The Relationship of *Heterodera schachtii* Population Densities to Sugarbeet Yields[1]

G. D. Griffin[2]

Abstract: Sugarbeet yields were compared with field populations of *Heterodera schachtii* Schmidt. The correlation between sugarbeet yields and viable larvae/g of soil was negative and high, but that between sugarbeet yields and viable cysts/g of soil was lower. Sugarbeet yields were also compared with *H. schachtii* populations by years of rotation with a nonhost crop. The coefficients of correlation (r) between yield and viable larvae/g of soil were negative and high: 0 yr of rotation, −0.935; 1 yr, −0.922; 2 yr, −0.954; 3 yr, −0.935; and combined years, −0.965, with 95% confidence limits of −0.91 to −0.98 for combined years. The comparable correlation coefficients between yield and "viable cysts"/g of soil were negative and lower: 0 yr of rotation, −0.151; 1 yr, −0.022; 2 yr, −0.490; 3 yr, −0.456; and combined years, −0.586, with 95% confidence limits of −0.22 to −0.80 for the combined years. *Key words:* sugarbeet cyst nematode, larvae g/soil, cysts/g soil, *Beta vulgaris,* sugarbeet yields, crop rotation.

The sugarbeet cyst nematode, *Heterodera schachtii* Schm., has plagued growers in some of the sugarbeet-producing areas of the world for more than 100 yr. Since its discovery in the United States in 1907 (9), the sugarbeet cyst nematode has been important in production of sugarbeets in the intermountain area of the western USA. The limited availability of land for sugarbeet production has currently intensified the problem. However, the increased cost of sugarbeet production and the depressed sugar profits have emphasized the importance of adequately determining economic nematode threshold levels and correlating this to effective control methods.

European nematologists were first to recognize the importance of correlating nematode population densities to sugarbeet yields. Hellinga (5) found a linear correlation between the logarithm of the initial population density of viable cysts and sugarbeet yields. This technique was refined by Jones (6) and Seinhorst (8), who expressed the nematode population density as eggs/g soil. Heijbroek (4) also related sugarbeet yields to population densities of filled cysts, eggs, and larvae. Cook and Thomason (1) related sugarbeet yields to nematode population densities of eggs/g soil in California, and Olthof (7) correlated initial nematode population densities to sugarbeet yields in Canada.

In the intermountain region of the United States, sugarbeet yields have been related to populations of sugarbeet cyst nematodes expressed in terms of the number of cysts with viable contents (2,3). These are commonly called "viable cysts," although that term is a misnomer because the cysts are dead. The eggs inside may be alive or dead. There is great variability in the number of eggs per cysts, depending on the cropping history of the field (2). This study was made to determine the relations between population densities expressed in terms of (i) "viable cysts" and (ii) eggs and larvae of *H. schachtii* as related to sugarbeet yields in the intermountain area of the western United States.

MATERIALS AND METHODS

A field near Dayton, Idaho, (Provo sand, M.H.C. 21%) infested with various population densities of *H. schachtii* was chosen for study. The field had been leveled 5 yr previously and planted to sugarbeets the year before the study.

Forty plots, 12 × 12 m, were positioned randomly in the field. No two plots were closer than 20 m, and all plots were at least 20 m from the border of the planting area. Plots were sampled with a 2.5-cm sampling probe to a depth of 30 cm. Initial sampling showed that 85% of the nematodes were found in the upper 30 cm of soil and 63% in the upper 15 cm of soil. Probe samples collected within 2 wk of spring planting (25 per plot) were composited and mixed, a 250-cc aliquant sample was weighed and processed, and the number of viable cysts/g of soil was determined. Viable cysts were macerated in a 10-cc mortar tube, and eggs

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[2]Nematologist, USDA, SEA, AR, Crops Research Laboratory, Utah State University, Logan, UT 84322.

and larvae counted. Assuming that each egg contained a viable larva, the eggs were equated with larvae. Henceforth, eggs plus encysted larvae/g soil will be referred to as larvae/g of soil.

Planting of sugarbeets followed standard agronomic practices for fertilization, weed control, and irrigation.

Plots were hand harvested 150 d after planting, and sugarbeet roots were weighed. Replicated samples were transported to the laboratory where tare weight and tonnage were determined, and yields (metric tons/ha) were equated to viable cysts/g soil and larvae/g soil.

Similar studies were established in other *H. schachtii* infested fields with similar soil types in the Dayton, Idaho, area. All were located within a radius of 13 km. The fields had similar cropping histories except that sugarbeets were grown 0, 1, 2, and 3 yr prior to initiation of the study. In these fields, plots measured 3.4 × 16 m. Nematode samples were collected and processed as previously described. Plantings were established within a 9-d period, 3–10 d after sampling, at soil temperatures of 14 to 16 C at a depth of 15 cm. One hundred and fifty days after planting, 15 m of the two center rows of each plot were hand harvested, and yields (metric tons/ha) were related to population densities of viable cysts and larvae.

