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# Pesticide Interactions with Peanut Cultivars[1]

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## ABSTRACT

Interactions among six peanut (*Arachis hypogaea* L.) cultivars, herbicides individually and in sequence, and a systemic insecticide were studied on four soil series in 1976 and on three soil series in 1977. Yields of peanuts grown on all soils were reduced significantly in 1976 by intensive sequential applications of the five herbicidal treatments. Additionally, repeated dinoseb treatment reduced yields on the Ruston and Greenville soils. In 1977, yield decreases did not occur from any herbicide treatment on the Dothan or Greenville soils; however, yields on the Tifton soil were reduced by intensive sequential herbicidal treatment or by 2,4-DB alone. Herbicides did not interact significantly with cultivars except on Greenville soil in 1977 when yields of only the Tifrun cultivar were increased by treatment with either benefin or dinoseb. The systemic insecticide disulfoton, with one exception, consistently increased the yield of peanuts when averaged over cultivars and herbicides. Also, in 1977, on the Greenville soil, Titrun yields were increased significantly by disulfoton but disulfoton effects on other cultivars were not statistically significant. Market quality tests indicated that the percentage of sound mature kernels (SMK) was frequently reduced by intensive herbicidal applications.

Key Words: Cultivars, Pesticide-interactions, Herbicide-sequences, Disulfoton, peanut.

During recent years, the intensity of herbicide usage by farmers on peanuts (*Arachis hypogaea* L.) has increased greatly. Introduction of new higher yielding peanut cultivars and the attainment of higher yield levels have accompanied this increase in herbicide usage. Many researchers and extension specialists are concerned about genetic vulnerability of crops to intensified pesticide treatment. Hauser *et al.* (2) summarized previous literature on pesticide interactions in oilseed crops and also presented new results which indicated that (a) peanut cultivars often respond differentially to pesticides and (b) that these interactions are influenced by edaphic and environmental conditions. On three of four soil series, an insecticide X cultivar interaction occurred accompanied by significant yield increases of Florunner, the most widely grown peanut cultivar in the United States. Herbicides interacted with cultivars in four of the eight experiments. In further studies, Hauser et al. (3) found that the yields of Florunner were increased by selected moderate herbicidal sequences involving only preplant incorporated and "cracking" treatments. However, yields were decreased by intensive herbicidal sequences which included four applications of dinoseb. As in the first studies, the average yield of peanuts was increased significantly by the insecticide disulfoton. For further clarification about interaction effects on a wider spectrum of germplasm, the responses of six cultivars on four soil series to the systemic insecticide disulfoton and to five herbicidal treatments applied singly and in sequence were studied.

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## Materials and Methods

Seven experiments were conducted in 1976 and 1977 on Dothan sandy loam (Headland, AL), on Greenville sandy clay loam (Plains, GA), on Ruston loamy fine sand (Marianna, FL - 1976 only) and on Tifton sandy loam (Ashburn, GA). The peanut cultivars were 'GK 3' and 'Early Bunch' (virginia types), 'Florunner' and 'Tifrun' (runner types), and 'Tamnut 74' and 'GK 19' (spanish types). Although dates varied among locations, all plantings were made during the traditional planting season from April 10 to May 20.

The experimental design at all locations was a split, split, split plot with four replicates. Either two- or four-row plots were used. Cultivars were whole plots and herbicidal treatments were split plots. A description of the herbicidal treatments follows: V was vernolate (*S*-propyl dipropylthiocarbamate) at 2.80 kg/ha applied as a preplant incorporated treatment; B was benefin (*N*-butyl-*N*-ethyl-α,α,α-trifluoro-2,6-dinitro-*p*-toluidine) at 1.68 kg/ha applied as a preplant incorporated treatment; A + ND was a mixture of alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] plus naptalam (*N*-1-naphthylphthalamic acid) and dinoseb (2-*sec*-butyl-4,6-dinitrophenol) at 3.36 + 2.24 + 1.12 kg/ha, respectively, applied at the "cracking" stage; D was dinoseb at 0.84 kg/ha applied four times beginning at "cracking" plus 10 days; 2,4-DB was 4-(2,4-dichlorophenoxy)butyric acid at 0.45 kg/ha applied twice as a mid- to late season postemergence spray: "Sequence" consisted of serial treatment with all of the aforementioned herbicides; and finally, "Check" consisted of peanuts which recieved no herbicide. All treatments, including the check, were handweeded as needed throughout the season to eliminate weed competition as a factor influencing crop yield. If cultivation was needed to control weeds in the check plots, all of the treated plots were cultivated at the same time as the checks. The split, split, split plots were disulfoton (*O,O*-diethyl *S*-(2)ethylthio)ethyl) phosphorodithioate at 1.12 kg/ha versus none. Disulfoton, formulated at 10% granules, was applied in the drill with the peanut seed. Other production practices followed the recommendations of the respective Cooperative Extension Service.

