the impression of better performance of chlorimuron compared to chlorimuron used as the sole means of Florida beggarweed control. However, this scenario was not created in our trials and is purely speculative.

It is clear in our trials that the risk of early applications of chlorimuron are minor compared to the potential benefits of controlling younger and smaller Florida beggarweed. Chlorimuron applied to weed-free peanut did not injure peanut enough to reduce yield compared to the nontreated control, regardless of the time of application. However, other weed control options such as flumioxazin are more efficacious and beneficial than chlorimuron at any time of application and improve peanut yield.

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