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Control of Bur Gherkins (*Cucumis anguria*) in Peanuts (*Arachis hypogaea*) with Herbicides[1]

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ABSTRACT

Experiments were conducted from 1975 to 1977 to determine the efficacy of herbicides for control of bur gherkin (*Cucumis anguria* L.) in peanuts (*Arachis hypogaea* L.). Most bur gherkins seed planted in the field germinated in the upper 2.5 cm of soil, although some seed germinated from 7 cm. In greenhouse and field experiments, preplant-incorporated applications of vernolate (*S*-propyl dipropylthiocarbamate) substantially reduced the green weight of bur gherkin plants and also improved the efficacy of several cracking and postemergence herbicidal treatments. Postemergence treatment sequences were much more effective when they were begun while bur gherkins were in the cotyledonary stage of development rather than the 3- to 5-leaf stage. Preplanting application and incorporation of vernolate + benefin (*N*-butyl-*N*-ethyl-α,α,α-trifluoro-2,6-dinitro-*p*-toluidine), followed by a cracking application of alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] + naptalam (*N*-1-naphthylphthalamic acid) + dinoseb (2-*sec*-butyl-4,6-dinitrophenol), followed by dinoseb controlled bur gherkins. Some of the most intensive herbicide programs reduced the yield of peanuts in some experiments. Bur gherkin plants that survived the herbicide treatments produced substantial quantities of fruit and seed.

Key Words: Bristly starbur, bur gherkins (*Cucumis anguria* L.), preplant incorporated, ground-cracking, peanuts (*Arachis hypogaea* L.), postemergence, weed biology.

In the past three decades, many weed scientists have observed that weed populations are highly dynamic and that "new" weed species are occasionally introduced into a given cropping situation. Bur gherkin recently has become a serious weed in the southeastern U. S. peanut belt.

Bur gherkin is a vigorously growing plant with viny growth habits that severely interferes with peanut harvesting. During harvesting the fruiting structures (gherkins) are picked along with the peanuts and cause difficulty in drying the crop because of their high moisture content.

Herbicidal control of bur gherkins in peanuts apparently has not been reported. However, various herbicides have been evaluated for control of weeds in cultivated varieties of *C. anguria*. Pelletier and Coilier (3) and Pelletier *et al.* (4) found that several herbicides, including naptalam and bensulide [0,0-diisopropyl phosphorodithioate *S*-ester with *N*-(2-mercaptoethyl)benzenesulfonamide], did not control weeds in cultivated bur gherkins. Naptalam applied preplant and incorporated reduced yields of gherkins (2). Verlaat (5) reported that dichlobenil (2,6-dichlorobenzonitrile) applied 1 month after planting was less injurious to gherkins as a 50% wettable powder (WP) than as granules.

The objectives of these experiments were to determine (a) the depth at which bur gherkin germinates under field conditions, (b) the efficacy of several commonly used herbicidal programs for control of bur gherkins in peanuts, and (c) the response of peanuts to these control programs.

Materials and Methods

Field experiments were conducted during 1976 and 1977 on Dothan sandy loam at Headland, Alabama, and on Tifton loamy sand at Tifton, Georgia. Hand-harvested bur gherkin seed (that had been stratified for about 3 weeks at 0 C to break dormancy) were used in all experiments.

Treatments were arranged in a randomized complete block with a split-plot design and four replications. The split plots were for comparison of benefin (1.68 kg/ha) versus benefin + vernolate (1.68 kg/ha + 2.68 kg/ha) applied as preplant-incorporated treatments. Subsequent herbicidal treatments were applied as preemergence, cracking, or postemergence sprays. Each whole plot, for comparison of postplanting herbicide treatments, was four rows wide and 9.1 m in length. Methyl bromide (bromomethane) was applied at 482 kg/ha to about 2m across one end of the plots in each replication. Near the center of the sterilized area, seeds of bur gherkin were planted in 929-cm^2 areas. An appropriate amount of soil was taken from each planting site. A designated amount of soil was mixed with the seed to provide planting depths of 0 to 2.5, 2.5 to 5, and 5 to 7.5 cm, respectively, in each plot. About 100 gherkin seed was planted at each site. Because of the heavy natural infestation of bristly starbur (*Acanthospermum hispidum* DC.) at the Headland location, the response of this species to herbicidal treatment was noted along with that of bur gherkins. 'Florunner' peanuts were planted with standard farm equipment in the remaining 7.1 m of each plot.

Postplanting herbicidal treatments were applied preemergence, at cracking, and postemergence with a tractor-mounted compressed-air sprayer set to deliver 140 L/ha. Postemergence treatments were made at the cotyledonary stage or at the 3- to 5-leaf stage. In addition to the preplant treatments, the following herbicides were applied: dinoseb, 2,4-DB [4-(2,4-dichlorophenoxy)butyric acid], toxaphene (chlorinated camphene containing 67 to 69% chlorine), alachlor, naptalam, and pronamide [3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide]. The number of bur gherkins surviving the herbicide treatments was determined about midway though the growing season.

