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TCN Tracker – A Decision-based Cyst Nematode Management Aid For Connecticut Wrapper Tobacco Types

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The Need:

The tobacco cyst nematode *Globodera tabacum tabacum* (Lownsbery & Lownsbery, 1954) Stone, is a damaging pathogen of shade and broadleaf cigar wrapper tobacco types in the Connecticut River Valley of Connecticut and Massachusetts. Nematode infection of roots can cause dramatic stunting, yield loss, and reduce leaf quality. Plant yield losses increase with increasing numbers of tobacco cyst nematodes, and we have developed nonlinear yield loss models to predict shade tobacco (LaMondia, 1995) and broadleaf tobacco (LaMondia, 2002) yield losses based on preplant nematode densities in sampled soil. Losses can exceed 40 to 60 percent at high nematode densities. Nematode management below damaging population levels is important in minimizing losses. In addition, *G. t. tabacum* population increase over a growing season has been described by using a linear relation on a log/log plot (LaMondia, 2002). Growers can sample soil from nematode-infested fields, combining multiple sub-samples to result in a better population estimate, and submit the soil to the Valley Laboratory for analyses. *G. t. tabacum* populations are reported as the number of second-stage juveniles (J2) per cm^3 in sampled soil. These nematode densities may then be used to predict yield loss and subsequent cyst nematode population density. Our objective in developing TCN Tracker was to produce a user-friendly point and click means of predicting the impact of various field use/management tactics on crop yield loss and cyst nematode population dynamics.

The Model:

Decision-based management models have been developed for a wide variety of pests on different crops, including, diseases, insects, weeds, and nematodes (Flinn et al., 2003; Kim and Ferris, 2002; Taylor and Rodriguez-Kabana, 1999; Welch et al., 2002; Wilkerson et al., 2002). These models generally predict the effects of various management options available to producers on pest populations and crop yields or losses. Tobacco cyst nematode management tactics include soil fumigation, fallowing or rotation to a nonhost crop, planting a resistant cultivar and trap cropping. Each management option has a different impact on tobacco cyst nematode populations that will be available to attack the next year's tobacco crop. We have developed TCN Tracker as a Microsoft Access-based decision based management model. Growers provide initial tobacco cyst nematode densities determined from field samples, click on a field use/management option and the program calculates a prediction of end of the season nematode density and the potential yield loss that may be anticipated for the next season. When any field use/management option is selected, the form automatically updates the end of the season nematode density and the potential yield loss for each of the following years. The Access interface utilizes a point and click form which can be printed and used in combination with additional sampling over time to plan multi-year nematode management programs.

The TCN Tracker model utilizes population dynamics models and yield loss functions developed for shade and broadleaf tobacco over the last decade in field plots and microplots and corrected for soil volume per plant (LaMondia, 2002; LaMondia, 1995). An inverse logistic function (Noe, 1993; Noe et al., 1991) was used for shade-grown tobacco (LaMondia, 1995; LaMondia, 2002) and broadleaf tobacco (LaMondia, 2002) to represent the relationship between harvested leaf weight and initial *G. t. tabacum* density for each tobacco type.

$$Y = m + \frac{M - m}{1 + \left(\frac{P_i}{u}\right)^b}$$

where Y = harvested leaf weight or total shoot weight; Pi = initial *G. t. tabacum* density in J2 and J2 in eggs per cm^3 soil; M = maximum yield or shoot weight; m = minimum yield or shoot weight; and the parameters u and b determine the shape of the curve (Figures 1 and 2).

