A Survey of Sugar Beet Nematode in Beet Growing Areas of the Utah-Idaho Sugar Company

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The sugar beet nematode *(Heterodera schachtii)* has long been recognized as one of the most serious problems of the sugar beet industry. Visual symptoms are readily recognizable in the field but by this time the infestation is generally high enough that yields have been greatly reduced. Yields are also frequently reduced even after rotation with nonhost crops. Obviously, infestations are being recognized too late and ideas as to degree of infestation are often erroneous.

A survey as to distribution and degree of infestation can be an essential part of a system of control by crop rotation. Such a system can work satisfactorily if the fields are found in the early stage of infestation (3)[2].

In view of these facts, in 1957, the Utah-Idaho Sugar Company initiated an extensive survey program to determine the extent and severity of infestation of fields where beets had been or were to be grown. Laboratories were established in Utah, Idaho and Washington for this purpose.

Method of Collecting Soil Samples

Two methods of collecting soil samples were used for this survey, field sampling and tare sampling.

Field Sampling

Samples were taken from the field with a soil probe or tube to a depth of 4 to 8 inches with at least five tube samples per acre of land. If a previous crop showed a spot where nemotode was suspected, a separate sample was taken from this area. The samples were thoroughly mixed and approximately 500 grams of soil sent to the laboratory.

Tare Sampling

A sample of soil was taken from the tare dirt at the receiving stations by holding a sample catcher (Figure 1) about a foot below the Reinks screens as a load of beets was being delivered. The container was held in the center of the area that the cone of dirt forms, sometimes being necessary to shake it to remove vegetative matter. Frequently this procedure would have to be repeated for a second load from the same field to obtain 500 grams of soil for the laboratory analyses.

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[2] Numbers in parentheses refer to literature cited.

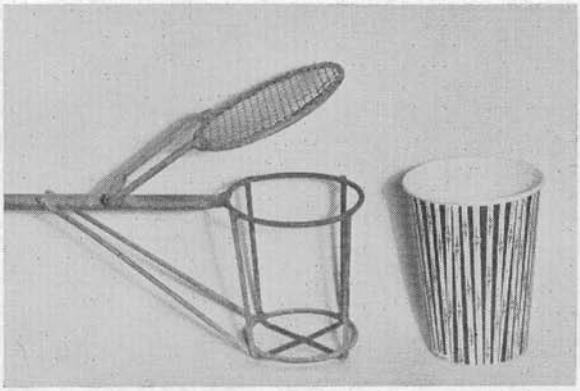

Figure 1.—A sample catcher which is used to take a sample of soil from the tare dirt. The catcher is held about a foot below the Reinks screens as a load of beets is being delivered.

The tare sampling method has proven to be cheaper and more convenient; however, the following precautions must be exercised in catching the sample by this method:

1. Obtain samples only during the last half of the load to eliminate the possibility of contaminating the sample from the previous load.
2. Obtain samples only during dry weather conditions as wet dirt sticks to belts and increases the possibility of contamination.
3. Observe the necessary caution in working around moving equipment. Holes have been cut in the sides of most of the dirt hoppers to allow the sample catcher to be placed under the Reinks screens. This eliminates much of the danger.

The soil samples taken by either method were carefully labeled as to date, grower, contract number, field location, and a note made if nematodes were suspected. The samples were sent to the laboratory where they were allowed to become dry or nearly dry before being analyzed.

Methods of Separating Cysts From Soil

The specific gravity of cysts in dry or nearly dry soil is less than water. The principle of separation used was to float the cysts to the surface and remove them by passing the sample through a series of screens.

Flotation: A 500-gram soil sample was thoroughly mixed with water in a 12-inch pan and allowed to settle momentarily. The water was then passed through a U.S. 10 series sieve to a second

