2006 NYS IPM Program
Research and Development Report

Title: Development of On-Farm Protocols for Assessing Soil Nematode Infestation Levels in Vegetable Fields and Making the Appropriate Management Decision.

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Abstract:

The northern root-knot (NRK) and lesion nematodes are the two primary nematode pathogens of vegetables grown in New York. Currently, there are no known resistant varieties and the crop rotations practiced are generally not effective. Also, it is often not cost-effective to rotate with less profitable non-host crops, thus nematicides are heavily relied upon. Three grower training sessions in the on-farm assessment of root-knot and lesion nematode infestations were held in Orange, Oswego and Yates Counties on 16 May, 27 and 29 June, respectively. Over 50 growers attended the sessions to learn how-to sample targeted fields, set-up and maintain the bioassay plants, record the severity of diagnostic visual symptoms and make the appropriate management decision, if needed. In cooperation with Cornell vegetable extension educators, 13 fields were soil sampled and assessed for nematodes using the developed bioassays. Several growers also conducted their own on-farm assessments. Five growth chamber experiments were conducted to further relate symptom severity on the soybean bioassay roots with natural lesion nematode infestation levels. The results indicated that the number of lesions caused by lesion nematode on soybean roots were correlated to soil infestation levels of this nematode, although there was considerable variability among the tests and further investigation is needed. The use of these soil bioassays as an IPM tool will decrease the use of chemical nematicides, increase profitability and contribute to improved environmental quality.

Background and Justification:

The lesion (*Pratylenchus penetrans*) and the northern root-knot (*Meloidogyne hapla*) nematodes are the most prevalent plant-parasitic nematodes found affecting vegetables grown in New York. Both of these nematodes have broad host ranges which include both agronomic crops and weed species in several plant families. When soil infestation levels are high, these nematodes are known to cause substantial yield and economic losses. Vegetable growers are aware of yield losses caused by plant-parasitic nematodes and are interested in implementing cost-effective management programs based on the use of action thresholds. Nematode diseases were ranked as a high research and extension priority across multiple vegetables in the 2006 NY State IPM Program list of vegetable priorities.

Growers still depend largely on the use of chemical nematicides for managing nematodes even though they are toxic, expensive, and pose considerable safety and environmental risks. Vydate, a carbamate, non-fumigant type nematicide, is the nematicide most commonly applied on vegetables in New York. Over the past several years, we have demonstrated the cost-effectiveness of applying Vydate for controlling nematodes in heavily infested onion, carrot and potato fields. However, we also learned that applying Vydate is not cost-effective or needed in either non-infested fields or fields with a low NRK and/or lesion nematode infestation level. Therefore, there is a need to assess the level of soil nematode infestation prior to planting in order to determine the need for management (application of a nematicide, crop rotation, etc.), if any. Laboratory procedures are available for extracting and enumerating these nematodes directly from soil and plant roots, but they require personnel experienced with nematode identification and can be costly. We have developed a protocol for the visual assessment of NRK nematode infestation levels and would like to continue to develop the bioassay protocol for the lesion nematodes as well as train growers and private consultants with limited experience with nematodes to conduct, evaluate, and interpret their own on-farm nematode assessments.

Growth and yield losses caused by nematodes are primarily determined by the initial soil population density of the nematode(s) present at planting. The damage threshold density of the RKN nematode on vegetables including carrots (0.4 and 0.8 eggs/cc mineral and organic soil, respectively) and onions (1-2 eggs/cc organic soil) has been determined. The NRK nematode causes diagnostic galls on most host plants, but those produced on lettuce are discrete, uniform, and easy to observe. Thus, we have validated a soil bioassay in the greenhouse with lettuce to relate soil population of this nematode to the root-galling severity developed on lettuce roots 4 to 6 weeks after planting. Root-galling severity is rated on a scale of 1 (no galls observed) to 9 (>80% of roots galled). Ratings of 2, 3, 4, 5, 6, 7, and 8 refer to 1-3% (1-3 galls/root system), 4-10%, 11-25%, 26-35%, 36-50%, 50-65% and 66-80% of roots galled, respectively. A simplified grower scale has recently been developed based on a 1 to 5 scale. An average root-galling severity rating of ≤ 2, > 2, and ≥ 3 on the bioassay lettuce roots will suggests the need to control the root-knot nematode on carrot, lettuce and onion, respectively.

