# Evaluation of Chlorimuron as a Growth Regulator for Peanut

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**ABSTRACT**

Chlorimuron was evaluated as a growth regulator on peanut. Treatments included chlorimuron at a total of 8.8 g ai/ha applied once at 60, 75, or 90 d after emergence (DAE) or in equal portions applied twice at 60 and 75, 60 and 90, or 75 and 90 DAE or three times at 60, 75, and 90 DAE. Daminozide at 950 g ai/ha applied 75 DAE was included as a comparison. In a year with excessive vine growth, daminozide and all chlorimuron treatments except 8.8 g/ha applied 90 DAE reduced cotyledonary lateral branch and main stem length at harvest 9 to 20 and 12 to 24%, respectively, due to suppression of internode length. Sequential applications of chlorimuron generally suppressed growth more than single applications. No improvement in row visibility at harvest was noted. In a dry year with limited vegetative growth, neither chlorimuron nor daminozide affected cotyledonary lateral branch or main stem length at harvest. Chlorimuron at 2.9 g/ha applied 60, 75, and 90 DAE reduced yield 18% at one of four locations; no other treatment affected yield. Chlorimuron at 8.8 g/ha applied 60 DAE or 4.4 g/ha applied 60 and 75 DAE reduced the percentage of fancy pods and extra large kernels at one or more locations. No treatment affected the percentage of total sound mature kernels. Results suggest chlorimuron has little to no potential for use as a growth regulator.

Key Words: *Arachis hypogaea* L., yield, market quality, row visibility, timing of application, daminozide.

Peanut (*Arachis hypogaea* L.) often produces more vegetative growth than is needed for maximum pod yield, especially when climatic conditions favor vegetative growth. Nutrients and photosynthate are directed toward vegetative growth and maintenance as opposed to reproductive development (5, 13). Additionally, excessive vine growth under high moisture conditions has been linked to increased disease incidence as well as harvesting inefficiency (2, 11, 13). Dense canopies inhibit foliar-applied fungicide contact with lower leaves (13). Suppressing vine growth can improve pesticide spray coverage and placement, resulting in improved disease and insect control (13, 17, 28). Suppressed vine growth also leads to less vine damage from tires of equipment used to apply mid- and late-season pesticides (28).

In peanut grown under irrigation or in years with above-normal rainfall, the top of the crop canopy often is nearly level across the rows and the row middles. Rows are not easily visible, making it difficult to align the mechanical digger over the rows. Failure to properly align the digger over the rows results in excessive pod loss during the digging operation (3). Synthetic growth regulators which increase row visibility at harvest by modifying canopy architecture would reduce the problem.

Use of synthetic plant growth regulators became part of an intensive management strategy for peanut production in the 1970s (10). Through 1989, producers used daminozide [butanedioic acid mono (2,2-dimethylhydrazide)] to suppress excessive peanut vine growth. Daminozide altered peanut canopy architecture and improved row visibility by shortening the internodes (5, 11, 13). Daminozide is no longer registered for use on peanut due to consumer concerns over residues in peanut and peanut products (16, 22). Producers need an alternative to daminozide to suppress excessive vine growth and to enhance row visibility to aid in digging.

Chlorimuron {2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino] sulfonyl] benzoic acid}, an apoplastically and symplastically mobile sulfonylurea herbicide, inhibits cell division in the $G_1$ and $G_2$ phases of mitosis (1, 21, 27). A reduction in internode length has been observed in cotton (*Gossypium hirsutum* L.) (20) and soybean [*Glycine max* (L.) Merr.] (19) treated with chlorimuron. Growth suppression and improved row visibility also has been noted in peanut treated with chlorimuron (26).

Chlorimuron is registered for late-season weed control in peanut. It is applied from 60 d after emergence (DAE) until 45 d prior to harvest according to the Classic herbicide product label (E. I. duPont de Nemours and Co., Agric. Products, Wilmington, DE 19898). Peanut is less tolerant of chlorimuron than soybean (21). However, tolerance is increased if application is delayed until at least 60 DAE because of decreased absorption and increased chlorimuron metabolism by peanut (27). Chlorimuron applied 3 or 7 wk after planting reduced peanut fresh weight 13 and 19%, respectively (27). Fresh weight of peanut treated with chlorimuron 10 wk after planting was not reduced (27). Yield response to chlorimuron has been variable. Sims *et al.* (24) reported that chlorimuron applied 5, 10, or 14 wk after planting reduced peanut yield. Brown *et al.* (6) observed that chlorimuron at 9 g/ha applied once at 60, 75, or 90 DAE did not decrease peanut yield.

