Yields of Six Soybean Cultivars Following Fumigation of Soil Infested With Root Knot Nematodes

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ABSTRACT

Nematode control, plant height, and yield of six soybean cultivars were compared in *Meloidogyne incognita*-infested soil with and without 1,2-dibromo-3-chloropropane (DBCP) fumigation. Yield differences among soybean entries grown in nonfumigated soil were closely related to root knot indices indicating a wide range of susceptibility to nematode attack and effects on yield. Cultivars tested were classified as follows: very tolerant — 'Hutton', 'Coker 68-41' and 'Hampton 266A'; tolerant — 'Bragg'; and susceptible — 'McNair 800' and 'Davis'. Two-year mean yields of Hutton and Coker 68-41 in nonfumigated plots were significantly greater than yields of McNair 800. Yield of Hutton was also significantly greater than those of Bragg and Davis. Yields of all entries except Hutton and Hampton 266A were significantly increased by fumigation. Differences in yield among entries in fumigated plots were not significant. Root knot indices were more accurate indicators of plant damage than larval populations. Differences in plant height between fumigated and nonfumigated plots were closely related to root knot indices.

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Control of root knot nematodes *Meloidogyne* spp. on soybeans, *Glycine max* (L.) Merr., in the past has been attempted primarily by the use of resistant varieties. In 1922, McClintock (9) reported that 'Biloxi', 'Laredo', and 'Otootan' had considerable resistance to root knot nematodes in Georgia. Wittle and Drain (13) suggested using Laredo soybeans in a rotation system to control root knot nematodes in Tennessee. Holston and Crittenden (5) and Crittenden (1) reported varying levels of resistance for several soybeans in both field and greenhouse tests. Root knot nematode-resistant varieties bred for the different soybean-producing areas are now available (2, 3, 4). In some instances varieties thought to be resistant were found to be susceptible (2, 12), probably because of the existence of different species or races of nematodes.

Several chamicals are effective against root knot nematodes on soybeans (6, 8, 10). The use of nematicides, however, is not a common practice in soybean production because of cost of the chemicals and the inconvenience of application. Now that the value of the crop has increased, chemical control may be economically feasible. The use of nematode-resistant varieties, nematicides, or both can make soybeans a profitable crop in problem areas.

Traditionally, soybean breeders have used galling as a criterion for measuring resistance to root knot nematodes. However, evidence that a resistant variety will respond to an effective nematicide in areas of heavy nematode infestation is limited. A leading cultivar in the Southeastern U.S., 'Bragg', has been described as having a high degree of resistance to *Meloidogyne incognita,* even though field experiments in Alabama (11) and Florida (8) showed significant yield increases (greater than 60% over yield of the control) when an effective nematicide was used. Galling was probably present in both experiments, but was not reported.

This paper reports data from field experiments in which soybean cultivars were compared with and without a nematicide in root knot nematode-infested soil.

MATERIALS AND METHODS.—The study was conducted at Tifton, Georgia for two yr on a Tifton sandy loam heavily infested with *Meloidogyne incognita* (Kofoid and White) Chitwood. Soybeans were planted after hairy vetch, *Vicia villosa* Roth, a nematode-susceptible winter legume, grown to increase the nematode population. The soil was turned to a depth of 25 cm 4-6 wk before planting. Lime and fertilizer were applied as indicated by soil tests.

The six soybean cultivars used in this experiment represented three maturity groups: early (VI) — 'Davis'; medium (VII) — Bragg and 'McNair 800'; and late (VIII) — 'Coker 68-41', 'Hampton 266A', and 'Hutton'.

DBCP (1,2-dibromo-3-chloropropane) was applied 5 days before planting in 1971 and at planting in 1972. The material was injected 20 cm deep with a single chisel under the row at the rate of 10 kg active ingredient (a.i.)/hectare (ha). Seeds were planted 2 June 1971 and 10 May 1972 with a precision planter at a constant rate of 33 viable seeds/m of row.

