Effects of Herbicides, a Nematicide and Rhizobium Inoculant on Yield, Chemical Composition and Nodulation of Starr Peanuts (**Arachis hypogaea** L.)[1]

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ABSTRACT

Most peanut (**Arachis hypogaea** L.) fields of the Southern Coastal Plain are treated with either vernolate (**S**-propyl dipropylthiocarbamate) or benefin (**N**-butyl-**N**-ethyl-**a,a,a**-trifluoro-2, 6-dinitro-**p**-toluidine) or a combination of these two herbicides to control certain weeds. The nematicide DBCP (1,2-dibromo-3-chloropropane) is also used in some fields. Field and greenhouse experiments were conducted to determine the effect of vernolate, benefin, DBCP, and **Rhizobium** sp. on nodulation, yield, quality, and chemical composition of 'Starr' peanuts. The application of herbicides, nematicide, and inoculant had no significant effect on yield, sound mature kernels, or ether extract of 'Starr' peanuts. The N content of the leaf and seed and the number of nodules were not affected by the treatments. Nematode infestation was low and did not affect yield. In the greenhouse studies, the application of lime, herbicides, or fertilizer did not affect certain morphological characteristics of the plant or N content of the peanut leaves. Nitrogen fertilization increased the weight of the peanut foliage.

Additional index words: herbicide, nematicide, lime, fertilization, **Rhizobium** sp.

The use of herbicides in the Coastal Plain of Georgia has been one of the major factors contributing to the increase of peanut (*Arachis hypogaea* L.) yields. The use of herbicides combined with other improved practices has enabled Georgia farmers to double peanut yields in the past 15 years. According to Hauser and Parham (5), the safest procedure for controlling weeds in peanuts is the use of appropriate herbicides alone or herbicides supplemented with minimum "non-dirting cultivation." Two commonly used herbicides for control of certain weeds in peanuts are vernolate and benefin (1, 4, 5, 7, 9). These materials have little or no effect on the peanut plant when used as recommended (9). In greenhouse studies, vernolate at 0, 1.68, and 3.36 kg/ha did not influence dry weight of tops or roots of 'Starr' peanuts (1). Benefin caused less visible injury to peanuts than vernolate, but yields were almost the same for the two herbicide treatments (4).

The soil fumigant DBCP is used on much of the peanut acreage to control nematodes. Peanut yields are increased as much as 50 to 100% when DBCP is applied to heavily infested soil.

There have been no reports of the effect of vernolate, benefin, or DBCP on the nodulation of peanuts. Kust (7) recently reported that trifluralin reduced the number of soybean nodules. Certain insecticides reduced or prevented nodulation of other legumes (2, 3, 8, 11). Studies (12, 13, 14) have been made to determine the relationship of *Rhizobium* sp. to nodulation and yields.

Our objectives were to determine the effect of vernolate, benefin, DBCP, and Rhizobium sp. on nodulation, yield, quality, and chemical composition of Starr peanuts in the field and the effect of herbicides and fertilization on morphological characteristics of Starr peanuts in the greenhouse.

Materials and Methods

FIELD EXPERIMENT (1969-71)

The field experiments were on Fuquay loamy sand in an area previously planted to peanuts. The soil pH was 5.6, and available P and K were 88 and 112 kg/ha, respectively. Lime and fertilizer were applied uniformly over the experimental area at the following rates per hectare: 2.24 metric tons dolomitic lime, 13.6 kg N, 27.2 kg P, and 40.8 kg K. Treatments were applied in a split plot experimental design with four replications. The 9.7 m x 6.1 m whole plots received herbicide and nematicide treatments as follows: (a) vernolate, 2.24 kg/ha incorporated 7.6 cm deep, (b) benefin, 1.68 kg/ha incorporated 7.6 cm deep, (c) DBCP 10 kg/ha injected 20 cm deep plus vernolate, 2.24 kg/ha, and (d) control (plots received neither herbicide nor DBCP). The 3.2 m x 6.1 m subplots received **Rhizobium** sp. inoculant as follows:

(a) no inoculant, (b) old strain (**Rhizobium** sp.)[3] and (c) improved strain (**Rhizobium** sp.).[3] Starr peanut seeds were coated with peat impregnated with inoculant. The inoculants were applied much heavier than recommended, and additional inoculant was applied in the planter-hopper to ensure an adequate level of inoculant in the furrow and around the germinating seed.

