Comparative Response of Three Peanut Cultivars To Multiple Herbicide Applications[1,2]

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ABSTRACT

Field studies in 1990 and 1991 at Tifton, GA and Gainesville, FL evaluated the response of Florunner, Southern Runner, and NC 7 peanut to multiple herbicide applications. A split-split plot experimental design was used with peanut cultivars as main plots. Sub-plots were four levels of chloroacetamide herbicides applied sequentially preplant incorporated and at vegetative emergence. Sub-subplots were five postemergence herbicide treatments. All herbicides were applied at registered rates and times of application. There were no interactions between cultivars, choloracetamide, and/or postemergence herbicides for canopy width, yield, and grade of peanut. There were no interactions between chloroacetamide and postemergence herbicides for the same parameters. Main effects were the only sources of significant (P = 0.05) differences in the data. Based on these results, unusual precautions in using these herbicide combinations on these cultivars are not needed.

Key Words: *Arachis hypogaea*, peanut injury, varietal susceptibility to herbicides.

Differential response of crop cultivars to herbicides is a phenomenon that influences herbicide and cultivar selection. An example is the differential tolerance of soybean (*Glycine max* Merr.) cultivars to metribuzin [4-amino-6(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one]. The extreme sensitivity of Tracy, Govan, and Narow soybean to metribuzin is the basis for the University of Georgia recommendation not to plant these cultivars if metribuzin is to be used (9).

Until recently, there has been little concern about differential tolerance of peanut (*Arachis hypogaea* L.) cultivars to herbicides. This has been due in part to the predominance of Florunner in southeastern peanut producing region. In 1978, Florunner was planted on 98.5% of the Georgia peanut acreage (6). However, in 1990 Florunner was planted on 71.0% of the Georgia acreage (1). The decrease in Florunner usage is due to the development and acceptance of new cultivars, such as Southern Runner, Sunrunner, and GK-7. Furthermore, incentives to plant virginia and spanish market types have become more common in recent years (J. A. Baldwin, 1992, personal communication).

Compared to other crops, the amount of research on differential tolerance of peanut cultivars to herbicides is limited. The earliest report of differences in peanut cultivar tolerance to herbicides was in 1976 in which GK-3 was more sensitive to herbicides than either Florunner or Tifspan (4). However, these differences occurred in only two of eight trials. Subsequent research reported that differences in cultivar tolerance to herbicides occurred in one trial out of seven, with Tifrun being the most tolerant cultivar to herbicides (5). In 1989, Brecke reported that Early Bunch and Southern Runner were more sensitive to herbicides than Florunner (2). In this study, both cultivars were more sensitive to paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) than Florunner. Southern Runner also was more sensitive than Florunner to high rates of chlorimuron [2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino]-sulfonyl]benzoic acid] (2). Subsequent field and laboratory research in Alabama indicated that there were no differences among Florunner, Sunrunner, NC 7, and Southern Runner in paraquat absorption and phytotoxicity from one application (13). However, yields of Sunrunner, Southern Runner, and Florunner were reduced by two applications of paraquat while NC 7 was not affected (8).

Most of the research reported on herbicide injury to peanut has been comparisons among herbicides, rates, or times of application (3,7,12,13). While useful in determining the injury potential of a herbicide, this data does not take into account effects of injury from multiple applications or combinations of different herbicides. Since peanut is usually treated with several different herbicides during the growing season, the effects of multiple herbicide stresses are of concern, especially with the new cultivars. Therefore, studies were initiated in 1990 to compare the sensitivity of three peanut cultivars to commonly used herbicides applied sequentially or in combination.

Materials and Methods

Irrigated experiments were conducted in 1990 and 1991 at the Coastal Plain Experiment Station in Tifton, GA and at the Archer Farm near Gainesville, FL. The soil type at Georgia location was a Tifton loamy sand (thermic Plinthic Kandiudults) composed of 85% sand, 8% silt, 7% clay, and 1.8% organic matter. The soil type at the Florida location was a Arrendondo fine sand (hyperthermic Grossarenic Paleudults) composed of 86% sand, 10% silt, 4% clay, and 0.7% organic matter. Land was moldboard plowed 23 cm deep 2 d before planting at the Georgia location and 2 months prior to planting at the Florida location. Ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benzenamine] at 0.8 kg ai ha^{-1} was applied preplant incorporated (PPI) to a depth of 8 cm with a tractor powered vertical action tiller to the entire experiment.

