Response Of Eight Genetically Diverse Peanut Genotypes To Chlorimuron[1,2]

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ABSTRACT

Field studies were conducted in 1988 and 1989 to compare the sensitivity of eight genetically diverse peanut (*Arachis hypogaea* L.) genotypes to early applications of chlorimuron. A split-plot experimental design was used to allow comparison between treated and nontreated peanut for each genotype. Chlorimuron (0.009 kg ai ha^{-1}) was applied 30 and 37 days after emergence in 1988 and 1989, respectively, to Florunner, Tifrun, Tifton 8, GA-207-3-4, New Mexico Valencia A, New Mexico Valencia C, Tamnut 74, and Pronto peanut. Chlorimuron reduced the percentage of total sound mature kernels when averaged across all genotypes, but was not specific to genotype. Chlorimuron reduced the weight of 100 kernels of Tifrun, Tifton 8, and New Mexico Valencia C in both years. The unit values of GA-207-3-4 and New Mexico Valencia C were significantly reduced both years by early applications of chlorimuron. Yields of Tifrun, Tifton 8, and GA-207-3-4 were reduced both years. Gross returns, which reflect effects on grade, unit value, and yield, were reduced by early applications of chlorimuron for Tifton 8 and GA-207-3-4 in both years. Based on these results, Tifrun, Tifton 8, GA-207-3-4, and New Mexico Valencia C are more inherently sensitive to chlorimuron than the other genotypes.

Key Words: Peanut injury, varietal susceptibility to herbicides.

Chlorimuron [2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl) amino] carbonyl] amino] sulfonyl] benzoic acid] is labelled for mid-season salvage control of Florida beggarweed [*Desmodium tortuosum* (Sw.) DC] in peanut (1). It is applied from 60 days after emergence (DAE) until 45 days prior to harvest. The mid-season limitation is due to reduced absorption and increased metabolism of chlorimuron 10 wk after planting (13), thus giving peanut greater tolerance compared to earlier applications. Chlorimuron injury symptoms on peanut are growth reduction and chlorosis. Currently, the only peanut cultivars that can be treated with chlorimuron are Florunner, Sunrunner, GK-7, Southern Runner, GK-3, Florigiant, and NC 7 (1). The restricted list of peanut cultivars is due to early research that indicated chlorimuron was injurious to the Southern Runner cultivar (6). This was the first reported study that indicated differential tolerance of peanut cultivars to herbicides that directly resulted in restrictions on herbicide use. Later, Southern Runner was found to be acceptably tolerant of chlorimuron, and the label was changed to permit its use on Southern Runner (G. G. Hammes, 1992, personal communication).

Differential cultivar response to herbicides is relatively common in other crops. A frequently cited example is the sensitivity of certain soybean [*Glycine max* (L.) Merr.] cultivars to metribuzin [4-amino-6-(1, 1-dimethylethyl)-3-(methylthio)-1, 2, 4-triazin-5(4*H*)-one]. First reported in 1974 (8), the mechanism for tolerance or sensitivity was found to be differential metabolism (11). Techniques soon were developed to screen soybean cultivars and genotypes for metribuzin sensitivity (4).

Cultivars of horticultural crops vary in sensitivity to herbicides. Sweet banana pepper (*Capsicum annuum* L.) is more tolerant of bentazon [3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide] than other pepper cultivars (14). Advantage and Red Plum tomato (*Lycopersicon esculentum* Mill.), are more tolerant of diphenyl ether herbicides than are other cultivars (10). Sweet corn (*Zea mays* L.) cultivars differ in sensitivity to chloroacetamide and thiocarbamate herbicides (5).

Breeding programs can be modified to include tolerance to herbicides as a selection criterion (7, 12). With chlorimuron becoming a key component of Florida beggarweed control systems in peanut and evidence of differential cultivar tolerance to chlorimuron, research was initiated in 1988 to examine eight genetically diverse peanut genotypes for tolerance to early applications of chlorimuron.

