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SOIL TREATMENT FOR CORN ROOTWORM CONTROL

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Corn rootworms have occurred in Kentucky in such an unpredictable manner that the control problem has been difficult to approach. Observations in past years have shown that the most frequently attacked areas occur on bottomlands. Infestations occur on upland corn-growing areas less frequently; in 1950, however, infestations of the Southern corn rootworm were widespread over many upland fields and much replanting had to be done as a result of heavy damage, or total loss of first plantings.

Investigations in progress since 1950 have been directed towards control of Southern corn rootworms by means of soil insecticide spray applications. During this time only two experiments have been located on sites where rootworms have occurred. Because these infestations cannot be predicted, a thorough evaluation of insecticide toxicity on Southern corn rootworms has not been made. Nevertheless, it has been possible to study the effect of certain chlorinated hydrocarbons, as soil insecticides, on the corn plant as they have affected growth and yield. This progress report is a summation of the work up to the present time.

1950 TESTS

The results of a test conducted near Bardwell, Kentucky on Mississippi River bottom land are shown on Table 1. Six acres of a field planted to Kentucky 203 were sectioned into plots which were arranged in randomized blocks; the insecticides were applied in bands over the planted row with a tractor mounted weed-type spray boom 3 days after the corn was planted. The Southern corn rootworm infestation was relatively light. Under these conditions aldrin gave somewhat better protection than all other materials; it produced the highest yield, 76.5 bushels per acre, as compared to 60.1 for the check plots. Aldrin and chlordane harvest yields were significantly higher than the yields of dieldrin and the untreated check.

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Another experiment was located in Jessamine county where an infestation of Southern corn rootworm was found damaging about two-thirds of the young plants in a 4 acre field of up-land corn. Corn (Ky. 103) was replanted over the original row and 4 days later, treatments were applied broadcast using a tractor-mounted weed spray boom. Injured plants in the replanted row were counted and height measurements were also taken; this corn was cut for silage on September 5. Results are summarized in Table 2. Less rootworm injury occurred in the aldrin-treated plots; furthermore, plant measurement records showed these plots averaging 5.2 inches taller plants than the untreated check. The BHC treated plots produced the most silage, however.

1951 TESTS

The results of a test conducted in a farm near Lexington are shown on Table 3. Four and one-half acres of a field were arranged in randomized plots and band applications of various soil insecticides were made with a weed spray boom at pre-emergence. Rootworm infestations failed to develop in this field, as well as in other tests in 1951; however, plant measurements made 6 weeks after planting showed that dieldrin and chlordane treated plots averaged 3.5 and 3.2 inches taller respectively, than the untreated plots. Drought conditions later in the year caused large yield variances and none of the treatments were significantly different than the check.

Two small-plot tests planted to Ky. 103 were located in the station farm; in one test materials were applied at pre-emergence in 12-inch bands and in another test aldrin was applied broadcast and in bands at planting time, at pre-emergence, and at post-emergence. The results in the first test (Table 4) showed that chlordane applied at 0.86 pound per acre was significantly different than the other treatments; chlordane plots produced 78 bushels per acre as compared to 59 for the untreated check. The results in the second test (Table 5) showed that differences in yield between the broadcast and the band treatments were not statistically significant; aldrin applied broadcast at 3 pounds per acre at post-emergence, however, was significantly different than the untreated check; the yields were 74.4 and 63.2 bushels per acre respectively. In both tests, amine 2, 4-D was used as a pre-emergence spray, applied in combination with insecticides whenever the insecticide treatment was to have been applied at pre-emergence.

1952 TESTS

The work conducted during 1952 involved one small plot test at the Station Farm and three large plot tests elsewhere in Fayette county; one other large plot test was located in Ballard county on Ohio River bottom land. None of the test sites developed corn rootworm infestations.

The results for the test located on the Station Farm are given on Table 6. Aldrin applied at the rate of 1 pound per acre in a band at planting produced 13 bushels more grain per acre than the untreated check, a highly significant difference; the BHC treatment was also highly significantly different from the untreated check.

The chlordane treatment was significantly different than the untreated check, producing 10 bushels more per acre. The hybrid was Ky. 103.

Two adjacent fields of seed corn (WF9 x 38 - 11) were treated with a sprayer-equipped planter in Fayette county and the results of the test are given in Table 7. The yields represent total harvest of U. S. 13 seed corn from these fields.

The results of the remaining tests are not shown; although plant measurements taken in the early part of the season were comparable to the differences found in the tests given in Tables 6 and 7, the yield differences at harvest were not significant. This is attributed to extreme variations brought upon by the drought in the areas where the tests were located.

DISCUSSION OF RESULTS

The work done in Bardwell in 1950 indicated that substantial increases in corn yields could be effected with soil insecticide application; only 5 percent of the untreated plants showed bud injury in this experiment (Table 1). When 10 percent of the plants showed bud injury, silage yields were increased up to 3.4 tons over the untreated check (Table 2); although comparatively heavy dosages of materials were used in this test, these applications were made broadcast and a comparable dosage as a band application would have reduced the dosage to 1/3 or 1/4 of the material used.

