The Incidence of Heterodera Schachtii Soil Population Densities in Various Soil Types

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Introduction

Many observations on the relationship between the sugar beet nematode, *Heterodera schachtii* Schmidt, 1871, and soil type lend support to the view that more serious nematode damage occurs in lighter soils. This would naturally lead to the conclusion that some characteristic or a complex of factors favoring *H. schachtii* development are inherent in light soils. However, heavy soils can and do allow the development of high population densities of *H. schachtii* (3, 7)[2].

Wallace (7) suggests that soil structure rather than soil texture is a more acute criterion in the study of *H. schachtii* response to soils and soil phenomena. Soil structures that favor plant growth also favor *H. schachtii* soil population development (1, 6, 7). Soil population is defined here as the infective larval force present in the soil, not the potential which would include the unhatched eggs within cysts. Recent studies (6, 7, 8) illustrate the complex interrelationships of soil structure, temperature, moisture content, aeration, and possibly other unknown factors on the emergence and movement of *H. schachtii* larvae.

The Beet Sugar Development Foundation initiated a study of the incidence of nematodes in sugar beet production.[3] One factor investigated was the correlation between nematode population densities and soil type.

Procedure

California, Colorado, and Michigan represent the leading states in sugar beet acreage as the far western, central, and general eastern limits of the sugar beet growing regions, respectively. Distribution and allocation of samples were based on sugar beet acreage planted with the sampling of approximately one field representative of 1600 acres. Sampling was timed to collect in the selected areas approximately at midseason.

The collection of samples was allocated to company fieldmen who are familiar with their particular territories and the sugar beet fields therein. Fields with a known or suspected nematode

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[2] Numbers in parentheses refer to literature cited.

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infestation were selected and samples were taken from each field. Fields selected for sampling were of a representative soil type used for growing sugar beets in the fieldman's particular area. Fields where nematode control practices by soil fumigation had been employed were avoided.

Four samples were taken from each field. Sample A was taken from the apparent center of an infested area as observed by sugar beet growth. Sample B was taken midway from the apparent center to the apparent edge of the infested area. Sample C was collected at a point believed to be the edge of the infested area. The collection of Sample D was from a presumably unaffected area of the field. If a field contained more than one infested area, only one such infestation was sampled.

The method of sampling was as follows: Each sample consisted of one whole sugar beet, top included, and one quart of soil. Sugar beet roots were dug, rather than pulled, to preserve the maximum number of secondary roots. Soil surrounding the beet one foot square and to the depth of the actively growing fibrous roots or ten inches, whichever was greater, was thoroughly mixed on a clean surface for each sample. Newspapers were most often used. A one-quart aliquot of soil was then taken. The beet and the quart of soil were placed in a plastic bag with proper identification. The four samples from each field were then placed in a tare bag for transportation to the collection and processing center for that particular area.

The nematodes were separated from the soil using the gravity-screening technique (2) and preserved in five-dram vials in five percent formaldehyde, after being relaxed by heat.

Samples of the beet were taken from the fibrous roots, the tap root, the crown, the petioles, and the leaf blade. The beet samples were then preserved and stained in steaming acid fuchin in lacto-phenol (4, 5). A total of 1,041 soil samples and 1,031 aggregate beet samples were examined at the nematode laboratory of the Beet Sugar Development Foundation in Fort Collins, Colorado.

Estimates of nematode populations were based on a proportionate number of the total nematodes in each soil sample as obtained by the dilution method. Root population estimates of nematodes were made by direct observation.

Results and Discussion

Ten general soil types were encountered in the three states. The soil types, frequency of appearance, and frequency of *H. schachtii* infestation, respectively, are as follows: (1) loam 27, 22; (2) fine sandy loam 24, 12; (3) sandy loam 85, 57; (4) silt loam 9, 7; (5) sediment loam 3, 3; (6) clay loam 97, 85; (7) silty clay loam 17, 9; (8) sandy clay loam 6, 6; (9) muck 2, 2; (10) peat 3, 3.

