Agricultural Innovations
Practical applications for sustainable agriculture
Fact Sheet
Sustainable Agriculture Research & Education

Cultural Practices for Root-Knot and Root-Lesion Nematode Suppression in Vegetable Crop Rotations

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Dorchester County, Md., Extension Agent Betsy Gallagher takes soil samples as part of a SARE-funded project seeking to reduce root-damaging nematodes in potatoes and soybeans.

Inside this fact sheet:

SARE Agricultural Innovations are based on knowledge gained from SARE-funded projects. Written for farmers and agricultural educators, these peer-reviewed fact sheets provide practical, hands-on information to integrate well-researched sustainable strategies into farming and ranching systems. The articles are written by project coordinators and published by SARE.

Geographic Range:

The cultural practices described in this publication were evaluated for nematode control in field and small plot studies in Maryland. The practices described in this fact sheet should be effective in mid-Atlantic vegetable crop production systems where the southern root-knot nematode is the most important root-knot species and where growing season and crop rotations are similar to Maryland's Eastern Shore.

Introduction

Growers of vegetable crops in the mid-Atlantic have typically used nematicides to control root knot nematodes (RKN) and root-lesion nematodes. The loss of many nematicides from the market due to environmental concerns and constraints of use, such as the length of the period when crops cannot be planted following application for currently labeled fumigant nematicides, have focused attention on the development of alternative methods for managing plant parasitic nematodes.

This publication discusses the use of non-host crops, sorghum sudangrass and castor bean grown as cover crops, RKN-resistant crops, and the application of poultry litter (PL) and PL compost to manage RKN and root-lesion nematode. These methods can be used in vegetable production systems to reduce build-up of nematodes over time, to lengthen the interval between nematicide applications and to provide a non-chemical management approach for organic growers. Examples of different cultural practices for managing RKN and root-lesion nematodes are shown in Table 1.

The southern RKN and root-lesion nematode are prevalent in Maryland and Delaware and cause severe damage in areas with sandy soils. The southern RKN damages a wide variety of crops grown throughout the mid-Atlantic region including soybeans and tobacco, and vegetables such as sweet potatoes, tomatoes, potatoes, cucumber and green beans. Fields cropped repeatedly to these crops have experienced significant losses due to RKN. Corn and wheat, common crops in the region, are reproductive hosts for RKN.

Root-lesion nematode also has caused severe damage on potato and cucumber, although yield losses due to root-lesion nematode are highly variable and influenced by environmental conditions. In addition, when the fungus *Verticillium dahliae* is present with root-lesion nematode, potato early dying disease occurs.

Symptoms of plant damage due to nematode activity may initially appear similar to lack of or improper fertilization, too little or too much water, improper soil pH, poor soil, or other environmental factors. Irregular patches in the field with poor plant growth (sickly growth, wilting, yellowing, stunting and premature plant aging) can range from a few feet to hundreds of feet across. Losses due to nematodes may be more prevalent than is currently known

Growers who use nematicides to control root-knot and root-lesion nematode on potatoes and cucumbers incur large expenses. For example, 25% of the pickling cucumber acreage in Maryland and Delaware was fumigated in 1998, a typical year.

Maryland potato growers met in the fall of 1999 and expressed interest in alternative strategies such as cover crops, non-host rotation crops and poultry manure for managing parasitic nematodes in the potato cropping system. The research and management tactics described in this publication were developed as a result of that meeting.

Symptoms of RKN infection on a cucurbit root.

Suppressive cover crops and nematode-resistant rotation crops have been reported to significantly reduce nematode populations in agricultural soils in trials conducted in other regions of the U.S.

Poultry litter (a mixture of poultry manure and pine shaving bedding) and composted poultry litter also have been used as an organic soil amendment to suppress root-knot nematodes and provide an alternative to nematicides. The breakdown of poultry litter (PL) or PL compost stimulates microbial activity in the soil that suppresses nematode damage and reduces population densities.

Table 1. Potential cropping sequences to minimize damage from root knot nematode in the mid-Atlantic.

Year 1				Year 2			
Crop 1	Crop 2	Amendment	Winter Cover Crop	Crop 1	Crop 2	Amendment	Winter Cover Crop
Potato	Soybean 'Manokin'	None	Oat	Cucumber	Soybean 'Manokin'	None	Oat
Potato	Castor bean	None	Oat	Cucumber	Castor bean	None	Oat
Potato	Sorghum sudan-grass	None	Rape-seed	Cucumber	Sorghum Sudan-grass	None	Rape-seed
Potato	Sorghum sudan-grass	7000 lb/A poultry litter	Oat	Cucumber	Sorghum sudan-grass	7000 lb/A poultry litter	Oat
Potato	Sorghum sudan-grass	10,500 – 31,000 lb/A poultry litter compost	Oat	Cucumber	Sorghum sudan-grass	10,500 – 31,000 lb/A poultry litter compost	Oat

Nematode Sampling Procedures

Proper management of root-knot and root-lesion nematodes begins with timely sampling of fields. Sampling soil in the spring is not reliable because few nematodes may be detected even in fields where the risk of potential damage is high. This is probably because inadequate degree-days have accumulated during the spring for nematode reproduction to occur. Samples collected in late summer or early fall are much more reliable. During the growing season, diagnostic samples may be taken whenever symptoms are observed.

