Control of Sugar-beet Nematode

field tests with soil fumigants indicate crop rotation using non-host plants is most effective control of sugar beet pest

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Chemical control of the sugar-beet nematode—*Heterodera schachtii*—would eliminate disadvantages of control by crop rotation which normally requires at least 3–4 years of non-host crops. In some areas the only alternate crops which can be grown are not so profitable as sugar beets or are themselves hosts of the nematode.

Furthermore, a large proportion of beets in California are cultivated on clay loams or clays with a high percentage of silt and clay particles so that dispersion of fumigants through the soil is highly restricted. Also, previous work has shown that large numbers of the sugar-beet nematode tend to survive in the upper 2″–3″ of fumigated soil regardless of soil type.

Therefore, field tests of different methods of chemical application designed to increase nematode control in the surface zone of the soil and to test new nematocides were conducted at Spreckels. The components of the soil—a clay loam with a moisture equivalent of 23%—include 28.8% sand, 44.8% silt and 26.4% clay.

Four replicates of each treatment were made in plots No. *1*, No. *2*, and No. *4*, six replicates in plot No. *3*. The treatments were three or four beds in width. Yield records were obtained by hand harvesting a section of the center beds only. The length of this section varied between 50′ and 80′ depending on the total length of the replicates, but was constant within each plot.

Soil samples to determine nematode control were taken by a soil tube to a depth of 18″ in plots No. *1* and No. *4* and to 3′ in plots No. *2* and No. *3*. Sugar beets were grown in the samples in the greenhouse and after approximately 30 days growth the roots were washed clean and counts made of the nematode females on the roots.

The first experiment in Plot *1* included the nematocides DD—1,3-dichloropropene, 1,2,-dichloropropane mixture; and Nemagon — 1,2-dibromo-3-chloropropane—applied by chisels and combination rototiller-chisel equipment. In the latter case one third of the fumigant was sprayed on the surface of the soil ahead of the rototiller part of the equipment which worked the soil to a depth of 4″–6″. The other two thirds of the dosage was applied by the chisel part to a depth of 7″–8″.

The treatments were applied April 10, when the moisture content of the soil was 16.7% with a temperature of 50°F at 6″ depth. Beets were planted May 20. Soil samples were taken May 12 to determine nematode control and yield records were obtained November 25.

Observations early in the growing season revealed a marked chemical injury to the plants in all the plots treated with Nemagon. Many of the leaves were misshapen, thickened and stunted to some extent. The degree of injury increased with dosage but persisted up to harvest time only at the 10 gallons per acre rate. Many plants at the high dosage also produced multiple crowns.

The results show there was a statistically significant increase in yield of beets on all of the treated plots. However, the increase was not sufficient even on the best treatment to be considered profitable.

The data also show a lower yield resulted from the use of the rototiller-chisel combination than from the straight chisel application. Possibly, that portion of the chemical which was rototilled into the soil vaporized and was lost to the air too quickly to be effective.

A second plot was established to permit a longer period of time between treatment with Nemagon and planting of the beets. The fumigants were applied by chisel November 4, and sugar beets were planted January 8. Soil samples were collected May 27, and yield records taken August 10. The soil moisture content at time of treatment was approximately 17% with a temperature of 55.4°F.

The results of the test in Plot *2* were particularly significant in that the untreated plots produced an average of 20.2

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Average Sugar-Beet Yields and Nematode Counts in Row Placement of Soil Fumigants

Treatment	Av. no. females /250 cc soil			Av. yield of sugar beets	
	0″–6″	6″–12″	12″–18″	Lbs./2 beds x 80′	Tons /A
Check	173	27	10	145.7	5.97
DD 25 gal./A[a]	9	6	12	309.3	12.68
DD 25 gal./A[b] (1 shank)	5	0	1	321.0	13.16
DD 25 gal./A[c] (2 shanks)	4	0	1	337.8	13.85
Least significant difference at 19:1				37.8	
Least significant difference at 99:1				54.3	

[a] Broadcast.
[b] 1 chisel/bed—rate of 83 gal./A.
[c] 2 chisels/bed—rate of 41.5 gal./A.

Average Sugar-Beet Yields and Nematode Counts in Split Applications of Soil Fumigants

	Treatment: First (March 21)	Treatment: Second (March 23)	Av. nematodes per 750 cc soil	Av. yield tons/acre
A	Check	Check	221	5.6
B	0	DD 30 gal./A	154	7.6
C	DD 20 gal./A	DD 10 gal./A	276	8.4
D	DD 20 gal./A	Nemagon 1 gal./A	173	5.9
E	DD-Nemagon[a] 14 gal./A	DD-Nemagon[a] 7 gal./A	167	7.8
F	DD-Nemagon[b] 10 gal./A	DD-Nemagon[b] 6 gal./A	175	7.7
	Least significant difference at 19:1		129	0.59
	Least significant difference at 99:1		174	0.79

[a] DD-Nemagon mixed 20 to 1.
[b] DD-Nemagon mixed 15 to 1.

Average Sugar-Beet Yields and Nematode Counts in Soil Fumigation Tests

Treatment	Plot No. 1 1953		Plot No. 2 1954	
	Tons of beets per acre	No. nematodes /pint of soil	Tons of beets per acre	No. nematodes /300 cc of soil
Check	3.1	29	20.2	293
DD 25 gal./A by chisel	11.5	3	20.5	122
DD 8.33 gal./A by rototiller + 16.66 gal./A by chisel	8.6	36	..	..
Nemagon 2.5 gal.[a]/A by chisel	9.3	48	19.9	78
Nemagon 5.0 gal.[a]/A by chisel	10.6	11	20.6	42
Nemagon 10.0 gal.[a]/A by chisel	9.6	3	11.5	114
Nemagon 1.66 gal./A by rototiller + 3.33 gal./A by chisel	9.7	50	..	..
Least significant difference at 19:1	2.2	..	7.2	..
Least significant difference at 99:1	3.0	..	10.1	..