At 4 to 6 weeks before harvesting peanuts, green weights of surviving bur gherkins were determined. In one experiment, gherkins were removed from the plants and counted. Peanuts were dug with a commercial digger-shaker, windrowed, and combined within 5 days. All control and yield data were subjected to analyses of variance. Where appropriate, means were compared with LSD's or Duncan's Multiple Range Test (DMRT) at the 5% level of probability. Where significant interaction between variables preclude the use of the DMRT or LSD partial analyses of variance are given with probabilities for F values.

Results and Discussion

In exploratory greenhouse experiments (data not pres-

[1]Cooperative investigations of Agricultural Research, Science and Education Administration, U. S. Dep. Agr., Coastal Plain Experiment Station, Tifton, GA 31794, and the Alabama Agr. Expt. Station, Auburn AL 36830. This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA, by Auburn University, or by the University of Georgia, nor does it imply registration under FIFRA.

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ented here), without vernolate pretreatment none of the postemergence treatments applied to bur gherkins caused a substantial stand reduction except toxaphene and sequences that included toxaphene. Fresh weight of bur gherkins was lower in every treatment that included pretreatment with vernolate (including the pretreated control, which was given no postemergence treatment) than in treatments not including vernolate. Treatment sequences that included preplant-applied vernolate followed by either high rates or repeated applications of toxaphene or toxaphene followed by dinoseb were the most effective in reducing foliar growth. Repeated applications of dinoseb, bentazon [3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide], and 2,4-DB were also highly effective.

Data are presented in Tables 1 and 2 on the survival of bur gherkin plants as affected by (a) preplant treatment, (b) depth of planting, and (c) stage of bur gherkin development at time of the first postplanting treatment. Overall survival of bur gherkins was 23% lower after treatment with vernolate plus benefin than after pretreatment with only benefin (Table 2). In contrast to the greenhouse study, pretreatment with vernolate in the field did not consistently increase the toxicity of toxaphene applied as a postemergence treatment. Only about 70, 20, and 10% of the bur gherkin plants could be accounted for by the seed which were planted at 0 to 2.5, 2.5 to 5.0, and 5.0 to 7.5 cm depths, respectively. Over twice as many bur gherkins survived when postemergence treatment sequences were delayed to the 3- to 5-leaf stage rather than initiated at the cotyledonary stage. Twice as many bur gherkins survived in 1977 as in 1976 and four times as many survived at Headland as at Tifton. The difference due to loca-

Table 1. Number of bur gherkin plants (of about 100 planted at three depths in 929 cm^2) that survived herbicide treatments in 1976 and 1977 at Tifton, Georgia (Tift), and Headland, Alabama (Wgs).