RESULTS

Experiment 1: Sugarbeet yields were negatively and significantly correlated with *H. schachtii* population densities as measured by both larvae/g of soil ($P = 0.01$) (Fig. 1) and cysts/g of soil ($P = 0.05$) (Fig. 2). However, the correlation between yield and population of viable cysts was weaker than that between yield and population of larvae. In the regression of sugarbeet yield (Y) and larvae/g of soil (X), 93% of the variation in Y was explained by the linear regression ($r^2 = 0.935$). In the regression of sugarbeet yield (Y) on viable cysts/g of soil (X), however, only 44% of the variation in Y was explained by the linear regression ($r^2 = 0.438$).

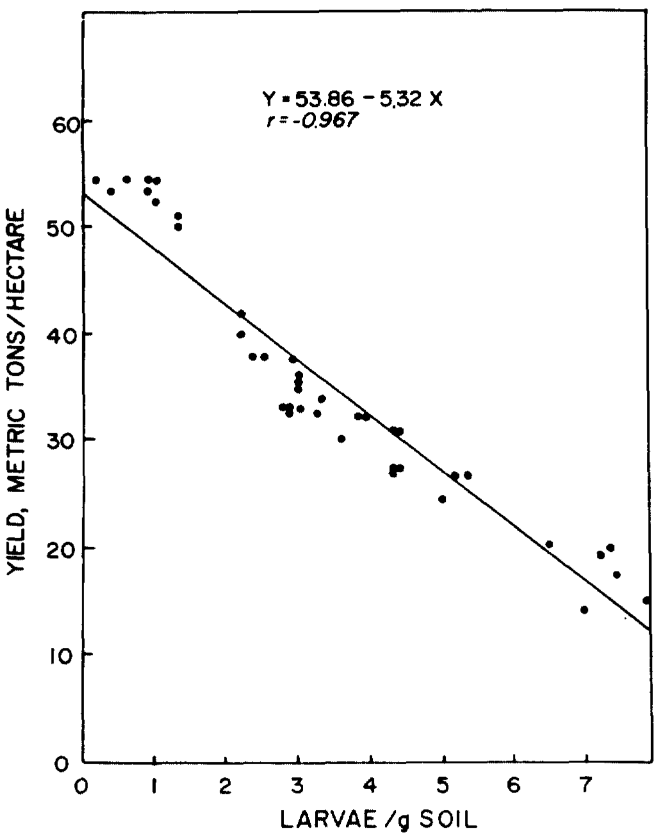

Fig. 1. Relationship of *Heterodera schachtii* population densities, as determined by larvae/g of soil, to sugarbet yield in field with no rotation with a nonhost crop.

Experiment 2: Correlations similar to that found in Experiment 1 were observed for the relationship between sugarbeet yield and *H. schachtii* population density (larvae/g of soil) by years of rotation with a nonhost crop ($P = 0.01$). However, the correlation between sugarbeet yield and viable cysts/g of soil by years of rotation was not significant, whether years were considered separately or combined. The coefficients of correlation (r) between yield and larvae/g of soil were negative and high: 0 yr of rotation, –0.935; 1 yr, –0.922; 2 yr, -0.954; 3 yr, -0.935; and combined years, –0.965 (Fig. 3), with 95% confidence limits of –0.91 to –0.98 for the combined years. The comparable correlation coefficient between yield and viable cysts/g of soil were negative and low: 0 yr of rotation, –0.151; 1 yr, –0.022; 2 yr, –0.490; 3 yr, –0.456; and combined years, –0.586 (Fig. 4), with 95% confidence limits of –0.22 to –0.80 for the combined years.

DISCUSSION

Extrinsic factors that affect the penetration and pathogenicity of *H. schachtii* are important in determining threshold populations of economic response (2). The fact that economic thresholds do differ from one area to another necessitates use of the most accurate technology available for determining nematode population densities. Although a significant correlation between a population of viable cysts and sugarbeet yields was found in Experiment 1, its importance appears to be reduced by the lack of such a significant correlation in the analysis by years of rotation. The consistent significance of the correlation between sugarbeet yield and number of larvae/g of soil indicates the validity of this technique. Therefore, the use of larvae rather than the number of cysts with viable contents is recommended for use by sugarbeet companies, sugarbeet growers, and extension personnel when determining economic threshold levels for *H. schachtii* in sugarbeet production.