[a] All three dosages of Nemagon are based on the amount of active ingredient actually applied.

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same treatments were made in two orchards, it was possible to analyze the interactions of rootstock and treatment, rootstock and orchard, and treatment and orchard. The interaction of rootstock and treatment was not statistically significant, reflecting the fact that growth of both California blacks and Paradox hybrids was improved in like manner by preplanting fumigation. However, the interactions analyses of rootstock and orchard, and treatment and orchard were statistically significant at the 5% level, indicating that growing conditions at the two orchards influenced the response to the treatments, and the relative performance of the rootstocks.

In March, 1956, the California blacks were pulled to allow normal growth of the Paradox hybrids remaining at each site. Roots of most of the California blacks—including those with good top growth at treated sites—showed considerable lesion formation. Moreover, soil samples taken in September, 1955, had shown that root-lesion nematode population density at treated sites had risen in many instances until it did not differ significantly from the population density at untreated control sites.

The response of the Paradox hybrids to preplanting fumigation indicated that they, too, were susceptible to the disease. It seemed doubtful that the remaining Paradox hybrids would continue to grow satisfactorily at the treated sites. Therefore annual Nemagon retreatments around half of the trees on treated sites were begun in March, 1956. The fumigant was injected by handgun at the rate of five gallons per acre over a 10′ × 10′ area covering the root zone of the tree. This provided Paradox hybrids with essentially three different histories in each of the two orchards: *1*—those grown at pretreated sites with annual retreatments begun after two growing seasons, *2*—those grown at pretreated sites without further treatment, and *3*—those grown without any fumigation treatment. Top growth of all trees except the complete checks continued to be satisfactory at the end of the fourth growing season. During the fourth season, growth of trees receiving annual Nemagon retreatments was significantly greater than growth of trees receiving preplanting treatment only.

In the Ventura County orchard the soil was a clay loam with a moisture equivalent of 26.7%. Test sites were fumigated in December, 1954, and California black walnuts planted in March, 1955. Treatments were arranged in five blocks of single tree replicates. Growth in all treatments was better than growth in the untreated controls. DD at 75 gallons per acre produced the greatest growth response.

The value of preplanting fumigation for walnuts depends on the duration of benefits. Striking initial growth responses are of no use, unless they presage productive walnut trees. Benefits of preplanting soil fumigation probably will be most prolonged where land to be replanted is left free of trees or vines for several years before fumigation, allowing time for woody, nematode-infected roots to rot. Such roots protect nematodes from soil fumigants.

The better growth of the San Joaquin County trees receiving supplemental Nemagon side dressings suggests the possibility that benefits of preplanting soil fumigation may be prolonged in that manner.

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tons per acre. This is further evidence of the importance of early planting to achieve maximum yields on sugar-beet nematode infested fields. The high population of nematodes surviving the treatments apparently explains the failure to obtain an increase in yield from any of the fumigants.

The significant decrease in yield at the 10 gallons per acre dosage of Nemagon was very likely a result of the stability of the chemical which—under some conditions—may persist in the soil for as long as six months.

In Plot No. *3* another attempt was made to increase control of the nematode in the upper 2″ or 3″ of the soil by the use of split applications of the fumigants. This required turning the soil by plowing between treatments. Forty-eight hours were allowed to elapse after the first fumigation was applied before the plots were plowed and the second dosage injected.

The nematocides DD and Nemagon were tested—alone and in combination—applied March 21 and 23. Soil moisture content was approximately 15% with a temperature of 50°–53°F. Beets were planted April 16, soil samples taken May 24 and yields recorded November 1.

The results showed no significant effect on the nematode population by the fumigants. There is a significant increase in yield in all of the treatments, but the maximum of 8.4 tons per acre is far below the minimum necessary for profitable production of beets.

In 1957, additional work was done in Plot *4* to test the effectiveness of row placement of DD. An area treated at the rate of 25 gallons per acre was compared with the same rate per acre injected by one chisel centered in the bed and two chisels per bed spaced 12″ apart.

The rate delivered by the single chisel was 83 gallons per acre and 41.5 gallons per acre for each in the two chisel application. The treatments were applied February 14, and beets planted April 10. Soil samples were taken April 26, and the beets were harvested October 2.

The results showed a highly satisfactory reduction in the nematode population, but the yields obtained were not sufficient to justify fumigation. The explanation for this is not evident and further work is planned to determine whether or not these soil treatments can be developed for successful practical use.

Exploratory tests have also been made on the possible use of sodium N-methyl dithiocarbamate—Vapam—as a control for sugar-beet nematode. Vapam is soluble in water and has highly effective nematocidal properties. It can be applied in irrigation water or by overhead sprinklers, but it is difficult to obtain an even distribution of the chemical by either method and—what is more important—the cost of Vapam is prohibitive for this purpose.

It is evident from these results that chemical control of the sugar-beet nematode is not practicable under the conditions of these tests.

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OAT HAY

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two critical times for harvest. Apparently the total nutrients realized from oats are greater at about 18%–20% flowering. Although the yield of dry matter has increased rapidly to this time lignification has not yet adversely influenced utilization. If situations prevent harvesting oat forage at 20% bloom, the forage should be allowed to mature to the dough stage rather than harvested at an in-between milk stage.

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