The objective of our research was to determine the potential for using chlorimuron as a growth regulator on peanut. Specifically, we evaluated the effect of single and multiple applications of chlorimuron on peanut vine growth, row visibility, yield, and grade.

## Materials and Methods

The experiment was conducted at the Peanut Belt Research Station at Lewiston, NC and the Upper Coastal Plain

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Research Station at Rocky Mount, NC in 1992 and 1993. Soils at Lewiston were a Norfolk loamy sand (fine-loamy, siliceous, thermic, Typic Kandiudults) with pH 6.3 and 2.9% organic matter in 1992 and a Norfolk sandy loam with pH 5.4 and 2.2% organic matter in 1993. The soil at Rocky Mount was a Norfolk sandy loam with pH 5.3 and 0.7% organic matter in 1992 and pH 6.2 and 1.8% organic matter in 1993.

Peanut cv. NC 9 was planted conventionally in 94-cm rows on 4 May 1992 and 6 May 1993 at Lewiston and 13 May 1992 and 1993 at Rocky Mount. NC 9 was selected because it tends to produce more vegetative growth than other commonly grown virginia-type cultivars (G. A. Sullivan, pers. commun., 1992). The experimental design was a randomized complete block with treatments replicated six times. Plots were four rows by 15 m. Additional plots were included for equipment passage so that treated plots received no wheel traffic after planting. Fertility and pest management practices were standard for the area. Plots at Rocky Mount in 1992 and 1993 and at Lewiston in 1992 were irrigated to promote vegetative growth. Irrigation was unavailable at Lewiston in 1993.

Treatments consisted of the following: chlorimuron at 8.8 g/ha applied once at 60, 75, or 90 DAE; chlorimuron at 4.4 g/ha applied twice at 60 and 75, 60 and 90, or 75 and 90 DAE; and chlorimuron at 2.9 g/ha applied three times at 60, 75, and 90 DAE. Daminozide at 950 g/ha applied 75 DAE was included as a comparison. All treatments were applied with a $CO_2$-pressurized backpack sprayer delivering 198 L/ha at 276 kPa. A nonionic surfactant X-77 (Valent U.S.A. Corp., 1333 N. California Blvd., Walnut Creek, CA 94596-8025) was included with all chlorimuron applications.

Peanut main stem and cotyledonary lateral branch length as well as number of nodes on the main stem and cotyledonary lateral branches at harvest were recorded from eight randomly selected plants per plot. Canopy shape at harvest was estimated visually as an indication of row visibility using a scale of 1 (flat canopy with vines completely overlapping in the row middles) to 10 (triangular-shaped canopy with no vines from adjacent rows touching in the row middles). A quantitative determination of row visibility also was made at harvest by calculating the difference in between canopy height in the rows and the row middles at three sites per plot.

The crop was mechanically dug and inverted in mid-Ocotober and allowed to dry in the field for 5 to 7 d. Pods were harvested mechanically from the center two rows of each plot, dried for 4 to 5 d with conventional drying equipment (30), and weighed. Yields were adjusted to 7% moisture. A subsample of pods from each plot was shelled and graded according to industry standards to determine the percentage of fancy pods, extra large kernels, and total sound mature kernels (9). Peanut value per kg was calculated based upon the USDA Agricultural Stabilization and Conservation Service loan schedule for the respective crop year.

Data were subjected to analysis of variance using the PROC GLM routine of SAS (23). F tests were based upon partial sums of squares, and treatment means were separated using the least squares means test at P = 0.05 (25). Treatment-by-year interactions were significant. After checking for homogeneity of error variance, data for all parameters were pooled over locations within years except yield in 1992 and percentage of fancy pods in 1993.

