Influence of Organic Pesticides on Nematode and Corn Earworm Damage and on Yield of Sweet Corn[1]

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Abstract: Soil fumigants and nonvolatile pesticides increased growth and yield of sweet corn 'Seneca Chief' over that of control plants in a 3-year study. Nematicide treatments increased average yields by 31% over controls, but did not significantly affect the mean weight per ear. Increase in yield was related to control of *Belonolaimus longicaudatus, Trichodorus christiei* and *Pratylenchus zeae*. Nonvolatile chemicals more effectively reduced populations of *B. longicaudatus* and *T. christiei* than did soil fumigants. Aldicarb did not control *Criconemoides ornatus*. All pesticides controlled *P. zeae*. Pesticides did not control *Heliothis zea* effectively. *Key Words:* Chemical control, *Belonolaimus longicaudatus, Trichodorus christiei, Criconemoides ornatus, Pratylenchus zeae*, insects, *Heliothis zea, Zea mays*, nematicides, insecticides.

Sweet corn is grown extensively in the southeastern United States as a cash crop, primarily for fresh market. About 1,600 hectares are grown in Georgia. Sweet corn can be planted early (March 10-15) and it matures in about 75 days; thus, it may be included in multi-crop systems. Many nematodes and insects that parasitize other crops also attack sweet corn. No estimate of the loss in production of sweet corn caused by nematodes in Georgia is available.

Organophosphate and carbamate pesticides which have both nematicidal and insecticidal properties stimulated interest in dual nematode and insect control. Several organophosphate and carbamate pesticides were active against nematodes (3, 4, 8, 11, 12, 14, 16) and insects (1, 2, 6, 10, 13, 15) under field conditions.

The objectives of our tests were to evaluate the effects of organic pesticides in controlling nematodes and the corn earworm and in increasing growth and yield of sweet corn.

MATERIALS AND METHODS

The site selected each year for this three-year study was on Tifton sandy loam (80% sand, 5% silt and 15% clay, pH 5.8) that was planted to pearl millet, *Pennisetum glaucum* (L.) R. Br., the previous year. The land was infested naturally with *Belonolaimus longicaudatus* Rau, *Trichodorus christiei* Allen, *Criconemoides ornatus* Raski and *Pratylenchus*

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zeae Graham. A randomized complete block design with four replications was used each year. Ethylene dibromide (EDB), 1,2-dibromo-3-chloropropane (DBCP) and 1,3-dichloropropene-1,2-dichloropropane (DD) were applied through a single chisel in-the-row and followed with a bedding attachment. At the time of application, April 2-23, soil temperature at a 15-cm depth ranged from 19-24 C, and soil moisture ranged from 4.8 - 6.0% (dry-weight basis). Granular formulations of nonvolatile insecticide-nematicides: 2-methyl-2-(methylthio)-propionaldehyde *O*-(methylcarbamoyl) oxime (aldicarb); 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate (carbofuran); *O,O*-diethyl *O*-[*p*-(methylsulfinyl) phenyl] phosphorothioate (fensulfothion); ethyl 4-(methylthio)-*m*-tolyl isopropylphosphoramidate (phenamiphus); and *O*-ethyl *S,S*-dipropyl phosphorodithioate (ethoprop) were applied (6.7 kg/hectare active ingredient) in a 30-cm band and incorporated 15- to 20-cm deep with a power-driven rototiller (all tines removed except those in a 30-cm band over the row) about two weeks after soil fumigants were applied. At time of application (April 16-30) soil temperature at 15-cm depth ranged from 20-25 C, and soil moisture ranged from 4.9 - 5.3% (dry-weight basis). Sweet corn, *Zea mays* var. *saccharata* (Slurtev.) Bailey, 'Seneca Chief', was planted 1-3 days after application of nonvolatile pesticides.

During May 1969, a plant-growth index (based upon a visual estimate of growth - see footnote Table 1) was recorded. Soil samples were collected from the rows 15-20 cm deep and assayed for plant-parasitic nematodes by the centrifugal-flotation method (7) one and three months after planting. Yield, as measured by the number and weight of ears per hectare, was recorded at harvest. Number and weight of ears provided similar yield data; therefore, yield is presented as number of ears per hectare. Damage, as measured by length of feeding tunnels of corn earworm, *Heliothis zea* Boddie, was recorded as a damage index from 15 ears selected randomly from each plot.

RESULTS

Plant growth on treated plots was greater than on control plots. Plants in plots treated with carbofuran and phenamiphus were taller than plants in other plots (Table 1).