Recommended sampling procedures are to collect soil cores or soil samples (if using a shovel) from a depth of 6-8 inches from at least 20 representative locations across the field. Soil core locations should target areas where the crop appears stunted, chlorotic or weak, and nematode damage is suspected. A field may be divided into sections for sampling purposes if either known or observed differences for nematode damage are present across the field. A minimum of one pint of soil is required per sample area for analysis. Root samples of both crop and weed plants that are present in the field should be submitted with the soil sample. Samples can be submitted to County Extension Educators or directly to either university or private nematode diagnostic laboratories for analysis.

Laboratory analysis will provide the proper identification of the plant-parasitic species and an estimate of the number of each nematode species that are present.

Swelling on the surface of a potato infected with root-knot nematode.

Cover Crops and Nematode Management

Use of cover crops is increasing in the mid-Atlantic region because they have been proven to reduce soil erosion and nutrient loss and improve soil health. Additionally, reductions in soil-borne and foliar disease may result from cover crop use. Nematode-suppressive cover crops provide the additional benefit of nematode disease suppression.

Two non-host cover crops that can be grown in the mid-Atlantic and may provide root-knot nematode population reduction are sorghum sudangrass and castor bean. In cropping system experiments in Maryland, sorghum sudangrass grown annually as a green manure crop following a nematode–susceptible potato or cucumber crop reduced the RKN population as effectively as a nematicide application prior to production of a susceptible soybean cultivar. An annual green manure crop of castor bean also significantly reduced RKN, but annual inclusion of these crops is necessary to maintain reduced populations. In addition, results may be variable (i.e. the nematode suppressive effect is not observed every year) due to other environmental influences upon the nematodes.

Field procedures

Sorghum sudangrass cv. 'Green Grazer' (AgriBiotech Brand, Inc.) can be planted following an early season vegetable crop such as potato, processing cucumber, pea or snap bean. Planting seed at 20 lb/acre in mid to late July produced adequate biomass to suppress RKN. For best suppression, the sorghum sudangrass crop should be chopped and incorporated into the soil in mid October. (Note: Although we used cv. 'Green Grazer', research throughout the U.S. has shown that other varieties also should work well.)

Castor bean cv. 'Mall' grown for green manure is seeded at a relatively low density-11,500 seeds/acre in mid to late July following spring vegetable crop production. Again, approxi-

Cover crops grown in micro-plots (note castor bean at left, and sorghum sudangrass at right, in the foreground).

mately three months of growth should produce adequate biomass to suppress nematodes. Castor bean should be mowed or chopped and the biomass tilled into soil in mid October. Table 2 provides planting dates and seeding rates for these cover crops in Maryland.

agement in fields with a mixed species infestation of parasitic nematodes. Use of soybean or vegetable crops that are RKN resistant offer an economically attractive strategy for vegetable crop growers.

Table 2. Production practices for nematode–suppressive crops in Maryland.

Crop	Planting Date	Seeds/A	Incorporation Date	Comments
Resistant soybean	10 July – 2 August[1]	250,000	N/A	'Manokin' is resistant to RKN and SCN. However, it is susceptible to root-lesion nematode. Therefore, use this practice where root-lesion nematode is not a problem.
Castor bean	10 July – 2 August	11,500 – 24,500	25 Sept – 19 Oct.	Nematode suppressive effect was observed in some, but not all, environments. This may be a difficult crop for many farmers to incorporate into production.
Sorghum sudangrass	10 July – 2 August	200,000	25 Sept – 19 Oct	Nematode suppression is not observed every year. Suppression is enhanced by addition of poultry litter compost.
Rapeseed	9 – 27 Oct	861,400	12 Mar – 18 Apr	This crop is planted in the "off-season" and because of timing may not replace a cash crop.

RKN-Resistant Crops and Nematode Management

Planting an RKN-resistant crop that can be harvested is a tactic that would allow growers to reduce nematode levels while still producing a marketable crop. The soybean cv. 'Manokin' (maturity group late IV-S) has resistance to RKN. Annual cropping of 'Manokin' resulted in consistent reduction in RKN detected in soil assays and less root galling (an indication of nematode damage) compared to roots of susceptible soybean cultivars. Because root galling is directly related to nematode reproduction, planting 'Manokin' or other RKN-resistant soybean cultivar should reduce RKN populations and improve crop performance over time.

While use of RKN-resistant soybeans has potential, it is important to choose cultivars that have maturity group ratings appropriate for the geographic region where they will be used as a double crop. In addition, 'Manokin' is susceptible to root-lesion nematode and therefore cannot be used alone for management in fields with a mixed species infestation of parasitic nematodes.

