Development and Evaluation of Management Alternatives for Root Knot Nematodes and Volunteer Potatoes

Final Report for LNE00-131

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Region: Northeast
State: Maryland
Project Leader:

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Project Information

Summary:

Southern root knot nematode (Meloidogyne incognita) and lesion nematode (Pratylenchus spp.) are important pathogens of vegetable and field crops, especially where intensive vegetable production occurs. The loss of some chemical nematicides, the primary management tool for over fifty years, due to environmental or health concerns and the costs of nematicide use has focused attention on the development of alternative methods for managing plant-parasitic nematodes. Nematode suppressive cover crops amended to soil, and tillage were tested for their ability to reduce nematode levels in Maryland. These sustainable management practices were evaluated on-farm (natural infestation) and in micro-plots (artificially infested). Date of sampling significantly affected the number of nematodes detected, and spring sampling, even in heavily infested fields, did not detect threshold level of nematodes for management practices. Sorghum sudangrass used in regular rotation with a susceptible host crop significantly reduced M. incognita compared to the control. However, the reduction was transitory and M. incognita levels rebounded if sorghum sudangrass was removed from the rotation.

Introduction:

Fields in Maryland (MD) cropped repeatedly to vegetables have experienced significant losses due to root knot nematodes (RKN), Meloidogyne spp. In addition, Maryland growers are expressing concern over sporadic but widespread surges of Lesion nematode populations (Pratylenchus spp.). Lesion nematodes are often found in soil assays in association with RKN, from symptomatic fields. Both RKN and Lesion nematodes are reported to have broad host ranges. Dorchester County, MD has approximately 1000 ha of potato, for potato chip manufacture, grown annually. Following a 1999 meeting of approximately twenty Dorchester County potato producers, where a discussion about the widespread increase in parasitic nematode populations following potato production occurred, two field sites that had potato in their crop rotation were identified for purposes of evaluating cultural control management practices. These two fields had documented root knot and root lesion nematode infestations. In addition, microplots at the University of Maryland Lower Eastern Shore Research and Education Center (UM-LESREC) were also used to evaluate additional cultural management practices. Cooperators on the project include specialists in Field Crops, Entomology, Nematology and Vegetable Pathology along with the Dorchester County Extension Educator, IPM Scout and Dorchester county growers. In this project, using a combination of on-farm (natural infestations) and micro-plot (artificially infested) experiments, sustainable management alternatives and their effect(s) on the plant-parasitic nematode populations were evaluated. We evaluated crop rotations that use non-host crops, organic soil amendment, tillage, winter cover crops and double crop soybeans in production fields using strip plots and in microplots.

Growers were initially concerned that harvesting practices were contributing to a high incidence of volunteer potatoes, and therefore nematode problems. In 2000, harvesting practices by potato producers were altered and therefore volunteer potatoes were no longer a problem. Following this change in harvest practices, greater emphasis was placed on potatoes as a susceptible rotation crop in microplot and field studies.

Project Objectives:

1. Determine the effectiveness of cover crops, soil amendment with poultry litter, alternative economic crops and tillage in vegetable rotation for suppressing nematode populations.

   Quantify the relationship between volunteer potato growth and root knot nematode populations.

   Identify currently-used crop rotation and tillage practices that adversely affect the survival of volunteer potatoes.

   Evaluate mechanical means of mulching tubers left in the field during harvesting, thereby reducing the chances of volunteer growth the following season.

Cooperators

- Galen Dively

  Professor, Department of Entomology

  University of Maryland

- L. Betsy Gallagher

  Dorchester County Extension Educator

  University of Maryland Cooperative Extension

- Robert Kratochvil

  Extension Specialist-Field Crops

University of Maryland

- Sandra Sardanelli

  Director, Nematology Laboratory

  University of Maryland

Research

Materials and methods:

Field Procedures
The two field sites are identified as 1) Andrews Farm, comprised of a Downer sandy loam soil (coarse-loamy, siliceous, mesic Typic Hapludults) and 2) Stevens Farm, comprised of both a Downer sandy loam soil and a Hammonton sandy loam soil (coarse-loamy, siliceous, mesic, Aquic Hapludults). Each field site was divided into four blocks that were 45 X 120 m. The experimental design was a randomized complete block arrangement of treatments with the six treatments randomly assigned to each of the blocks creating six plots per block that were 7.5 X 120 m in size. In order to increase sample size and improve sampling technique because of the known spatial variability for nematode populations, three subplots (7.5 X 40 m) were delineated within each plot.