Each cultivar was harvested separately at maturity. The peanuts were dug with a commercial digger-shaker, windrowed, and combined within five days. Yield (from all studies) and harvest sample market quality data (from Greenville and Tifton soils) were subjected to analayses of variance and to Duncan's multiple range test using comparisons at the 5% level and, where noted, at the 10% level. Only those sets of treatment or interaction means which were statistically significant are presented and discussed.

The number of nematodes in the soil at the 0 to 20 cm depth was determined in 1976. Assays were made on the Greenville soil at planting, at midseason and at harvest. They were made on the Dothan and Tifton soils only at harvest. Ten soil cores (1.9 X 20 cm) were taken from the drill rows in each plot. The soil was composited and thoroughly mixed. Nematodes were extracted and counted by genera from a 150 $cm^3$ subsample using the centifuge-sugar-flotation method (4).

## Results

**Yield of peanut cultivars.** The average yields of GK 3 and Tifrun were significantly higher than the other cultivars (Table 1). As in our previous studies, GK 3 consistent-

Table 1. Summary of peanut yields from cultivar-pesticide interaction studies on selected soil types in the Southeast peanut belt, 1976 and 1977.

| Source of variation | Yield of in-shell peanuts (kg/ha)a/ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Soil Type | | | | Soil Type | | | |
| | Dothan | Greenville | Ruston | Tifton | Dothan | Greenville | Tifton | Av. |
| | 1976 | | | | 1977 | | | |
| Cultivar | Averaged over herbicide and insecticide treatments | | | | | | | |
| GK 3 | 3390a | 4400b | 5270a | 4340a | 5450a | 3730b | 4260a | 4410a |
| Early Bunch | 2740b | 4950a | 5620a | 4070a | 3740c | 4480ab | 3600b | 4170b |
| Florunner | 2660b | 4790a | 4680b | 3820a | 4870b | 4390ab | 2670c | 3980b |
| Tifrun | 2600b | 5080a | 5480a | 4490a | 4650b | 4780a | 4600a | 4530a |
| Tamnut 74 | 2460b | 2830d | 3700c | 2750c | 1370d | 3760b | 2790c | 2810d |
| GK 19 | 2500b | 4020c | 4430b | 3360bc | 4140c | 4490ab | 3350b | 3760c |
| Herbicide Treatmentsb/ | Averaged over cultivar and insecticide treatments | | | | | | | |
| V | 2890ab | 4340bc | 5130ab | 3860bc | 4020NS | 4240NS | 3390ab | 3980bc |
| B | 3150a | 4670a | 5300a | 4250a | 4140 | 4360 | 3720a | 4230a |
| A+ND | 2720b | 4480ab | 5000ab | 4040ab | 4020 | 4350 | 3740a | 4050b |
| D | 2740b | 4200c | 4240c | 3680c | 4310 | 4310 | 3570ab | 3860c |
| 2,4-DB | 2670b | 4460ab | 4940b | 3920bc | 4000 | 4320 | 3330b | 3950c |
| Sequence | 1920c | 3680d | 4270c | 3060d | 3880 | 4140 | 3300b | 3460d |
| Check | 2960ab | 4590ab | 5180ab | 3900bc | 3930 | 4160 | 3770a | 4070b |
| Insecticide | Averaged over cultivar and herbicide treatments | | | | | | | |
| Disulfoton | 2820a | 4390ac/ | 4950a | 3840NS | 4180a | 4330a | 3610ac/ | 4020a |
| No disulfoton | 2620b | 4290b | 4780b | 3800 | 3910b | 4210b | 3490b | 3870b |

a/ Means in the same column within the same set of averages not followed by the same letter are significantly different at the 5% level except as indicated.

b/ In all tables, the herbicidal abbreviations are as follows: V is vernolate; B is benefin; A+ND is a mixture of alachlor-naptalam-dinoseb; D is dinoseb; 2,4-DB is 2,4-(dichlorophenoxy) butyric acid; sequence includes all of the individual herbicide treatments applied serially.

c/ Significance tested at the 10% level.

ly yielded higher than the other varieties on the Dothan soil. Florunner and Early Bunch produced intermediate yields. Early Bunch outyielded Florunner on the Ruston soil in 1976 and on the Tifton soil in 1977; however, Florunner outyielded Early Bunch by 1130 kg/ha on the Dothan soil in 1977. Average yields of the Spanish type cultivars were lower than for either the bunch or runner types with GK 19 generally yielding higher than Tamnut 74.

