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Effects of Some Insecticide Formulations on Fruiting of the Cotton Plant[1]

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IN 1959 and 1960 a commercial formulation of an organophosphate insecticide, methyl parathion (*O,O*-dimethyl *O*-*p*-nitrophenyl phosphorothioate), delayed the initiation of fruiting branches when it was sprayed on seedling cotton plants (5). This response was not related to infestations of insects. It was suggested, therefore, that methyl parathion had acted on the cotton plant itself, and literature was cited to support this viewpoint. Weaver and Harvey[3] recently presented additional evidence that methyl parathion delays production of seed cotton by several varieties of *Gossypium hirsutum,* and Krishnamurthy (1) reported in 1961 that ethyl parathion delays initiation of fruiting branches by *G. herbaceum*. The present paper gives results of an experiment conducted in 1962 with formulations of (a) methyl parathion, (b) *O,O*-dimethyl *S*-*p*-chlorophenylthiomethyl phosphorodithioate[4] (hereafter called phosphorodithioate I), (c) *O,O*-dimethyl *S*-(4-oxo-1,2,3-benzotriazin-3-(4*H*)-ylmethyl) phosphorodithioate[5] (hereafter called phosphorodithioate II), (d) toxaphene (chlorinated camphene containing 67–69% chlorine), (e) endrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-*endo-endo*-5,8-dimethanonaphthalene), and (f) carbaryl (1-naphthyl *N*-methylcarbamate).

MATERIALS AND METHODS

American upland 'Deltapine Smooth Leaf' cotton (*Gossypium hirsutum* L.) was planted in sandy loam on April 23, 1962. One hundred pounds of nitrogen (using commercial anhydrous ammonia) per acre were applied in the seedbed before planting. Rows were 40 inches apart, and hills were spaced at 20-inch intervals along each row. There were about 6 plants/hill.

Eight experimental treatments and 4 replications of each treatment were arranged in a randomized, complete-block, experimental design. Each plot contained 0.135 acre. The treatments (active ingredients in pounds per acre) were (a) methyl parathion, 0.17; (b) phosphorodithioate I, 0.33; (c) phosphorodithioate II, 0.17; (d) toxaphene, 2.00; (e) endrin, 0.13; (f) carbaryl, 0.67; (g) solvent + emulsifier without insecticide; and (h) unsprayed cotton. On July 9, about 2½ weeks after flowering commenced, these rates were increased 50%. Treatments were repeated at 4- or 5-day intervals whenever weather permitted. Altogether, 25 applications of each treatment were made beginning May 7 and ending September 12.

Water dispersions used for treatments (b), (c), and (f) were prepared from commercial formulations readily available to farmers. Water dispersions used for treatments (a), (d), (e), and (g) were prepared from emulsifiable concentrates specially formulated to have the same xylene-type solvent. They were applied with an 8-row, high-clearance, spray machine. Earlier applications were made using 2 No. X-4 nozzles per row and applying 4 gallons per acre of spray. Commencing with the fourteenth application (July 9), the rate was increased 50% by using 3 No. X-4 nozzles per row and applying 6 gallons per acre of spray. All plots were given a supplemental application of 0.5 lb. ethion (*O,O,O',O'*tetraethyl *S,S'*methylenebisphosphorodithioate) per acre on June 27 to control aphids and mites. On July 13, 0.1 lb. per acre of 2-dimethylcarbamoyl-1-methylvinyl dimethyl phosphate[6] was applied to all plots to control aphids.

Each plot was 16 rows wide. Three rows near the center of each plot were reserved for determination of yield of seed cotton (cotton seed and lint before ginning). They were picked by hand 4 times. All other data were obtained from remaining rows. Methods for obtaining data on aphids, thrips, and tarnished plant bugs (*Lygus lineolaris* (Palisot de Beauvois)) have been described previously (3, 4).

RESULTS AND DISCUSSION

First fruiting branches developed at a higher node of the main axis on plants sprayed with methyl parathion than on control plants sprayed only with solvent + emulsifier (Table 1). This response was similar to that reported for 1959 and 1960 (5). Plants sprayed with phosphorodithioate I also developed first fruiting branches from a higher node of the main axis than control plants. In contrast, plants sprayed with phosphorodithioate II, toxaphene, endrin, or carbaryl developed first fruiting branches at the same node level as control plants treated only with solvent + emulsifier. Corresponding to the delay in initiation of fruiting branches, fewer floral buds developed in early June on plants treated with methyl parathion or phosphorodithioate I (Table 1). Unlike methyl parathion, phosphorodithioate I retarded plant growth as measured by oven-dry weight. Control plants sprayed only with solvent + emulsifier did not differ significantly from unsprayed plants.

Since fruiting branches are initiated before the first floral buds (squares), only treatments applied before squaring can modify the development of the first potential fruiting branches (2). In this experiment plants treated with methyl parathion received a total of 1.00 pound (6 applications of 0.166 pound each) per acre of methyl parathion before the first square count. The minimum amount of

Table 1. Average growth (roots excluded), production of flower buds, and position of lowest fruiting branch on main axis after different treatments were applied to cotton plants. Treatments begun in seedling stage. Planted April 23, 1962, and evaluated on dates indicated.