It is recognized that bud injury on the plant may result only when the rootworm larvae penetrate the crown of the seedling plant and the effects of root feeding or root pruning on plants past the seedling stage by this same insect or other insects may not be obvious on the top part of the plant. Thorough and extensive examination of roots could not be made. However, in order to detect effects on influences on the plant, measurements of the extended height of the foliage were used as a criterion. These plant measurement data established the fact that a favorable condition was induced by the application of chlorinated hydrocarbons (Tables 2-7). The plants responded in increased top growth to application of aldrin, dieldrin, chlordane, heptachlor, and BHC. Measurements taken 4 to 6 weeks after planting, showed more than 5 inches growth over the untreated plants; although measurements were not taken at harvest, observations made at that time generally showed that the treated plots were easily distinguishable from the untreated check plots. Some indication of this may be gotten from the data presented on silage and fodder on Tables 2 and 6.

Increased harvest yields were also obtained (Tables 1, 3-7). It is not understood why some materials showed superiority over others in one instance and in another instance the reverse was true. (Tables 1, 4, 6, 7); nevertheless, the data show that aldrin and chlordane were consistently more effective than the other materials.

The phenomena involved in inducing favorable plant responses and yields are not completely understood but the following factors or combination of factors may be responsible:

1 - Elimination or reduction of common root feeding insects (root-worms, wireworms, grubs, aphids, cutworms).
2 - Elimination or reduction of less important root feeding microfauna (springtails, symphilids, millipedes).
3 - Effects of above factors or introduction or dissemination of pathogenic agents (rots, diseases).
4 - Direct effects of soil insecticides on soil microorganisms.
5 - Direct physiological effects on the plant system.

CONCLUSIONS

Certain conclusions can be reached from the work thus far:

1 - Soil treatment effected a uniform stand.
2 - Favorable effects on plant development were obtained. Aldrin increased plant growth an average of 5.2 inches in one test. Silage yields were significantly higher in the treated plots than in the untreated check plots in this test.
3 - Significant increases in harvest yields of grain were obtained with aldrin or chlordane treatment. A carefully designed experiment in the Station Farm in 1952 produced an increase of 13 bushels in the aldrin treated plots (1 pound per acre) over the untreated check plots, in spite of the fact that no visible corn rootworm infestation occurred.
4 - One pound of aldrin or chlordane per acre, applied in a band during planting, effectively reduces Southern corn rootworm and it is likely that many other insect species are reduced or eliminated.

Table 1. Corn Rootworm Control, 1950 (T.A. Bishop Farm, Bardwell, Kentucky)

Treatment [1]	Dosage [2] (lb./A.)	Percent Injured [3] Plant (Av.)	Yield [4] (Bu./A.)
1 BHC	2	1.0	71.6
2 Chlordane	4	1.1	73.8
3 Aldrin	4	0.6	76.5
4 Dieldrin	4	0.8	62.8
5 Toxaphene	4	2.1	67.2
6 Check		5.0	60.1
L. S. D., 5 percent			10.4
L. S. D., 1 percent			14.4

1/ Materials applied to plots replicated 4 times, each plot 8 rows wide and 395 feet long, at pre-emergence on May 26.
2/ Application made in 12" bands over row using 6 gallons of spray mixture per acre.
3/ Count made on June 16 of plants showing bud injury.
4/ Computed from 4 samples taken at random from each plot; each sample, 25 feet of row. Yield given as shelled grain at 15 1/2% moisture.

Table 2. - Corn Rootworm Control, 1950 (Smizer West Farm, Jessamine County, Kentucky)

Treatment [1]	Dosage [2] (lb./A)	Percent Injured [3] Plants (Av.)	Plant [4] Height (Av. inches)	Silage [5] (lb./A.)
1 BHC	2	2.7	22.8	21,697
2 Chlordane	5	2.7	23.9	19,780
3 Aldrin	5	1.8	25.0	19,243
4 Dieldrin	5	2.1	23.6	19,534
5 Toxaphene	5	5.8	21.8	19,015
6 Check		10.0	19.8	14,915
L. S. D., 5 percent				584
L. S. D., 1 percent				796

1/ Materials applied to plots replicated 5 times, each plot 14 rows wide and 131 feet long, at pre-emergence on June 13.
2/ Application broadcast at 13 gallons of spray mixture per acre.
3/ Count made June 30 of plants showing bud injury.
4/ Mean extended height-250 plants per treatment - on July 3.
5/ Computed by sampling; approximately 25% of the total yield was weighed.

