Experiments on Control of the Sugar-Beet Root Maggot[1]

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The sugar beet root maggot (*Tetanops myopaeformis* (Roeder)) was first described by Roeder in 1881 from specimens collected at Sacramento, California. Towley (2)[3] was the first to report this insect as a pest of sugar beets from observations made near Amalga, Utah, during July, 1920. Maxson (4) reported that it had caused serious injury to sugar beets in Alberta, Canada; northern Colorado, Idaho, Montana, Wyoming and Utah. Essig (1) called this insect the sugar-beet ortalid, since it belongs to the family Ortalidae, "the picture winged flies." He reported that H. H. P. Severin had noted it injuring sugar beets in California. Hawley (2) reported that flies of this species had been collected at Burns, Oregon, and Moscow, Idaho, and stated that it was apparently a native insect which had fed for many years on such weeds as lamb's-quarters {*Chen op odium album* L.) , red root (*Amaranthus retroflexos* L.) , and prostrate pigweed (*A. blitoides* S. Wats.) . In addition, it has been observed breeding on black nightshade (*Solanium nigrum* L.) .

Thorn and Jensen (5) used ethylene dibromide for the control of the sugar-beet root maggot in 1947, and later Jensen and Parrish (3) showed that this soil fumigant was effective in controlling the maggot when applied as a side-dressing.

Nature of Injury

The sugar beet root maggot feeds by rasping. It eats the tap and feeder roots of the beet plants and often cuts off these roots. From the injured roots plant juices escape, causing the tissues to turn black at the wound and the soil to become moist about the injury. When the tip of the tap root is eaten off, the plants wilt during the heat of the day and many of them die. Infestations are heaviest in fields where sugar beets follow beets or in fields adjacent to last year's beet fields.

The major injury to sugar beets is done by first generation maggots while the beets are small. In severe infestations, from 80 to 90 percent of the beet stand may be killed, as shown in Figure 1, and the stand loss occurs so late in the season that replanting is not practicable.

Life History

In southern Idaho the sugar beet root maggot passes the winter as a full-grown maggot in the soil of old beet fields. These overwintering maggots are found concentrated along the old beet rows, as many as 60 per square foot. As the sun warms the soil in early spring, the maggots move slowly toward the surface, where they pupate at a depth of one to three inches about the middle of April. Adult flies begin to emerge about May 10 and reach the peak about May 20. Most of the eggs are laid during the latter

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[3] Numbers in parentheses refer to literature cited.

Figure 1.—Field of sugar beets at Rupert, Idaho, on July 18, 1951. The beets at the left were treated with ethylene dibromide for the control of the sugar-beet root maggot, and those at the right were untreated.

half of May. The eggs are laid in clusters of 10 to 20 about 14 inch deep in the soil around the stems of the plants. The eggs begin to hatch about June 1, and the maggots crawl down the beet to feed on the roots. Most of the maggots continue to feed for the remainder of the season and work their way deeper into the ground, where they pass the winter. It requires about a month for the development of the first generation of maggots. A few early maturing maggots pupate about July *1* and give rise to a small second generation of flies during August and early September.

Methods

The three methods used in the control of the sugar beet root maggot were seed treatments, soil treatments and fumigation. These experiments were conducted on sugar beets growing in sandy loam soil in the Rupert Idaho, area during 1950 *md 1951. The randomized-block method was used in setting up the experiments, and tests were run in four-row parallel plots 400 to 500 feet long. The treatments were replicated four times in 1950 and five times in 1951. During the first week o'f March a survey was made to determine the overwintered maggot population in the previous year's beet fields, so that the fields expected to have an infestation could be selected for the experiments in June.

In the soil-treatment method the insecticides were mixed with phosphate fertilizer in a roller-drum mixer. The mixtures were broadcast with a spreader over the soil surface at the rate of 100 pounds per acre and were harrowed lightly into the soil on March 29, 1950, and on April 5, 1951.

In the seed-treatment method the dry insecticides were dusted over the seeds in a bag, which was shaken and tipped in the field just prior to planting. The treated beet seed was planted with a four-row plate-type beet and bean planter. At the end of each plot the seeds in the planter can were removed to the bag and shaken and then replaced in the planter can. A sufficient amount of insecticide adhered to the seed in this method, and the excess material was distributed into the furrow with the seed.

In the soil-fumigant method, ethylene dibromide was diluted with kerosene at the rate of 1^4 to 814 gallons to increase the volume for even distribution, and 10 gallons of the mixture were injected per acre. Since ethylene dibromide is heavier than kerosene, it was thoroughly mixed before being pumped into the applicator tank. The applicator, mounted on a tractor, applied the fumigant as a side-dressing to four rows at a time. The fumigant was applied six inches below the soil surface and six inches to both sides of the row.