Materials and Methods

Irrigated experiments were conducted in 1988 and 1989 at the Coastal Plain Experiment Station in Tifton, GA on Clarendon loamy sand (fine-loamy, siliceous, thermic Plinthaquic Paleudults) containing 1.4% organic matter. Land was moldboard plowed 23 cm deep 2 d before planting. Benefin [*N*-butyl-*N*-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine] was applied at 1.7 kg ai ha^{-1} to the entire experiment and incorporated 8 cm deep with a tractor-powered vertical action tiller. Weeds not controlled by benefin were removed by hand throughout the season. Cultural practices, along with disease and insect management were based on recommendations by the Georgia Cooperative Extension Service.

The experimental design was a split-plot with five replications. Main plots were four rows wide (3.7 m) by 6.1 m long. Main plots were eight genetically diverse peanut genotypes. The genotypes were Florunner, Tifrun, Tifton 8, GA-207-3-4 (GA-207), New Mexico Valencia A (Val. A), New Mexico Valencia C (Val. C), Tamnut 74, and Pronto. These genotypes varied in market type and growth habit (Table 1). Sub-plots were two rows wide (1.8 m) and 6.1 m in length. Sub-plots were two levels of chlorimuron application; chlorimuron (0.009 kg ai ha^{-1}) applied 30 and 37 DAE in 1988 and 1989, respectively, and a nontreated control. Chlorimuron was applied with a CO_2-pressurized backpack sprayer calibrated to deliver 234 L ha^{-1} at 207 kPa with flat fan nozzle tips. A non-ionic surfactant was added at a concentration of 0.25% by vol[2,4].

The chlorimuron application dates were earlier than registered (i.e. 60 DAE) (1). However, the authors felt this was necessary in order to insure stress from chlorimuron. Furthermore, any cultivar with superior early season tolerance to chlorimuron would give growers greater application flexibility and may be included in future breeding programs.

Peanut harvest date was based on optimum maturity of a nontreated control for each variety using the Hull Scrape Method (9). Yields were measured by harvesting each plot with a peanut combine. Grades and unit values were based on Peanut Loan Schedules for 1988 and 1989 (2, 3). Grade values included percentage total sound mature kernels (TSMK), extra large kernels (ELK), 20/64, medium, and number 1 (No. 1). Runner, spanish/valencia, virginia, and extra large virginia kernels that are classified

[1]Cooperative investigations of the USDA Agric. Res. Serv. and the Univ. of Ga. College of Agric. Exp. Stn., Tifton.

[2]Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the USDA or the University of Georgia and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

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[4]X-77 (a nonionic surfactant containing alkylarylpolyoxyethylene glycols, free fatty acids, and isopropanol). Valent U.S.A. Corp., P.O. Box 8025, Walnut Creek, CA 94596-8025.

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Table 1. Description of eight peanut genotypes.

Genotype	Market type	Growth habit
Florunner	runner	runner
Tifrun	runner	runner
Tifton 8	virginia	decumbent
GA-207	small runner	decumbent
Val. A	valencia	loose bunch
Val. C	valencia	loose bunch
Tamnut 74	spanish	bunch
Pronto	spanish	bunch

as TSMK are retained by 6.35 x 19.05, 5.95 x 19.05, 5.95 x 25.40, and 8.53 x 25.40 mm screen, respectively. ELK are retained by a 8.53 mm screen. Kernels that are classified as 20/64 are retained by a 7.93 mm screen but pass through a 8.53 mm screen. Medium kernels are retained by a 7.14 mm mm screen but pass through a 7.93 mm screen. No. 1 are retained by 5.95 mm screen but pass through a 7.14 mm screen. An aggregate estimate of seed size was determined by weighing 100 randomly selected TSMK kernels from each treatment. Gross returns for each plot were calculated based on individual plot yields, grades, and established unit values (2, 3).

Data were subjected to analysis of variance. Differences among treatment means were determined using Fisher's Protected Least Significant Difference Test at P = 0.05. Only significant differences will be discussed unless stated otherwise.

Results and Discussion

Analysis of variance indicated significant differences between years. Therefore, data were not pooled over years. Interactions between genotype and chlorimuron application were not significant for TSMK, ELK, 20/64, medium, and No. 1 in 1988 and 1989. Therefore, only main effect treatment means for these parameters will be presented. A significant interaction existed between genotype and chlorimuron application for weight of 100 kernels, unit value, yield and

Table 2. Effect of chlorimuron application on peanut grades for eight peanut genotypes[†].