Herbicides[a]		Postplanting treatment			Survival of gherkins planted at indicated depth												
					0-2.5 cm				2.5-5.0 cm				5.0-7.5 cm				
					1976		1977		1976		1977		1976		1977		
Preplant incorporated[b]	Postplant treatment	Rate (kg/ha)	No. of applications	Stage at first treatment[c]	Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)	Total (no.)
V+B	Tox	1.12	4	Cotyl	8.0	5.0	4.3	13.3	0.3	0.0	0	5.0	0.0	0.0	0	1.7	37.6
B	Tox	1.12	4	Cotyl	4.3	13.3	14.7	17.0	0.0	2.7	0	11.0	0.3	0.3	0	4.7	68.3
V+B	Tox	2.24	4	Cotyl	0.3	9.0	0.7	10.7	0.0	4.0	0	6.3	0.0	0.0	0	2.3	33.3
B	Tox	2.24	4	Cotyl	3.0	18.3	4.0	11.7	0.0	4.0	0	3.0	0.0	0.7	0	6.7	51.4
V+B	DB	0.45	2	Cotyl	0.3	10.0	3.7	7.0	0.0	2.0	0	8.0	0.0	0.7	0	0.3	32.0
B	DB	0.45	2	Cotyl	6.0	19.7	9.3	7.7	0.0	4.7	0	3.7	0.7	0.7	0	1.0	53.5
V+B	Di	0.84	4	Cotyl	0.0	0.3	0.0	7.7	0.0	0.0	0	0.7	0.0	0.0	0	0.0	8.7
B	Di	0.84	4	Cotyl	1.6	5.0	1.3	8.7	0.3	1.3	0	2.0	0.0	0.0	0	0.7	20.9
V+B	Al+N+Di	3.36+2.24+1.12	1	Cotyl	0.0	0.0	0.0	12.3	0.0	0.0	0	21.0	0.0	0.0	0	9.0	42.3
B	Al+N+Di	3.36+2.24+1.12	1	Cotyl	2.6	6.0	0.3	7.0	0.0	4.0	0	3.3	0.0	0.3	0	1.0	24.5
V+B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	0.0	0.0	0.0	6.3	0.0	0.0	0	3.0	0.0	0.0	0	1.0	10.3
B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	2.0	0.0	0.0	8.3	0.0	0.0	0	3.3	0.0	0.3	0	3.0	16.9
V+B	Di/DB	0.84/0.24	3/1	Cotyl	0.0	0.0	0.0	5.7	0.0	0.0	0	4.3	0.0	0.0	0	3.0	13.0
B	Di/DB	0.84/0.24	3/1	Cotyl	1.0	7.3	3.0	8.7	0.0	0.7	0	4.7	0.0	0.0	0	3.7	29.1
V+B	Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	1.0	0.0	0.0	5.7	0.0	0.0	0	0.3	0.0	0.0	0	0.0	7.0
B	Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	1.0	8.7	1.0	15.0	0.0	0.3	0	7.7	0.0	0.0	0	0.3	34.0
V+B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	4.3	15.7	8.7	19.0	0.0	2.0	0	8.7	0.0	0.0	0	10.0	68.4
B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	3.0	10.7	11.0	20.0	0.0	4.0	0	10.3	0.3	0.7	0	3.7	63.7
V+B	DB	0.45	2	3-5 leaf	4.3	4.3	9.0	26.3	0.0	2.0	0	18.7	0.3	0.3	0	18.3	83.5
B	DB	0.45	2	3-5 leaf	7.6	19.3	9.3	30.7	0.0	1.7	0	11.7	0.3	1.7	0	6.3	88.6
V+B	Di	0.84	3	3-5 leaf	2.0	2.0	5.0	34.7	0.0	0.0	0	21.3	0.0	0.0	0	13.3	78.3
B	Di	0.84	3	3-5 leaf	5.6	22.0	8.3	22.3	1.0	5.7	0	3.7	0.0	1.7	0	3.7	74.0
V+B	Di/DB	0.84/0.32	3/1	3-5 leaf	0.0	3.0	5.3	33.0	0.0	0.0	0	16.0	0.0	0.0	0	12.7	70.0
B	Di/DB	0.84/0.32	3/1	3-5 leaf	5.6	20.0	11.3	12.0	1.3	2.0	0	10.0	3.0	2.3	0	2.7	71.2
V+B	Tox	2.24	4	3-5 leaf	4.3	8.7	4.3	21.5	0.0	1.3	0	6.3	0.0	0.0	0	7.0	53.4
B	Tox	2.24	4	3-5 leaf	5.0	13.7	36.0	11.0	1.7	1.0	0	5.0	1.0	0.0	0	2.3	76.7
V+B	Pro	2.24	1	Pre	0.0	2.7	0.3	17.7	0.0	0.0	0	6.3	0.0	0.0	0	3.0	30.0
B	Pro	2.24	1	Pre	1.0	5.3	0.0	13.7	0.0	1.3	0	7.3	0.0	0.0	0	3.3	31.9
V+B	---	---	---	---	5.0	2.7	6.3	19.0	0.0	0.7	0	1.3	0.0	0.3	0	0.3	35.6
B	---	---	---	---	10.6	12.7	9.3	14.5	0.3	8.0	0	4.3	0.3	0.3	0	1.7	62.0
LSD[d]					2.4	7.7	3.1	19.9	2.4	7.7	--	19.9	2.4	7.7	--	19.9	---

[a] Al, alachlor; B, benefin; DB, 2,4-DB; Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene; V, vernolate. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[b] Vernolate applied at 2.8 kg/ha; benefin applied at 1.68 kg/ha.

[c] Cotyl, cotyledonary; Pre, preemergence.

[d] LSD may be used only to distinguish differences for V+B versus B within a specific cracking or postemergence treatment.

Table 2. Combined treatment means for number of bur gherkin plants (of about 100 planted at three depths in 929 cm²) that survived herbicide treatments in 1976 and 1977 at Tifton, Georgia, and Headland, Alabama.

Variable	Survival (no.)		
	Vernolate + benefin		Benefin
Pretreatment	3.3		4.3
	Cotyledonary		3- to 5-leaf
Stage at 1st postemergence treatment	2.5		5.5
	1976		1977
Year	2.3		5.3
	Tifton		Headland
Location	1.5		6.1
	0-2.5 cm	2.5-5.0 cm	5.0-7.5 cm
Depth of planting	7.9	2.3	1.2

tion is puzzling. Table 3 shows that in three of the four studies the differences among the treatment means for both the preplant and postplant herbicidal treatments exceed the probability level of .007. Differences among planting depths exceed the .0001 level in all studies; therefore all planting depths are significantly different in every study.