Information about the six treatments is found in Table 1. Sampling of soil and roots was conducted at various times (P1-P7, Table 2) throughout the study to monitor plant-parasitic root nematode species and to assess their population densities. Information about soil, root, and cucumber yield sampling procedures and dates is in Table 2. Root samples were collected from the agronomic and vegetable crops as well as the cover crops just prior to harvest for each, respectively (Table 2).

Micro-plot Procedures
2000. The micro-plot experiment was established in the spring of 2000 by planting 400 micro-plots with three potato 'Atlantic New Leaf' seed pieces each on 14 April. Prior to planting, seed pieces were dusted with Maneb (1 lb/100 lb potatoes). Weeds were managed with Roundup Ultra(26 fl. oz./A), Dual Magnum (1 pt/A), and Linex 50DF (0.8 lbs/A) on 21 April and Poast Plus (26 fl. oz./A) on 16 June. Fertilizer (52 lbs/A 8N-8P-16K) was applied on 26 April and on 27 June. Potatoes were harvested and weighed on 12 July. On the same day samples of three roots, two potatoes and 250 cm3 of soil were collected from each plot for vermiform extraction and enumeration.
Results of nematode enumeration were used to select replicate plots for treatments (Table 3). Plots (120) with high root knot nematode populations were assigned treatments according to RKN detection. Replicate one comprised the highest RKN numbers, replicate twelve the lowest. Plots (84) with high Pratylenchus spp.were selected. Plots were assigned the same twelve treatments. Replicates of treatments were arranged so that replicate one had the highest lesion nematode level and replicate and even, the lowest.

Roundup Ultra (26 fl. oz./A) was applied for weed control prior to cover crop planting. Soil amendments (poultry litter, or poultry litter compost) were applied on 15 July (Table 3). Plots were seeded with soybean (pioneer '94B01'or Manokin), castor bean, sudan grass or grain sorghum 'NK KS585' on 20 and 21 July (Table 3). Fallow plots were tilled on 14 August, 5 and 28 September and 16 October. On 18 and 19 October soil was sampled, three roots/plot were collected, where available, and soybean biomass measured. Cover crops were chopped and incorporated into plots. Oat (3 bu/A) or Canola (9 lb/A) was planted on 24 or 27 October in the root knot or lesion experiment, respectively.

2001. Oats and canola were incorporated into soil, to represent disking, on 18 April. Plots were fertilized (50 lb/A 5N-10P-10K) on 25 April and on 29 May (50 lb/A 34N). Weeds were managed with RoundUp Ultra (26 fl. oz./A) on 29 April. Cucumber 'Asgrow' was seeded at 58,000 seeds/A on 1 May. Cucumber beetles were managed with Asana XL (7 fl. oz./A) on 30 May and 19 June. Soil was sampled and the roots of three cucumber plants were collected for vermiform extraction, enumeration, and root gall indeces evaluation and cucumber fruit were harvested on 27 June.

Soil amendments were applied on 5 July, and soybean, castor bean, sudan grass and sorghum were seeded on 10 July as described previously. The fallow plots were tilled on 26 July, 16 August, 5 and 27 September. Soil, root and plant biomass samples were taken and cover crops were chopped and incorporated on 3 and 4 October. Oats and canola were seeded on 9 October.

