2007-2008 Final Report for Slosson Foundation

Trap Cropping Plus Bionematicides for Management of Root-knot Nematode in Home Gardens

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Introduction

Plant-parasitic nematodes are microscopic roundworms that cause problems for home gardeners. Few control measures are available to California homeowners other than two years fallow or planting nematode resistant tomatoes. The root-knot nematode, *Meloidogyne* sp., causes the most serious problem as its effects are readily visible to home gardeners by the presence of knots or galls visible on roots, as shown in Figure 1 (Fennimore et al., Westerdahl et al.).

Recently (2007 Slosson Final Report), it was demonstrated that trap cropping, while not providing total nematode control, could be a viable technique for home gardeners. Trap cropping is a nematode management technique that has been tested periodically since the late 1800's (Christie, 1959). A susceptible host is planted and larvae of a sedentary parasitic nematode such as root-knot are induced to enter and establish a feeding site. Once this has occurred, and the female begins to mature, she is unable to leave the root. The plants are then destroyed before the life cycle of the nematode can be completed, trapping nematodes within the root (Ferris). By itself, trap cropping is not likely to provide the same level of control as a chemical nematicide, because not all nematodes are induced to enter the roots. Because of this, it has not been widely used in commercial agriculture where chemical nematicides are available to control nematodes at a reasonable cost. Recently, the bionematicide DiTera (Valent Biosciences) has become available for use in California. The OMRI approved product consists of a toxin produced in fermentation by a fungus, similar to the way the bacteria based Bacillus thuringiensis (Bt) insecticides are produced. This proposal explored whether using trap cropping plus a bionematicide will provide better control than trap cropping alone.

Materials and Methods

A trial with 5 replicates of 19 treatments using carrots as a trap crop was conducted in a randomized complete block design at the UC South Coast Research and Extension Center in Orange County in a field with an established population of root-knot nematode (*Meloidogyne javanica*). Each replicate was 15 feet long by 36 inches wide with a 3-foot buffer on each end. The field location has a loam soil (66 percent sand, 21 percent silt, 13 percent clay and 0.6 percent stable organic matter) with a pH of 7.6 and a CEC of 0.68 milimhos/cm. Temperatures within the plots were monitored with Hobo microloggers for determination of nematode degree-day information.

The carrot trap crop was planted June 29 and germination was July 6. On July 13, 1 week post-germination, some plots received RoundUp or tillage. On July 20, 2 weeks post-germination, additional plots received RoundUp or tillage. On July 30, some plots received tillage and/or DiTera applications and carrots were planted. The trial was harvested on November 16.

The treatments were (where the numbers represent the weeks following planting): Carrot + till3 + Ditera, Carrot + till3, Carrot + till2 + Ditera, Carrot + till2, Carrot +Roundup3 + Ditera, Carrot + Roundup3 + till4 + Ditera, Carrot + Roundup3 + till4, Carrot +Roundup3, Carrot +Roundup2 + Ditera, Carrot + Roundup2 + till3 + Ditera, Carrot + Roundup2 + till3, Carrot + Roundup2, Wet fallow + Roundup3 + till4, Wet fallow + Roundup3, Wet fallow + Roundup2 + till3 + Ditera, Wet fallow + Roundup2 + till3, Wet fallow + Roundup2, Dry fallow + till3 + Ditera, Dry fallow + Roundup3 + till4.

Following planting, seeded plots and wet fallow treatments were watered daily or every other day as needed through drip irrigation tubing to maintain required moisture for germination and growth. Dry fallow was maintained by running hoses around the replicates needing to remain dry. One week after the completion of the tillage and Roundup treatments, DiTera treatments were applied and all plots were planted to carrots. The trial was sampled for nematodes pre-plant, to establish the level of the population, and at harvest. Soil samples consisted of 12, 1-inch diameter cores per replicate to a 12 inch depth. Nematode extraction was by elutriation followed by sugar centrifugation. Harvested carrots were graded into 4 categories: 1) without nematode damage, 2) with nematode damage only on lateral roots that would normally be removed prior to eating, 3) not typically edible because of nematode damage, and 4) not typically edible without nematode damage. Carrots in each category were counted and weighed. For data analysis, categories 1 and 2 were combined to determine typically acceptable numbers and weights of carrots. Data were analyzed with Analysis of Variance (ANOVA) followed by Fisher's Least Significant Difference Test. Percent values were arcsin transformed prior to analysis.