## Results and Discussion

Moisture conditions in 1992 were more favorable for peanut vegetative growth than in 1993. Rainfall and irrigation combined from June through September 1992 exceeded normal precipitation by 42 and 33% at Lewiston and Rocky Mount, respectively (Table 1). The above-normal precipitation in 1992 occurred primarily during June and August. The 1993 season was dry. Rainfall plus irrigation at Lewiston in 1993 was 18% below normal during June through September, with below-normal precipitation occurring during each of the 4 mo. At Rocky Mount in 1993, precipitation levels were 7% above normal for June through September. Precipitation was below normal in June and August but 115% above normal in September due to extensive irrigation. Average temperatures during June through September were 3 C below normal and 3 C above normal in 1992 and 1993, respectively (data not shown).

***Growth Suppression.*** All treatments except chlorimuron at 8.8 g/ha applied 90 DAE reduced the length of both cotyledonary lateral branches and main stems at harvest in 1992 (Table 2). Chlorimuron was equally effective at reducing cotyledonary lateral branch length when applied once at 60 or 75 DAE and when applied twice. Reductions in cotyledonary lateral branch length by 8.8 g/ha of chlorimuron applied 60 or 75 DAE or by 4.4 g/ha of chlorimuron applied twice were similar to the reduction by daminozide and ranged from 9 to 16%. Chlorimuron applied three times at 2.9 g/ha was more effective than daminozide and suppressed cotyledonary lateral branch length 20%.

Daminozide applied 75 DAE suppressed main stem length 14% in 1992 (Table 2). Suppression by chlorimuron applied once at 60 or 75 DAE or twice at 60 and 75, 60 and 90, or 75 and 90 DAE was similar to that with daminozide. Suppression tended to be greater when chlorimuron was applied two or three times (18 to 24%) compared with a single application at 60 or 75 DAE (12 to 14%). Greater suppression of main stem length was noted with 2.9 g/ha of chlorimuron applied 60, 75, and 90 DAE than with daminozide. No treatment affected the number of nodes on either cotyledonary lateral branches or main stems (data not shown). Thus, shorter main stems and cotyledonary lateral branches were due to reduced internode length.

Peanut grew less vegetatively in 1993. Pooled over locations within years, cotyledonary lateral branch length

**Table 1. Precipitation at Lewiston and Rocky Mount during the summers of 1992 and 1993[a].**

| | Lewiston | | Rocky Mount | |
|---|---|---|---|---|
| Month | 1992 | 1993 | 1992 | 1993 |
| | cm | | | |
| June | 18.7 (+8.2) | 9.2 (-1.3) | 15.9 (+6.2) | 5.7 (-4.0) |
| July | 12.0 (-3.4) | 10.1 (-5.3) | 7.2 (-5.8) | 13.0 (+0) |
| Aug. | 33.9 (+19.9) | 11.7 (-2.3) | 29.7 (+16.9) | 7.9 (-4.9) |
| Sept. | 7.4 (-3.4) | 10.4 (-0.4) | 8.2 (-2.3) | 22.6 (+12.1) |

[a]Values listed include irrigation. Numbers in parentheses are the departure from the 30-yr average precipitation.

**Table 2. Effect of daminozide and chlorimuron on peanut cotyledonary lateral branch (CLB) and main stem (MS) length.[a]**

| Growth regulator | Time of application | Rate per application | 1992[b] CLB | 1992[b] MS | 1993 CLB | 1993 MS |
|---|---|---|---|---|---|---|
| | DAE[c] | g/ha | cm | | | |
| Daminozide | 75 | 950.0 | 65 c (12) | 43 cd (14) | 62 a | 39 a |
| Chlorimuron | 60 | 8.8 | 67 bc (9) | 44 bc (12) | 60 a | 38 a |
| Chlorimuron | 75 | 8.8 | 63 cd (15) | 43 cd (14) | 62 a | 39 a |
| Chlorimuron | 90 | 8.8 | 71 ab (4) | 48 ab (4) | 62 a | 38 a |
| Chlorimuron | 60, 75 | 4.4 | 63 cd (15) | 39 de (22) | 60 a | 38 a |
| Chlorimuron | 60, 90 | 4.4 | 62 cd (16) | 41 cde (18) | 60 a | 37 a |
| Chlorimuron | 75, 90 | 4.4 | 62 cd (16) | 40 cde (20) | 62 a | 39 a |
| Chlorimuron | 60, 75, 90 | 2.9 | 59 d (20) | 38 e (24) | 60 a | 37 a |
| Nontreated | | | 74 a | 50 a | 63 a | 39 a |