2002. Root samples of oat and canola were collected from plots (three to five samples/plot) on 11 March, 2002. Oats and canola were incorporated on 12 March and 10 g of 10N-10P-10K was amended in each plot on 15 March. Three potato seed pieces were planted in each plot. Weeds were managed with RoundUp Ultra (26 oz./A), Dual Magnum (1 pt./A) and Linex 50DF (0.8 lbs/A). Sidedress fertilizer was applied at 10g/microplot of 10N-10P-20K on 7 June. Colorado potato beetles were managed with SpinTor (6 fl. oz./A) on 11 and 18 June. Soil, three root samples, and two tubers/micro-plot were collected for vermiform extraction and enumeration and root gall indeces evaluation. Potatoes were harvested and weighed on 26 and 27 June. Plots received fertilizer amendment (10g 10N-10P-20K) on 27 June. Soybeans were planted on 11 July. Weeds were managed with Dual Magnum II (1 pt/A), Linex 50DF (0.7 lbs/A), and RoundUp Ultra (26 oz/A) on 12 July. Roundup was applied again on 8 August. Three roots and soil samples were collected for vermiform extraction and enumeration, root gall indeces evaluation and biomass measurement on 9 October.

Laboratory Procedures

Each soil sample was mixed thoroughly before removing a 250 cm3 sub-sample for vermiform extraction using a modified Baermann method (Christie and Perry, 1951). Extracted vermiforms were collected into a counting dish and parasitic species were identified to genus (using standard morphological characteristics) and enumerated using a sterioscopic microscope (40x). Roots were evaluated by washing them and then rating them on the following root galling index (RGI) scale for percentage roots galled: 1 = no galling, 2 = 1-25, 3 = 26-50, 4 = 51-75, and 5 = 76-100 (Carter and Sasser, 1982).

Statistical Analyses

Root knot and lesion nematode spp. populations in the soil samples collected at the seven sampling dates were first analyzed by sample date using analysis of variance (ANOVA) procedure for randomized complete block experimental design (Gomez and Gomez, 1976). A chi square test for homogeneity of error variances for each of the sampling dates and for each of the nematode species was conducted. These tests indicated heterogeneity of error variances among the different sampling dates. All soil nematode population data were log (X+1) transformed (Gomez and Gomez 1976) to normalize the data and to accommodate the zero population counts that were present. This log-transformed data was subjected to a pooled analysis of variance for measurements over time (Gomez and Gomez, 1976). Mean separation for the planned comparisons was conducted using the Least Significant Difference

(LSD) test.

Research results and discussion:

It is evident from this research that sampling date for assessing the threshold levels of M. incognita and Pratylenchus spp. can greatly influence the assumed infestation level that exists for these pests. Currently, Maryland recommends either spring or fall sampling for assessing M. incognita and Pratylenchus spp. threshold levels for vegetable, corn and soybean production (Krusberg and Sardanelli, 1993) with fall sampling preferred. The extremely low parasitic nematode populations found at P1 in this study (Tables 4 and 5) enhanced this fall sampling recommendation. The spring sampling date was too early to detect meaningful threshold levels for the two species. This failure to detect threshold populations can affect the recommendation for pest population management as the levels that were detected on both farms at date P1 were considerably less than the threshold levels recommended by Maryland for spring sampling (Krusberg and Sardanelli, 1993). However, by potato harvest in July and August of 2000 on the two farms, respectively, the populations of both genera had reached levels that would warrant a management practice be employed. This point was reiterated at sample date P6 on the Stevens Farm. The sample date was 11 June 2002 and the detected populations were virtually zero (Table 5) for M. incognita. Late summer and fall sampling, as was the case for sample dates P2 and P7, were better options for detecting threshold levels for M. incognita and Pratylenchus spp. populations.

The bio-control practice that induced the best M. incognita suppression was sorghum-sudangrass used in regular rotation with the susceptible host crops. M. incognita populations were significantly less than the control treatment at both P3 and P5 sample dates and continued to impact the M. incognita population in cucumber at sample date P6 on the Andrews Farm (Table 4). On the Stevens Farm, sorghum-sudangrass significantly reduced the M. incognita population to a level less than the control following its second production cycle (P5) (Table 5). However, once sorghum-sudangrass is removed from the crop rotation (P7 on both farms), the M. incognita populations began to return to pre-study levels (Tables 4 and 5).

