Estimate of Yield Loss from the Citrus Nematode in Texas Grapefruit[1]

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Abstract: Chemical control of the citrus nematode, *Tylenchulus semipenetrans* Cobb, has consistently increased yield of grapefruit on sour orange rootstock in Texas. In this study, data from chemical control tests conducted from 1973 to 1980 were analyzed to determine the relationship between nematode counts and grapefruit yield and fruit size. The correlation between yield and nematode counts was negative ($r = -0.47$) and highly significant ($P < 0.01$). The data best fit the exponential decay curve: $y = 160.3e^{-0.0000429x}$ where y = yield in kg/tree and x = nematodes/100 cm^3 of soil. The correlation between fruit size and nematode counts was not significant because yield and fruit size were inversely related. Yield loss in an average untreated orchard was estimated to be 12.4 tons/ha. Economic loss to citrus nematode in Texas grapefruit, assuming no treatment and an average on-tree price of $60/ton, was estimated to be $13.2 million annually. *Key words: Tylenchulus semipenetrans*, control, economics.

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Many studies have indicated that nematicide treatment reduces populations of the citrus nematode, *Tylenchulus semipenetrans* Cobb, and increases citrus yields and fruit size (1,2,3,4,5,6,8,9,10,11). However, no attempt has been made to relate nematode numbers to yield or fruit size, to determine the threshold population at which nematicide treatment would provide economic benefit, or to estimate losses from citrus nematode. Research on chemical control has been conducted over a number of years in Texas citrus orchards. In this study, we assembled published (2,9,10,11) and unpublished data and attempted to relate nematode counts to yield and fruit size of grapefruit in Texas.

MATERIALS AND METHODS

All studies were conducted in 'Ruby Red' grapefruit (*Citrus paradisi* Macf.) orchards on sour orange (*C. aurantium* L.) rootstock at the Texas A&I University Citrus Center near Weslaco, Texas. Data were collected from plots treated by soil application of 1,2-dibromo-3-chloropropane (DBCP); aldicarb (2-methyl-[methylthio] propionaldehyde 0-[methylcarbamyl]oxime); phenamiphos (ethyl 4-[methylthio-m-tolyl isopropylphosphoramidate]); or ethoprop (0-ethyl S,S-dipropyl phosphorodithionate); by foliar application of oxamyl (methyl N',N'-dimethyl-N[methylcarbamyl] oxy-1-thiooxamimidate); or from untreated control plots in a series of experiments conducted from 1973 to 1980.

For the purposes of this study, each data point represents the information collected in one year from a single treatment which was replicated 3 or 4 times. Nematodes were collected as described previously (2,9,10,11), extracted from soil samples using a modified Baermann funnel technique (7), and expressed as the number of larvae per 100 cm^3 of soil. Several samples from each plot were composited, and a single determination was made for each count date. Each data point represents the average of 3 or 4 counts made from April through October of each year. Fruit were harvested from November to February each year and weighed and sized. Yields were expressed in kilograms per tree and size as the percentage of total fruit weight of size 96 or larger; i.e., fruit 9.2-cm d or larger. Plots varied in size, but each data point represents the average yield from about 18 to 24 trees.

Regression analyses of nematode counts and yield and fruit size were performed to determine the relationship between these parameters. Analyses of nematode counts and yield were based on 48 data points and those involving fruit size were based on 35 data points.

RESULTS AND DISCUSSION

There was a great deal of variation in yield and fruit size since results were from

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trees of different ages harvested in different years. Nevertheless, the correlation between yield and nematode counts was negative (r = −0.47) and highly significant ($P < 0.01$). The data best fit the exponential decay curve:

$$y = 160.3e^{-0.0000429x} \quad (1)$$

where y is yield in kg/tree and x is nematodes/100 cm³ (Fig. 1).

Linear regression analysis indicated that there was no significant correlation (at $P = 0.05$) between nematode counts and fruit size (r = 0.10). This would appear to conflict with reports that nematicide treatment increases fruit size (9,10,11). However, as fruit load increases, fruit size is reduced. In the data reported here, the correlation between yield and fruit size was negative and highly significant (r = −0.436, $P < 0.01$). Thus, nematicide treatment, by reducing nematode numbers, increases fruit load and thereby negates any effect on fruit size. Trees heavily infested with citrus nematode set few fruit, but the fruit grow to a relatively large size. When fruit set is equal, fruit size is greater on the trees with low populations than on trees with high populations.

The equation derived in Fig. 1 was used to calculate yield losses at various nematode population levels (Table 1). There was no obvious threshold below which yield losses did not occur (Fig. 1). Loss of yield in untreated orchards is substantial. The average number of larvae per 100 cm³ of soil in untreated control plots throughout the study was 8,600. The predicted yield loss at this level would be 12.4 tons/ha (Table 1). Using the rather conservative on-tree fruit price estimate of $60 per metric ton, dollar losses of $744/ha would be predicted in untreated orchards. Aldicarb is presently the most widely used material for postplant control of citrus nematode. Present material and application costs with this nematicide are estimated at $185/ha at the lowest recommended rate, which is usually effective for citrus nematode control in Texas (3,11), and $350/ha

