CONTROL OF BUDWORMS AND HORNWORMS IN FLUE-CURED TOBACCO[1]

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Seven of the newer insecticides were tested on tobacco in a small plot experiment in the summer of 1948. DDT, Toxaphene, and Rhothane were much superior to all other materials in controlling budworms and hornworms. Parathion and Marlate gave good control of hornworms, but practically no control of budworms, and the plots receiving these treatments showed nearly as much plant injury as the check plots. Chlordane and Isotox were intermediate between the two groups but more nearly like the less effective materials. The wide variation in the degree of control obtained with the different insecticides clearly showed the need for further work. It was decided to repeat the experiment in 1949 and in this test larger plots were used and a larger number of materials were tested. The results of these tests are given in the pages that follow.

PLOT ARRANGEMENT.—The tobacco field used in the 1949 tests was approximately square and contained slightly less than one acre. The land sloped gently to the North and the field lay below a long and somewhat steeper slope. Early in March the land was prepared and the fertilizer applied but dry weather prevented planting until April 4. It began to rain just as the last plants were set and during the next 24 hours 7.14 inches of rain fell. Torrents of water rushed down the slope and through the tobacco field causing considerable damage. Many of the newly set plants were washed entirely out of the ground and others were completely buried. Recovery from the washing was surprisingly good but even with much replanting, many plants were missing and growth of the tobacco was uneven throughout the season. Scattered irregular areas of heavy root-knot infestation added a further complication. These various factors made it evident almost from the start that plot yields would be of little or no use in evaluating the effectiveness of the different insecticides.

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The experimental area was divided into 48 four-row plots arranged in three blocks of 16 plots each. Each of the plot rows contained 30 plants at planting time, but when the insecticide applications were made only two plots had their full complement of 120 plants. The poorest plot, which happened to be a check, contained only 71 plants. This plot arrangement provided for three replications of 15 treatments which included 11 dusts, three sprays and a poison bait. Each treatment appeared once in each block and the various treatments were located at random within the blocks. No buffer rows or alleys were left between plots or blocks as the 1948 tests showed that the slight drift of insecticides from plot to plot could be disregarded.

METHOD OF APPLICATION.—Dust materials were applied with rotary type (Root) hand dusters. Rather complete plant coverage was attained at the first application but when the plants got larger the dust was directed principally at the buds and upper leaves of the plants. An attempt was made to use equal amounts of the different dusts but in spite of all efforts there was considerable variation in the amounts actually applied.

Through an oversight the amounts of dust used at the first application were not determined. The amounts used at the second and third applications are shown in Table 1.

The sprays were applied with a continuous pumping (Champion) knapsack sprayer. In the first application the sprays were used at the rate of approximately 80 gallons per acre. In the second and third applications about 125 gallons per acre were used.

A pinch of the poison bait was applied with the fingers to the bud and upper leaves of each plant in the plot receiving this treatment. The amounts of bait used at the second and third applications are given in Table 1.

MATERIALS USED.—The materials tested, the formulations and concentrations used, and the sources of the materials were as follows: *Dusts*—(1) Toxaphene 10 percent, Alltox 100 made by California Spray-Chemical Corporation and purchased from a local insecticide store; (2) Toxaphene 5 percent, made by mixing equal parts of the above and Pyrax; (3) Rhothane 3 percent, prepared from 50 percent wettable powder, obtained from Rohm and Haas Company, and Pyrax; (4) Experimental Insecticide 497 1 percent, an experimental sample furnished by Julius Hyman and Company; (5) DDT 5 percent, Gesarol A-5 an agri-

cultural dust prepared by Geigy Company, Inc.; (6) DDT 3 percent, Gesarol A-3 an agricultural dust from Geigy; (7) Parathion 1 percent, the dust for the first two applications prepared from 25 percent wettable powder, furnished by American Cyanamid Company, and Pyrax, and for the third application a 1 percent commercial dust purchased locally; (8) Isotox 1.5 percent gamma, Isotox 15 a commercial dust prepared by California Spray-Chemical Corporation; (9) Lead Arsenate 16 percent, prepared by mixing 1 part of commercial lead arsenate with 5 parts of Pyrax; (10) DDT 2.5 percent plus Parathion 0.5 percent, prepared by mixing equal parts by weight of materials 5 and 7 above; (11) DDT 2.5 percent plus Toxaphene 5 percent, prepared by mixing equal parts of materials 1 and 5 above; *Sprays*—(12) Tetraethyl Pyrophosphate, Vapotone 20 percent made by California Spray-Chemical Corporation, used at rate of one pint per 100 gallons of water; (13) Parathion, Vapophos 15 percent wettable powder made by California Spray-Chemical Corporation, used at 1 pound per 100 gallons of water; (14) Toxaphene, Alltox Wettable 400, a commercial 40 percent wettable powder, made by California Spray-Chemical Corporation, used at 2.5 pounds per 100 gallons of water; *Poison Bait*—(15) Chlordane bait, a commercially prepared bait containing 1.5 percent of chlordane in a citrus pulp base.

