Multiple Pest Control in Cotton with Mixtures of Selective Pesticides

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ABSTRACT

When we applied an 8:2:1 mixture of the nematicide aldicarb (2-methyl-2 [methylthio] propionaldehyde *0*- [methylcarbamoyl] oxime) plus the soil fungicide PCNB (pentachloronitrobenzene); and the herbicide trifluralin (*a,a,a*-trifluro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine) in the seed furrow at time of planting cotton it controlled sting nematode (*Belonolaimus longicaudatus*), *Fusarium* wilt (*Fusarium oxysporum* f. sp. *vasinfectum*), and weeds (*Richardia scabra*, Florida pusley, and *Digitaria sanguinalis*, large crabgrass). A similar mixture, in which we replaced aldicarb with *0,0*-diethyl *0-p*-(methylsulfinyl) phenyl phosphorothioate (B-25141), did not adequately control *B. longicaudatus*. There was no evidence of incompatibility among compounds. However, weed control was 7 to 22% greater when trifluralin was applied in combination with other pesticides than when applied alone. Reduction in the incidence of *Fusarium* wilt resulted largely from nematode control rather than from control of *Fusarium* wilt with PCNB. Increase in yield of cotton was closely correlated with control of *B. longicaudatus* and *Fusarium* wilt. Phytopathology 60:1609-1612.

Additional key words: disease complex.

Implementation of recommended practices for chemical control of crop pests requires knowledge of several divergent principles of pesticide application and different types of application equipment (3, 10, 11, 13, 15, 16, 17). The need to reduce pesticidal costs to increase the efficiency of crop production necessitates the development of techniques for multiple pest control through single application procedures. The use of combinations of selective pesticides to achieve multiple pest control was recently reviewed (7). Attempts to control several pests of cotton with single applications of mixtures of selective pesticides have involved the nematicide 1,2-dibromo-3-chloropropane (DBCP) (4, 5, 18), a compound whose nematicidal effectiveness diminishes rapidly when applied less than 6 inches deep (11). Consequently, in-furrow applications of pesticide mixtures containing DBCP do not provide adequate protection against nematodes (4, 5). More recently, however, combinations of nonvolatile nematicides (organic phosphates and carbamates) with fungicides and herbicides controlled nematodes, weeds, and soil fungi in tomato transplants (9). Initial studies with phosphate and carbamate nematicides alone and in combination with other pesticides indicated their possible effectiveness as in-furrow treatments for nematode control (6, 7). Our present efforts were to determine the efficacy of mixtures of selective pesticides when applied in the seed row at time of planting cotton for control of nematodes, weed, and soil fungi.

MATERIALS AND METHODS.—The experimental site was in Tifton sandy loam (average 80% sand, 15% clay, and 5% silt) naturally infested with *Belonolaimus longicaudatus* Rau, *Fusarium oxysporum* Schlecht. f. sp. *vasinfectum* (Atk.) Snyd. & Hans., *Richardia scabra* L. (Florida pusley), and *Digitaria sanguinalis* (L.) Scop. (large crabgrass). Each plot consisted of two rows 15 m long and 0.9 m apart. Eleven treatments were arranged in a randomized complete block design replicated 4 times. Treatments consisted of the nematicides aldicarb (2-methyl-2 [methylthio] propionaldehyde *0*-[methylcarbamoyl] oxime), and B-25141 (*0,0*-diethyl *0-p*-[methylsulfinyl] phenyl phosphorothioate); the fungicide PCNB (pentachloronitrobenzene); and the herbicide trifluralin (*a,a,a*-trifluro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine) alone and in combinations of (i) nematicide-fungicide; (ii) nematicide-herbicide; and (iii) nematicide-fungicide-herbicide. All chemicals were granular formulations. Dosage levels, expressed as amount active ingredient, were 4.5, 1.12, and 0.56 kg/ha (4, 2, and 0.5 lb./acre) of the nematicides, fungicide, and herbicide, respectively. To prepare combination treatments, measured amounts of the desired chemicals were placed in a 1-gal drum and rotated for 5 min. Treatments were applied with a Demco[R] gravity-flow applicator attached to a two-row Birch[R] cotton planter. The applicator was equipped with two delivery tubes which were adjusted to meter one-half of the treatment directly behind the opening plow of the planter and one-half in the seed furrow. A row-bander 10 cm wide was attached to the delivery tube that was placed behind the opening plow. Pesticide application and planting were simultaneous. The planter was equipped with 25-cm opening plows, 20-cm furrow-covering discs, and pneumatic tire press wheel. Movement of the planter through the soil provided the only means of incorporating the treatment into the soil.

Nematode population was determined from soil samples taken 4 weeks after planting. Samples consisted of 20 cores (2.1 × 20 cm) randomly located within each plot. Each sample was thoroughly mixed, and a 150-cc aliquant was wet-sieved (20- and 325-mesh) and Baermann-pan extracted for 48 hr to separate nematodes from the soil.