Seeds of Improved U. S. 22 curly top-resistant variety of sugar beets were used both years. These seeds were treated with a fungicide 2.3-dichloro 1,4- Naphthoquinone in 1950 and thiram in 1951. The fields for the soil and seed treatments were planted on March 31 and April 17, 1950, and on April 9 and 16, 1951. The fumigants were applied on June 1 and 12, 1951.

The number of plants injured by the maggots was determined by examining plants taken at random from the center rows of each four-row plot. "Where the plants had been thinned, 50 beets were examined in each treatment; and where they had not been thinned, approximatly 50 beets were examined. The beets were examined on June 26 and 30, 1950, and on June 11 and 14, 1951. The stand of beets was determined by counting all plants in the plots just prior to harvesting. All beets were harvested mechanically. The yields given in the tables are for clean beets, the weights of which have been converted from plot yields to yields per acre. The beets were harvested from October 23 to 30, 1950, and from October 24 to 27, 1951.

Insecticides Tested

The following insecticides were tested:

- Aldrin
- Chlordane
- Dieldrin
- DDT
- Ethylene dibromide
- Heptachlor
- Lindane
- Parathion
- Toxaphene

All the materials except ethylene dibromide were wettable powders containing 25 to 50 percent of toxicant by weight. The ethylene dibromide was a liquid containing 83 percent by weight of ethylene dibromide, or 12 pounds per gallon.

Before the field experiments were planned, exploratory tests were conducted in the greenhouse to determine what effect, if any, insecticides would have upon the germination of beet seed. These tests showed that it was safe to treat sugar beet seed at the dosages used.

Discussion of Results

The effectiveness of the treatments was based upon three criteria—percentage of beets injured by the maggots, plant stand and yields.

Experiments in 1950.—The results obtained in both the soil- and seed-treatment field experiments in 1950 are presented in Table 1. In both experiments aldrin gave, in general, the least maggot injury, the best stands and the largest yields. The increases in yield over the checks in the soil and seed treatments were 2.61 and 2.50 tons per acre. Although these gains were not significant, they showed the possibility of controlling this insect by both treatments.

Experiments **in 1951.**—The field in which the soil-treatment experiment was conducted in 1951 was divided into two portions for crop-rotation purposes. Beans had been grown on the east portion of the field in 1950 and were followed by beets in 1951. The west portion of the field was in beets in 1950 and was followed by beans in 1951. This old beet field contained a high population of overwintered maggots and was the principal source of infestation. As the flies emerged from the bean field, they moved with the wind into the adjoining beets. The density of maggot infestation in the beets decreased as the distance from the bean field increased. The beets nearest the beans were infested earlier, and the injury to the seedling beets was evidently greater in the plots adjoining the beans, as shown in Figure 2. In general, the stand of beets and its uniformity increased across the field from the beans. The average yields of beets per block across the plots, beginning on the side adjoining the beans, were 9.2, 10.4, 13.8, 18.3 and 18.5 tons per acre, which substantiates the above conclusions.

Xable 1.—Effectiveness of Soil and Seed Xreatments for the Control of the Sugar-beet Root Maggot on Beets, 1950.

Soil treatments

Insecticide	Toxicant[1]	Average beets injured	Mean stand of beets per 100 feet of row at harvest	Mean yield of beets per acre
	Pounds	Percent	Percent	Tons
Aldrin	1	46	87.6	23.22
Toxaphene	2½	62	84.4	22.43
Chlordane	2½	58	85.8	21.73
Lindane	½	54	86.5	21.54
DDT	4	60	86.8	21.11
Untreated	....	48	86.0	20.61
		Seed treatments		
Aldrin	¼	65	79.8	23.88
Chlordane	¼	73	77.5	22.45
Chlordane	½	60	77.3	21.38
Lindane	¼	68	69.2	21.98
Lindane	⅛	75	78.1	19.48
Parathion	¼	55	66.4	19.48
Untreated	....	67	77.0	21.38

[1] Pounds per acre for soil treatments and per 100 pounds of seed for seed **treatments.**

All soil treatments gave increases in yield over the check, as shown in Table 2. Aldrin, dieldrin and heptachlor gave gains of 4.96, 4.68, and 4.32 tons per acre over the check, although they were not significant.

In the fifth replicated block the degree of maggot infestation and injury to the beets was so low that the untreated plot and those treated with

Table 2.—Effectiveness of Soil and Seed Treatments in Comparison with a Soil Fumigant for the Control of the Sugar-beet Root Maggot on Beets, 1951.

