Effects of Subsoiling and Nematicides on *Hoplolaimus columbus* Populations and Cotton Yield

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Abstract: Subsoiling to a depth of 35 cm under the planting row for 3 consecutive years increased annual yields of seed cotton by 50 to 200%. Annual subsoiling was essential for maximum yields. The application of a nematicide, 1,2-dibromo-3-chloropropane (DBCP) or aldicarb, reduced the population of *Hoplolaimus columbus* but did not increase seed-cotton yields over subsoiling alone. Subsoiling reduced *H. columbus* in the top 20 cm of soil since the treatment favored deeper penetration by much of the root system and, consequently, less root colonization of the upper soil zone. *Key Words: Gossypium hirsutum,* nematode control.

Cotton stunt, or irregular cotton growth, is a severe and widespread problem in the southeastern cotton belt. Plant-parasitic nematodes and soil compaction are important factors contributing to this disease syndrome (2, 4). In certain locations, subsoiling under the planting row and bedding have increased cotton root growth and promoted penetration to lower depths of the soil profile (2, 4, 5). Therefore, subsoiling is rapidly becoming a popular tillage practice used by cotton growers in the southeastern United States.

In previous work, Bird et al. (2) reported a 70 to 80% increase in seed-cotton yields after subsoiling was carried out in a field infested with *Hoplolaimus columbus* Sher. However, no additional benefit was obtained with the application of a fumigant nematicide. Because of the probable buildup of nematodes at the lower depths of the soil profile, it was postulated that in subsequent years a nematicide treatment combined with subsoiling would be required to alleviate the stunt symptoms. Soybeans also respond to subsoiling and bedding, and research has recently shown that subsoilng alone increases soybean yields during the first year. Response to subsoiling during the second year, however, was limited only to fumigated plots (6).

This paper reports the effects of continued subsoiling under the same row for 3 years on populations of *H. columbus* and on seed-cotton yields.

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MATERIALS AND METHODS

The experiments were conducted at Midville, Georgia on Marlboro sandy loam soil naturally infested with *H. columbus.* The soil consisted of ca 20 to 25 cm of a sandy loam topsoil, a 5- to 8-cm, sand textured, plow-pan layer, and a sandy clay subsoil (Fig. 1). All plots were limed and fertilized for cotton production according to soil test results. The herbicide, trifluralin (Treflan), was applied as a preplant treatment at a rate of 0.84 kg (a.i.)/ha.

Six treatments were arranged in a randomized complete block design with six replications each. Treatments were: *(i)* bedding; *(ii)* bedding with 1,2-dibromo-3 chloropropane (DBCP), 10 kg (a.i.)/ha injected 20 cm under the row; *(iii)* subsoiling and bedding; *(iv)* subsoiling and bedding with DBCP (10 kg/ha) applied 20 cm under the row at subsoiling time; *(v)* subsoiling and bedding with DBCP applied 35 cm deep; and *(vi)* subsoiling and bedding with aldicarb, 0.8 kg (a.i.)/ha applied in-furrow at planting. One additional treatment in 1974 consisted of bedding only plots that had been subsoiled the previous year. Each plot consisted of four 15.2-m rows spaced 95 cm apart. Beds 20 to 25 cm high were made with lister-bedders directly over the subsoil furrow. Plots were subsoiled 35 cm under the planting row and bedded 21 days before planting in the same pattern each year. Plots were planted 29 May 1975 with 13.4 kg seed/ha cotton (*Gossypium hirsutum* L. 'Coker 310') and were maintained throughout the growing season under recommended cultural practices. The two center rows of each plot were mechanically harvested for yield data. Seedling stand counts were made 1 month