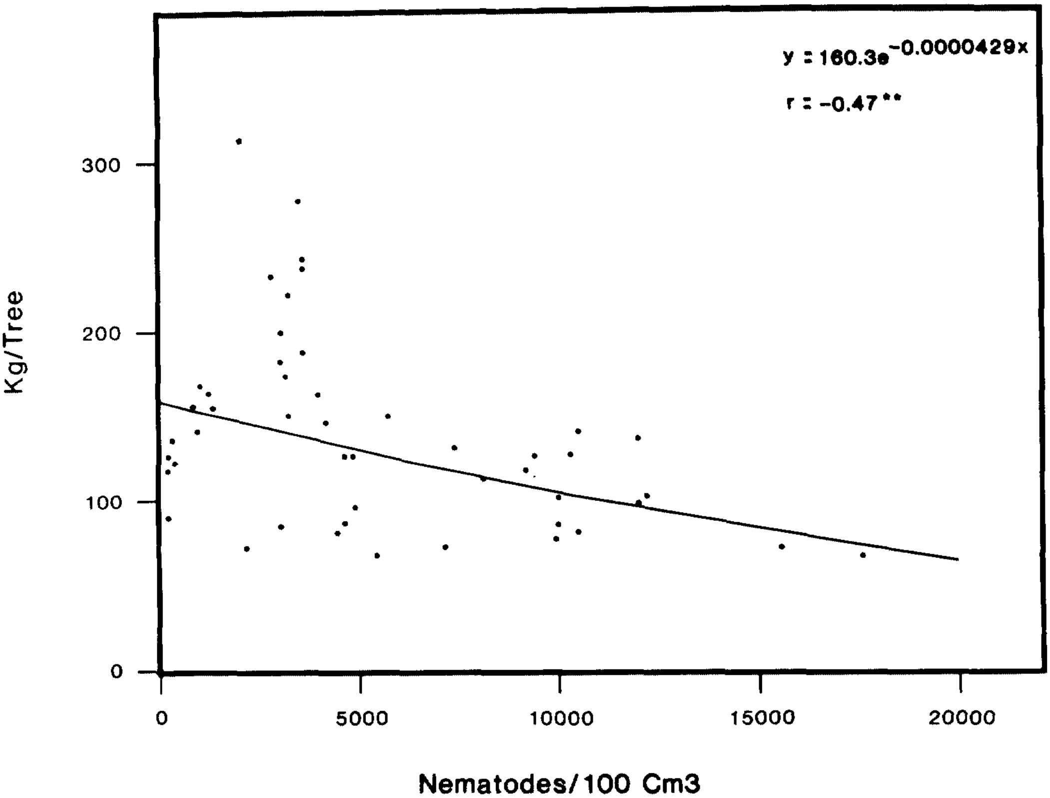

Fig. 1. Relationship of citrus nematode populations to yield of grapefruit in Texas.

Table 1. Predicted yield and economic losses in Texas grapefruit from citrus nematode.

Nematode population (No. of larvae/ 100 cm³ soil)	Predicted yield* (kg/tree)	Predicted yield loss* kg/tree	Predicted yield loss* tons/ha†	Predicted dollar loss (ha‡)
0	160.3	0.0	0.0	$ 0
1,000	153.6	6.7	1.7	102
2,000	147.1	13.2	3.3	198
3,000	141.0	19.3	4.8	288
4,000	135.0	25.3	6.3	378
6,000	123.9	36.4	9.1	546
8,000	113.8	46.5	11.6	696
8,600§	110.9	49.4	12.4	744
10,000	104.4	55.9	14.0	840
15,000	84.3	76.0	19.0	1,140
20,000	68.0	92.3	23.1	1,386

*Calculated from equation (1).
†Assuming 250 trees/ha.
‡Assuming $60 per metric ton of fruit.
§Average population in all untreated control plots over all years.

at the maximum recommended rate. Thus, treatment costs would be repaid if nematode counts reached 2,000–4,000 larvae/100 cm³. At the average nematode population in untreated orchards of 8,600 larvae/100 cm³, benefits above treatment costs could easily amount to $300–$500 per ha.

Citrus nematode is often considered to be a minor pest because large numbers are required to have any substantial effect on citrus yields. However, in the fine-textured soils of the Lower Rio Grande Valley of Texas, populations of citrus nematode are high and yield losses are substantial (9,10, 11). In the only previous attempt to evaluate nematode losses on Texas grapefruit, M. A. Luttner of the Environmental Protection Agency, in testimony given at the DBCP cancellation hearing in September 1979, estimated yield losses of 8.2 tons/ha in untreated orchards. Our loss estimate of 12.4 tons/ha in untreated orchards is somewhat higher but of the same order of magnitude. If these yield loss figures for untreated control plots are extrapolated to the 17,750 ha of grapefruit in Texas, then losses, presuming no treatment, would be 220,100 tons/yr or $13,206,000 per year, if an average on-tree price of $60/ton is used.

It is difficult to extend these results to other citrus areas because other scion and rootstock varieties are used and soils may be quite distinct. A single nematode extraction method was used throughout these studies, and we do not know how our population estimates relate to counts made by other methods. However, these results give an indication of the magnitude of the yield losses that might occur in other citrus areas where citrus nematode multiplies rapidly and reaches high populations.

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