Determination of weed control was made 2 weeks after treatment. Weed control was measured in a 10-cm band directly over the seed row, and was expressed as per cent reduction in weed growth in relation to weed growth in nontreated plots. Relative ratings of cotton seedling growth, rated as plant vigor, were made 4 weeks after treatment. A scale of 1 = poor growth and 10=optimum growth was used. After weed control and plant growth ratings were made, all plots were hand hoed and cultivated.

Control of *Rhizoctonia solani* was determined from seedling emergence counts 4 weeks after planting. Incidence of *Fusarium* wilt was determined from visual observations of wilt symptoms.

Result.—Nematode counts, disease incidence, and weed growth indicated a uniform infestation of *B. longicaudatus, F. oxysporum* f. sp. *vasinfectum*, Florida pusley, and large crabgrass (Table 1, Fig. 1-A). Counts of seedling emergence indicated negligible infection by *Rhizoctonia solani.* Each pesticide, except B-25141, controlled the pest for which it was intended (Table 1). Aldicarb controlled *B. longicaudatus* and promoted good growth of cotton seedlings (Fig. 1-B). The nematicidal effectiveness of aldicarb was not altered in mixtures with other compounds. Trifluralin controlled 58 to 80% of Florida pusley and large crabgrass (Fig. 1-C). Weeds were controlled better with mixtures of trifluralin and other compounds than with trifluralin alone (Table 1). Outstanding control of *B. longicaudatus* and weeds, and excellent cotton seedling growth, were obtained with a mixture of aldicarb, trifluralin, and PCNB (Fig. 1-D). Counts of cotton seedlings did not detect significant effectiveness of PCNB against *R. solani;* there were no significant differences in seedling emergence among treatments. All treatments involving aldicarb controlled *Fusarium* wilt. Best control of *Fusarium* wilt resulted from treatments (aldicarb and trifluralin) which controlled both nematodes and weeds (Table 1).

Growth and yield of cotton were closely correlated with pest control, particularly with control of *B. longicaudatus* (Table 1). Excellent growth and yield were obtained with a mixture of aldicarb and trifluralin. Poor plant growth and yield occurred in plots treated with PCNB, trifluralin, or B-25141. This was due to inadequate control of *B. longicaudatus* and *F. oxysporum* f. sp. *vasinfectum.*

Discussion.—Our results with the different pesticides, when used singly, essentially agree with previous results (6, 13, 16). Inadequate nematode control with B-25141 was possibly caused by a sublethal dosage or from inadequate incorporation of the compound in the soil. Although trifluralin controls certain weeds well (13), we did not expect greater than 80% control from this type of application which employed min incorporation of the herbicide in the soil.

Apparently, no loss of pesticidal effectiveness occurred among any of the compounds when applied in mixture. Phytotoxicity with some mixtures appeared to reduce cotton seedling emergence. We did not determine if this was a direct action of the chemicals or predisposition of the plant to *R. solani* as was previously reported (2, 14). There appeared to be synergism between certain compounds, as trifluralin mixed with other pesticides controlled weeds and increased seedling growth consistently better than trifluralin alone. Increased cotton seedling growth following application of mixtures of trifluralin and certain systemic insecticides may be attributable to an increase in num-

Table 1. Effect of chemical soil treatment on *Belonolaimus longicaudatus*, weeds, and *Fusarium* wilt and growth and yield of cotton

Treatment	Dosage kg/ha[a]	*B. longicaudatus*/150 cc of soil	% Weed control[b]	Healthy plants/15m of row	Growth rating[c]	Yield[d] kg/ha
Control		30	0	40	1.0	19.0
Aldicarb	4.5	10	0	160	9.3	636.1
B-25141	4.5	27	0	117	4.3	211.6
Trifluralin	0.56	9	58	63	3.5	115.4
PCNB	1.12	58	0	13	1.0	0.0
Aldicarb + Trifluralin	4.5 + 0.56	7	76	153	7.3	719.0
B-25141 + Trifluralin	4.5 + 0.56	16	65	105	5.5	256.5
Aldicarb + PCNB	4.5 + 1.12	5	0	190	9.8	500.6
B-25141 + PCNB	4.5 + 1.12	29	0	66	3.0	204.9
Aldicarb + Trifluralin + PCNB	4.5 + 0.56 + 1.12	9	71	155	7.5	334.0
B-25141 + Trifluralin + PCNB	4.5 + 0.56 + 1.12	16	80	118	7.0	231.8
LSD .05		17	14	63	2.5	240.8

[a] Expressed as amount active ingredient of toxicant, 4.5, 1.12, and 0.56 kg/ha = 4, 2, and 0.5 lb/acre, respectively.
[b] Relative rating based on weed growth in plots that received no herbicide.
[c] Relative rating based on growth in nontreated plots. Scale 1-10, with 1 representing poor growth and 10 opt growth.
[d] Expressed as seed cotton.