Averaging results over planting depths and preplant treatments indicates that several cracking- or postemergence-applied treatments were highly effective in controlling bur gherkins at Tifton but not at Headland (Table 4). Among the more effective and consistent treatments were (a) dinoseb (four applications) and (b) alachlor + naptalam + dinosebfollowed by dinoseb or dinoseb/2,4-DB (all applied at the cotyledonary leaf stage). Preemergence application of pronamide reduced the number of bur gherkin plants at both locations in 1976 but only at Tifton in 1977.

Except for postplant treatments, the treatment vari-

Table 3. Analysis of variance in stand of bur gherkins that survived herbicide treatments in 1976 and 1977 at Tifton, Georiga, and Headland, Alabama.

Sources of significant variation	Probability of a larger F from analysis of variance			
	1976		1977	
	Tift	Wgs	Tift	Wgs
Postplant treatment (T_1)	0.0004	0.0080	0.0001	NS
Preplant treatment (T_2)	0.0001	0.0001	0.0004	NS
$T_1 \times T_2$	0.0083	NS	NS	NS
Replication x $T_2 \times T_1$	NS	NS	NS	0.0001
Planting depth (D)	0.0001	0.0001	0.0001	0.0001
$T_2 \times D$	0.0001	0.0002	0.0001	NS
$T_1 \times D$	0.0001	0.0001	0.0001	NS

Table 4. Number of bur gherkin plants (of about 100 planted in 929 cm²) that survived herbicide treatments in 1976 and 1977 at Tifton and Headland, averaged over planting depths and preplanting treatments.

Postplant treatment			Stage at first treatment[c]	Survival[a]			
				1976		1977	
Herbicide[b]	Rate (kg/ha)	No. of applications		Tift (no.)	Wgs (no.)	Tift (no.)	Wgs (no.)
Tox	1.12	4	Cotyl	2.2ab	3.6abcde	3.2ab	8.7abc
Tox	2.24	4	Cotyl	0.6cd	6.0a	0.8bcd	6.8abc
DB	0.45	2	Cotyl	1.2bcd	6.3a	2.2abc	4.6bc
Di	0.84	4	Cotyl	0.3d	1.1de	0.2d	3.3c
Al+N+Di	3.36+2.24+1.12	1	Cotyl	0.4d	1.7abcde	0.0d	8.9abc
Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	0.3d	0.1e	0.0d	4.2bc
Di/DB	0.84+0.24	3/1	Cotyl	0.2d	1.3cde	0.5cd	5.0bc
Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	0.3d	1.5de	0.2d	4.8bc
Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	1.3bcd	5.5ab	3.3a	12.0abc
DB	0.45	2	3-5 leaf	2.1ab	4.9abcd	3.0a	18.7a
Di	0.84	3	3-5 leaf	1.4abcd	5.2abc	2.2abc	16.5ab
Di/DB	0.84/0.32	3/1	3-5 leaf	1.8abc	4.6abcd	2.8a	14.4abc
Tox	2.24	4	3-5 leaf	2.0abc	4.1abcd	6.7a	8.8abc
Pro	2.24	1	Pre	0.2d	1.6bcde	0.0d	8.6abc
None (pretreated check)	---	---	---	2.7a	4.1abcde	2.6ab	6.8abc

[a] Any two means in a column not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

[b] Al, alachlor; DB, 2,4-DB; Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[c] Cotyl, cotyledonary; Pre, preemergence.

ables (when each was averaged over all others) affected the green weight of surviving bur gherkins generally as they did the number of surviving plants (Tables 5 and 6). Vernolate usually improved the performance of toxaphene, regardless of rate or time of application (Table 5). Sometimes the response of bur gherkins to either 2,4-DB or dinoseb was also markedly enhanced by pretreatment with vernolate. In three of four experiments, the preplant-incorporated treatment (benefin vs. benefin + vernolate) significantly affected green weight (Table 7). In both experiments at Headland, depth at which bur gherkin seed was planted was significant. Since there were no surviving bur gherkins except at the 0 to 2.5 cm depth bur gherkin plants were not harvested by depth at Tifton. Consequently, we were not able to determine the influence of depth at that location. The influence of depth of planting was similar with regard to number and green weight of surviving bur gherkins; of the total fresh weight, 69, 15, and 16% could be accounted for by seed planted at depths of 0 to 2.5, 2.5 to 5.0, and 5.0 to 7.5 cm, respectively (Table 6). Over six times as much fresh weight was produced when treatments were delayed to the 3- to 5-leaf stage rather than the cotyledonary stage, and about twice as much green matter was produced when the pretreatment did not include vernolate. Amost twice as much fesh weight of bur gherkin was produced in 1977 as in 1976. While four times as many plants survived at

Table 5. Green weight of bur gherkin plants (from seed planted at three depths) that survived herbicide treatments at Tifton, Georgia (Tift), and Headland, Alabama (Wgs), in 1976 and 1977.