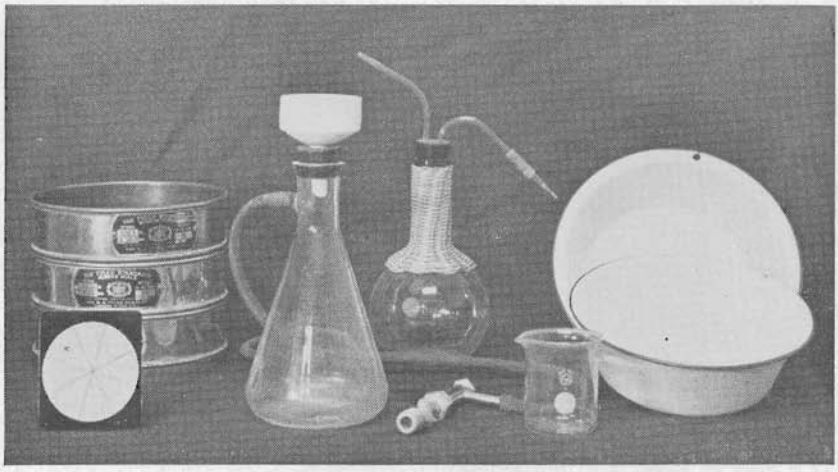

Figure 2.—Equipment needed to separate the cysts from the soil.

pan. The residue collected on the screen was gently washed, and the sediment in the pan and the residue on the screen were discarded.

Sieving: The muddy water in the second pan was passed through U. S. series 30 and 60 screens. After rinsing the 30-mesh screen gently, the residue on the screen and the sediment in the pan were discarded. The residue on the 60-mesh screen is composed of nematode cysts along with some organic matter. This residue is washed into a 250 cc beaker by directing a small stream of water from a wash bottle on the back of the screen.

Filtering: The cysts and organic matter floating in the beaker were poured onto a marked filter paper in a Buchner funnel. Filtering was accomplished by using a suction pump or an aspirator connected by rubber tubing to a filtering flask.

The filter paper was placed on a plastic plate where it was examined and a cyst count made using a 15× binocular with wide-angle magnification.

Cyst Report: A simple cyst count of the total number of cysts in 500 grams of soil can be misleading in advocating a program to the grower. Hijner (2) has shown that an average of 40% of the cysts become nonviable each year whereas only 13% of the cysts decay. Therefore, a more accurate population estimate can be made by determining the number of viable cysts. In this survey, the total number of cysts was determined and, in addition, a representative number of cysts was ruptured and examined. If any eggs or larvae were present in the cysts examined, they

were considered viable and the percent of viable cysts was also determined. As no standard meaning of viable cysts has been agreed upon by workers in this field, this method of determining viability is used to help in advisory work. The total number of cysts will give information as to how heavily infested the field is or has been, and the number of viable cysts along with crop history and soil type will give information as to the effectiveness of the rotation.

Classification of Infestation

An arbitraary scale of nemotode cyst counts has been established for making recommendations to the growers. It is difficult to closely associate a cyst count with the damage done by the nematodes. However, field trials conducted by the Utah-Idaho Sugar Company support the following classifications:

1. Noninfested—no cysts present.
2. Slightly-infested—1 to 10 viable cysts.
3. Moderately-infested—11 to 50 viable cysts.
5. Heavily-infested—more than 50 viable cysts.

Results

In the four years from 1958 to 1961 inclusive, 4,375 samples were collected and analyzed. The results of these tests are shown in Tables 1 through 4. Tables 1 and 2 show the data for each year separately and Table 4 shows a summary of the results for the four years. Table 3 shows a relationship between total and viable cyst counts as determined by samples taken in Utah.

The degree of infestation may seem to have changed from year to year, however, this may only be a reflection of the information desired by the fieldman. Some years samples may have been collected at random and without regard to known or suspected infestation. Other years many of the samples may have been collected to ascertain the infestation of a suspected field. This would result in a higher percentage having nematodes. Other years many of the samples may have been collected to determine the degree of infestation in fields known to have nematode, which would result in an even higher percentage of infestation. Some years the fieldman may have selected many of the samples to determine the possible spread of nematode into areas thought to be free of infestation. This would result in a lower percentage of infestation than any of the others.

These data show that some areas are much more heavily infested than are others. The tables only show the difference between districts but similar differences also occur between areas within districts.

Table 1.—Nematode survey for 1958 and 1959 showing the number of samples and the percentage in the various degrees of infestation.