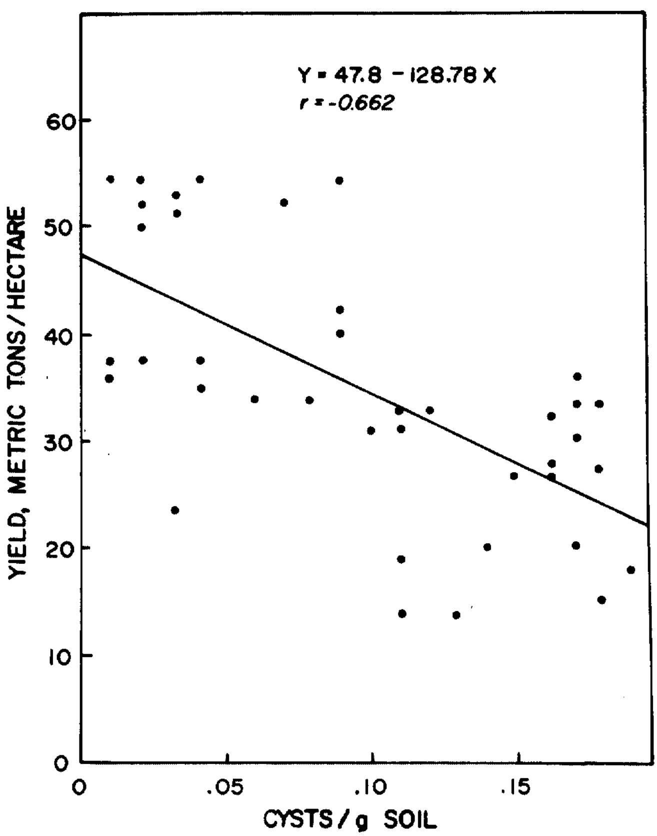

Fig. 2. Relationship of *Heterodera schachtii* population densities, as determined by viable cysts/g of soil, to sugarbeet yield in field with no rotation with a nonhost crop.

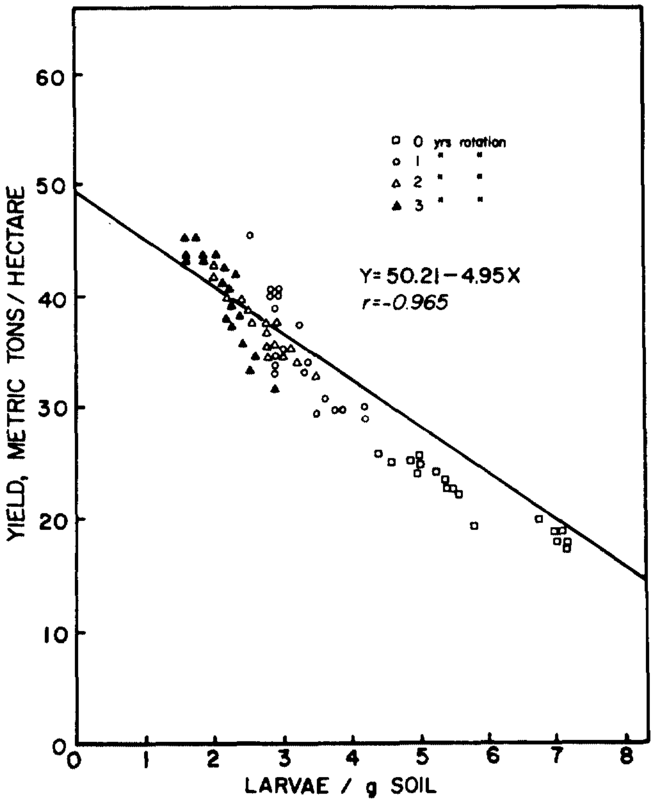

Fig. 3. Relationship of *Heterodera schachtii* population densities, as determined by larvae/g soil, to sugarbeet yield in field with 0, 1, 2, and 3 yr rotation with a nonhost crop.

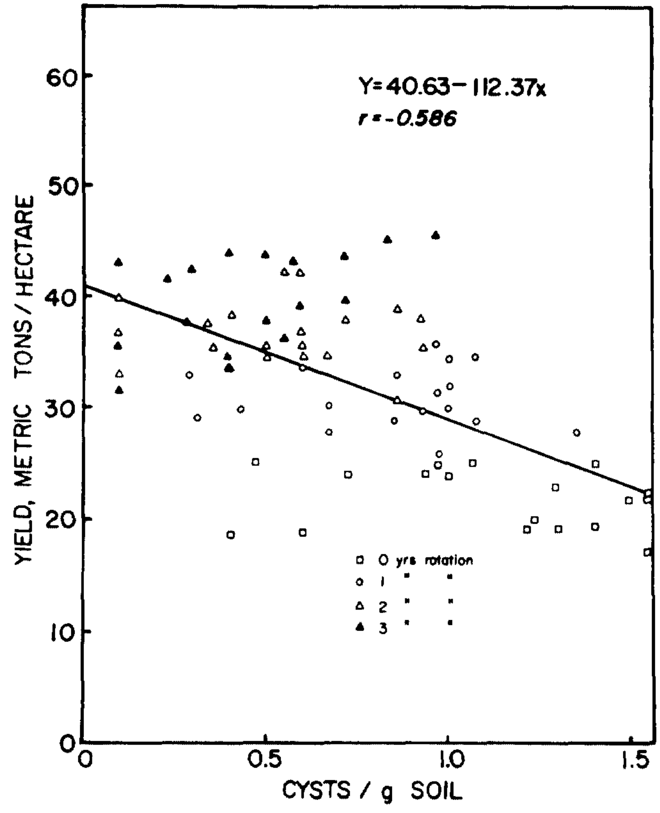

Fig. 4. Relationship of *Heterodera schachtii* population densities, as determined by viable cysts/g soil, to sugarbeet yields in field with 0, 1, 2, and 3 yr rotation with nonhost crop.

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