Herbicides[a]		Postplanting treatment			Green weight of gherkins planted at indicated depth[d,e]												
					0-2.5 cm				2.5-5.0 cm				5.0-7.5 cm				
					1976		1977		1976		1977		1976		1977		
Preplant incorporated[b]	Postplant treatment	Rate (kg/ha)	No. of applications	Stage at first treatment[c]	Tift (g)	Wgs (g)	Tift (g)	Wgs (g)	Tift (g)	Wgs (g)	Tift (g)	Wgs (g)	Tift (g)	Wgs (g)	Tift (g)	Wgs (g)	Total (g)
V+B	Tox	1.12	4	Cotyl	150	212	567	121	0	0	0	439	0	0	0	136	1655
B	Tox	1.12	4	Cotyl	917	166	1917	499	0	0	0	484	0	15	0	76	4074
V+B	Tox	2.24	4	Cotyl	8	167	25	0	0	0	0	0	0	0	0	0	200
B	Tox	2.24	4	Cotyl	58	15	192	0	0	348	0	0	0	0	0	0	613
V+B	DB	0.45	2	Cotyl	17	181	217	91	0	0	0	1407	0	30	0	0	1943
B	DB	0.45	2	Cotyl	758	999	1458	1967	0	227	0	1256	0	0	0	333	6998
V+B	Di	0.84	4	Cotyl	0	30	0	0	0	0	0	0	0	0	0	0	30
B	Di	0.84	4	Cotyl	50	0	492	0	0	0	0	0	0	0	0	0	542
V+B	Al+N+Di	3.36+2.24+1.12	1	Cotyl	0	0	0	0	0	0	0	0	0	0	0	0	15
B	Al+N+Di	3.36+2.24+1.12	1	Cotyl	708	91	150	0	0	76	0	0	0	0	0	0	1025
V+B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	0	0	0	0	0	0	0	0	0	0	0	0	T
B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	17	0	0	1476	0	0	0	0	0	0	0	0	1493
V+B	Di/DB	0.84/0.24	3/1	Cotyl	0	0	0	0	0	0	0	0	0	0	0	0	T
B	Di/DB	0.84/0.24	3/1	Cotyl	67	0	383	151	0	15	0	666	0	0	0	0	1282
V+B	Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	17	0	0	0	0	0	0	0	0	0	0	136	153
B	Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	17	0	100	636	0	0	0	0	0	0	0	0	753
V+B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	3083	242	717	2361	0	0	0	499	0	0	0	1483	8385
B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	3058	1438	2408	1574	0	878	0	742	0	0	0	899	10997
V+B	DB	0.45	2	3-5 leaf	517	1801	575	3844	0	969	0	1286	0	0	0	4101	13093
B	DB	0.45	2	3-5 leaf	2567	3134	1208	4540	0	0	0	2421	0	0	0	3995	17865
V+B	Di	0.84	3	3-5 leaf	617	0	500	1846	0	0	0	1317	0	0	0	2497	6777
B	Di	0.84	3	3-5 leaf	1908	2497	1567	3239	0	76	0	1423	0	0	0	2330	13040
V+B	Di/DB	0.84/0.32	3/1	3-5 leaf	0	0	525	3102	0	0	0	787	0	0	0	560	4974
B	Di/DB	0.84/0.32	3/1	3-5 leaf	1483	1362	1392	3511	0	0	0	3556	0	227	0	2075	13606
V+B	Tox	2.24	4	3-5 leaf	800	30	175	46	0	0	0	348	0	0	0	953	2352
B	Tox	2.24	4	3-5 leaf	1400	136	675	1090	0	711	0	666	0	0	0	0	4678
V+B	Pro	2.24	1	Pre	0	424	442	605	0	0	0	0	0	0	0	0	1471
B	Pro	2.24	1	Pre	125	136	0	0	0	787	0	0	0	0	0	0	1245
V+B	---	---	---	---	1402	---[f]	1358	2724	0	0	0	0	0	30	0	0	5514
B	---	---	---	---	10167	---[f]	3308	999	0	15	0	257	0	2391	0	151	17288
LSD[g]					997.0	1262.8	1032.8	2934.4	907.0	1262.8	1032.8	2934.4	997.0	1262.8	1032.8	2934.4	---

[a] Al, alachlor; B, benefin; DB, 2,4-DB; Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene; V, vernolate. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[b] Vernolate applied at 2.8 kg/ha; benefin applied at 1.68 kg/ha.

[c] Cotyl, cotyledonary; Pre, preemergence.

[d] "T" indicates only trace amounts of plant material.

[e] Occasionally, where some bur gherkin plants were counted earlier (Table 1) no corresponding green weights were recorded (Table 5) because the number of plants were determined several weeks prior to green weight measurements (and before herbicides produced maximum effects).