Planting was at the rate of 134 kg seed/ha. The peanuts were cultivated as needed. Insects and leaf spot were controlled by recommended practices. Plots that received no herbicide were hand-weeded and cultivated along with the other treatments. Leaf for N determination and roots for nodulation counts were harvested when the peanut plants were 60 days old. Soil samples were collected from the root zone on June 19 and July 29, 1969, and July 14, 1970, and assayed for nematodes by the centrifuge-sugar flotation method (6) with 150 cc of soil. Peanuts were dug with a mechanical digger-shaker, allowed to dry in the windrow in the field, and harvested with a field combine. A 0.454 kg sample from each plot was used by the Federal-State Inspection Service to determine percentage of sound mature kernels (SMK's). Ether extract was determined on a 5-g sample of shelled peanuts by the procedure described in the Official and Tentative Method of Analysis of the Association of Official Agricultural Chemist (10).

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[3]"E1" Nitrogen for peanuts, Nitragin Co.

Chemicals were analyzed on oven-dry leaf samples ground to pass through a 40-mesh screen. The procedure for N determination on leaf and seed was a modification of Kjeldahl Gunning-Arnold method of analysis A.O.A.C. (10).

GREENHOUSE EXPERIMENT (1969)

Peanuts were grown in 13.6 kg of Fuquay loamy sand in clay pots 29.2 cm in diameter. The experimental design was a split-split plot, with three replications. The whole plots were treated with dolomitic lime at 0 or 2,240 kg/ha. Sub plots were herbicide treatments consisting of (a) no herbicide, (b) vernolate at 2.24 kg/ha, and (c) benefin at 1.68 kg/ha. Sub-sub plot treatments were (a) P and K at 58 and 111 kg/ha, respectively, (b) N at 33.6 kg/ha, P at 58 kg/ha, and K at 111 kg/ha, and (c) P at 58 kg/ha, K at 111 kg/ha, and Mo at 0.224 kg/ha. The pots were planted on May 16 with three seeds of Starr peanuts per pot and thinned to two plants when 15.2 cm high. Optimum soil moisture was maintained throughout the experiment. Flowers were counted daily from June 16 to August 14. Peanuts were harvested on August 15, and the following measurements were made: number of flowers, nodules, seeds and gynophores, weight of roots, tops and seeds and plant height. The aboveground parts of the plants were ground to pass through a 40-mesh screen for N determination.

Results and Discussion

FIELD EXPERIMENT

The herbicides, DBCP, and *Rhizobium* sp. had no influence on yield, sound mature kernels, or ether extract of Starr peanuts (Table 1). These data are similar to those reported by Greer, Tripp, and Santelmann (4).

Benefin, vernolate, DBCP, and *Rhizobium* sp. had no significant effect on the percent N of the leaf and seed. Also, the number of nodules was not affected by these treatments (Table 2). These data indicate that vernolate, benefin, and DBCP had no detrimental effect on the number of *Rhizobium* sp. in the soil and that the natural population was adequate so that the addition of inoculant had no measurable effect.

Table 1. Effects of benefin, vernolate, DBCP, and Rhizobium sp. on yield, sound mature kernels, and ether extract of 'Starr' peanuts in field studies at Tifton, Ga. 1969-71.

Treatments: Herbicides and nematicides	Rhizobium sp.	Yield (kg/ha)	SMK (%)	Ether extract (%)
No herbicide	No Rhizobium	2,657	68.8	43.9
	Strain*	2,649	68.6	43.6
	Strain†	2,730	69.3	44.1
Vernolate	No Rhizobium	2,657	69.5	43.2
	Strain*	2,912	69.0	43.3
	Strain†	2,754	68.8	44.7
Benefin	No Rhizobium	2,503	69.0	43.3
	Strain*	2,602	69.1	43.4
	Strain†	2,694	69.5	43.4
DBCP + vernolate	No Rhizobium	2,746	68.5	43.1
	Strain*	2,806	69.0	43.4
	Strain†	2,592	67.5	43.2
		N.S.‡	N.S.	N.S.

* "Old Strain" Rhizobium for peanuts (Nitragin Company Inc.).
† "New Strain" Rhizobium for peanuts (Nitragin Company Inc.).
‡ No significant difference.

Table 2. Effects of benefin, vernolate, DBCP, and Rhizobium sp. on number of nodules, and percent N in leaf and seed of 'Starr' peanuts in field studies at Tifton, Ga. 1969-71.