Treatment	Plants per hill June 5-7	Plant wt. per hill, g. † June 5-7	Buds per hill June 5-7	Lowest fruiting branch node‡ Oct. 19-23
Methyl parathion	6.5	21.9 a§	15.0 de	7.68 a
Phosphorodithioate I	6.0	18.1 b	13.5 e	7.73 a
Phosphorodithioate II	5.8	21.1 a	16.4 cd	7.10 b
Toxaphene	6.4	20.3 a	18.9 bc	7.05 bc
Endrin	6.5	21.4 a	23.0 a	6.55 cd
Carbaryl	6.2	21.0 a	20.2 b	6.60 bcd
Solvent + emulsifier	6.6	20.3 a	19.5 b	6.88 bcd
No spray	6.7	21.3 a	20.4 b	6.50 d
Analysis of variance	ns	**	***	***
Coeff. of variability (%)	6	6	9	5

† Oven-dry weight basis. ‡ The cotyledonary node was counted as node no. 1.
§ Averages followed by the same letter do not differ significantly at the 5% level.
ns - Not significant at 5% level. **, *** Significant at 1% and 0.1% levels.

Table 2. Seed cotton (pounds/acre) picked on given dates after different treatments were applied to cotton in 1962.

Treatment	Seed cotton, lb./A. picked on:				
	Aug. 23	Sept. 4,5	Sept. 13	Oct. 2	Total
Methyl parathion	675 c†	1035	477 ab	506	2693
Phosphorodithioate I	622 c	775	337 bc	413	2147
Phosphorodithioate II	749 c	862	419 abc	638	2668
Toxaphene	806 bc	852	326 bc	413	2397
Endrin	1052 a	852	352 bc	325	2581
Carbaryl	970 ab	851	274 c	338	2433
Solvent + emulsifier	712 c	886	495 ab	484	2577
No spray	751 c	959	556 a	498	2764
Analysis of variance	***	ns	*	ns	ns
Coeff. of variability (%)	16	27	28	37	18

† Numbers in the same column followed by the same letter do not differ significantly at the 5% level. ns - Not significant at 5% level.
*, *** Significant at 5% and 0.1% level.

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[3] Weaver, J. B., Jr., and Harvey, L. Differences in varietal reaction to toxaphene + DDT vs. methyl parathion. Proc. 15th Ann. Cotton Improvement Conf., Dallas, Tex. pp. 91–104. 1963.

[4] Commercially available as Methyl Trithion (R).

[5] Commercially available as Guthion (R).

[6] Commercially available as Bidrin (R).

methyl parathion required to delay the initiation of fruiting branches probably is even less than this.

Methyl parathion and phosphorodithioate I caused a similar delay in initiation of fruiting branches. Both are highly toxic phosphorus esters related in chemical structure and having generally similar biochemical activity. Phosphorodithioate II also belongs to this group of chemicals, but its effect on initiation of fruiting branches is not clear from Table 1. Plants sprayed with phosphorodithioate II had significantly fewer early squares, but not significantly later initiation of fruiting branches, than control plants sprayed only with solvent + emulsifier. Phosphorodithioate II may have been absorbed more slowly into the plant, have had a different reaction rate, or have had a different specific activity than methyl parathion. Shipp and Brazell (6) recently demonstrated that both methyl parathion and phosphorodithioate II accumulate in the internal tissues of cotton leaves and persist there for several days.

Plants sprayed with endrin produced significantly more squares in early June than plants receiving any other treatment. This response seems unrelated to time of initiation of fruiting branches and cannot be explained from the data of this experiment.

Insect populations were unusually low prior to the first square counts on June 5 and 7. Aphids, thrips, and tarnished plant bugs were the only pests of cotton detected. As reported (5) for methyl parathion in 1959 and 1960, consistent differences in infestations of these insects did not occur between plots treated with methyl parathion or phosphorodithioate I and plots treated with other insecticides. Thus the delayed initiation of fruiting branches, which was observed when seedling cotton plants were sprayed with methyl parathion or phosphorodithioate I, seems unrelated to infestations of insects. This suggests that methyl parathion and phosphorodithioate I can participate directly in plant metabolism and modify physiological processes which control initiation of fruiting branches.

Yields of seed cotton at first picking were highest (Table 2) on plots treated with endrin and carbaryl, where effective insect control was maintained throughout the season and where initiation of fruiting branches was not delayed. Significant differences in total yield of seed cotton were not obtained for any treatments.

SUMMARY

Delayed initiation of fruiting branches and delayed production of floral buds were observed after cotton plants were sprayed during the seedling stage with either of two organophosphate insecticides. This response was not related to infestations of insects and appeared to be due to action of the insecticides on physiological processes in the cotton plant controlling initiation of fruiting branches. A third organophosphate insecticide had less effect on initiation of fruiting branches. Spraying with toxaphene, endrin, or carbaryl did not affect initiation of fruiting branches. Corresponding differences were observed in yield of seed cotton at first picking, but significant differences between treatments in total yield of seed cotton after the final harvest were not obtained.

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