The experimental design was a split-split plot with four replications. Main plots were three peanut cultivars planted in blocks 18.2 m wide and 12.1 m long. Cultivars used were Florunner, Southern Runner, and NC 7. Florunner was chosen as a standard since it is the most commonly planted runner type cultivar in the southeast. Southern Runner was chosen since persistent rumors exist among growers that it is sensitive to herbicide stress (S. M. Brown, 1992, personal communication). NC 7 was chosen since it

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[1]Cooperative investigations of the USDA Agric. Res. Ser., the Univ. of Florida Agric. Exp. Stn., Gainesville, and the Univ. of Georgia 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, the University of Florida, or the University of Georgia and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

[3]Res. Agron., USDA-ARS, Assoc. Prof., Univ. of Florida, and Agric. Res. Stat., Univ. of Georgia, Coastal Plain Exp. Stn., Tifton, GA 31793-0748.

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

[5]Agridex (a petroleum oil adjuvant containing 83% paraffin base petroleum oil, and 17% polyoxyethylated polyol fatty acid and polyol fatty ester). Helena Chemical Company, 5100 Poplar Ave., Memphis, TN 38137.

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is the most commonly planted virginia market type cultivar in the southeast. Two rows of Florunner were used as a border around all main plots.

Sub-plots were 9.1 m wide and 6.0 m long with four levels of chloroacetamide herbicide combinations. The chloroacetamide herbicide combinations were metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-2-(methoxy-1-methylethyl)acetamide] at 2.2 kg ai ha^{-1} PPI followed by metolachlor at 2.2 kg ha^{-1} applied at vegetative emergence (VE), alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)acetamide] at 3.4 kg ai ha^{-1} PPI followed by alachlor at 2.2 kg ha^{-1} VE, metolachlor at 2.2 kg ha^{-1} PPI followed by alachor at 2.2 kg ha^{-1} VE, and nontreated with chloroacetamides. Chloroacetamide herbicides were chosen since they are commonly used and have been shown to be phytotoxic to peanut under certain conditions (3,12).

Sub-sub plots were two rows (1.8 m) wide and 6.0 m long with five postemergence (POST) herbicide treatments. The POST herbicide applications were bentazon [3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one, 2,2-dioxide] at 0.6 kg ai ha^{-1} plus paraquat at 0.15 kg ha^{-1} applied VE and 2 wk after VE (VE + 2 wk), bentazon at 1.1 kg ha^{-1} applied at VE +2 wk and 4 wk after VE (VE + 4 wk), 2,4-DB [4-(2,4-dichlorophenoxy) butanoic acid] at 0.28 kg ai ha^{-1} applied VE + 2 wk and VE + 4 wk, chlorimuron at 0.009 kg ai ha^{-1} applied 60 days after emergence (DAE), and nontreated with POST herbicides. In plots where chloroacetamides and POST herbicides were applied at VE, they were applied as a mixture.

In Georgia, plots were planted on May 24, 1990 and May 30, 1991, while in Florida plots were planted on May 9, 1990 and May 6, 1991. All cultivars were planted with a two row planter at a seeding rate of 112 kg ha^{-1}. Row spacing was 91 and 76 cm at the Georgia and Florida locations, respectively. Herbicide treatments at the Georgia location were applied with a tractor-mounted compressed air plot sprayer calibrated to deliver 234 L ha^{-1} at 207 kPa with flat fan nozzle tips. A tractor-mounted CO_2 plot sprayer and backpack sprayer with flat fan tips were used to apply herbicides at the Florida location. These were calibrated to deliver 187 1 ha^{-1} at 311 and 193 kPa, respectively. A nonionic surfactant[4] was included with all paraquat and chlorimuron treatments at a concentration of 0.13% and 0.25% by vol, respectively. A petroleum oil adjuvant (POA)[5] was included with all applications of bentazon (1.1 kg ha^{-1}) at a concentration of 1.0% by vol.

Weeds not controlled by the herbicide treatments were removed by hand throughout the season. Cultural and pest management practices were based on recommendations by the Georgia Cooperative Extension Service and the Florida Cooperative Extension Service.

At the Georgia location, canopy width for each plot was measured 61 and 54 DAE in 1990 and 1991, respectively. Canopy width was not recorded for chlorimuron treatments due to the late season application of this treatment. Canopy width at the Florida location was not measured in 1990, but was measured 62 DAE in 1991. At both locations, peanut harvest dates were based on optimum maturity for each cultivar. Yields were measured by harvesting each plot with a peanut combine. Grades from the Georgia location were measured and based on standards established by the Federal State Inspection Service. Grades are expressed as percentage total sound mature kernels (TSMK).

All data were subjected to analysis of variance to determine sources of variation and significant interactions. Differences in 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

Data were not pooled across locations and years due to the array of planting dates and growing conditions between locations. Analysis of variance indicated few significant interactions (Table 1), which were not consistantly repeatable. Furthermore, the authors felt that these interactions were an artifact of the exceedingly large cultivar effect and outlier data points in the nontreated controls. Therefore, it was concluded that there were generally no significant interactions among cultivars, chloroacetamides, and POST herbicides. Only the results for the main effects will be discussed.