Damage threshold densities for the lesion nematode on most vegetables under New York conditions are not well defined. A population density of >100 and >150 lesion nematodes/100 cc soil is considered damaging to onions and beans, respectively. In New York, nematode populations as high as 2000 nematodes/100 cc soil have been observed in samples collected from onion, bean, potato and corn fields. Lesion nematodes are considered migratory plant-parasitic nematodes since they spend a portion of their life cycle inside the root and a portion in the soil. They penetrate roots directly by puncturing the root with their stylet and by using the enzymatic effects of their saliva which produce discolored lesions on roots that can coalesce to produce larger areas of necrotic tissue. However, the lesions are not conspicuous on roots of many hosts. Several types of peas (California blackeye, Mississippi Silver, Pinkeye Purple Hull) and lima beans (Fordhook 242, Burpee improved lima bean) have been identified in our laboratory as potential bioassay indicators for the lesion nematode. The roots of these plants develop characteristic long, narrow and brown-black lesion symptomatic of lesion nematode infection, even at low infestation levels. Although, California blackeye pea had been the most consistent in exhibiting the diagnostic lesions and was going to be the focus of the continued development of this bioassay, more recent trials have indicated that soybean can also be a diagnostic host. Since

is it not as susceptible to other soilborne pathogens that can cause general root browning and can mask symptoms of lesion nematode infection, soybean became the focus of the continued development of this bioassay.

Objectives of the project were to:

1. Provide hands-on participatory training to vegetable growers in conducting, evaluating and interpreting soil bioassays to assess root-knot nematode infestation levels and determine if management is necessary or not.
2. Finalize the development of a visual symptom severity scale for assessing the lesion nematode soil infestation level and correlate it to natural soil infestation levels.
3. Evaluation of the project objectives.

Procedures:

Objective 1. Soil samples were collected from commercial production fields in collaboration with Cornell vegetable extension educators. A minimum of four composite soil samples consisting of 10-15 sub-samples were collected in a 'W' or 'X' pattern. Each sample was mixed thoroughly, placed into 4 pots/containers, and then two pots were planted with two lettuce seedlings and two pots planted with 2 or 3 soybean seeds. The growers were encouraged to also set-up and maintain their own set of bioassay plants and place them in a lit location and to water them regularly. After 4-6 weeks, we, the project leaders with the extension educators, assisted/trained the growers how to examine and rate the roots for root-galling severity and count the number of lesions on the soybean roots and then interpret the data to make a management decision based on the action threshold (root-galling severity thresholds of ≤ 2, > 2, and ≥ 3 for carrot, lettuce and onion, respectively). Several interested growers have already been trained in this on-farm nematode assessment and an illustrated step-by-step guide has been developed and distributed to interested growers at various grower meetings and field days.

Objective 2. Symptoms and damage caused by different soil populations of the lesion nematode were validated on soybean cv. SG1405RR. Cone tubes used for nursery seedlings production were filled with approximately 200cc of natural or pasteurized organic soil infested with 0, 0.5, 1, 2, 4, or 8 lesion nematodes/cc soil. *P. penetrans* were extracted from the roots of vetch stock plants using the shaker method, the population density in the suspension determined under a dissecting microscope prior to being incorporated into the soil at the various densities. Two seeds were planted in each tube and replicated 10 times. After 2 weeks in the growth chamber, half of the plants were removed, the roots washed free of soil and then examined and the number of diagnostic symptoms (lesions) were recorded. The second half of the plants was evaluated after 3 weeks. The soybean cv. SG1405RR was also used to index soil from commercial vegetable fields with suspected nematode problems. Four growth chamber trials were completed and a fifth one is in progress and is further described in the results and discussion section of the report. The first two experiments were conducted using natural (unpasteurized) organic soil while the second two experiments used pasteurized organic soil in order to relate lesion count with nematode infestation level.

Objective 3. The cost-effectiveness of the nematode management decisions made using the results of the bioassays will be used to validate the ability of the soil bioassay to accurately assess the level of nematode infestation in the field and resulting yield loss. Other indicators that

can be used to measure the impact of this project is the reduction in the application of nematicides by applying them only on an as need basis and the increase adoption of crop rotation with non-host or antagonistic crops.