Soil treatments vs. fumigant

Insecticide		Average beets injured	Mean stand of beets per 100 feet of row at harvest	Mean yield of beets per acre
	Pounds	Percent	Percent	Tons
Aldrin	3	14	48.3	15.94
Dieldrin	3	19	52.3	15.66
Heptachlor	2	18	55.1	15.30
Toxaphene	5	69	48.6	14.42
Chlordane	4	21	51.2	14.13
Parathion	2½	47	48.2	14.12
Ethylene dibromide				
Applied June 1	21	27	54.2	13.47
Applied June 12	21	75	54.7	12.48
Untreated	----	57	42.3	10.98
Difference required for significance				
At 5 percent level		30.1	6.7	ns
At 1 percent level		40.4	9.0	ns
Seed treatments vs. fumigant				
Ethylene dibromide				
Applied June 1	21	16	74.2	25.74
Heptachlor	¼	52	75.4	25.41
Aldrin	½	52	75.9	25.35
Dieldrin	¼	62	69.0	23.89
Aldrin	¼	72	69.6	23.80
Parathion	¼	76	66.8	23.41
Ethylene dibromide				
Applied June 12	21	82	72.9	23.06
Lindane	¼	88	61.3	21.65
Chlordane	½	84	63.8	21.59
Untreated	----	98	60.2	20.83
Difference required for significance				
At 5 percent level		19.0	6.7	2.25
At 1 percent level		25.4	9.0	3.02

[x] Pounds per acre for soil treatments and per 100 pounds of seed for seed treatments.

the less effective materials gave, in general, as high yields as the most effective treatments. This block was the farthest from the source of infestation. In this check plot only 29 percent of the beets were injured. By eliminating this block from the statistical analysis, one finds that aldrin, dieldrin, heptachlor and parathion gave highly significant increases in yields over the check. Although parathion was better than the check at the one percent level, it did not give the desired protection under a very severe maggot infestation.

Aldrin, chlordane, dieldrin and heptachlor gave a lower percentage of injured beets than the checks when compared at the 5 percent level, but only aldrin at the 1 percent level. The plots fumigated late with ethylene dibromide and those treated with toxaphene contained more injured beets than the checks. All treatments except aldrin, parathion and toxaphene gave better plant stands than the checks at the 5 percent level, but only dieldrin, ethylene dibromide and heptachlor at the 1 percent level.

Figure 2.—The soil-treatment experimental plots at Rupert, Idaho, on July 16, 1951. Six rows adjoining the beans on the left were untreated, and the four rows to the right of stake "H" were treated with heptachlor.

Although the differences required for significance are given at two levels, the discussion of the data on the seed treatment is based upon the 1 percent level. Aldrin, dieldrin, ethylene dibromide (June 1 application), and heptachlor gave a lower percentage of beets injured than the checks. Aldrin, ethylene dibromide and heptachlor gave better stands than chlordane, dieldrin, lindane, parathion and the checks. Aldrin, at $^1/_2$ pound per **100** pounds of seed; dieldrin, ethylene dibromide (June 1 application), and heptachlor gave gains in yield of 4.52, 4.91, and 4.58 tons per acre over the check.

The average percentage of beets injured by the maggots in both of the ethylene dibromide applications on June 1 was 21.5, as compared with 78.5 percent for the June 12 application. The June 1 application gave gains in yield of 0.99 and 2.68 tons per acre over the June 12 treatments. This shows that in 1951 the critical period for applying soil fumigant for the control of this maggot was above June 1 *in* the Rupert area.

Messrs. Jensen and Parrish, working with ethylene dibromide in the Rupert area, have determined the dosage, placement, plant tolerance and efficiency of application for sandy loam soil. The successful fumigation of 300 acres of sugar beets in 1950 and 600 acres in 1951 established the ethylene dibromide treatment as an effective commercial control for this pest.

The use of aldrin, dieldrin, or heptachlor mixed with fertilizer, applied broadcast over the soil surface, and harrowed lightly into the soil has proved successful in controlling this maggot. Treating seed before planting to prevent damage to seedlings by soil-infesting insects, such as wireworms and the seed-corn maggot, is a recent development. Seed treatment gives as good control of the sugar beet root maggot as any method tested. It should be emphasized, however, that this is a report of experimental results **and** does not constitute a recommendation for the use of these materials.

Summary

Experiments with several insecticides were conducted for the control of the sugar beet root maggot at Rupert, Idaho, in 1950 and 1951. The effectiveness of insecticides applied mixed with a fertilizer as a soil treatment and as a seed treatment was compared with that of a soil fumigant. Plots were four rows wide and were arranged in randomized blocks.

The most effective soil treatments were aldrin, dieldrin and heptachlor, all of which gave gains in yields of beets more than four tons per acre as compared with untreated checks.

The most effective seed treatments were aldrin at ½ pound and heptachlor at 14 pound per 100 pounds of seed. The most effective time for fumigation with ethylene dibrpmide was during the egg stage of the root maggot, which resulted in an increase in yield over the check of nearly five tons per acre. The June 1 application of ethylene dibromide gave an increase in yield of beets of nearly three tons per acre over the June 12 treatment.

These experiments show[r] that seed treatment gives as good control of this insect as any method tested.

The results of the experiments reported do not constitute a recommendation.

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