Treatments were replicated four times in a randomized complete block experiment with a split-plot design. Cultivars made up the whole plots which were eight rows 0.9 m wide and 6 m long. Each whole plot was divided into two subplots, fumigated and nonfumigated.

Weeds were controlled with trifluralin at 0.56 kg a.i./ha applied before planting and cultivated as needed. Irrigation and insecticides were applied when needed.

The level of nematodes in the soil was determined 84 and 54 days after planting in 1971 and 1972, respectively. Soil samples were collected from the two center rows of each subplot, and nematodes were extracted by the centrifuge-sugar-flotation method (7). Roots of 10 plants from the two outside rows of each four-row subplot were rated for galling 7 wk after planting.

TABLE 1. Comparison of nematode control, plant height, and yield of six soybean cultivars grown in nematode-infested soil with and without DBCP[x]

Cultivar[z]	Nematode larvae per 150 cc soil		Root knot index rating[y]		Plant height (cm)		2-yr avg yield (kg/ha)	
	Untreated	DBCP	Untreated	DBCP	Untreated	DBCP	Untreated	DBCP
McNair 800	73 a	18 a	4.4 b	1.0 a	59 a	80 a	2291 a	3417 a
Davis	56 a	18 a	3.8 b	1.0 a	82 b	87 b	2412 ab	3062 a
Bragg	102 a	56 a	2.1 a	1.0 a	82 b	93 bc	2425 ab	3136 a
Hampton 266A	72 a	24 a	1.4 a	1.0 a	93 cd	100 c	2687 a-c	2935 a
Coker 68-41	20 a	13 a	1.2 a	1.0 a	95 d	100 c	2807 bc	3176 a
Hutton	44 a	21 a	1.2 a	1.0 a	87 bc	88 b	3028 c	3357 a

[x]Applied 10 kg active ingredient (DBCP) per hectare injected with single chisel under row.

[y]Root knot index rating based on 1 = no galling, 5 = severe galling.

[z]Data in same column followed by same letter, and data underscored by same line in paired columns, are not significantly different at the 5% level according to Duncan's Multiple Range Test.