District	1958 No. of samples	1958 Percent of samples None	1-10	11-50	Above 50	1959 No. of samples	1959 Percent of samples None	1-10	11-50	Above 50
Idaho	130	73	18	9	....	553	70	17	5	8
West Jordan	70	22	34	44	....	74	16	24	33	27
Garland	57	39	31	30	....	154	20	33	22	25
Gunnison	77	43	21	36	....	97	31	28	27	14
South Dakota	...	...	...	...	...	230	71	21	6	2
Toppenish	158	24	34	41	1	200	52	23	11	14
Columbia Basin	62	100	0	0	0	57	100	0	0	0
Total	554	48	24	28	...	1365	58	21	11	10

Table 2.—Nematode survey for 1960 and 1961 showing the number of samples and the percentage in the various degrees of infestation.

District	1960 No. of samples	1960 Percent of samples None	1-10	11-50	Above 50	1961 No. of samples	1961 Percent of samples None	1-10	11-50	Above 50
Idaho	652	75	14	6	5	446	80	11	5	4
West Jordan	138	24	31	18	27	49	19	33	22	26
Garland	126	15	26	29	30	70	51	17	17	15
Gunnison	68	52	22	16	10	61	5	34	41	20
South Dakota	385	74	21	4	1	82	90	8	1	1
Toppenish	70	34	20	22	24	229	49	18	21	12
Columbia Basin	42	100	0	0	0	39	97	3	0	0
Total	1,481	63	19	9	9	976	65	15	12	8

Table 3.—Comparison of viable and total cyst count in Utah.

State	No. of samples	Percent infested: Total cyst None	1-10	11-50	Above 50	Viable cyst None	1-10	11-50	Above 50
Utah	203	29	23	23	25	29	33	22	16
Percent safe to plant			52				62		

Table 4.—Nematode survey for 1958 to 1961 inclusive showing the total number of samples and the percentage in the various degrees of infestation.

District	No. of samples	Percent of samples None	1-10	11-50	Above 50
Idaho	1,781	74	15	6	5
West Jordan	331	21	30	28	21
Garland	407	57	28	24	21
Gunnison	303	33	26	30	11
South Dakota	697	75	19	5	1
Toppenish	657	43	24	22	11
Columbia Basin	199	99	1	0	0
Total	4,375	60	19	13	8

To establish the relationship between total and viable cysts, 203 samples from Utah were analyzed and compared. These results are shown in Table 3.

Twenty-nine percent of the 203 samples did not contain cysts. Twenty-three percent were in the 1 to 10, or slightly-infested class when total cysts were counted as compared to thirty-three percent when only viable cysts were counted. In the moderately-infested class there were twenty-three percent of the samples by total cyst count and twenty-two percent by viable cyst count. Twenty-five percent of the samples were in the above 50 cysts or heavily-infested class according to total cysts and only sixteen percent according to the number of viable cysts present. According to the total cyst count, fifty-two percent of the fields were noninfested or slightly infested, whereas sixty-two percent of the fields were in these classifications according to the number of viable cysts. This is an increase of ten percent in the fields where immediate beet production is permissible.

The data on all the other tables are shown as total number of cysts. The number can be applied directly for most fields. However, when beets are planted in a field where a previous beet crop has not been grown for several years the viable cyst count will give the more accurate estimate of expected results than the total cyst count. Recommendations are therefore made on the basis of viable cyst counts.

Of the 1,781 samples taken during the four-year period in Idaho, 26 percent were infested with nematode and 11 percent had high enough populations to make sugar beet production highly precarious. This percentage changes to 79 percent infestation in the West Jordan District with 49 percent in the dangerous area. In Garland, with 407 total samples, 73 percent were infested with 45 percent having a medium to high population. Gunnison had 67 percent of the samples with cysts and 41 percent were high enough to be a serious threat to a beet crop. In South Dakota 25 percent of the samples were infested and only 6 percent had populations high enough to be troublesome. The Toppenish District had 57 percent infested and 33 percent had a medium to high population. The Columbia Basin is a new area and during 1958, 1959, and 1960 not a single cyst was found in any of the samples. However, in 1961 one sample containing one nonviable cyst was found. This clearly indicates that nematodes are present in this new area and that a renewed effort will have to be extended to keep them under control.