Shade tobacco yield loss as a function of initial *G. t. tabacum* density used in the model was:

$$Loss(Year\#) = 45.26 \cdot \left\{1 - \frac{1}{1 + \left[Pi/220.4\right]^{2.8}}\right\}$$

Broadleaf tobacco yield loss as a function of initial *G. t. tabacum* density was:

$$Loss(Year\#) = 39.81 \cdot \left\{1 - \frac{1}{1 + \left[Pi/220.4\right]^{1.8}}\right\}$$

The relationship between $\log_{10}$ final density (Pf) and $\log_{10}$ initial density (Pi) were best represented by linear regression and correlation (LaMondia, 2002). The equation used for shade tobacco population change on a susceptible plant was:

$$P_f = \frac{10^{\left(1.96 + 0.29 \cdot Log\left(P_i\right)/Log\left(10\right)\right)}}{2}$$

The timing of soil tillage after broadleaf harvest has a large impact on the population of cyst nematodes (LaMondia, unpublished). Three years of data from field plots were used to develop population changes after tillage within 24 hours of harvest or within 3 weeks of harvest. The equation used for broadleaf tobacco that was tilled immediately after harvest was:

$$P_f = 10^{\left(0.068 + 0.824 \cdot Log\left(P_i\right)/Log\left(10\right)\right)}$$

The equation used for broadleaf tobacco that was tilled 3 weeks after harvest was:

$$P_f = 10^{\left(1.146 + 0.476 \cdot Log\left(P_i\right)/Log\left(10\right)\right)}$$

The average impact of fallowing or nonhost crop production such as rotation to a grain on tobacco cyst nematode populations has been a 20% decline annually (LaMondia, unpublished). The effects of resistant tobacco cultivars on nematode densities were determined in field plots and microplots (LaMondia, 2000a, 2000b). The average effect was a 58% population decline. The use of trap crops as a management tactic was investigated in field plots and microplots over three years (LaMondia, 1996) and determined to cause a 45% population decline. The effects of soil fumigation on nematode populations were determined in field plots (LaMondia, 1993) and estimated at an 80% population decline.

Using TCN Tracker:

TCN Tracker is written as a Microsoft Access database nematode management decision aid and the Microsoft Access program is required to use the database. The file may be obtained on a CD from the CAES Publications Office or by request from James A. LaMondia, The Connecticut Agricultural Experiment Station Valley Laboratory, 153 Cook Hill Rd. P. O. Box 248, Windsor, CT 06095 or by email: from James.LaMondia@po.state.ct.us.

Transfer the file 'TCN Tracker Database' from the CD to the computer hard drive. Open the database on the hard drive and then open either the 'Shade Tobacco TCN Model Form' (Figure 3) or the 'Broadleaf Tobacco TCN Model Form' (Figure 4) to open the appropriate page. A title and date may be assigned to designate the farm, field, or other specific location and date associated with the initial tobacco cyst nematode population, which may also be entered on the form. Clicking the appropriate box for field use for years one through five then results in an estimated cyst nematode population after each year and the yield loss prediction associated with that nematode population. When any field use/management option is selected or changed the form automatically updates the end of the season nematode density and the potential yield loss for all following years. Each page is automatically saved for future reference.

If the form page cannot be saved or changed, highlight the 'TCN Tracker Database', right click the mouse, click properties, and remove the check in the read-only box. The numbers generated are predictions based on the data and models described above and may differ from actual nematode populations and yield losses experienced, especially as the number of years from sampling increases. Environmental conditions and sampling error may significantly affect plant growth and nematode population changes. The model is intended, however, as a means of planning field use over time to manage tobacco cyst nematode populations below damaging levels to minimize yield losses.

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FIGURE LEGENDS

Figure 1. The effect of initial *Globodera tabacum tabacum* population density in soil on broadleaf tobacco shoot weight (g) in microplots, 1995 to 1996.

Figure 2. The effect of initial *Globodera tabacum tabacum* population density in soil on shade tobacco shoot weight (g) in microplots, 1995 to 1998.

Figure 3. Shade Tobacco TCN Model Form.

Figure 4. Broadleaf Tobacco TCN Model Form.

Figure 1.

