

# Interaction of Four Soybean Cultivars with Subsoiling and a Nematicide<sup>1</sup>

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**Abstract:** Yields of four soybean, *Glycine max*, cultivars were increased with subsoiling under the row and application of the nematicide, DBCP (1,2-dibromo-3-chloropropane) in Tifton sandy loam heavily infested with the root-knot nematode *Meloidogyne incognita*. These cultivars represent four maturity groups: very early (V), 'Essex'; early (VI), 'Davis'; medium (VII), 'Ransom'; and late (VIII), 'Hutton'. The average increase for the four cultivars was about the same for subsoiling or DBCP. When the treatments were used together, the increase was greater than when either was used alone, but the effects were not additive. Increased yields were obtained with subsoiling and DBCP for the most nematode resistant cultivar, Hutton, as well as for the most susceptible, Davis. Subsoiling reduced root-knot galling in nonfumigated plots but did not affect it in fumigated plots. On 12 September, *M. incognita* larvae were most numerous at the 0- to 20 cm depth, intermediate at 20 to 33 cm depth and least numerous at 33 to 46 cm depth. Subsoiling did not affect larval populations at the three levels. **Key Words:** nematode control.

The tremendous expansion of soybean acreage in the southeastern United States during the past few years has focused attention on many problems associated with soybean production. Among these problems are nematodes, soil compaction, and cultivar selection.

As early as 1922, McClintock (11) reported considerable resistance in several soybean cultivars to root-knot nematodes in Georgia. Holston and Crittenden (8) and Crittenden (4) found resistance for several soybean cultivars in both field and greenhouse tests. Root-knot nematode-resistant cultivars bred for different soybean-producing areas are now available (5, 6, 7). In some instances, cultivars thought to be resistant were found to be susceptible (5, 16), probably because of infection by different races of nematodes. In addition to resistant cultivars, some chemicals are effective for control of nematodes on soybeans (10, 12). One may have a choice of using resistant cultivars or nematicides to control certain nematodes. In areas of heavy infestation, a combination of two methods may be beneficial. 'Bragg' a cultivar reported to have a high degree of resistance to *Meloidogyne incognita*, gave significant yield

increases (> 60% over the control) when an effective nematicide was used in field experiments in Alabama (15), Florida (10), and Georgia (13).

Sandy soils of the southeastern Coastal Plain area are particularly subject to development of hard pans or traffic pans where heavy equipment and certain cultivation implements are used (3, 9). Subsoiling to a depth of 43 - 46 cm directly under the tobacco row consistently (six years) increased the yield and acre value of leaf on Norfolk and Tifton soils in Georgia (1). Combination treatments of subsoiling and nematicides increased soybean yields in South Carolina on compacted soil infested with lance nematodes (H. L. Musen' and C. W. Blackmon, Clemson Univ., Edisto Exp. Stn., Blackville, S. C., *personal communication*). Parker et al. (14) reported that either subsoiling to a depth of 46 cm under the soybean row or application of 10 kg actual ingredient (a.i.)/hectare (ha) of DBCP increased soybean yields 64% in Georgia in a Marlboro soil infested with *Hoplotaimus columbus*. Combination treatments increased yields 89%. Bird et al. (2) at the same location increased cotton yields with subsoiling and nematicides.

The purpose of this paper is to report the effects of subsoiling and nematicide treatments on four soybean cultivars having different maturity dates and levels of susceptibility to root-knot nematodes.

## MATERIALS AND METHODS

Treatments were cultivars, subsoiling and nematicides. Each treatment was replicated four times in randomized block split-split plots. Cultivars were main plots, subsoiling

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first split, and nematicide second split. Subplots were 6.1 m long with four rows each spaced 0.9 m apart.

The study was conducted in 1973 at Tifton, Georgia, on a Tifton sandy loam heavily infested with root-knot nematodes, *Meloidogyne incognita* (Kofoid and White) Chitwood. A nematode-susceptible winter legume, common hairy vetch (*Vicia villosa* Roth), was grown to ensure a high nematode population. The soil was turned about 25 cm deep 2-3 weeks before the soybeans were planted. Lime and fertilizer were applied according to soil tests, and the herbicide nitratin [(4-methylsulfonyl)-2,6-dinitro-*N,N*-(dipropylaniline)] was applied as a preplant treatment at the rate of 0.6 kg (a.i.)/ha.

Plots were subsoiled 41 cm deep directly beneath the intended row 7 days before planting. The soil was leveled with a power-driven rototiller, and DBCP (1,2-dibromo-3-chloropropane) was injected 20 cm deep with a single chisel in the row at a rate of 10 kg(a.i.)/ha. The soil was firmed and leveled with a bed shaper.