	1988					1989				
Genotype	TSMK[‡]	ELK[§]	20/64[¶]	Med.[#]	No. 1[††]	TSMK	ELK	20/64	Med.	No. 1
	(%)					(%)				
Florunner	75.2	11.3	20.9	26.4	9.1	68.1	11.2	20.6	23.1	10.9
Tifrun	72.8	25.6	19.3	17.4	5.4	68.5	11.1	26.2	21.7	6.3
Tifton 8	72.9	48.6	10.8	7.1	4.1	67.4	37.1	13.6	10.5	5.2
GA-207	61.2	1.5	5.5	22.2	28.5	61.1	1.3	6.4	24.2	26.5
Val. A	61.7	0.6	4.9	22.4	32.5	52.7	0.1	1.5	16.7	33.5
Val. C	64.5	1.4	7.7	25.5	28.7	52.5	0.1	2.4	20.0	29.4
Tamnut 74	64.4	0.1	1.7	16.0	41.4	58.7	0.0	2.2	20.0	32.4
Pronto	69.1	0.4	4.1	22.6	38.1	58.0	0.2	2.7	21.3	29.8
LSD (0.05)	1.7	1.3	1.1	1.8	0.7	3.0	1.5	1.3	2.0	1.3
Nontreated	69.1	12.0	9.9	20.6	22.7	62.6	9.1	10.2	20.6	20.6
Chlorimuron	66.4	10.4	8.8	19.2	24.3	59.1	6.1	8.7	18.8	22.9
LSD (0.05)	0.8	0.6	0.6	0.9	0.4	1.5	0.7	0.7	1.0	0.7

[†] Chlorimuron (0.009 kg ai ha^{-1}) was applied to weed free peanut 30 and 37 days after emergence in 1988 and 1989, respectively.

[‡] Total sound mature kernels.

[§] Extra large kernels.

[¶] Kernels that are passed and retained by 8.53 and 7.93 mm screens, respectively.

[#] Medium kernels, passed and retained by a 7.93 and 7.14 mm screen, respectively.

[††] Number 1 kernels, passed and retained by a 7.14 and 5.95 mm screen, respectively.

gross return. Individual treatment means will be presented for these variables.

Grade

Florunner, Tifrun, and Tifton 8 consistently had more TSMK, ELK, and 20/64 than the other genotypes (Table 2). Conversely, these genotypes had fewer of the smallest kernels (No. 1) compared to other genotypes. These results reflect the intrinsic differences among genotypes, not an effect due to chlorimuron treatment. When averaged across all genotypes, chlorimuron application resulted in fewer TSMK, ELK, 20/64, and medium size kernels compared with the nontreated control, but more No. 1 kernels. Early applications of chlorimuron lower peanut grades by shifting the kernels into progressively smaller size categories. However, based on the lack of significant interaction, this is not specific to genotype. Rather, it is a phenomenon of all the genotypes evaluated.

Weight per 100 kernels

In 1988, chlorimuron applied to Tifrun, Tifton 8, Val. A, Val. C, and Pronto reduced the weight of 100 kernel samples compared to the nontreated control (Table 3). Kernel size of Florunner, GA-207, and Tamnut 74 were not affected by chlorimuron. Chlorimuron applied to Val. A and Pronto did not reduce kernel size in 1989 (Table 4). However, all of the remaining genotypes had smaller kernels as a result of early applications of chlorimuron. Tifrun, Tifton 8, and Val. C. produced smaller kernels due to chlorimuron application both years.

These results are in general agreement with those seen in the grade analysis. Early applications of chlorimuron can potentially reduce kernel size of all the genotypes. Of the genotypes evaluated, Tifrun, Tifton 8, and Val. C were the most sensitive to reduction in kernel size when expressed as weight per 100 kernels.

Grade and weight of 100 kernels are indirect measurements of the degree to which the kernel had filled the pod. As a peanut plant matures, kernels enlarge. Immature peanut kernels are smaller and do not completely fill the pod. Thus it is plausible that the maturity of genotypes which had lower grades, small kernels, or lower weights of 100 kernels was retarded by chlorimuron. However, since maturity comparisons between chlorimuron treatments were not directly measured, this question cannot be answered by this study.