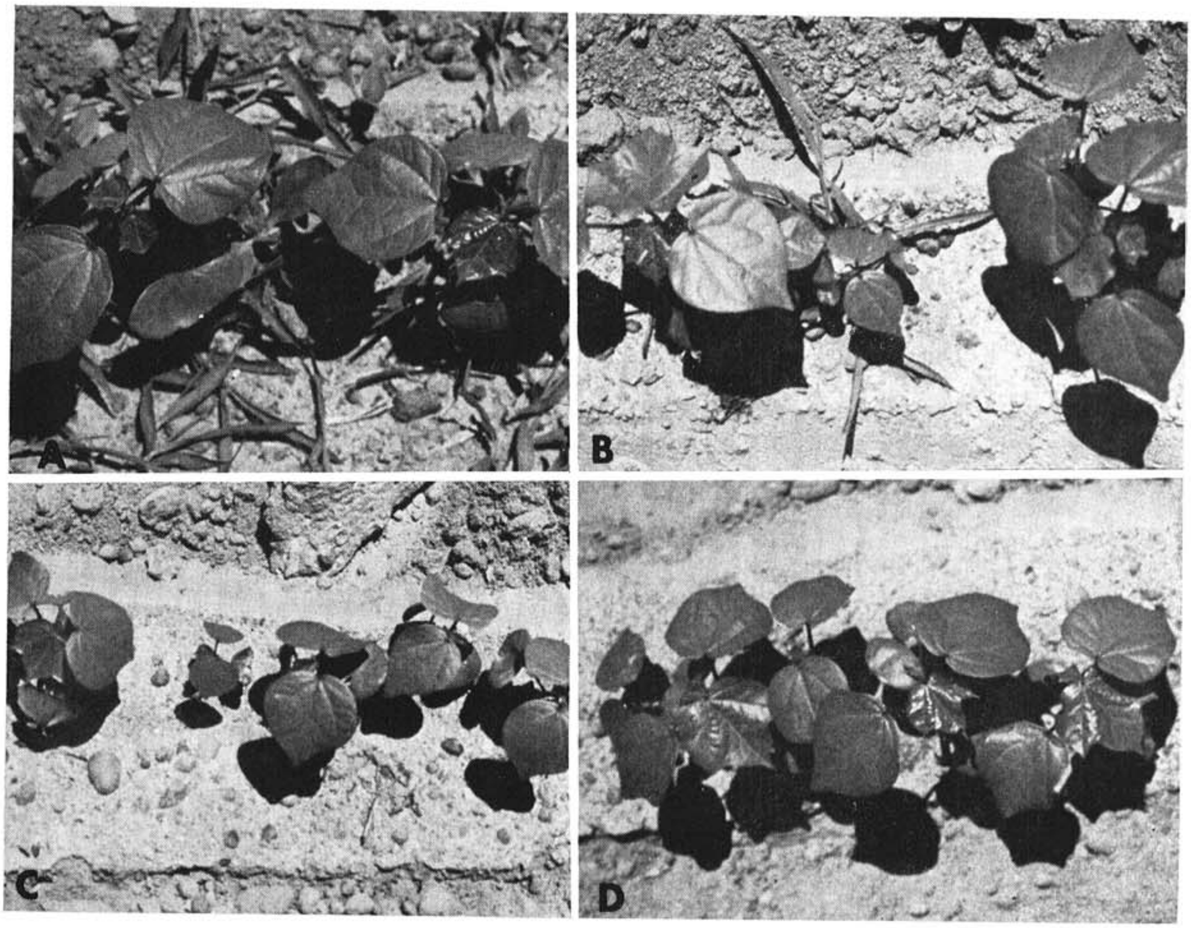

Fig. 1. Cotton seedlings growing in **A)** nontreated soil, **B)** in soil treated with aldicarb, **C)** trifluralin, **D)** aldicarb, trifluralin, and PCNB.

ber of secondary roots in the zone of incorporation (1). This phenomenon, together with evidence of control of *B. longicaudatus* with trifluralin, needs further investigation.

The relation of *Fusarium* wilt of cotton to *B. longicaudatus* infection has been reported (12). In our study, the lack of *B. longicaudatus* control was readily evident from increased incidence of *Fusarium* wilt. Also, seedling emergence appeared to be influenced by *B. longicaudatus*. Increased seedling emergence followed all treatments involving aldicarb. It is not known whether *B. longicaudatus* predisposes cotton seedlings to *R. solani* infection, as is the case with other nematodes (8).

We believe that mixtures of selective pesticides provide a possible means of reducing pesticide application cost and of increasing efficiency of crop production. This is particularly true for crops whose margin of profit prohibits expensive, intensive, and separate programs of nematicide, fungicide, and herbicide application. The insecticidal properties of the organic phosphate and carbamate nematicides (3) would further reduce pesticide application cost by providing some insect control. Furthermore, formulations containing a nematicide, herbicide, and fungicide on the same granule, or in the same liquid, would further reduce application costs and probably increase pest control efficiency. Such formulations would necessarily be tailored for specific crops, pests, and soil conditions. But since the method we used for applying trifluralin has not resulted in satisfactory weed control, and may have injured crops in other geographic areas (1, 10), additional research is needed before final conclusions can be made.

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