Based on the average number of nematodes across all sampling dates and years, nonvolatile chemicals were more effective than soil fumigants against *B. longicaudatus* and *T. christiei* (Table 2). Fensulfothion and phenamiphus were more effective than other pesticides against *B. longicaudatus* and *T. christiei*. All pesticides, except aldicarb and ethoprop, significantly reduced populations of *C. ornatus*. Each year on all sampling dates, plots treated with aldicarb contained almost as many, if not more, *C. ornatus* than did control

TABLE 1. Growth index, yield and weight per ear of sweet corn as influenced by chemical soil treatment.

Treatment	Method of application[a]	Dosage active/ha	Growth index[b] 1969	Yield[c] Number ears ($\times 10^3$/ha)	Yield[c] g/ear
Control	A		3.33 b	24.8 d	193
Control	B		2.50 c	24.8 d	191
DD	A	15.3 liter	4.67 a	31.0 b	191
DBCP	A	1.1 liter	4.50 a	29.4 c	193
EDB	A	3.8 liter	4.83 a	35.3 a	193
Aldicarb 10G	B	6.7 kg	4.83 a	35.7 a	190
Carbofuran 10G	B	6.7 kg	5.00 a	30.7 b	196
Fensulfothion 15G	B	6.7 kg	4.83 a	37.8 a	192
Phenamiphus 15G	B	6.7 kg	5.00 a	32.1 b	189
Ethoprop 10G	B	6.7 kg	4.67 a	30.1 bc	188

[a]A = injected with a single chisel per row, followed with a bedding attachment; B = granules spread on surface of soil (30-cm band) and incorporated 15-20 cm with a power-driven rototiller.
[b]1-5 scale: 1 = very poor; 2 = poor; 3 = fair; 4 = good; 5 = excellent growth. Means followed by the same letter do not differ (P = .05) according to Duncan's multiple range test. No letter indicates nonsignificance.
[c]Average for 3 years.

TABLE 2. Nematode populations on sweet corn as influenced by chemical soil treatment.

			Nematodes/150 cc soil[b]							
			Belonolaimus longicaudatus		*Trichodorus christiei*		*Criconemoides ornatus*		*Pratylenchus zeae*	
Treatment	Method of application[a]	Dosage active/ha	1 mo	3 mo	1 mo	3 mo	1 mo	3 mo	1 mo	3 mo
Control	A		160 a	97 a	15 b	28 b	72 b	195 b	0	104 a
Control	B		175 a	83 a	29 b	24 b	58 b	191 b	0	94 a
DD	A	15.3 liter	46 b	57 bc	33 ab	28 b	6 d	68 d	0	14 b
DBCP	A	1.1 liter	3 c	70 b	42 a	23 b	14 cd	12 d	0	3 c
EDB	A	3.8 liter	1 c	21 d	33 ab	42 a	35 c	115 c	0	4 c
Aldicarb 10G	B	6.7 kg	24 b	31 cd	10 bc	8 c	103 a	414 a	0	8 bc
Carbofuran 10G	B	6.7 kg	13 bc	48 c	0 c	9 c	7 d	34 d	0	1 c
Fensulfothion 15G	B	6.7 kg	3 c	5 d	3 c	5 c	22 c	71 cd	0	3 c
Phenamiphus 15G	B	6.7 kg	2 c	12 d	7 c	8 c	4 d	38 d	0	1 c
Ethoprop 10G	B	6.7 kg	20 b	43 c	7 c	5 c	16 cd	143 bc	0	15 b

[a]A = injected with a single chisel per row, followed with a bedding attachment; B = granules spread on surface of soil (30-cm band) and incorporated with a power-driven rototiller.

[b]Soil sampled one and three months after chemical application. Means followed by the same letter do not differ (P = .05) according to Duncan's multiple range test. No letter indicates nonsignificance.

plots. Ethoprop was effective against *C. ornatus* one month after planting, but *C. ornatus* increased to levels comparable to those in nontreated plots three months after planting. No *P. zeae* were recorded one month after planting, but three months after planting they were detected in all plots in 1969 and in most plots in 1971; higher numbers were in the controls. All pesticides significantly reduced populations of *P. zeae* three months after planting.

Nematicide treatments increased average yield over respective controls by 31%, but did not significantly affect the mean weight per ear (Table 1). The highest yields came from plants in plots treated with fensulfothion, aldicarb and EDB. Yield and nematode data indicate that *B. longicaudatus, T. christiei* and *P. zeae* were responsible for reduction in yield. Correlation coefficients show an inverse relationship between yield and number of *B. longicaudatus* ($r = -0.29$), *T. christiei* ($r = -0.03$) and *P. zeae* ($r = -0.20$) per 150-cc soil sample; coefficients were significant ($P = 0.05$) for *B. longicaudatus* and *P. zeae*.