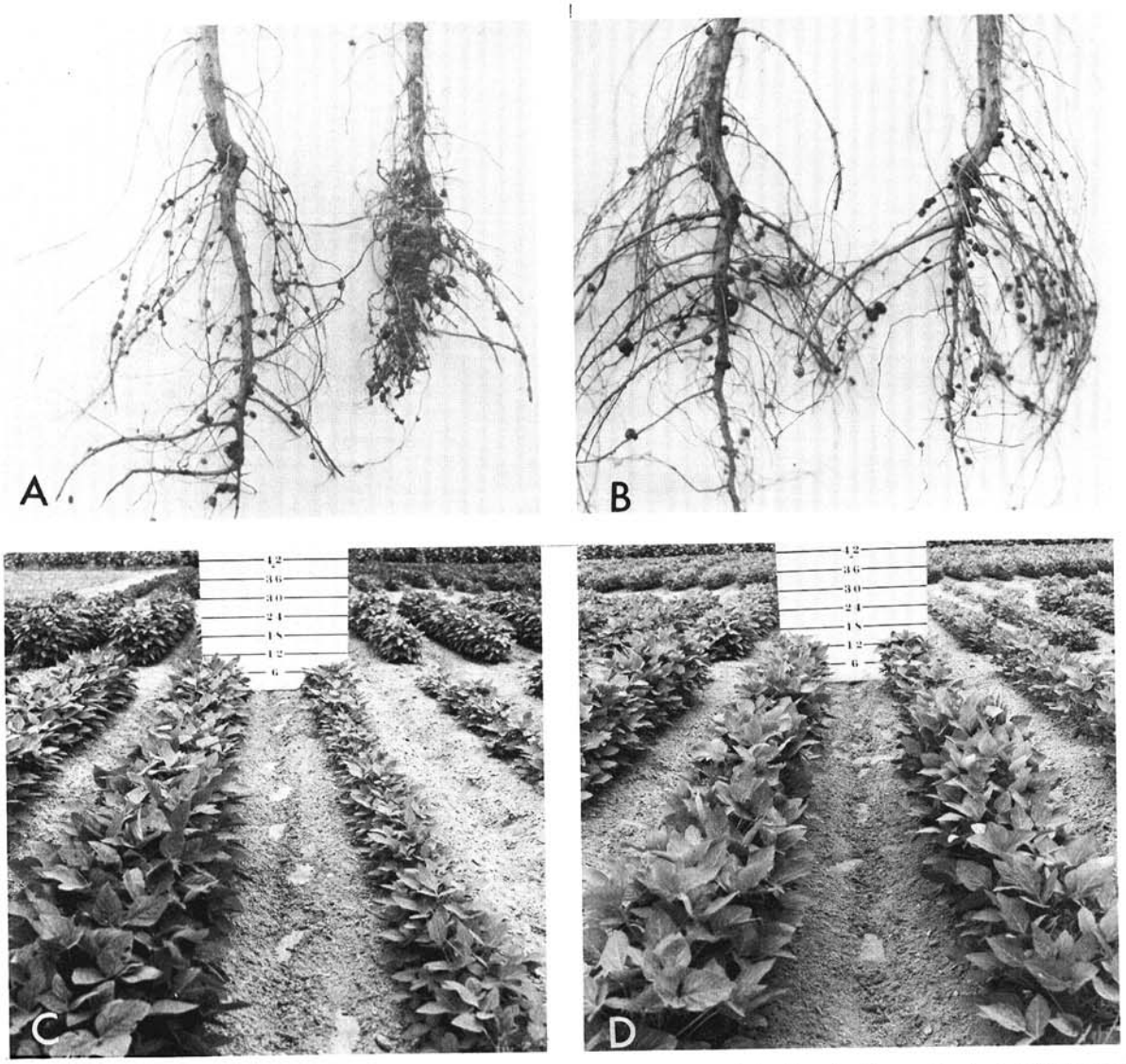

Fig. 1-(A-D). Root knot nematode-infested soybeans. **A)** Roots of McNair 800. Left, fumigated; right, nonfumigated. **B)** Roots of Hutton. Left, fumgiated; right, nonfumigated. **C)** McNair 800. Left, fumigated; right, nonfumigated. **D)** Hutton. Left, fumigated; right, nonfumigated.

Plant-height measurements were made at harvest. Yields were obtained from the two center rows of each subplot. Harvest dates for the entries varied with maturity.

RESULTS.—Nematode counts, root knot indices, and plant-height measurements were similar both yr; therefore only 1971 data are shown (Table 1). Yield data presented are means for 2 yr because response by each variety was similar both yr. Root knot nematode larval counts in 1971, taken 84 days after planting, were not significantly different among entries or between treatments for each entry at the 5% level of probability. The large variability in counts among plots may account for the lack of significance. The root knot nematode was the only nematode present numerous enough to damage soybeans.

McNair 800 and Davis in nontreated plots were more heavily galled than the other entries (Table 1). Fumigation essentially eliminated galling in all entries and significantly reduced the galling on McNair 800 (Fig. 1) Davis, and Bragg.

Plant height varied more among entries in nonfumigated plots than among fumigated plots (Table 1). Plants of McNair 800, Bragg, and Hampton 266A in fumigated plots were significantly taller than those in nonfumigated plots. Stunting of McNair 800 plants by nematodes was more pronounced than that of other entries. The height of McNair 800 plants was increased 35% by DBCP (Fig. 1). Plant height differences in the fumigated and nonfumigated plots were closely related to root knot indices. With the exception of Davis, height differences were greatest for entries with high gall indices in nonfumigated plots.