DATES OF APPLICATION.—The first application of insecticides was made May 18, 1949 between the hours of 5:30 and 7:30 A.M. Dusting conditions were good though there was a light variable breeze at times. The plants were wet with dew, the soil was dry, but the plants were not wilted at time of application. During the heat of the day the tobacco wilted badly.

On June 4, the second insecticide application was made from 5:00 to 7:50 A.M. Dusting conditions were excellent. There was practically no air movement and the dusts hung in the air about the plants with only a slight drift. The soil was dry and there was a light dew on the plants.

The third application was made June 16, from 5:00 to 7:30 A.M. Again dusting conditions were excellent. As before, the plants were wet with dew and the soil was fairly dry.

TEST INSECTS.—The principal insect pests on the tobacco were the tobacco budworm, *Heliothis virescens* (F.) and the tobacco hornworm, *Protoparce sexta* (Johan.). For several weeks the tobacco was surprisingly free of insects but by the middle of May some budworm damage began to appear and

hornworm larvae were fairly common. The budworm infestation developed rapidly and by June first 25 percent of the plants in the check plots showed recent larval injury. Counts made in the middle of June showed that 50 percent of the plants in the check plots and in those treated with the less effective insecticides had been injured recently. Worm damage rapidly became more noticeable and by the end of June some plants were reduced to stems and bare midribs.

Winged aphids were noted frequently on the tobacco and at times they were so numerous that three or four individuals would be found on a single leaf. Specimens of the aphids were collected by means of a camel hair brush dipped in 70 percent alcohol. The green peach aphid, *Myzus persicae* (Sulzer), was taken every time a collection was made and on one occasion 20 individuals of this species were collected in less than an hour. They frequently were seen producing young but they rarely were successful in establishing themselves. During the entire season three or four small colonies were noted but these never contained more than a dozen individuals. This could not be attributed to the insecticides since there was a narrow border of untreated plants around the edges of the field in addition to the check plots. No satisfactory explanation could be given for the failure of the aphids to become established.

EVALUATION OF INSECTICIDES.—When insect damage began to appear in the field, it was already evident that the poor stand and uneven growth of the tobacco would make plot yield records of no value for comparing the effectiveness of the various insecticides. Careful counts of the larvae and observations on feeding damage seemed to be the most practical method available. In the count made May 16 preceding the first insecticide application, ten plants selected at random in every fourth row of the field were examined. The 120 plants thus examined had a total of 20 budworms and 42 hornworms. In the post-treatment count following the application, every fourth plant in each of the two inside rows of the plots was examined until a total of 10 plants per plot was checked. These early counts showed that the larvae were distributed very unevenly through the field and that examination of only a few plants per plot would not give a true picture of the infestation. In subsequent counts every plant in each plot was examined carefully and all larvae recorded. Sometimes the larvae could not be found even though there was evidence of recent feeding so the number of freshly

injured plants also was recorded. It was felt that the counts made at the time of the first insecticide application had no significance because too few plants were examined so they are not recorded here. The number of larvae found before and following the second and third applications and the number of freshly injured plants noted at the pretreatment counts, are summarized in Table 1.

DISCUSSION.—The data given in the table clearly show that eight of the treatments gave excellent control of both budworms and hornworms. It is just as evident that the TEPP and Parathion sprays had very little if any effect on the larvae and that they failed entirely to protect the plants from injury. The remaining five treatments obviously gave some larval control and varying degrees of plant protection but the benefits were so small that it would be impractical to use them.

Although the table shows striking differences between the various materials, the figures alone do not give a complete picture. Attention is called to the small numbers of larvae found at the pretreatment counts in the plots receiving Experimental Material 497 (now known as Octalox), DDT, Toxaphene, and Rhothane. These attest to the excellent residual qualities of these insecticides and their value in preventing or delaying reinfestation. Likewise reference should be made to the plants with fresh injury. Plants were recorded as injured even though the damage was slight. In some cases the larvae that caused the injuries were newly hatched and it was quite certain that they would succumb to the insecticide within a few hours. A word of explanation also is needed relative to the hornworm counts at the June 16 application. In many cases the post-treatment counts are higher than the pre-treatment ones and this is especially noticeable in the plots receiving DDT 2.5 percent plus Parathion 0.5 percent and DDT 3 percent. At that time the hornworm moths were unusually active and they were laying eggs freely. Apparently the insecticides had little deterrent effect and they did not prevent the eggs from hatching. The majority of hornworm larvae, and to a lesser extent the budworms, were newly hatched ones which almost certainly were killed by the better insecticides before they could cause any material plant injury.