Unit value

Unit value reflects the overall effect of chlorimuron on peanut grade with a monetary value considered. As grades change, the actual unit value of farmer stock peanut will change based on established formulae (2, 3). These formulae reflect premiums for ELK, standard values for TSMK, reduced values for other kernels (OK) and loose shelled kernels (LSK), and various deductions. Early chlorimuron applications reduced the unit value of GA-207, Val. A, and Val. C. compared with the nontreated controls in 1988 (Table 3). In 1989, chlorimuron reduced the unit value of Florunner, GA-207, and Val. C. (Table 4). Using this parameter, GA-207, and Val. C. are the most sensitive to chlorimuron.

Yield

In 1988, yields of all 8 genotypes were reduced by early applications of chlorimuron (Table 3). Yields of the spanish market types Tamnut 74 and Pronto were reduced by 38 and

Table 3. Effect of chlorimuron on weight of 100 kernels, unit value, yield, and gross returns of eight peanut genotypes, 1988†.

	Wt. of 100 kernels		Unit value‡		Yield		Gross return‡	
Genotype	Nontreat.	Chlor.	Nontreat.	Chlor.	Nontreat.	Chlor.	Nontreat.	Chlor.
	-(g 100 kernels^{-1})-		----- (\$ t^{-1}) ----		---- (kg ha^{-1}) ---		----- (\$ ha^{-1}) ---	
Florunner	48.9	48.9	734	731	5120	4450	3760	3250
Tifrun	59.8	53.5	714	705	4960	4350	3540	3070
Tifton 8	76.3	69.5	744	738	4400	3650	3270	2700
GA-207	38.1	37.6	638	597	2690	2180	1720	1300
Val. A	36.7	33.4	637	584	1510	1010	960	590
Val. C	38.5	36.5	648	621	1570	1280	1020	800
Tamnut 74	31.1	29.7	648	633	2700	1670	1750	1060
Pronto	38.7	34.9	689	671	3040	1640	2090	1100
LSD (0.05)§	1.9		21		270		200	

†Chlorimuron (0.009 kg ai ha^{-1}) was applied to weed free peanut 30 days after emergence.

‡Based on 1988 Peanut Loan Schedule, U.S. Dept. of Agric., Agric. Stab. and Conserv. Ser.

§Least significant difference between treatments within a given genotype.

Table 4. Effect of chlorimuron on weight of 100 kernels, unit value, yield, and gross returns of eight peanut genotypes, 1989[†].

	Wt. of 100 kernels		Unit value[‡]		Yield		Gross return[‡]	
Genotype	Nontreat.	Chlor.	Nontreat.	Chlor.	Nontreat.	Chlor.	Nontreat.	Chlor.
	-(g 100 kernels^{-1})-		---- (\$ t^{-1}) -----		---- (kg ha^{-1}) ---		---- (\$ ha^{-1}) ---	
Florunner	52.6	47.9	696	642	2190	1860	1530	1230
Tifrun	54.6	50.9	676	659	3710	3000	2520	1970
Tifton 8	78.6	67.9	688	676	3490	2710	2400	1830
GA-207	44.5	39.6	633	590	2240	1700	1430	1010
Val. A	37.2	35.6	544	515	1050	1240	570	650
Val. C	39.2	36.1	551	499	1070	1040	590	530
Tamnut 74	35.7	31.7	595	572	2030	1750	1220	1010
Pronto	40.0	37.3	582	578	1700	1560	990	990
LSD (0.05)[§]	3.0		39		490		370	

[†]Chlorimuron (0.009 kg ai ha^{-1}) was applied to weed free peanut 37 days after emergence.

[‡]Based on 1989 Peanut Loan Schedule, U.S. Dept. of Agric., Agric. Stab. and Conser. Ser.

[§]Least significant difference between treatments within a given peanut genotype.