Two of the bio-control treatments had a population reducing effect upon Pratylenchus spp. On both the Andrews and Stevens Farms, sorghum-sudangrass and poultry litter/tillage/fallow were able to significantly reduce the Pratylenchus spp. populations below the levels that were present for the control treatment at P3 (Tables 6 and 7). And, on the Andrews Farm, the poultry litter/tillage/fallow treatment continued to have a significantly lower population at P5 while the sorghum-sudangrass treatment was equivalent to the nematicide applied control treatment. Both treatments were the same as the control at P5 on the Stevens Farm. The use of sorghum-sudangrass in a regular rotation with susceptible vegetable and agronomic crops can be a suitable bio-control management practice for M. incognita and Pratylenchus spp. In addition, the late summer and early fall production of this high biomass producing crop should effectively manage residual nitrogen. Sorghum sudangrass has the potential to be both a good cover crop for nutrient management and a good bio-control option for managing parasitic root nematodes.

The effect of some nematode suppressive cover crop treatments on Meloidogyne incognita juveniles (J2's) was detected in the year following the use of the cover crop in micro-plots (Table 11 and 12). Populations of M. incognita J2's were significantly lower following a susceptible cucumber crop, in plots that had been cropped to sudan grass in the previous year than in plots where susceptible soybeans were planted the previous year (Table 11). In addition, soybean biomass in the fall was higher in plots that had been planted with sudan grass (three of five treatments) or castor bean (Table 12).

Lesion nematode populations were also decreased following a crop of sudan grass cv. "Green Grazer V" or grain sorghum cv. "NKKS 585". Following a potato crop planted in the subsequent spring, the reduction in lesion nematodes was still apparent for two of five sudan grass treatments and the grain sorghum treatment. Following a summer crop of susceptible soybean cv. "Pioneer 94B01" no reduction in lesion nematode levels were observed (i.e. there was no apparent residual effect of the previous years cover crop). However, the soybean biomass was greater in three of the five treatments where sundan grass had been planted previously, as well as in treatments where grain sorghum was planted.

Results are being disseminated to farmers. A fact sheet will be written following the development of two journal articles (see attached draft of one article). In addition, two meetings will be held in Dorchester county in winter 2003-2004. Drs. Kratochvil and Everts will present the results of this project to field and vegetable crop growers during meetings in the winter of 2003-4, respectively.

Participation Summary

Education

Educational approach:

Kathryne L. Everts, G. Dively, L. E. Gallagher, R. Kratochvil, and S. Sardanelli. 2000. Exploring Alternative Nematode Management Tactics. In: University of Maryland 2000 IPM Progress Report. P. 9.

Sardanelli, S., Everts, K., Kratochvil, R. and G. Dively. 2001. Grower Initiated IPM-SARE Project Explores Alternative Nematode Management Tactics. In: University of Maryland 2001 IPM Progress Report.

Kratochvil, R. 2001. Field Crops. In: University of Maryland 2001 IPM Progress Report. p. 9.

Mallozzi, T., Kratochvil, R., Sardanelli, S., Meyer, S., and Everts, K. 2001. Evaluating Alternatives to Methyl Bromide for Management of Root-Knot Nematode. In: University of Maryland 2001 IPM Progress Report. p. 34.

Mallozzi, T., Sardanelli, S., Kratochvil, R., and Everts, K. 2002. Evaluating Biocontrol Alternatives to Methyl Bromide for Management of Root-Knot Nematode. In: Maryland IPM 2002 Annual Report. p. 20.

Sardanelli, S., Mallozzi, T., Everts, K. and Kratochvil, R. 2002. Sustainable Management Alternatives for Root Knot Nematodes. In: Maryland IPM 2002 Annual Report. p. 19.

No milestones

Project Outcomes

Impacts of Results/Outcomes

See tables 4 through 12 in hardcopy report.

Farmer Adoption

Growers that participated in the project, at least 20 of whom helped devise research plot treatments, have begun to change their production practices. One grower recently reported "It's learning in progress, but we're still experimenting with cover crops. We've noticed a difference in the nematode populations - not 100 percent reduction, but we're getting there."