Two-yr mean yields of Hutton and Coker 68-41 in nonfumigated plots were significantly greater than yields of Bragg or Davis. Yields of all entries except Hutton and Hampton 266A were significantly increased by fumigation. Differences in yield among entries in fumigated plots were not significant.

DISCUSSION.—Yield differences among the soybean entries grown in nonfumigated soil were closely related to root knot indices, indicating a wide range of nematode susceptibility and effects on yield. The higher yields obtained in fumigated plots than in nonfumigated plots indicate the magnitude of nematode damage in all entries. These data suggest that in soils with heavy nematode populations some reduction in yield may occur in more highly resistant cultivars, although galling may not be severe. Use of both resistance and chemicals may be required to obtain maximum control under extreme conditions. Split plots using fumigated and nonfumigated soil for evaluating entries for root knot resistance, provide more meaningful information than could be obtained if only nonfumigated plots had been used.

Root knot indices were more accurate indicators of plant damage than was larval population. In nonfumigated plots nematode populations were the same under all entries but severe galling did not occur on some cultivars. These data support earlier results which suggested that the light galling may indicate tolerance rather than true resistance (5). The cultivars tested might be classified as follows: very tolerant — Hutton, Coker 68-41 and Hampton 266A; tolerant — Bragg; and susceptible — McNair 800 and Davis. Thus, planting "resistant" soybeans in rotations may not always insure that the susceptible crop that follows will be free from nematode attack. Nematodes reproduced on all entries in fumigated plots even though large galls were not formed. Fumigation protected the tap and major lateral roots of susceptible entries from early season attack. Apparently, larvae recovered from the soil in these plots were produced on small infested lateral roots which were frequently left in the soil when the root systems were lifted for examination.

LITERATURE CITED

1. CRITTENDEN, H. W. 1955. Root-knot nematode resistance of soybeans. Phytopathology 45:347 (Abstr.).
2. DUNLEAVY, J. M., D. W. CHAMBERLAIN, and J. P. ROSS. 1966. Soybean diseases. U.S. Dep. Agric. Res. Serv. Handb. 302. 38 p.
3. EPPS, J. M., and E. E. HARTWIG. 1967. Dyer, a new nematode-resistant soybean variety. Tenn. Agric. Exp. Stn. Bull. 426. 10 p.
4. HINSON, K., and E. E. HARTWIG. 1964. Bragg and Hardee soybeans. Crop Sci. 4:664.
5. HOLSTON, W. M., and H. W. CRITTENDEN. 1951. Resistance of soybeans to root-knot nematodes. Phytopathology 41:562 (Abstr.).
6. JENKINS, L. 1963. Nematode research from 1956-1962 in Missouri. Mo. Agric. Exp. Stn. Res. Bull. 833:14-17.
7. JENKINS, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Reptr. 48:692.
8. KINLOCH, R. A. 1972. Evaluation of varietal and nematicidal combination for the control of Meloidogyne incognita on soybean. J. Nematol. 4:228-229.
9. MC CLINTOCK, J. A. 1922. Report on resistant plants for root-knot nematode control. Ga. Agric. Exp. Stn. Circ. 77. 4 p.
10. MILLER, W. O., P. A. THOMAS, and M. G. NORRIS. 1971. Nematode diseases of soybeans and the economics of their control with Fumazone nematicide. Down Earth 26(4):25-27.
11. RODRIGUEZ-KABANA, R., and H. F. YATES. 1972. Response of Bragg soybeans to commercial nematicides. Highlights Agric. Res., Agric. Exp. Stn., Auburn Univ., Auburn, Ala. 19(2):3.
12. TAYLOR, A. L. 1942. Root-knot resistance of five soybean varieties. Phytopathology 32:650 (Abstr.).
13. WITTLE, W. O., and B. D. DRAIN. 1935. The root-knot nematode in Tennessee. Its prevalence and suggestions for control. Tenn. Agric. Exp. Stn. Circ. 54. 8 p.