[f] Data for these plots were inadvertently lost.

[g] LSD may be used only to distinguish differences for V+B versus B within a specific cracking or postemergence treatment.

Table 6. Combined treatment means for green weight of bur gherkin plants (from seed planted at three depths) that survived herbicide treatments in 1976 and 1977 at Tifton, Georgia, and Headland, Alabama.

Variable	Green weight (g)		
	Vernolate + benefin		Benefin
Pretreatment	256.4		530.6
	Cotyledonary		3- to 5-leaf
Stage at 1st postplanting treatment	108.2		681.1
	1976		1977
Year	277.8		509.2
	Tifton		Headland
Location	277.0		510.0
	0-2.5 cm	2.5-5.0 cm	5.0-7.5 cm
Depth of planting	811.3	180.7	188.4

Table 7. Analysis of variance in green weight of bur gherkins that survived herbicide treatments in 1976 and 1977 at Tifton and Headland.

Sources of significant variation	Probability of a larger F from analysis of variance			
	1976		1977	
	Tift	Wgs	Tift	Wgs
Replication	0.0342	0.0506	NS	NS
Postplant treatment (T_1)	0.0001	NS	0.0003	0.0001
Preplant treatment (T_2)	0.0001	0.0021	0.0001	NS
$T_1 \times T_2$	0.0001	NS	NS	NS
Planting depth (D)	---	0.0001	---	0.0019
$T_1 \times D$	NS	0.0005	NS	0.0436

Headland as at Tifton (Table 3), only twice as much green matter was produced (Table 6).

Averaging results over planting depths and preplanting treatments showed that several of the treatment sequences controlled growth of bur gherkins (Table 8). While the difference was statistically significant in only one of eight comparisons, toxaphene applied at 2.24 kg/ha and begun at the cotyledonary stage tended to be more effective than toxaphene applied at a lower rate or initiated at the 3- to 5-leaf stage. Generally, applications initiated at the cotyledonary stage were much more effective than those initiated at the 3- to 5-leaf stage.

At Headland in 1977, bur gherkin plants surviving treatment producd substantially more gherkins when treatments were delayed to the 3- to 5-leaf stage than when treatments were initiated at the cotyledonary stage (Tables 9, 10, and 11). Treatments resulting in the highest production of gherkins were 2,4-DB, dinoseb, and dinoseb/2,4-DB applied at the 3- to 5-leaf stage (Table 11).

Table 8. Green weight of bur gherkin plants that survived herbicide treatments in 1976 and 1977 at Tifton, Georgia, and Headland, Alabama, averaged over planting depths and preplanting treatments.

Postplant treatment			Stage at first Treatment[c]	Green weight[a]			
				1976		1977	
Herbicide[b]	Rate (kg/ha)	No. of applications		Tift (g)	Wgs (g)	Tift (g)	Wgs (g)
Tox	1.12	4	Cotyl	533c	71b	1242bc	293de
Tox	2.24	4	Cotyl	33c	88b	108d	0e
DB	0.45	2	Cotyl	388c	240b	838bcd	842cd
Di	0.84	4	Cotyl	25c	5b	246cd	0e
Al+N+Di	3.36+2.24+1.12	1	Cotyl	354c	30b	75d	0e
Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	8c	0b	0d	246de
Di/DB	0.84+0.24	3/1	Cotyl	33c	3b	192cd	136de
Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	17c	0b	50d	129de
Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	3071b	426ab	1563ab	1260c
DB	0.45	2	3-5 leaf	1541bc	984a	892bcd	3364a
Di	0.84	3	3-5 leaf	1262bc	429ab	1033bcd	2109b
Di/DB	0.84/0.32	3/1	3-5 leaf	742c	265b	958bcd	2265b
Tox	2.24	4	3-5 leaf	1100bc	146b	425cd	517cde
Pro	2.24	1	Pre	63c	257b	221d	101de
None (pretreated check)	---	---	---	5784a	609ab	2333a	688cde

[a] Any two means in a column not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

[b] Al, alachlor; DB, 2,4-DB; Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[c] Cotyl, cotyledonary; Pre, preemergence.

Table 9. Number of gherkins produced by bur gherkin plants (from seed planted at three depths) that survived herbicide treatments at Headland, Alabama in 1977.