Of all the samples analyzed, 40 percent contained nematode cysts. As the samples were not taken in proportion to the land

growing beets this does not necessarily mean that 40 percent of the beet land is infested with nematode. However, it clearly indicates that a fairly high percentage of the land is infested and that a strong program will have to be pursued to keep the nematode under control.

For all of the samples, the fieldmen indicated whether or not a nematode infestation was suspected. In practically all cases where nematode was suspected, the infestation was high and in a large percentage of fields where it was not suspected the infestation varied from low to high. These data indicate that nonsuspected fields are frequently infested and that infestation can be determined long before there are visual symptoms in the field. It also indicated that when visual symptoms appear, the cyst count is always above 50 but that the cyst count may be above 50 without visual symptoms. This is generally because the damage is masked by good growing conditions.

Discussion

Recommendations based on the cyst count.

1. No viable cysts—Permissible for sugar beet production, however it is suggested that beets be planted only two years out of six. Beets probably can be produced indefinitely on this program providing the rotation does not include host crops other than beets.
2. 1-10 viable cysts—One crop of beets can be grown after which the field should be put into at least a four-year rotation with nonhost crops.
3. 11-50 viable cysts—Land should be rotated for four years with nonhost crops before beets are planted unless the soil is fumigated. A four-year rotation will probably reduce populations enough to permit one crop of beets; however, if fumigation is practiced the soil should be tested again before planting beets.
4. Above 50 viable cysts—Land should definitely go into a minimum of a four-year rotation of nonhost crops or be fumigated before planting beets. Soil should be tested again before planting beets without fumigation.

Many fumigation trials have been conducted with the above cyst counts as the measure of infestation. The response to fumigation supports these recommendations.

The following additional practices are recommended for all beet-growing areas. These practices have resulted from known and proven facts frequently reported.

1. Have a good crop rotation for each field.
2. Keep field free of weeds.
3. Have soil tested for nematode infestation and plant beets only if cyst count is favorable.
4. Plant early—most of the nematode egg hatching and thus, nematode damage is done when the soil temperature is 60 degrees F or higher (1). Sugar beets grow fairly well in temperatures less than 60 degrees. If sufficient early growth is made the beets will be able to produce fairly good yields despite the presence of nematodes.
5. Apply adequate fertilizer and water. The earliest symptom of nematodes is the appearance of drought areas in the field. Adequate fertilizer and water help the beet make rapid growth and thereby help it resist and outgrow the damage caused by the nematode.
6. Never return tare dirt to the farm. There is always the possibility that infested beets have gone over the receiving station and that the tare dirt is contaminated. The Utah-Idaho Sugar Company has made areas available for the tare dirt so that it is not returned to the farm.
7. Fumigate to get one more beet crop in the rotation. This will further increase the nematode population and though satisfactory yields can generally be obtained it is recommended only as an emergency program. Continuous fumigation is discouraged as other pests and diseases will become troublesome.
8. Adopt strict regulations concerning moving equipment and machinery from an infested area to a noninfested area. Frequently nematodes are introduced into new areas on machinery of a grower using the same equipment in infested and noninfested areas.

The above programs can control nematode infestations so as to minimize the damage and permit profitable production of sugar beets.

Summary

During the years from 1958 to 1961 inclusive, 4,375 soil samples were collected and analyzed for sugar beet nematode. Some districts had a much higher infestation than did others.

This varied from a low of only one percent in the relatively new Columbia Basin area to a high of 79 percent in the West Jordan District.

The data indicate that a soil sampling program will ascertain the degree of infestation and a control program can then be effected long before there are visual symptoms in the field. It further shows that in many infested fields neither the grower nor the fieldman were aware of the presence of nematode.

Arbitrary standards of infestations were established and the following control program suggested depending upon the degree of infestation.

No viable cysts– –Permissible to grow beets. Suggest planting beets only two years of six.

11-50 viable cysts– –Have a four-year crop rotation of nonhost crops or fumigate before planting beets. Test soil again before planting beets if soil is fumigated.

Above 50 viable cysts—Have rotation of nonhost crops for a minimum of four years –preferably longer. Field can be fumigated for an extra crop of beets, however, this will further increase nematode population and make a longer rotation necessary. Test soil again before growing beets without fumigation.

A program of testing the soil and then initiating a control program depending upon the degree of infestation will minimize the damage from the sugar beet nematode.

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