The corn earworm was the only economic insect evaluated during the tests. Neither the number of ears infested nor the damage index was significantly affected by chemical soil treatments.

DISCUSSION

Our data indicate that the growth response in treated plots was attributed to control of *B. longicaudatus, T. christiei* and *P. zeae*. Landis (10) reported a similar growth response on corn when root worms were controlled with carbofuran. Since many chemicals in our tests also possess insecticidal properties, increased plant growth and yield may have been due in part to the control of soil insects. We concluded that nematicide-insecticide compounds at rates used in our tests did not control the corn earworm effectively.

Aldicarb was not effective against *C. ornatus*. This suggests that its nematicidal properties were not effective or had disappeared. *C. ornatus*, possibly freed from competitors plus having a good root system on which to feed, increased rapidly. Johnson and Burton (9) reported similar results with alidcarb on millet and sorghum-sudangrass hybrids.

Sweet corn supports large numbers of *B. longicaudatus, T. christiei, C. ornatus* and *P. zeae*. Similar results were reported by other workers (3, 5). In the southeastern United States, sweet corn is a poor spring and summer cash crop because it favors extensive development of these potentially damaging nematode species. We also concluded that the insecticide-nematicide chemicals reduced initial nematode populations, and delayed population buildup so that economic threshold levels were not reached until after crop maturity.

LITERATURE CITED

1. APPLE, J. W. 1971. Response of corn to granular

insecticides applied to the row at planting. J. Econ. Entomol. 64:1208-1211.

2. BARIOLA, L. A., R. L. RIDGWAY and J. R. COPPEDGE. 1971. Large-scale field tests of soil applications of aldicarb for suppression of populations of boll weevils. J. Econ. Entomol. 64:1280-1284.

3. BRODIE, B. B. 1968. Systemic pesticides for control of sting and stubby-root nematodes on vegetables. Plant Dis. Rep. 52:19-23.

4. BRODIE, B. B. and G. W. BURTON. 1967. Nematode population reduction and growth response of Bermuda turf as influenced by organic pesticide applications. Plant Dis. Rep. 51:562-566.

5. GOOD, J. M. 1968. Relation of plant parasitic nematodes to soil management practices. p 113-138. *In* G. C. Smart, Jr. and V. G. Perry [ed.]. Tropical nematology. Univ. Florida Press, Gainesville.

6. HOPKINS, A. R. and H. M. TAFT. 1965. Control of certain pests with a new systemic insecticide, UC-21149. J. Econ. Entomol. 58:746-749.

7. JENKINS, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48:692.

8. JENSEN, H. J. 1966. Phosphate pesticides control root-lesion nematodes in Oregon Easter lily plantings. Plant Dis. Rep. 50:923-927.

9. JOHNSON, A. W. and G. W. BURTON. 1971. Effects of two nematicides on a mixed population of five species of plant-parasitic nematodes and on yield of selected millet and sorghum-sudangrass hybrids. J. Nematol. 3:314-315 (Abstr.).

10. LANDIS, W. R. 1971. The effect of carbofuran on stalk rot of corn. Plant Dis. Rep. 55:634-638.

11. MILLER, P. M. 1966. Control of *Heterodera tabacum* with volatile and nonvolatile nematicides. Plant Dis. Rep. 50:506-509.

12. RHOADES, H. L. 1967. The effects and control of sting and stubby-root nematodes on onions. Proc. Fla. State Hort. Soc. 80:175-180.

13. RIDGWAY, R. L., S. L. JONES, J. R. COPPEDGE and D. A. LINDQUIST. 1968. Systemic activity of 2-methyl -2-(methylthio) propionaldehyde *O*-(methylcarbamoyl)oxime (UC-21149) in cotton plants with special reference to the boll weevil. J. Econ. Entomol. 61:1705-1712.

14. SASSER, J. N. 1952. Studies on the control of root-knot nematodes (*Meloidogyne* spp.) with systox spray (E-1059), an organic phosphate insecticide. Plant Dis. Rep. 36:228-233.

15. WEIDEN, M. H. J., H. H. MOOREFIELD and L. K. PAYNE. 1965. *O*-(methylcarbamoyl)oximes: A new class of carbamate insecticides. J. Econ. Entomol. 58:154-156.

16. WINCHESTER, J. A. and C. W. AVERRE III. 1967. Post-plant nematicides for tomatoes in calcareous soils. Proc. Fla. State Hort. Soc. 80:205-208.