**Effects of herbicides on yields.** Peanut yields at all locations were reduced significantly in 1976 by intensive sequential applications of the five herbicidal treatments (Table 1). In addition, the repeated dinoseb treatments reduced yields on the Ruston and Greenville soils. On the Tifton soil, benefin increased yields in 1976. In 1977, yield decreases did not occur from any herbicide treatment on the Dothan or Greenville soils; however, the intensive sequential treatments and 2,4-DB applied alone reduced yields on the Tifton soil.

**Effect of disulfoton on yield.** When averaged over all experiments disulfoton treated peanuts yielded significantly higher than the nontreated (Table 1). The average difference of 150 kg/ha was almost three times the magnitude observed in our previous work (2). The greatest difference due to disulfoton occurred on the Dothan soil with increases of 200 and 270 kg/ha in 1976 and 1977, respectively.

**Interactions among cultivars and pesticides.** Herbicides did not interact significantly with cultivars except on the Greenville soil in 1977 when yields of only the Tifrun cultivar were increased by treatment with either benefin or dinoseb above the check but not above other herbicidal treatments (Table 2). Also, in 1977, on the Greenville soil, Tifrun yields were increased significantly by disulfoton but disulfoton effects on other cultivars were not statistically significant. In general, fewer interactions among

Table 2. Peanut yields as affected by interaction of cultivars with pesticide treatments, Greenville soil, 1977[a].

| Source of variation | Yield of in-shell peanuts (kg/ha) | | | | | |
|---|---|---|---|---|---|---|
| | Cultivars | | | | | |
| | GK-3 | Early Bu. | Florunner | Tifrun | Tamnut | GK-19 |
| Herbicide Treatments | Interaction of herbicides and cultivars | | | | | |
| V | 3380b | 4890a | 4330a | 4720ab | 3520a | 4580a |
| B | 4010a | 4440ab | 4370a | 5270a | 3770a | 4320a |
| A+ND | 3670ab | 4780a | 4670a | 4760ab | 3826a | 4610a |
| D | 3380b | 4690a | 4350a | 4960a | 3750a | 4760a |
| 2,4-DB | 3810ab | 4380ab | 4330a | 4760ab | 3950a | 4690a |
| Sequence | 4010a | 3970b | 4370a | 4730ab | 3570a | 4170a |
| Check | 3810ab | 4380ab | 4290a | 4240b | 3940a | 4340a |
| Insecticide Treatments | Interaction of insecticide and cultivars | | | | | |
| Disulfoton | 3650a | 4520a | 4480a | 4980a | 3770a | 4580a |
| No disulfoton | 3800a | 4430a | 4300a | 4580b | 3760a | 4410a |

a/ Herbicide or insecticide means within a cultivar in the same column not followed by the same letter are significantly different.

cultivars and pesticides occurred in these studies in comparison to previous research (2).

**Effect of pesticides on SMK's.** The percentage of SMK's following herbicidal treatments from 1976 to 1977 are shown in Table 3. The herbicidal sequence consistently reduced SMK's of peanuts grown on the Greenville soil.

On the Tifton soil, a significant interaction of herbicides X disulfoton occurred in 1976 (Table 4) where the sequence treatment with no disulfoton reduced SMK's significantly.

**Number of peanut plants.** The number of peanut plants at harvest on the Tifton soil was reduced 11% in 1976 by herbicides applied in sequence (Table 5). Herbicides used singly did not significantly affect plant number. Compared to the check, disulfoton increased the number of plants by 4% in 1976, a difference which was statistically significant at the 5% level of probability.

Table 3. Percentage of sound mature kernels following herbicide treatments on Greenville soil, 1976-1977[a].

| Herbicide treatment | Percent sound mature kernels | |
|---|---|---|
| | 1976 | 1977 |
| V | 71.6 ab | 67.9 ab |
| B | 72.0 a | 68.4 a |
| A+ND | 70.1 ab | 68.2 ab |
| D | 70.9 ab | 67.6 ab |
| 2,4-DB | 70.2 b | 67.0 bc |
| Sequence | 67.0 c | 66.1 c |
| Check | 71.8 ab | 67.9 a |

a/ Means in the same column not followed by the same letter are significantly different at the 5% level.