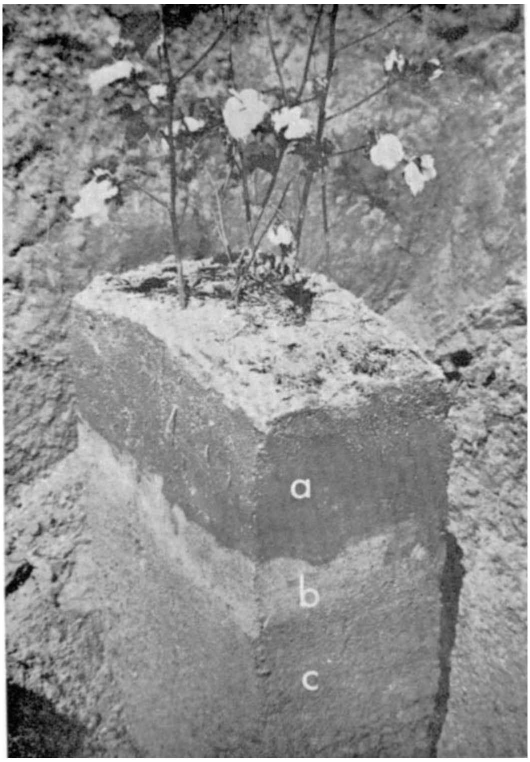

FIG. 1. Marlboro sandy loam soil profile consisting of (a) 20 to 25 cm of a sandy loam topsoil, (b) 5- to 8-cm, sand textured, plow-pan layer, and (c) sandy clay subsoil.

after planting and plant heights were measured in August.

Soil samples for nematode assays were collected from the top 20 cm of soil from the two center rows (10 cores/row) of each plot prior to treatment in April, and following treatment, in July and September. Nematodes were extracted from the soil by a flotation-sieving technique (3) and from cotton roots by a shaker incubation method (1).

RESULTS

Since similar results were obtained whether plots were subsoiled for 1, 2, or 3 consecutive years, most of the data presented will be from plots subsoiled for 3 years.

Initial stands of cotton were not significantly different among treatments (Table 1). However, subsoiling under the planting row alleviated the cotton stunt symptoms (Fig. 2-A). Plants in subsoiled plots were twice as tall as plants in nonsubsoiled plots (Table 1). Root systems on plants from the nonsubsoiled plots were restricted to the upper zone of the soil profile. Tap roots often grew horizontally along the surface of the plow pan (Fig. 2-B).

Subsoiling and bedding enhanced seed-cotton yields by more than 200% over those of plants receiving bedding treatment alone (Table 1). Combining DBCP with bedding or with subsoiling and bedding did not increase seed-cotton yields. However, injecting DBCP at 35 cm when subsoiling was done resulted in the highest yields and lowest nematode populations. Aldicarb was also ineffective in increasing seed-cotton yields over subsoiling and bedding.

In 1974, one treatment consisted of bedding only plots that had been subsoiled the previous year to determine the need to subsoil on an annual basis. Seed-cotton yield from this treatment (1,422 kg/ha) was lower than that from plots that had been bedded for 2 years without subsoiling (2,071

TABLE 1. Influence of subsoiling and nematicides on *Hoplolaimus columbus* and the growth and yield of cotton.[a]

Treatment	Plant height (cm)	Plants per 15.2-m row	*Hoplolaimus columbus* 7/21/75 100 cm³ soil	*Hoplolaimus columbus* 7/21/75 gm roots	Seed cotton (kg/ha)
Bedding	54 a	246 a	324 c	1,032 d	423 a
Bedding & DBCP at 20 cm	63 a	255 a	125 ab	77 a	566 a
Bedding & subsoiling	100 b	258 a	175 b	808 cd	1,408 b
Bedding, subsoiling & DBCP at 20 cm	123 c	261 a	31 a	54 a	1,518 b
Bedding, subsoiling & DBCP at 35 cm	117 bc	252 a	29 a	13 a	1,800 b
Bedding, subsoiling & Aldicarb	102 bc	267 a	56 ab	224 ab	1,420 b

[a]Values followed by the same lower case letters do not differ significantly according to Duncan's multiple range test ($P = 0.05$).