Table 3. - Corn Rootworm Control, 1951 (S. J. Stokes Farm, Lexington, Kentucky)

Treatment [1]	Dosage [2] (lb./A.)	Plant Height [3] (Av. inches)	Yield [4] (Bu./A)
1 BHC --------	1	44.4	59.6
2 Dieldrin------	1	46.9	61.0
3 Chlordane----	2	46.6	68.2
4 Aldrin-------	2	44.2	61.4
5 Heptachlor---	2	44.0	62.4
6 Check-------		43.4	60.6
L. S. D., 5 percent -----		2.4	10.2

1/ Materials applied to plots replicated 5 times, each plot 12 rows by 167 feet, at pre-emergence on June 1.
2/ Application made in 20-inch bands at 6 gallons of spray mixture per acre.
3/ Mean extended height - 250 plants per treatment - on July 6.
4/ Fifty feet of double row harvested from each plot; yield as shelled grain at 15 1/2% moisture.

Table 4. - Corn Rootworm Control, 1951 (Station Farm, Lexington, Kentucky)

Treatment [1]	Dosage [2] (lb./A.)	Plant Height [3] (Av. inches)	Yield [4] (Bu./A.)
1 BHC------- -	3	44.8	66.3
2 Chlordane----	3	42.9	78.0
3 Dieldrin -----	2	45.3	64.1
4 Aldrin -------	3	44.5	62.1
5 Heptachlor---	2	44.5	59.2
6 Check------ -		42.5	59.0
L. S. D., 5 percent ----		2.5	12.0
L. S. D., 1 percent----			16.3

1/ Materials applied to plots replicated 5 times, each plot 4 rows by 35 feet, at pre-emergence on May 30.
2/ Application made in 12-inch bands at 6 gallons of spray mixture per acre.
3/ Mean extended height - 250 plants per treatment - on July 5.
4/ Thirty-five feet of double row harvested on October 29; yield as shelled grain at 15 1/2% moisture.

Table 5. - Corn Rootworm Control, 1951 (Station Farm, Lexington, Kentucky)

Aldrin Treatment [1]	Dosage [2] (lb./A.)	Plant Height (Av. inches)	Yield [4] (Bu./A.)
Bands			
1 At planting	0.86	43.8	65.9
2 At pre-emergence	0.86	44.8	66.8
3 At post-emergence	0.86	46.2	66.0
Broadcast			
4 At planting	3.0	43.7	71.2
5 At pre-emergence	3.0	44.6	71.2
6 At post-emergence	3.0	44.5	74.4
7 Check		42.2	63.2
L. S. D., 5 percent		2.9	8.9

1/ Aldrin applied to plots replicated 5 times, each plot 4 rows by 35 feet, on May 26 (planting), May 30 (Pre-emergence) and June 5 (emergence).
2/ Application made in 12-inch bands at 12 gallons of spray mixture per acre.
3/ Mean extended height - 250 plants per treatment - on July 5.
4/ Thirty-five feet of double row harvested on October 29; yield as shelled grain at 15 1/2% moisture.

Table 6. - Corn Rootworm Control, 1952 (Station Farm, Lexington, Kentucky)

Treatment and Dosage (1 lb./A.) [1]	Plant Height (Inches) [2] 5 wks.	6 wks.	Yield [3] (Bu./A)	Fodder Wt. [4] (lbs./A)
1 Aldrin	30.2	48.6	99.9	9232
2 Chlordane	28.4	45.9	96.9	8930
3 Heptachlor	30.0	46.5	92.4	9807
4 Dieldrin	28.7	47.2	94.4	9505
5 BHC	30.4	49.4	98.8	9769
6 Check	26.9	44.4	86.9	8874
L. S. D., 5 percent			8.5	
L. S. D., 1 percent			11.6	

1/ Materials applied to plots replicated 5 times each plot 4 rows by 33 feet, at planting, May 17. Application made in 12-inch bands at 7 gallons of spray mixture per acre.
2/ Mean extended height - 250 plants per treatment - 5 and 6 weeks after planting.
3/ Harvest October 13; yield as shelled grain at 15 1/2% moisture.
4/ Field weight.

Table 7. - Corn Rootworm Control, 1952 (David Prewitt Farm, Lexington, Kentucky)

Treatment and Dosage (1 1/2 lb./A.)[1]	Field 1		Field 2	
	Plant Height 2 Av. In.)	Yield 3 (Bu./A.)	Plant Height 2 (Av. In.)	Yield 3 (Bu./A.)
1 Chlordane ------	27.0	78.5	26.8	68.9
2 Aldrin---------	27.4	70.0	25.5	63.5
3 Heptachlor --- ---	26.4	66.4	24.8	61.7
4 Check----------	23.3	67.7	25.6	59.8

1/ Materials applied in bands with planter-sprayer - June 1, using 5 gallons of spray mixture per acre.

2/ One-hundred plants measured - extended height - 3 weeks after planting.

3/ Computed on total harvest of U. S. 13 seed corn harvested - 2 plots (replicates) each 0.636 acre on Field 1 and 0.549 acre on Field 2; 1 plot on untreated check in each field.