Table 4. Percentage of sound mature kernels from interaction study, Tifton, soil, 1976[a].

| Herbicide treatment | Percent sound mature kernels | |
|---|---|---|
| | Disulfoton | No Disulfoton |
| V | 72.00 a | 71.22 a |
| B | 71.72 a | 72.22 a |
| A+ND | 70.50 a | 70.94 a |
| D | 70.72 a | 71.17 a |
| 2,4-DB | 69.65 a | 70.83 a |
| Sequence | 68.50 a | 65.50 b |
| Check | 72.24 a | 71.44 a |

a/ Means within the same line not followed by the same letter are significantly different at the 5% level.

Table 5. Number of peanut plants at harvest following herbicide and insecticide treatments, Tifton soil, 1976-1977[a].

| Source of variation | Average number of plants/plot 1976 | 1977 |
|---|---|---|
| V | 103 a | 116 a |
| B | 99 a | 118 a |
| A+ND | 102 a | 120 a |
| D | 100 a | 117 a |
| 2,4-DB | 103 a | 114 a |
| Sequence | 91 b | 123 a |
| Check | 102 a | 120 a |
| Insecticide | | |
| Disulfoton | 102 a | 119 a |
| No disulfoton | 98 b | 118 a |

a/ Means in the same column within the same set of averages not followed by the same letter are significantly different at the 5% level.

An interaction between herbicides and disulfoton on the number of peanut plants occurred only once (Table 6). The preplant incorporated treatments, both vernolate and benefin, were characterized by fewer plants where no disulfoton was applied.

**Effects of nematodes.** No major peanut nematode pathogen was recovered in economically damaging numbers from any of the soil types. Ring nematode, *Criconemoides* sp., a weak pathogen of peanuts, was the only nematode recovered in large numbers from the Tifton soil and in low numbers from the Dothan and Greenville soils. Root-knot larvae, *Meloidogyne* sp., were recovered from a few plots on the Greenville soil. The application of disulfoton did not significantly affect nematode population levels. Peanut pods from the Dothan and Greenville soils, examined at harvest time, were virtually free of nematode damage.

Table 6. Interaction of herbicide treatments and disulfoton on the number of peanut plants, Tifton soil, 1976[a].

| Herbicide treatment | Average number of plants/plot Disulfoton | No Disulfoton |
|---|---|---|
| V | 121 a | 112 b |
| B | 122 a | 114 b |
| A+ND | 119 a | 120 a |
| D | 117 a | 117 a |
| 2,4-DB | 113 a | 115 a |
| Sequence | 120 a | 125 a |
| Check | 117 a | 122 a |

a/ Means within the same line not followed by the same letter are significantly different at the 5% level.

## Discussion

In previous field studies in Oklahoma by Cargill and Santelmann (1), insecticides and herbicides did not interact significantly. In our studies, interactions sometimes occurred; but detrimental interactions between the systemic insecticide and herbicides, between insecticide and cultivars and between herbicides and cultivars were minimal. However, intensive sequential herbicide treatment, in five of the seven studies reported herein, reduced peanut yields significantly. In addition, dinoseb reduced yields once and 2,4-DB reduced yields twice when used as individual treatments. No other herbicides used alone reduced average yields significantly. In our interaction research conducted from 1973 to 1977 (including the studies reported herein) intensive herbicide sequences reduced peanut yields in 14 of 21 experiments.

Conversely, disulfoton increased average peanut yields in 13 of 21 studies. Yield increases promoted by disulfoton were 3.6% when averaged over all 21 experiments. According to Minton and Morgan (5), control of thrips by systemic pesticides such as disulfoton does not contribute to increased crop yields except where extreme damage occurs although control of the more pathogenic nematodes does increase yields. However, nematode assays indicated that the yield increases were not associated with their control. Therefore, the cause of disulfoton related yield increases remains obscure.

In the 14 studies from 1973 to 1977 in which various peanut cultivars were used, disulfoton interacted with cultivars in five experiments while herbicides interacted with cultivars only three times. Among the 21 studies, only one interaction between disulfoton and herbicides occurred.

Our data suggest that severe detrimental interactions among the systemic insecticide disulfoton, herbicides and peanut cultivars are unlikely to occur with the herbicides and peanut cultivars now being used in production systems. However, our results suggest that intensive sequences of herbicides should be used with utmost discretion. Widespread adoption of close-row patterns, which increase the competitiveness of the crop with weeds, may eliminate the need for intensive postemergence herbicide applications in many situations.

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