Herbicides[a]					Gherkins produced by plants planted at indicated depths			
Preplant incorporated[b]	Postplant treatment	Rate (kg/ha)	No. of applications	Stage at first Treatment[c]	0 to 2.5 cm (no.)	2.5 to 5.0 cm (no.)	5 to 7.5 cm (no.)	Total (no.)
V+B	Tox	1.12	4	Cotyl	2	7	5	14
B	Tox	1.12	4	Cotyl	8	11	2	21
V+B	Tox	2.24	4	Cotyl	0	0	0	0
B	Tox	2.24	4	Cotyl	0	0	0	0
V+B	DB	0.45	2	Cotyl	40	50	0	90
B	DB	0.45	2	Cotyl	112	39	29	180
V+B	Di	0.84	4	Cotyl	0	0	0	0
B	Di	0.84	4	Cotyl	0	0	0	0
V+B	Al+N+Di/Di	3.36+2.24+1.12	1	Cotyl	0	0	0	0
B	Al+N+Di/Di	3.36+2.24+1.12	1	Cotyl	0	0	0	0
V+B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	0	0	0	0
B	Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	37	0	0	37
V+B	Di/DB	0.84/0.22	3/1	Cotyl	0	0	0	0
B	Di/DB	0.84/0.22	3/1	Cotyl	5	26	0	31
V+B	Al+N+Di/DiDB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	0	0	3	3
B	Al+N+Di/DiDB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	18	0	0	18
V+B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	77	21	57	155
B	Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	15	7	8	30
V+B	DB	0.45	2	3-5 leaf	159	53	189	401
B	DB	0.45	2	3-5 leaf	150	91	145	386
V+B	Di	0.84	3	3-5 leaf	51	48	116	215
B	Di	0.84	3	3-5 leaf	70	48	93	211
V+B	Di/DB	0.84/0.32	3/1	3-5 leaf	105	15	30	150
B	Di/DB	0.84/0.32	3/1	3-5 leaf	51	135	76	262
V+B	Tox	2.24	4	3-5 leaf	0	6	42	48
B	Tox	2.24	4	3-5 leaf	3	2	0	5
V+B	Pro	2.24	1	Pre	30	0	0	30
B	Pro	2.24	1	Pre	0	0	0	0
V+B	---	---	---	---	50	0	0	50
B	---	---	---	---	11	5	1	17
LSD[d]					36	36	36	--

[a] Al, alachlor; B, benefin; DB, 2,4-DB; Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene; V, vernolate. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[b] Vernolate applied at 2.8 kg/ha; benefin applied at 1.68 kg/ha.

[c] Cotyl, cotyledonary; Pre, preemergence.

[d] LSD may be used only to distinguish differences for V+B versus B within a specific cracking or postemergence treatment.

Table 10. Analysis of variance in number of gherkins produced by bur gherkin plants that survived herbicide treatments at Headland in 1977.

Sources of significant variation	Probability of a larger F from analysis of variance
Postplant treatment	0.0001
Planting depth	0.0500

Because of the particularly heavy and uniform population of bristly starbur at Headland, control of this species was determined in both years (Table 12). Analysis of variance revealed a significant effect from postplant treatments in both years. It was interesting, however, that in neither 1976 nor in 1977 did the preplant application of vernolate have a significant effect on the results of subsequent herbicidal treatments. This lack of pretreatment effect is in sharp contrast to the findings with bur gherkins. Treatments delayed to the 3- to 5-leaf stage of bur gher-

Table 11. Number of gherkins produced by bur gherkin plants that survived herbicide treatments at Headland in 1977, averaged over planting depths and preplant treatments.

Postplant treatment				
Herbicide[a]	Rate (kg/ha)	No. of appli-cations	Stage at first treatment[b]	No. of gherkins[c]
Tox	1.12	4	Cotyl	1.9 ef
Tox	2.24	4	Cotyl	0.0 f
DB	0.45	2	Cotyl	15.0 cd
Di	0.84	4	Cotyl	0.0 f
Al+N+Di	3.36+2.24+1.12	1	Cotyl	0.0 f
Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	2.1 ef
Di/DB	0.84+0.24	3/1	Cotyl	1.4 ef
Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	0.4 ef
Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	10.4 de
DB	0.45	2	3-5 leaf	42.8 a
Di	0.84	3	3-5 leaf	25.4 b
Di/DB	0.84/0.32	3/1	3-5 leaf	22.9 bc
Tox	2.24	4	3-5 leaf	2.9 ef
Pro	2.24	1	Pre	1.7 ef
None (pretreated check)	---	---	---	3.7 ef

[a] Al, alachlor; DB, 2,4-DB, Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[b] Cotyl, cotyledonary; Pre, preemergence.

[c] Any two means in a column not followed by the same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

kins (bristly starbur plants were 10 to 12 cm in height) controlled bristly starbur far better than they did bur gherkins, which illustrates that the latter species is generally more difficult to control.

Peanut yields were taken only in 1976 at Headland and in 1977 in Tifton (Table 13 and 14). Differences due to postplant treatments were significant in both experiments. At Tifton, some of the more intensive treatments such as dinoseb, alachlor + naptalam + dinoseb/dinoseb, alachlor + naptalam + dinoseb/dinoseb/2,4-DB, and dinoseb/2,4-DB at the 3- to 5-leaf stage, caused significant yield reductions.