The Toxaphene spray appeared to be somewhat less effective than the Toxaphene dusts. This probably can be attributed to in adequate coverage with the spray. When the tobacco grew

TABLE 1.—EFFECTIVENESS OF INSECTICIDES IN CONTROL OF TOBACCO BUDWORMS AND HORNWORMS.

Materials	Total No. of Plants in 3 Plots	Application Made June 4						Application Made June 16					
		Amount Used—Pounds per Acre	No. of Plants with Fresh Injury	Number of Larvae Found				Amount Used—Pounds per Acre	No. of Plants with Fresh Injury	Number of Larvae Found			
				Budworms		Hornworms				Budworms		Hornworms	
				Pre-treat	Post-treat	Pre-treat	Post-treat			Pre-treat	Post-treat	Pre-treat	Post-treat
TEPP Spray 1 pt. 20% : 100 gals.	330		66	41	28	12	14		142	100	119	40	61
Toxaphene 10%	344	42	17	10	6	0	1	44	14	6	4	1	0
Toxaphene 5%	330	47	26	23	7	0	0	55	18	14	5	0	1
Rhothane 3%	319	45	28	19	1	2	0	36	13	8	4	0	4
Parathion Spray 1 lb. 15% : 100 gals.	318		66	47	27	5	3		168	107	90	62	66
DDT 2.5% plus Parathion 0.5%	323	40	23	9	7	5	4	19	13	6	4	1	23
DDT 2.5% plus Toxaphene 5%	318	37	20	11	6	0	0	22	17	13	6	0	3
Experimental Insec i cide 497 1%	277	35	7	6	1	3	0	39	3	2	2	1	4
DDT 5%	335	26	11	5	2	2	1	32	17	12	7	1	6
Check	287		72	45	42	4	6		143	102	136	49	83
Chlordane Bait	286	6	31	18	9	0	4	4	83	40	29	45	91
Lead Arsenate 16%	283	29	40	24	27	6	2	45	111	103	65	20	10
Parathion 1%	333	52	47	31	26	9	0	48	127	97	95	33	26
Toxaphene Spray 2.5 lbs. : 100 gals.	302		39	30	7	3	2		36	31	24	0	14
Isotox 1.5% gamma	293	24	20	8	6	5	2	29	89	57	66	19	75
DDT 3%	329	19	7	3	0	0	1	50	23	17	7	5	13

Pretreatment larval counts made June 3 and June 13-15; Post-treatment counts made June 7-8 and June 20-22.

large it was most difficult to get complete coverage with the type of sprayer used and some of the leaves likely did not get enough of the insecticide to protect them.

PHYTOTOXICITY.—Although some of the insecticide applications were considerably heavier than are recommended for tobacco, no evidence of insecticide injury was noted at any time during the 1949 tests. It is true that no yield records were taken and it cannot be said positively that none of the materials adversely affected production but there was nothing to indicate that such was the case.

CONCLUSIONS.—Of the 15 different insecticidal formulations used, Toxaphene, DDT, Experimental Insecticide 497, and Rhothane were outstanding in controlling tobacco budworms and hornworms. Lead Arsenate and Parathion dusts gave some control of the budworm and hornworm but were considerably inferior to the better materials. The Isotox and Chlordane bait treatments were effective during periods of light infestations but were definitely inferior to the better materials. When larval infestations were heavy, TEPP and Parathion sprays failed to give any appreciable control of budworms or hornworms, while the Toxaphene spray gave fair control in spite of rather poor coverage. The green peach aphid failed to become a serious pest in any plot during the season although the limiting factor could not be traced to the use of the insecticides. No phytotoxic reaction was noticed on any plant at any time.

RESEARCH NOTES

AN INTERESTING INSECT ASSOCIATION.—During the spring of 1948 Mr. T. E. Brooks of the Plant Pathology Department, Kansas State College, brought some parasitic wasps to me for examination. He stated that the wasps had emerged from packrat droppings which he had collected in Morris County, Kansas for purposes of culturing fungi. After collecting the droppings they were placed in petri dishes and stored at room temperature. Mr. Brooks reported that he had observed small wasps inside the petri dishes on numerous occasions.

The following observations were made from a study of several hundred packrat droppings furnished me by Mr. Brooks. Two species of coleoptera and two species of parasitic hymenoptera were obtained from the droppings. In numerous instances