Treatments: Herbicides and nematicides	Rhizobium sp.	%N: Leaf	%N: Seed	No. of nodules*
No-herbicide	No Rhizobium	2.58	4.52	444
	Strain†	2.57	4.47	430
	Strain‡	2.57	4.62	418
Vernolate	No Rhizobium	2.66	4.60	447
	Strain†	2.57	4.65	491
	Strain‡	2.75	4.57	398
Benefin	No Rhizobium	2.63	4.57	357
	Strain†	2.59	4.39	374
	Strain‡	2.69	4.47	480
DBCP + vernolate	No Rhizobium	2.66	4.59	463
	Strain†	2.58	4.43	480
	Strain‡	2.69	4.54	507
		N.S.§	N.S.	N.S.

* Average six plants.
† "Old Strain" Rhizobium for peanuts (Nitragin Company Inc.).
‡ "New Strain" Rhizobium for peanuts (Nitragin Company Inc.).
§ No significant difference.

The soil was assayed for nematodes on June 19 and July 29, 1969, and July 14, 1970. Relatively high numbers of *Criconemoides ornatus* Raski were recovered. DBCP significantly reduced the number of nematodes by July 29, 1969, and July 14, 1970; however, there was no yield response (nematode data are not shown).

GREENHOUSE EXPERIMENT

Lime, herbicides, and fertilizer in greenhouse experiments had no significant effect on certain growth characteristics or N content of the peanut leaves (Table 3), but N fertilization significantly increased the weight of peanut foliage (Table 4). That vernolate and benefin had no influence on the number of nodules is similar to the data in the field experiments. Neither vernolate nor benefin affected the top or root weight of Starr peanuts. Similar results were reported by Cargill (1).

The data obtained from field and greenhouse studies indicate that vernolate and benefin had no significant effect on yield, quality, or certain chemical composition of Starr peanuts. The data also indicate that these herbicides and DBCP had no effect on the number of nodules formed on the roots and that the sources of *Rhizobium* sp. used in this study were not beneficial.

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Table 3. Effects of lime, herbicides, and fertilizer on plant growth, nodulation and nitrogen content of 'Starr' peanuts in greenhouse studies at Tifton, Ga. 1969.

Treatments		Plant ht. (cm)	Peanut tops (gm)	No. of flowers	No. of gynophores	Root wt. (gm)	No. of nodules	No. of seeds	Seed wt. (gm)	Leaf N (%)
No lime										
	P K	27.1	17.0	90	14.3	1.90	190	18.3	6.70	2.31
No herbicide	N P K	23.7	24.0	155	21.3	2.40	260	23.0	8.00	2.13
	P K + Mo	24.6	19.1	106	23.6	2.20	263	23.0	7.30	2.45
	P K	25.4	21.7	134	27.0	2.30	256	30.0	10.00	2.52
Vernolate	N P K	23.3	20.3	106	28.0	2.10	161	20.7	6.00	2.22
	P K + Mo	23.7	20.3	147	26.3	2.20	167	24.7	8.70	2.33
	P K	25.8	14.3	101	14.6	1.70	161	16.7	6.30	2.33
Benefin	N P K	22.9	24.0	126	21.3	2.50	202	20.3	8.30	2.36
	P K + Mo	24.2	25.0	149	27.0	2.70	212	31.0	9.70	2.30
Lime										
	P K	22.9	15.7	79	22.0	2.00	118	20.0	5.30	2.20
No herbicide	N P K	20.3	24.0	106	10.0	2.20	156	20.3	6.30	2.03
	P K + Mo	20.3	16.0	85	24.0	2.50	165	16.7	5.70	2.32
	P K	20.8	15.3	73	8.0	2.30	148	22.7	6.70	2.30
Vernolate	N P K	21.6	16.7	75	17.6	1.80	103	20.7	5.30	2.00
	P K + Mo	22.4	11.7	97	14.3	1.50	103	13.3	2.70	2.08
	P K	22.0	13.0	48	13.0	1.80	114	13.7	4.30	2.40
Benefin	N P K	20.8	19.7	123	15.6	2.20	103	19.7	6.70	2.05
	P K + Mo	20.3	13.7	106	7.6	1.50	103	20.3	5.60	2.85
		N.S.*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

*No significant difference.

Table 4. The effect of N, P, K, and Mo on the weight of the aboveground portions of the peanut plant in greenhouse studies at Tifton, Ga. 1969.

Treatments	Weight (g/2 plants) *
P K	16.2 b
N P K	21.4 a
P K + Mo	17.7 b

*Duncan's Multiple Range Test: mean values not followed by the same letter differ significantly at the P = 0.05 level.

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