Summary

In this series of experiments we have shown that bur gherkins can be controlled in peanuts. The principal factors that contributed to the control of this weed included (a) the use of vernolate as a pretreatment and (b) the initiation of herbicide treatment sequences at the cotyledonary stage of weed development.

Our studies show that judicious use of presently la-

Table 12. Control of bristly starbur plants (of naturally occurring stands in plots) that survived herbicide treatments in 1976 and 1977 at Headland, Alabama, averaged over preplanting treatments.

Postplant treatment				Control[a] %[d]	
Herbicide[b]	Rate (kg/ha)	No. of applications	State at first treatment[c]	1976	1977
Tox	1.12	4	Cotyl	0c	0d
Tox	2.24	4	Cotyl	28bc	40c
DB	0.45	2	Cotyl	83a	27cd
Di	0.84	4	Cotyl	100a	100a
Al+N+Di	3.36+2.24+1.12	1	Cotyl	70a	85ab
Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	99a	100a
Di/DB	0.84+0.24	3/1	Cotyl	100a	97ab
Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	83a	83ab
Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	62ab	38c
DB	0.45	2	3-5 leaf	77a	58bc
Di	0.84	3	3-5 leaf	97a	93ab
Di/DB	0.84/0.32	3/1	3-5 leaf	90a	80ab
Tox	2.24	4	3-5 leaf	0c	0d
Pro	2.24	1	Pre	0c	0d
None (pretreated check)	---	---	---	0c	0d

[a] Any two means in a column not followed by same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

[b] Al, alachlor; DB, 2,4-DB, Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene."+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

[c] Cotyl, cotyledonary; pre, preemergence.

[d] Percent control; 0 = no control; 100 = complete control as compared to untreated plots.

Table 13. Yield of Florunner peanuts treated with herbicides in 1976 in Headland and 1977 at Tifton, averaged over preplanting treaments.

Postplant treatment				Yield[a]	
Herbicide[b/]	Rate (kg/ha)	No. of applications	Stage at first treatment[c]	Wgs 1976 (kg/ha)	Tift 1977 (kg/ha)
Tox	1.12	4	Cotyl	4806 ab	2009a
Tox	2.24	4	Cotyl	3945 bcde	1937 ab
DB	0.45	2	Cotyl	5237 a	1722 abc
Di	0.84	4	Cotyl	4376 abcde	1076 gh
Al+N+Di	3.36+2.24+1.12	1	Cotyl	4735 abc	1435 cdef
Al+N+Di/Di	3.36+2.24+1.12/0.84	1/3	Cotyl	3372 e	861 h
Di/DB	0.84+0.24	3/1	Cotyl	4878 ab	1578 cde
Al+N+Di/Di/DB	3.36+2.24+1.12/0.84/0.24	1/2/1	Cotyl	4376 abcde	1291 efg
Di+DB+Tox	0.84+0.45+1.12	1	3-5 leaf	4806 ab	1506 cde
DB	0.45	2	3-5 leaf	3659 cde	1793 abc
Di	0.84	3	3-5 leaf	3945 bcde	1291 defg
Di/DB	0.84/0.32	3/1	3-5 leaf	3587 de	1148 fgh
Tox	2.24	4	3-5 leaf	4519 abcd	1722 abc
Pro	2.24	1	Pre	4448 abcde	1650 bcd
None (pretreated check)	---	---	---	3874 bcde	1722 abc

a Any two means in a column not followed by same letter are significantly different at the 5% level according to Duncan's Multiple Range Test.

b Al, alachlor; DB, 2,4-DB, Di, dinoseb; N, naptalam; Pro, pronamide; Tox, toxaphene. "+" indicates herbicides used together in one application; "/" indicates herbicides used separately in sequential applications.

c Cotyl, cotyledonary; Pre, preemergence.

Table 14. Analysis of variance in yield of peanuts treated with herbicides in 1976 at Headland and in 1977 at Tifton.

Sources of significant variation	Probability of a larger F from analysis of variance: Headland 1976	Tifton 1977
Replication (R)	NS	0.0003
Postplant treatment (T_2)	0.0104	0.0001
R X T_2	NS	0.0001
Preplant treatment (T_1)	NS	0.0090

beled herbicides can suppress bur gherkins if applications are timely. It is important to note that each of these experiments was initiated fairly late in the season. As a result, the normal cracking application of herbicide coincided with early development of bur gherkin. Unfortunately, this weed does not begin germination early inthe spring, when peanut planting is initiated. Therefore, consistent and effective bur gherkin control programs might require some of the more intensive herbicide programs which include dinoseb, 2, 4-DB, and toxaphene. Based on other studies, it is very probable that if *all* the bur gherkin plants are controlled for 6 weeks after peanuts emerge, the competitive capacity of the peanut canopy will suppress those bur gherkin plants which emerge later in the season (1).

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