46%, respectively while other types were reduced 12 to 33%. Yields were generally lower in 1989 compared to 1988 (Table 4). This was due to late season drought stress in 1989, compared to 1988. Total rainfall in July, August, and September of 1988 was 5.1, 10.4, and 19.8 cm, respectively. However, total rainfall in July, August, and September of 1989 was 3.8, 5.3, and 4.8 cm, respectively. Chlorimuron reduced yields of Tifrun, Tifton 8, and GA-207 in 1989. Yields from these three genotypes were reduced both years by early applications of chlorimuron. The highly significant yield reduction of the spanish genotypes in 1988 and their lack of significant yield response in 1989 may be related to the time of application in relation to their determinate fruiting pattern. Even though the timing of chlorimuron application was similar both years (30 and 37 DAE in 1988 and 1989, respectively), they may have been at different stages of peanut growth and development. The slightly later application date in 1989 appears to have been less disruptive to the determinate fruiting period of the spanish market types.

Gross returns

Gross returns reflect effects on grade, unit value, and yield. Gross returns are computed directly from the calculated unit values and yield. Chlorimuron reduced the gross returns of all peanut genotypes in 1988 (Table 3). In 1989, gross returns of Tifrun, Tifton 8, and GA-207 were reduced by early applications of chlorimuron while gross returns of the other genotypes were unaffected (Table 4). Thus, the yield effect exhibited the greatest influence on gross returns.

Early applications of chlorimuron are potentially injurious to all the peanut genotypes evaluated, including the commonly planted Florunner. This is contradictory to earlier research in which Southern Runner was the only cultivar whose yields were reduced by early applications of chlorimuron (6). Tifrun, Tifton 8, and Val. C. were the most sensitive to kernel size reduction. When a monetary value was placed on grade, GA-207 and Val. C were the most sensitive. Yields and gross returns of Tifrun, Tifton 8, and GA-207 were consistently reduced by chlorimuron. Based on these results, Tifrun, Tifton 8, GA-207, and Val. C are genotypes more sensitive to chlorimuron. None of the genotypes evaluated exhibited improved tolerance to early applications of chlorimuron to warrant inclusion into peanut breeding programs for the purpose of improving cultivar tolerance to chlorimuron.

Literature Cited

1. Anonymous. 1990. Supplemental labelling, "Classic" herbicide. E. I. duPont de Nemours and Co.
2. Anonymous. 1988. Peanut loan schedule. USDA Agric. Stab. and Conserv. Serv.
3. Anonymous. 1989. Peanut loan schedule. USDA Agric. Stab. and Conserv. Serv.
4. Barrentine, W. L., C. J. Edwards, Jr., and E. E. Hartwig. 1976. Screening soybeans for tolerance to metribuzin. Agron. J. 68:351-353.
5. Bennett, M. A., and S. F. Gorski. 1989. Response of sweet corn (*Zea mays*) endosperm mutants to chloracetamide and thiocarbamate herbicides. Weed Technol. 3:475-478.
6. Brecke, B. J. 1989. Response of peanut cultivars to selected herbicide treatments. Proc. So. Weed Sci. Soc. 42:28.
7. Buzzell, R. I., and A. S. Hamill. 1988. Improved tolerance of soybean (*Glycine max*) to metribuzin. Weed Technol. 2:170-171.
8. Hardcastle, W. S. 1974. Differences in the tolerance of metribuzin by

varieties in soybeans. Weed Res. 14:181-184.

9. Johnson, W. C., III. 1987. The hull scrape method to assess peanut maturity. Georgia Coop. Ext. Serv. Bull. 958.
10. Masiunas, J. B. 1989. Tomato (*Lycopersicon esculentum*) tolerance to diphenyl ether herbicides applied postemergence. Weed Technol. 3:602-607.
11. Smith, A. E., and R. E. Wilkinson. 1974. Differential adsorption, translocation, and metabolism of metribuzin by soybean cultivars. Plant Physiol. 32:253-257.
12. Wax, L. M., R. L. Bernard, and R. M. Hayes. 1974. Response of soybean cultivars to bentazon, bromoxynil, chloroxuron, and 2,4-DB. Weed Sci. 22:35-41.
13. Wilcut, J. W., G. R. Wehtje, M. G. Patterson, T. A. Cole, and T. V. Hicks. 1989. Adsorption, translocation, and metabolism of foliar-applied chlorimuron in soybeans (*Glycine max*), peanuts (*Arachis hypogaea*), and selected weeds. Weed Sci. 37:175-180.
14. Wolff, D. W., T. J. Monaco, and W. W. Collins 1989. Differential tolerance of peppers (*Capsicum annum*) to bentazon. Weed Techol. 3:579-583.

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