High nematode population densities, 101 or more *H. schachtii* larvae per quart of soil, occurred in all soil types (Figure 1). *H. schachtii* population density estimates of 1 through 100 larvae per quart of soil were assigned to 19, or 9.19 percent, of the fields found infested. Nonclay soils accounted for 11 and clay soil for 8 of these low population density fields. These data are weighted as compared with fields of higher population densities because fields with visible growth symptoms were sought out for sampling. This procedure would naturally cause population density ratings to be grouped at the higher levels.

Loam, sandy loam, and clay loam soils were encountered most frequently, comprising 82.12 percent of the sugar beet fields sampled. Wallace (7) found the emergence of larvae from 100 cysts decreased from about 3,000 larvae to about 1,000, 100, and 50 or less larvae in seven days as the clay content was increased from none, to one, five, and 18 percent, respectively, in structureless mixtures of sand and clay. Of the 86 clay loam soil samples, 79, or 91.86 percent, allowed the development of a dense soil population of *H. schachtii* larvae (101 or more larvae per quart of soil) (Figure 1). These results suggest that a dense soil tex-

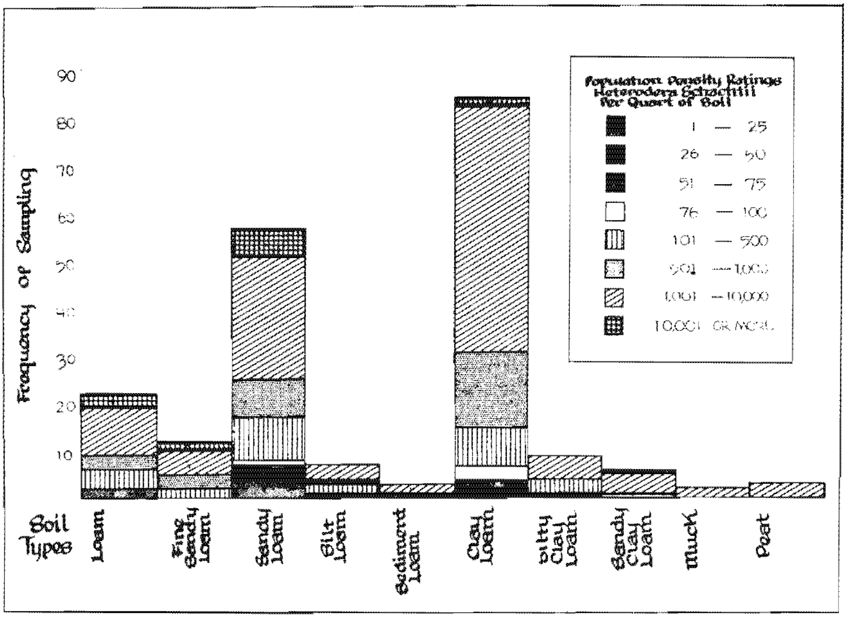

Figure 1.—The frequency of occurrence and densities of *Heterodera schachtii* populations as encountered in various soil types in California, Colorado, and Michigan.

ture can be modified, possibly by soil structure, creating conditions favorable for larval emergence from cysts.

Of the 101 samples collected in the "lighter" soils 90, or 89.10 percent, had dense populations of *H. schachtii.* Out of the 15 samples from silty clay loam and sandy clay loam, one had less than 100 *H. schachtii* larvae per quart of soil. Muck with two samples and peat with three samples were assigned population density ratings 1,001-10,000 larvae per quart of soil for all five samples.

The frequency of susceptible crops is fundamental in the build-up of plant-parasitic nematode populations. Of the 71 fields with clay loam soil assigned population density ratings 501 to 10,001 or more larvae per quart of soil, just eight fields had received a minimum rest period of three years from susceptible crops. On other soil types, satisfactory rest periods were also lacking.

Summary and Conclusions

Infestations of *H. schachtii* were encountered in ten soil types in California, Colorado, and Michigan. Dense *H. schachtii* populations occurred in all soil types. The appearance of dense *H. schachtii* populations in a great number of the clay soil samples suggests the modifying agency of some biotic and/or abiotic factors.

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