Four soybean cultivars representing four maturity classifications at Tifton were used in the study. These were: 'Essex' (V), very early; 'Davis' (VI), early; 'Ransom' (VII), medium; and 'Hutton' (VIII), late. Seeds were planted 28 May 1973 with a precision planter at a constant rate of 33 viable seeds per meter of row. Three days after planting, a herbicidal mixture of naptalam [*N*-1-naphthylphthalamic acid] plus dinoseb (2-sec-butyl-4,6-dinitrophenol) was applied at rates of 1.4 and 3.1 kg(a.i.)/ha, respectively. Cultivation was used as needed to control weeds and insecticides were applied to control insects. At least 2.5 cm of water by overhead irrigation was applied on 24 May, 11 September, and 24 September.

The number of nematodes in the soil at 0-20, 20-33, and 33-46 cm depths was determined 1 July and 12 September. Soil samples were collected with a 7-cm diam bucket auger from the two inside rows of each subplot. Five soil cores from each subplot were placed in a pail, mixed well, and a 500-cc subsample was withdrawn for assay. Each sample contained only soil from the depth zone indicated. Nematodes were extracted from 150 cc of soil by the centrifugation-sugar flotation method. Roots of 10 plants from the two outside rows of each four-row subplot were rated for galling 12 weeks after planting.

TABLE 1. Influence of preplant subsoiling (41 cm deep beneath the row) and nematicide treatments [10 kg(a.i.)/hectare, 20 cm deep in each row] on yield of four soybean cultivars.

Subsoiling and Cultivar	Yield (kg/ha)		
	No nematicide	DBCP	Avg
Not subsoiled <sup>1</sup>			
Essex	2439 a	2742 b	2591 b
Davis	1935 b	2695 b	2315 b
Ransom	2916 a	3407 a	3162 a
Hutton	2681 a	3293 a	2987 ab
Avg	2493	3034	2764 <sup>2</sup>
Subsoiled <sup>1</sup>			
Essex	3064 ab	3105 a	3085 ab
Davis	2661 b	2916	2789 b
Ransom	3165 ab	3434 a	3300 a
Hutton	3232 a	3340 a	3286 a
Avg	3031	3199	3115 <sup>2</sup>

<sup>1</sup>Data underscored by the same line in rows or followed by the same letter in columns within a soil treatment are not significantly different,  $P = 0.05$ , according to Duncan's multiple range test.

<sup>2</sup>Highly significant response ( $P = 0.01$ ) to subsoiling.

TABLE 2. Influence of preplant subsoiling (41 cm deep beneath the row) and nematicide treatments [10 kg(a.i.)/hectare, 20 cm deep in each row] on root-knot indices of four soybean cultivars.

Fumigation and Cultivar	Index <sup>1</sup>		
	Not sub-soiled	Subsoiled	Avg
No nematicide <sup>2</sup>			
Essex	2.5 bc	2.2 b	2.4 b
Davis	4.0 a	3.2 a	3.5 a
Ransom	2.8 b	2.8 ab	2.8 b
Hutton	1.8 c	1.1 c	1.4 c
Avg	2.8	2.3	2.6 <sup>3</sup>
DBCP			
Essex	1.2 a	1.2 a	1.2 a
Davis	1.8 a	1.9 a	1.9 a
Ransom	1.2 a	1.4 a	1.3 a
Hutton	1.1 a	1.2 a	1.2 a
Avg	1.3	1.4	1.4 <sup>3</sup>

<sup>1</sup>Root-knot rating based on 1 = no galling, 5 = severe galling.

<sup>2</sup>Data underscored by the same line in rows or followed by the same letter in columns within a nematicide treatment are not significantly different,  $P = 0.05$ , according to Duncan's multiple range test.

<sup>3</sup>Highly significant response ( $P = 0.01$ ) to nematicide.

TABLE 3. Numbers of *Meloidogyne incognita* larvae recovered per 150 cc of soil sampled at three depths as related to soybean cultivars, subsoiling (41 cm deep beneath the row), and nematicide [10 kg(a.i.)/hectare, 20 cm deep in each row], 1 July 1973.

Sample depth and cultivar	Number of larvae					
	No nematicide			DBCP		
	Not sub-soiled	Sub-soiled	Avg	Not sub-soiled	Sub-soiled	Avg
0-20 cm depth <sup>1,2</sup>						
Essex	38 a	10 b	24 a	12 a	12 a	12 a
Davis	18 a	80 a	49 a	12 a	8 a	10 a
Ransom	18 a	20 b	19 a	2 a	10 a	6 a
Hutton	20 a	12 b	16 a	4 a	4 a	4 a
Avg	23	31	27	8	8	8
20-33 cm depth <sup>1,2</sup>						
Essex	52 a	22 b	37 ab	4 a	0 a	2 a
Davis	26 a	42 b	34 b	6 a	4 a	5 a
Ransom	52 a	90 a	71 a	2 a	2 a	2 a
Hutton	88 a	32 b	60 ab	20 a	2 a	11 a
Avg	54	46	50	8	2	5
33-46 cm depth <sup>1</sup>						
Essex	0 a	2 a	1 a	8 a	0 a	4 a
Davis	2 a	6 a	4 a	2 a	0 a	1 a
Ransom	6 a	8 a	7 a	0 a	0 a	0 a
Hutton	2 a	2 a	2 a	0 a	0 a	0 a
Avg	2	4	3	2	0	1

<sup>1</sup>Data underscored by the same line in rows or followed by the same letter in columns within a nematicide treatment and depth are not significantly different,  $P = 0.05$  according to Duncan's multiple range test.