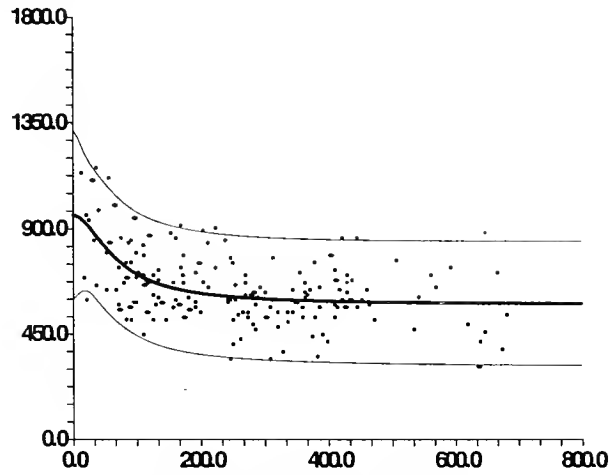

Figure 2.

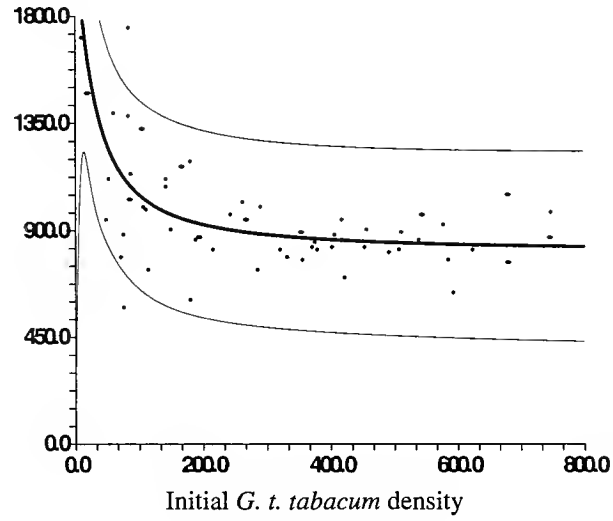

Figure 3.

TCN Tracker - Shade
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Shade Tobacco Cyst Nematode Management Decision Model

Title:

Date:

Initial Tobacco Cyst Nematode Population: 0.0 J2/cm^3

Year One Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Fumigation and Susceptible

Population After Year 1: 0.0 J2/cm^3

Yield Loss prediction: 0.0 %

Year Two Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Fumigation and Susceptible

Population After Year 2: 0.0 J2/cm^3

Yield Loss prediction: 0.0 %

Year Three Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Fumigation and Susceptible

Population After Year 3: 0.0 J2/cm^3

Yield Loss prediction: 0.0 %

Year Four Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Fumigation and Susceptible

Population After Year 4: 0.0 J2/cm^3

Yield Loss prediction: 0.0 %

Year Five Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Fumigation and Susceptible

Population After Year 5: 0.0 J2/cm^3

Yield Loss prediction: 0.0 %

Figure 4.

TCN Tracker - Broadleaf

Connecticut Agricultural Experiment Station Valley Laboratory

Broadleaf Tobacco Cyst Nematode Management Decision Model

Title:

Date:

Initial Tobacco Cyst Nematode Population: 0.0 J2/cm^3

Year One Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible (Till Immediately
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Susceptible (Till Later)

Population After Year 1: 0.0 J2/cm^3

Yield Loss Year 1: 0.00 %

Year Two Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible (Till Immediately
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Susceptible (Till Later)

Population After Year 2: 0.0 J2/cm^3

Yield Loss Year 2: 0.00 %

Year Three Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible (Till Immediately
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Susceptible (Till Later)

Population After Year 3: 0.0 J2/cm^3

Yield Loss Year 3: 0.00 %

Year Four Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible (Till Immediately
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Susceptible (Till Later)

Population After Year 4: 0.0 J2/cm^3

Yield Loss Year 4: 0.00 %

Year Five Field Use

- ☐ Fallow
- ☐ Resistant
- ☐ Susceptible (Till Immediately
- ☐ Fumigation
- ☐ Trap Crop
- ☐ Susceptible (Till Later)

Population After Year 5: 0.0 J2/cm^3

Yield Loss Year 5: 0.00 %