[a]Data recorded at harvest. Means within a column followed by the same letter are not different at $P \leq 0.05$ according to the least squares method of means separation. Data pooled over locations within years.
[b]Numbers in parentheses are percentage reduction compared with the nontreated check.
[c]DAE = days after emergence.

at harvest in nontreated checks was 74 and 63 cm in 1992 and 1993, respectively; main stem length was 50 and 39 cm in 1992 and 1993, respectively (Table 2). In contrast to results obtained in 1992, none of the treatments suppressed cotyledonary lateral branch or main stem length at harvest in 1993. Differential results between years may have been due to less precipitation (Table 1) and less vegetative growth in 1993. Gorbet and Rhoads (11) also noted greater suppression of main stem and cotyledonary lateral branch length by daminozide when environmental conditions favored greater vine growth. No treatment affected the number of nodes on either cotylodonary lateral branches or main stems in 1993 (data not shown).

***Row Visibility***. With lush vegetative growth in 1992, rows and row middles in the nontreated check were nearly indistinguishable at harvest. No treatment improved peanut row visibility at harvest (data not shown). The canopy at harvest was only 3 to 6 cm taller in the row than in the row middles regardless of treatment (data not shown). Although both chlorimuron and daminozide suppressed growth in 1992, lack of an effect on row visibility would be anticipated because lateral and vertical growth were suppressed similarly (Table 2).

Peanut row visibility in the nontreated check was greater in 1993 than 1992 primarily because of less vegetative growth. Differences in canopy height between the row and the row middles ranged from 8 to 11 cm (data not shown). In contrast to 1992, all treatments improved row visibility in 1993. Ratings ranged from 3.3 to 4.4 in treated plots compared with 1.6 for the nontreated check (data not shown). Row visibility with all chlorimuron treatments was similar to that with daminozide. Although treatments did not affect length of main stems or cotyledonary lateral branches in 1993 (Table 2), they did appear to suppress lateral growth in the upper portion of the canopy, leading to a more pyramid-shaped canopy that enhanced row visibility. The reduced lateral growth in the upper portion of the canopy in 1993 compared with 1992 may have been due to more moisture stress in 1993.

***Yield***. Excellent peanut yields were obtained in both years (Table 3). No treatment affected peanut yield at Lewiston in 1992 or at either location in 1993. At Rocky Mount in 1992, chlorimuron at 2.9 g/ha applied at 60, 75, and 90 DAE reduced yield 18%.

Peanut yield response to chlorimuron has been variable. No yield impact (8, 12, 15, 26) as well as decreased yields (23, 26) have previously been noted. The effect of daminozide on peanut yield has been variable as well. Yield increases of 5 to 19% have been noted in some studies (5, 10, 11) while no response was noted in other studies (7, 28). Yield decreases have occasionally been noted (29).

***Market Quality***. No treatment affected the percentage of sound mature kernels (data not shown). Pooled over locations, the percentage of sound mature kernels averaged 70 and 66% in 1992 and 1993, respectively. Any chlorimuron treatment initiated at 75 or 90 DAE did not

**Table 3. Yield of peanut as affected by daminozide and chlorimuron.[a]**

| Growth regulator | Time of applic. | Rate per applic. | 1992 Lewiston | 1992 Rocky Mount | 1993[b] |
|---|---|---|---|---|---|
| | DAE[c] | g/ha | kg/ha | | |
| Daminozide | 75 | 950 | 4060 a | 5030 b | 5020 a |
| Chlorimuron | 60 | 8.8 | 3970 a | 5000 b | 4750 a |
| Chlorimuron | 75 | 8.8 | 4170 a | 5600 a | 4950 a |
| Chlorimuron | 90 | 8.8 | 4320 a | 5220 ab | 4850 a |
| Chlorimuron | 60,75 | 4.4 | 4140 a | 5340 ab | 4980 a |
| Chlorimuron | 60,90 | 4.4 | 4610 a | 5030 b | 4800 a |
| Chlorimuron | 75,90 | 4.4 | 4010 a | 4970 b | 5300 a |
| Chlorimuron | 60,75,90 | 2.9 | 4610 a | 4450 c | 4920 a |
| Nontreated | | | 4370 a | 5440 ab | 5020 a |