<sup>2</sup>Highly significant response ( $P = 0.01$ ) to DBCP for average of four cultivars at 0-20 and 20-33 cm depths.

Yields were obtained from the two center rows of each subplot. Harvest dates for the entries varied with maturity.

## RESULTS

Application of DBCP increased yields of all cultivars except Essex when the soil was not subsoiled (Table 1); however, the root-knot index (Table 2) shows that Essex was only moderately resistant to *M. incognita*. Stink bug damage early in the season may have masked partly the effect of DBCP on this early maturing cultivar. On subsoiled plots, DBCP had no significant effect on yields. Average yield for DBCP-treated plots without subsoiling was 3,034 kg/ha or 541 kg higher than control (not subsoiled or fumigated). About the same yield increase was obtained with subsoiling over no subsoiling when DBCP was not applied. The combined treatment of DBCP and subsoiling increased yields 706 kg/ha, or 28.3% over the control

treatment. The effects of subsoiling and nematicide were not additive.

Root-knot ratings differed among cultivars (Table 2). Davis had the highest galling, Hutton had the lowest, and Ransom and Essex were intermediate. DBCP reduced galling on all cultivars. Without nematicide treatment, the average root-knot index was 2.6 compared with 1.4 where DBCP was applied. Subsoiling without DBCP reduced galling, but did not reduce it in DBCP-treated plots.

Numbers of *M. incognita* larvae in soil samples were low 1 July (Table 3), but numbers increased about 40-fold in the 0-20 cm depth by 12 September (Table 4). The number of larvae varied with depth at both sampling dates; populations were usually highest at 0-20 cm and lowest at 33-46 cm. In most instances, subsoiling had little or no effect on larval populations, but DBCP reduced populations at both sampling dates at

TABLE 4. Numbers of *Meloidogyne incognita* larvae recovered per 150 cc of soil sampled at three depths as related to soybean cultivars, subsoiling, and a nematicide, 12 September 1973.

Sample depth and cultivar	Number of larvae					
	No nematicide			DBCP		
	Not sub-soiled	Sub-soiled	Avg	Not sub-soiled	Sub-soiled	Avg
0-20 cm depth <sup>1/2</sup>						
Essex	1068 b	668 b	868 b	134 a	56 a	95 a
Davis	2428 a	2324 a	2376 a	336 a	924 a	630 a
Ransom	794 b	1188 ab	991 b	154 a	66 a	110 a
Hutton	186 b	58 b	122 b	10 a	32 a	21 a
Avg	1119	1059	1089	158	269	214
20-33 cm depth <sup>1/2</sup>						
Essex	216 b	152 b	184 c	26 a	6 a	16 a
Davis	1774 a	1028 a	1401 a	96 a	230 a	163 a
Ransom	506 b	734 a	620 b	14 a	52 a	33 a
Hutton	42 b	114 b	78 c	12 a	22 a	17 a
Avg	634	507	570	37	77	57
33-46 cm depth <sup>1</sup>						
Essex	8 a	14 b	11 b	10 a	6 b	8 a
Davis	98 a	434 a	266 a	4 a	320 a	162 a
Ransom	166 a	290 ab	228 ab	4 a	30 b	17 a
Hutton	52 a	26 b	39 b	10 a	1 b	5 a
Avg	81	191	136	7	89	48

<sup>1</sup>Data underscored by the same line in rows or followed by the same letter in columns within a nematicide treatment and depth are not significantly different,  $P = 0.05$ , according to Duncan's multiple range test.

Highly significant response ( $P = 0.01$ ) to DBCP for average of four cultivars at 0-20 and 20-33 cm depths.

### 0-20 and 20-33 cm depths.

Statistical differences in numbers of larvae on 1 July are not believed to be valid because populations were low. On 12 September, the average number of larvae for Davis plots without a nematicide were greater than for all other cultivars at the 0-20 and 20-33 cm depths, and for all cultivars except Ransom (not subsoiled) at the 33-46 cm depth. In fumigated plots, the average number of larvae did not differ among cultivars at any sampling depth.

Root-knot indices on 21 August were correlated with larval populations on 12 September. Correlation coefficients between root-knot index and larval numbers for the 0-20, 20-33, and 33-46 cm soil depths were 0.80, 0.83, and 0.60, respectively.

### CONCLUSIONS

These results show that cultivars of different maturity groups, and with different

levels of nematode resistance, may respond to subsoiling and nematicides. However, the magnitude of the response varied among cultivars. Where soil compaction and root-knot nematodes occur together, both subsoiling and nematicides are necessary for maximum yield. Besides providing more uniform soil moisture, subsoiling may have decreased the nematode effect, because roots were able to grow into the subsoil where nematodes were less numerous.

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