Peanut canopy width. Canopy width differed among cultivars, regardless of herbicide treatment (Table 2). Canopy width of NC 7 and Southern Runner were the narrowest in 1990 at the Georgia location. In 1991, Florunner and NC 7 had the narrowest canopy width in Florida. In 1991, the canopy width of Southern Runner was the narrowest at the Georgia location. Chloroacetamide herbicides did not affect

Table 1. Analysis of variance for peanut canopy width, yield, and grade (data as presented in Table 2).

	Canopy width			Yield				Grade	
	1990	1991		1990		1991		1990	1991
	GA	FL	GA	FL	GA	FL	GA	GA	GA
Sources of variation†									
Main Effects:	F value§								
cult.‡	14.33**	4.11	23.7**	21.16**	9.34*	28.15**	1.83	37.12**	40.79**
chlor.‡	1.19	0.31	1.41	0.84	0.13	2.03	0.83	1.33	0.53
POST‡	50.45**	0.66	27.15**	0.05	4.26**	0.47	4.98**	1.71	2.10
Interactions:									
cult. by chlor.	0.52	1.82	0.55	2.06	0.21	1.92	0.81	2.83*	0.98
chlor. by POST	1.10	0.69	0.60	2.32*	2.34*	1.57	1.74	1.85*	0.64
chlor. by POST	2.01*	1.24	1.12	2.04*	1.60	1.82*	0.83	3.44**	0.66
cult. by chlor. by POST	0.47	1.41	0.99	1.17	0.75	1.20	0.50	1.44	0.74

†Two and three way interactions were considered to be nonsignificant due to unusually large main effects or outlier responses in nontreated controls.

‡Abbreviations: chlor., chloroacetamide herbicides; cult., cultivar; POST, postemergence herbicides

§Levels of significance: *(P = 0.05); **(P = 0.01).

canopy width at either location in both years. POST herbicides had no effect on canopy width in 1991 at the Florida location. However, two applications of paraquat plus bentazon or bentazon plus POA reduced canopy width both years in Georgia.

Peanut yield. Yield differed among cultivars in three of four trials, regardless of herbicide treatment (Table 2). Yields were the greatest from Florunner in 1990 at the Florida location, while Southern Runner had the greatest yields in 1991. NC 7 and Southern Runner yields were the greatest in 1990 at the Georgia location. Yields did not differ in 1991 among cultivars in Georgia. Sequential applications of chloroacetamide herbicides did not reduce yield compared to the nontreated in all four trials. Post herbicides did not affect yields at the Florida location in either year. However, chlorimuron reduced yields both years at the Georgia location. Two applications of bentazon plus paraquat also reduced yields in 1990 in Georgia.

These results partially agree with previous research. Cardina *et al.* (3) reported significant injury from metolachlor applied PPI. However, injury was reported only with higher than registered rates of metolachlor and when peanut was irrigated immediately after herbicide application. Similarly, Wehtje *et al.* (12) injured peanut with alachlor and metholachlor, but only at rates greater than twice the maximum registered rate. In both of these studies registered rates of alachlor or metolachlor, used under conditions not specifically designed to create injury, did not reduce peanut

Table 2. Main effects of treatment means for peanut canopy width, yield, and grade.

Treatment Variable		Canopy width†		
		1990	1991	
		GA	FL	GA
	kg/ha	cm		
Cultivar				
Florunner	----------	78.3	76.4	82.7
NC 7	----------	71.0	75.1	81.0
Southern Runner	----------	73.9	78.9	72.8
LSD (0.05)		3.4	3.3	3.8
Chloracetamide				
metol. fb metol.‡	2.2, 2.2	74.4	76.5	80.4
metol. fb ala.‡	2.2, 2.2	73.9	76.3	78.2
ala. fb ala.	3.4, 2.2	73.6	77.4	77.7
nontreated	----------	75.6	76.9	79.0
LSD (0.05)		ns	ns	ns
Postemergence treatment				
bent. + para. twice‡	0.6 + 0.14	67.0	76.3	73.6
bent. + POA twice‡	1.1 + 1.0%	74.4	76.4	78.1
2,4-DB twice	0.3	76.1	77.6	80.4
chlorimuron	0.009	----	----	----
nontreated	----------	76.9	77.1	81.0
LSD (0.05)		1.7	ns	1.7

Treatment Variable	Yield			
	1990		1991	
	FL	GA	FL	GA
	kg ha^{-1}			
Cultivar				
Florunner	4070	2100	4210	3690
NC 7	3190	2840	3680	3350
Southern Runner	3130	2520	4770	3950
LSD (0.05)	390	420	350	ns
Chloracetamide				
metol. fb metol.‡	3590	2510	4090	3610
metol. fb ala.‡	3400	2500	4320	3610
ala. fb ala.	3500	2460	4310	3770
nontreated	3370	2470	4170	3660
LSD (0.05)	ns	ns	230	ns
Postemergence treatment				
bent. + para. twice‡	3470	2440	4260	3740
bent. + POA twice‡	3480	2560	4190	3730
2,4-DB twice	3460	2480	4260	3670
chlorimuron	3460	2380	4190	3400
nontreated	3440	2580	4200	3770
LSD (0.05)	ns	110	ns	190