[a]Means within a column followed by the same letter are not different at $P \leq 0.05$ according to the least squares method of means separation.
[b]Data pooled over locations.
[c]DAE = days after emergence.

affect the percentage of fancy pods (Table 4). Chlorimuron applied three times at 2.9 g/ha also did not affect the percentage of fancy pods. However, treatments containing chlorimuron at 4.4 g/ha or greater applied 60 DAE reduced the percentage of fancy pods 8 to 10% in 1992. The percentage of fancy pods at Lewiston in 1993 was reduced only when 8.8 g/ha of chlorimuron was applied at 60 DAE. No treatment affected the percentage of fancy pods at Rocky Mount in 1993.

The percentage of extra large kernels was unaffected by treatments in 1993 (Table 4). In 1992, chlorimuron at 8.8 g/ha applied 60 DAE or chlorimuron at 4.4 g/ha applied 60 and 75 DAE reduced the portion of extra large kernels 4%. No treatment affected the peanut value per kg at any location. Chlorimuron reduced the percentage of extra large kernels and total sound mature kernels in some studies (14) while having no effect on market quality factors in others (8).

Daminozide had no effect on the percentage of fancy pods, extra large kernels (Table 4), or total sound mature kernels. Effects of daminozide on market quality parameters have been variable in previous studies where increases (10, 18) and decreases (29) in kernel size have been reported. Daminozide application decreased the percentage of total sound mature kernels in some studies (11, 18, 29) while having no effect in others (4, 10).

## Conclusions

The major attribute growers desire from a growth regulator is canopy modification to enhance row visibility at harvest in years with excessive vine growth. Such canopy modification allows the operator of the mechanical digger to better align the equipment over the rows, thereby reducing harvesting losses. Our results show little to no benefit from using chlorimuron as a growth regulator on peanut. No improvement in row visibility at locations with excessive vine growth were observed nor improvement in yield or quality obtained.

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**Table 4. Effect of daminozide and chlorimuron on percentage of fancy pods and extra large kernels.[a]**

| Growth regulator | Time of application | Rate per application | Fancy pods 1992[b] | Fancy pods 1993 Lewiston | Fancy pods 1993 Rocky Mount | Extra large kernels 1992[b] | Extra large kernels 1993[b] |
|---|---|---|---|---|---|---|---|
| | DAE[c] | g/ha | % | | | | |
| Daminozide | 75 | 950.0 | 71 a | 66 ab | 63 a | 29 abc | 45 a |
| Chlorimuron | 60 | 8.8 | 59 c | 56 c | 62 a | 26 c | 46 a |
| Chlorimuron | 75 | 8.8 | 68 ab | 71 a | 57 a | 27 bc | 44 a |
| Chlorimuron | 90 | 8.8 | 70 a | 69 a | 60 a | 32 a | 45 a |
| Chlorimuron | 60,75 | 4.4 | 59 c | 68 ab | 59 a | 26 c | 45 a |
| Chlorimuron | 60,90 | 4.4 | 61 c | 61 bc | 63 a | 27 bc | 45 a |
| Chlorimuron | 75,90 | 4.4 | 67 ab | 71 a | 67 a | 27 bc | 48 a |
| Chlorimuron | 60,75,90 | 2.9 | 64 bc | 67 ab | 63 a | 29 abc | 46 a |
| Nontreated | | | 69 ab | 65 ab | 64 a | 30 ab | 46 a |

[a]Means within a column followed by the same letter are not different at $P \leq 0.05$ according to the least squares method of means separation.
[b]Data pooled over locations within years.
[c]DAE = days after emergence.

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