Field procedures

When grown as a double crop option, seed soybean cv. 'Manokin' at 175,000 seeds/acre following harvest of an early season vegetable crop. Maturity of 'Manokin' requires that it be planted no later than late June – early July if it is to be harvested for grain. Soybean may be used as forage, if season length does not allow grain harvest. Following harvest, a non-host (or poor host) crop for parasitic nematodes such as oat or rapeseed can be planted.

Brown discoloration beneath the potato skin at the site of a RKN infection.

Poultry Litter (PL) and PL Compost and Nematode Management

In mid-Atlantic vegetable fields, more than one species of parasitic nematode often are present; therefore, strategies to minimize damage from more than one species are necessary. Castor bean and the RKN-resistant soybean 'Manokin' reduce RKN populations and root galling. However, only sorghum sudangrass reduces RKN and also root-lesion nematode. In addition, incorporation of poultry litter (PL) or PL compost in combination with production of sorghum sudangrass as a cover crop provided the most consistent reduction in root-lesion nematode, although variation in the response did occur across years. This variation was likely due to:

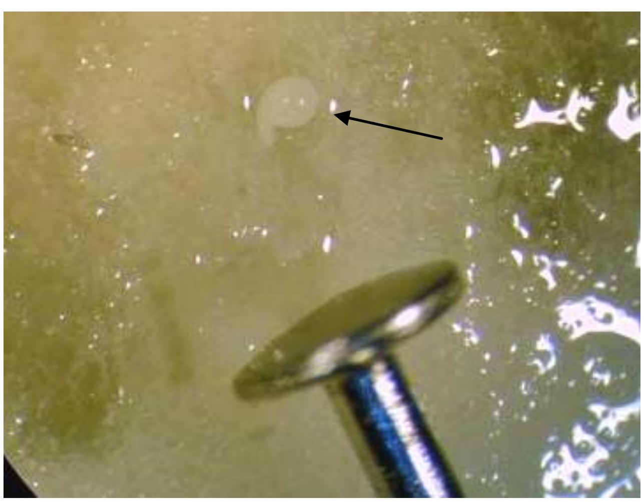
1) Differences in soil environments across locations and years that impact microbial or nematode activity, or

2) The generation of nematicidal compounds in response to organic amendments.

Addition of PL or PL compost may result in longer-lasting nematode suppression than cover crops alone. For example, carry-over suppression of nematodes was observed where PL compost was combined with a sorghum sudangrass cover crop. Combining a cover crop with addition of PL that has been composted prior to application will mitigate nutrient loss potential in fields prone to runoff.

Field Procedure

Amendments of PL or PL compost may be applied in mid July following early season vegetable crop harvest and before a cover crop is planted. Effective rates varied from 2,500 lb to 7,000 lb/acre PL and 10,500 lb to 31,000 lb/acre PL compost.



Root-knot nematode female and, for size comparison, the head of a pin.

SARE Research Synopsis

With funding from Northeastern SARE, trials were conducted in small plots and on grower fields to evaluate cultural methods to manage RKN and root-lesion nematode. Meetings with Maryland and Delaware producers of potatoes and other vegetable crops led to the selection of 12 three-year rotational sequences for evaluation in small plots and six three-year rotations to evaluate on two farms in Dorchester County, Maryland. The experimental locations all were infested with RKN (*Meloidogyne incognita*) and root-lesion nematode (*Pratylenchus penetrans*). Experiments in small plots and on growers' fields were arranged as a randomized complete block design with seven and four replications, respectively.

Early season sampling (i.e. April or May) was determined to be too early for detection of damaging levels of RKN or root-lesion nematode. Summer or early fall sampling dates effectively identified fields that exceeded threshold levels of the two nematodes.

The field and micro-plot experiments demonstrated that, while not consistent, RKN resistant soybean 'Manokin' or sorghum sudangrass grown annually as a green manure cover crop could reduce RKN compared to the control treatment of an RKN susceptible soybean. 'Manokin' or castor beans grown as a cover crop and incorporated as green manure reduced RKN by 60% or greater in the fall of 2000 and 2001. Sorghum sudangrass, which was grown as a cover crop and incorporated as green manure, reduced RKN by 50% or more in 2001. In addition to reductions in RKN in the soil, cucumber root-knot indices were reduced in 2001. This reduction occurred where sorghum sudangrass was grown and amended in the fall of 2000 with 2,500 lb/acre PL or 31,000 lb/acre PL compost.

Likewise, high rates of PL and PL compost alone or in combination with sorghum sudangrass also led to a reduction in root -lesion nematode – though not in all years. Reductions in root-lesion nematode were observed only in 2001 and when grain sorghum (with no amendment) or sorghum sudangrass amended with 2,500 to 7,300 lb/acre PL or with 10,500 to 31,000 lb/acre PL compost reduced root-lesion nematode by 70% or more compared to a grower standard treatment. However, the cover crop, PL or PL compost treatment effect generally did not carry over to the following year and therefore cover crop and PL and PL compost amendment needs to be included annually.

This fact sheet is based on a SARE-funded project. For more information, please visit www.sare.org > Project Reports >Search the database for project # LNE00-131

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