Treatment Variable	Grade	
	1990	1991
	GA	GA
	% TSMK‡	
Cultivar		
Florunner	74.7	78.5
NC 7	70.1	73.7
Southern Runner	74.3	73.3
LSD (0.05)	1.4	1.6
Chloracetamide		
metol. fb metol.‡	73.1	75.2
metol. fb ala.‡	73.2	75.3
ala. fb ala.	72.8	75.1
nontreated	73.1	75.0
LSD (0.05)	ns	ns
Postemergence treatment		
bent. + para. twice‡	72.8	75.4
bent. + POA twice‡	73.2	75.3
2,4-DB twice	73.0	75.1
chlorimuron	72.9	74.8
nontreated	73.3	75.2
LSD (0.05)	0.4	0.5

†Canopies were measured 54 and 61 days after emergence in 1990 and 1992, respectively, in Georgia. In Florida, canopies were measured 62 days after emergence in 1991.

‡Abbreviations: ala., alachlor; bent., bentazon; fb, followed by; metol., metolachlor; para., paraquat; POA, petroleum oil adjuvant; TSMK, total sound mature kernels.

yields. Our results concur with this facet of the research reported.

The lack of significant interaction between cultivars and either group of herbicides is not in complete agreement with previous research. Southern Runner, but not Florunner, was significantly injured when chlorimuron was applied at high rates and at times earlier than specified on the label (2). Our results indicated that Southern Runner is no more sensitive to chlorimuron than either Florunner or NC 7 when applied at registered rates and times of application. Our results agree with those that showed similar levels of paraquat phytotoxicity among Florunner, Southern Runner, and NC 7 cultivars (13). However, two applications of paraquat reduced yields of Southern Runner, Florunner, and Sunrunner in Florida (8). The difference between our results and those from the Florida study is our use of bentazon plus paraquat, which is less phytotoxic than paraquat alone (10).

The yield reduction at the Georgia location from applications of chlorimuron was not specific to a particular cultivar. Rather, it was a characteristic of all three cultivars. The occurrence of yield reduction from applications of chlorimuron in Georgia, but not in Florida, may be attributed to late season heat and drought stress at the Georgia location which was not as severe at the Florida location. For example, rainfall totals in August at Tifton, Georgia were 7.1 and 9.1 cm in 1990 and 1991, respectively. Rainfall totals in August at Gainesville, FL were 20.6 and 19.3 cm in 1990 and 1991, respectively. In 1990, the average daily temperature for August at Tifton was 28.8 C, while at Gainesville the average daily temperature was 26.7 C. These stresses appear to have affected the ability of the plants to recover from chlorimuron injury at the Georgia location.

Total sound mature kernels. TSMK differed among cultivars in Georgia (Table 2). NC 7 had the least TSMK in 1990, whereas NC 7 and Southern Runner had the least TSMK in 1991. Sequential applications of chloroacetamide herbicides had no affect of TSMK both years while chlorimuron reduced TSMK both years. Two applications of bentazon plus paraquat also reduced TSMK in 1990.

These results agree with those from the yield measurements. Chlorimuron reduced yields and TSMK at the Georgia location in 1990 and 1991. In 1990, two applications of bentazon plus paraquat reduced yield and TSMK. These affects were observed in all cultivars. In previous studies, two applications of paraquat alone reduced TSMK in Florunner and Southern Runner in Florida (8), while in an unrelated study Florunner TSMK was unaffected (11). Our study agrees more with the Florida study, even though we used the less phytotoxic combination of bentazon plus paraquat.

With increased plantings of Southern Runner and NC 7 cultivars in the southeast, there is no evidence that they are more sensitive to herbicides than the commonly planted Florunner cultivar. Differences in growth, yield, and TSMK in this study were due to innate differences in the cultivars, not to differential tolerance to herbicides. Therefore, unusual precautions in using these herbicides, either singularly, in combination, or sequentially on these cultivars are not needed.

Most of the herbicides used in this study have been shown to be phytotoxic to peanut, but only at excessive rates, unusual times of application, extemely wet conditions, or conditions designed to create injury. In our study, registered rates and times of application were used. When growth and yield reductions occurred, they were usually caused by POST-applied herbicides. Sequential applications of chloroacetamide herbicides rarely affected peanut. The lack of consistant interaction between chloroacetamide and POST herbicides (Table 1) indicates that under most conditions the injury potential from use of these herbicides is based on individual phytotoxicity characteristics and is not additive.

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