Results and Discussion:

Objective 1. Three grower training workshops/ twilight meetings were held in Orange, Oswego, and Yates Counties on 16 May, 27 and 29 June, respectively to demonstrate how to set-up, maintain, evaluate and interpret the soil bioassays using lettuce and soybean to assess root-knot and lesion nematode infestation levels; a total of over fifty growers were in attendance (other digital images also submitted separately).

Figure 1. Root-knot and lesion nematode bioassay indicator plants set-up and maintained by a collorating grower in Genesee County, NY.

In cooperation with vegetable extension educators, soil samples were collected from 13 commercial vegetable production fields of seven growers in Central and Western New York and nematode infestation levels were assessed using the developed soil bioassays with lettuce and soybean. Three of the growers set-up and maintained their own set of soil bioassays on the farm (Figure 1). After 4-6 weeks, we (the participating growers and project leaders) took down the bioassay plants, washed the roots and rated them for symptom severity and counted the number of lesions. In all cases, the results of the grower bioassays were similar to those conducted by the project leaders and led to the same management conclusions/ decisions. The results are presented in Table 1. Seven of the fields had root-knot nematode bioassay ratings above the recommended threshold of 2.0 and 3.0 for carrot and onion, respectively. Although only one field had a high lesion nematode population in this study, the distribution and infestation levels of this nematode are increasing as growers continue to incorporate grain crops into their rotations. Therefore work will be continued to fine-tune the lesion nematode bioassay using soybean and to relate visual symptom assessments to yields of onion and other crops for the development of economic thresholds.

The development of the soil bioassays for assessing nematode infestations and needed management decisions provides another practical technique that can be incorporated into an integrated pest management program for each vegetable crop. Successful implementation of these bioassays will result in reduced nematode damage, increased yield and profitability as well as in the reduction of nematicide applications made to fields with nematode infestation levels below the economic threshold. It will definitely increase IPM adoption and implementation that can also be documented by conducting surveys, interviews, and other methods.

Objective 2. Several growth chamber experiments were conducted using soybean cv. SG1405RR instead of California blackeye pea as originally proposed. Although the characteristic elongated chocolate-brown lesions symptomatic of lesion nematode infection develop on California blackeye pea roots, we observed that the roots also become brown as a result of infection by other soilborne root pathogens thus increasing the difficulty of evaluation. Soybean

roots, which develop the same characteristic lesions (Figure 2), tend to retain their white color and therefore have been used in the further development of this bioassay for lesion nematode. Four growth chamber trials were conducted in both natural and pasteurized organic soils that were infested with increasing levels of *Pratylenchus penetrans*. One half of the trial was evaluated after 14 days and the second half after 21 days to determine an optimum duration for the bioassay.

Figure 2. Diagnostic chocolate-brown elongated lesions caused by lesion nematode (*Pratylenchus penetrans*) infection on soybean roots.

The results of the four experiments are presented in Figure 3 (A-D). In general, these results confirm the correlation of soil infestation with lesion nematode to the number of diagnostic lesions observed on soybean roots. However, the variability among the experiments and between different soils is of concern to us and warrants further testing. To further simulate natural infestations under field conditions, pasteurized soil was infested with increasing levels of *P. penetrans* and planted with snap bean cv. Hystyle for 41 days. The top of the plant was removed at the soil line and the bean roots and soil from each infestation rate (5 4-in. pots/ treatment) were uniformly mixed together and then planted to soybean. The results after the 14-day bioassay with soybean are presented in Figure 4 and show an incremental increase in the average number of lesions on the primary soybean root. The lesion counts are higher than the previous experiments since they were planted to bean (a good host) prior to being planted with soybean. The 21-day bioassay is still currently in progress.

Objective 3. The levels of attendance at the twilight meetings and follow-up requests for information on nematode assessments and bioassay results are indicative of the success of the project. In addition, a number of growers have already conducted the bioassay on their farms. We will continue monitoring progress in the use of these bioassays and provide assistance to growers and extension educators. We will also follow-up on the effective management of nematodes based on results of the bioassay by collecting data on nematode damage and marketable yield.

Project Location (s):

- Wayne, Genesee, Yates and Orleans Counties and is applicable in the Northeast.