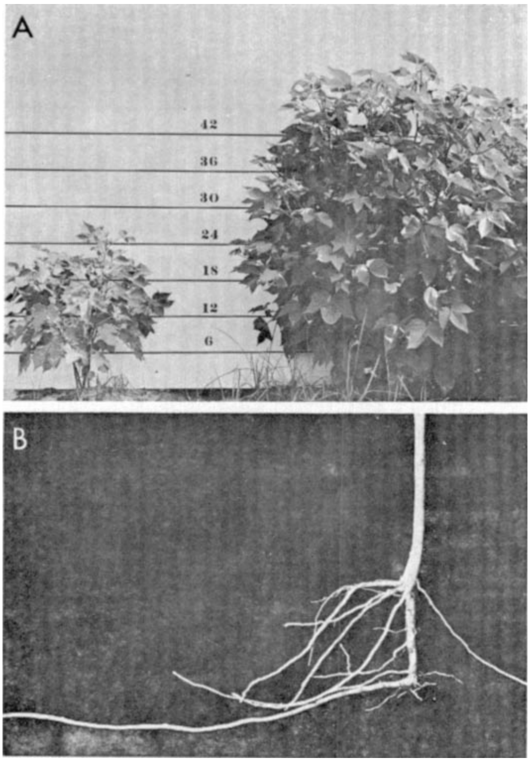

FIG. 2 (A-B). *A*) Growth response of cotton to subsoiling 35 cm under the row. Both plots received 10 kg (a.i.)/ha of DBCP. *B*) Horizontal growth of the tap root of cotton grown in the absence of subsoiling.

kg/ha) and was significantly lower than yield from the treatment of subsoiling and bedding for 2 years (3,261 kg/ha). Populations of *H. columbus* were greater in soil that was subsoiled and bedded the first year and bedded only the second year than in soil which was bedded only for the 2 years (476 vs 224/100 cm^3).

Populations of *H. columbus* were affected both by subsoiling and nematicides (Table 1). Subsoiling and bedding with no nematicide caused significant reductions in populations of *H. columbus* in the soil (but not in the roots) in comparisons with reductions from bedding alone. The greatest reduction in both the soil and the root populations of *H. columbus* occurred in soil treated with nematicides. Injection of DBCP at 20 cm or 35 cm reduced nematode populations equally well. Aldicarb was effective in reducing the soil populations of *H. columbus* and, to a lesser extent, root populations.

DISCUSSION AND CONCLUSIONS

Annual subsoiling under the planting row resulted in increases in seed-cotton yield. This yield increase resulted from greater productivity per plant rather than from changes in plant populations since stand counts were not significantly altered by the treatment. Subsoiling annually was essential for maximum yields. Apparently, the plow pan is reformed through soil tillage.

The lack of an additional response to combined treatments of nematicide, subsoiling, and bedding during the second and third year of the study was unexpected in view of earlier reports (2, 6). Previous investigators (2) postulated that plant-parasitic nematodes could build up at the lower depths of the profile after the first year of subsoiling and that, during the second and subsequent years, a combination of subsoiling and a nematicide would be necessary to alleviate the stunt symptoms. This concept is supported somewhat by work which has shown that subsoiling a second year without DBCP did not increase yields of soybean over those of the control, whereas subsoilng combined with DBCP increased yields 95% (6). Apparently, cotton plants, unlike soybean, are able to compensate for nematode damage to some degree if the tap root is able to penetrate the moist subsoil.

The reduction in *H. columbus* in the top 20 cm of the soil on subsoiled plots seems to be related to the presence of fewer roots in this top zone because of deeper penetration by much of the cotton-root system. In the absence of subsoiling, the cotton-root system is compacted above the plow pan (4) and therefore provides more feeding sites for nematodes at the shallow depths. The confined root system makes the plant more susceptible to nematode attack. The restriction of the root system above the plow pan, however, appears to be the primary factor contributing to the cotton-stunt disease syndrome.

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