Results and Discussion

A trap crop can be any root-knot nematode susceptible seed easily available to home gardeners. Carrots were selected for this trial based on results of previous research (2007 Slosson Foundation Final Report). The trap crop was destroyed after planting, either with tillage via hula hoe, or with Roundup herbicide, or with a combination of the two. Several of the treatments then received an application of DiTera prior to replanting carrots. Carrots were used as the final demonstration crop because they are a very sensitive root-knot nematode bioindicator crop. Results from carrots can be extended to other root-knot sensitive crops such as heirloom varieties of tomatoes, beans, potatoes, sweet potatoes, cucumbers, peppers, squash, and melons. Digital photographs were taken throughout the trial to illustrate the technique and to be used on an instructional web page for home gardeners.

In this trial, the Dry fallow + Roundup2 + till3 treatment is considered the untreated. Percent marketable carrots (Figure 2) based on number of carrots was greater than the untreated for the following (P = 0.05): Dry fallow + till2 + Ditera, Wet fallow + Roundup1, Wet fallow + Roundup1 + till2, Wet fallow + Roundup1 + till2 + Ditera, Wet fallow + Roundup2 + till3, Carrot + Roundup1, Carrot + Roundup1 + till2, Carrot + Roundup1 + till2 + Ditera, Carrot +Roundup1 + Ditera, Carrot + Roundup2 + till3, Carrot +Roundup2 + Ditera, Carrot + till2, Carrot + till2 + Ditera. All treatments except Carrot + Roundup2 + till3 + Ditera and Carrot + till1 had a greater percentage of marketable carrots based on weight (Figure 3) than the untreated (P = 0.05). All treatments except Wet fallow + Roundup1 + till2, Wet fallow + Roundup1 + till2 + Ditera, and Wet fallow + Roundup2 had a lower number of root-knot nematode juveniles in the soil at harvest (P = 0.05) (Figure 4).

A potential problem with trap cropping is that something prevents destruction of the crop until so late in the nematode life cycle that a generation is completed. In commercial agriculture, this can be avoided by the use of soil temperature monitoring equipment and calculations of nematode degree days. For home gardeners, this approach is less practical. If something should prevent timely crop termination by a home gardener, the use of common vegetable crops for the trap crop will make it so that they are no worse off than they would have been, and can continue to let the crop mature to harvest. In a previous Slosson Proposal (2006-2007), a single timing of three weeks after planting was tested. This timing was selected to assure that a dangerous level of nematode degree days would not be reached. In this proposal, we demonstrated that a shorter time interval of two weeks after planting would work as effectively as the three week interval.

The results of the trial will be included on a web page that is being developed on the UC Davis Department of Nematology server (ucdnema.ucdavis.edu) to explain the trap cropping technique to home gardeners. Examples of pages previously developed by the Principal Investigator are listed in Literature Cited. The page will be illustrated with photographs taken during the research. A downloadable pdf file of the technique will be included for use by homeowners or others who might want to distribute the information as a hard copy rather than use a digital format.

Conclusions

This proposal clearly demonstrated the benefits of trap cropping and that a shorter interval of crop termination two weeks after planting was as effective as termination at three weeks after planting. Addition of the bionematicide did not appear to improve the effectiveness of trap cropping. Not all home gardeners have problems with plant parasitic nematodes, but for those who do, we have little to offer in terms of nematode management. Trap cropping, the use of bionematicides, or a combination of the two could allow the growing of highly susceptible root-knot nematode sensitive crops such as carrots, heirloom varieties of tomatoes, beans, potatoes, sweet potatoes, cucumbers, peppers, squash, and melons. of trap cropping.

Literature cited:

Christie, J. R. 1959. Plant Nematodes Their Bionomics and Control. The H. and W. B. Drew Company. Jacksonville, FL.

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http://pestdata.ncsu.edu/cropprofiles/Detail.CFM?FactSheets__RecordID=285

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Peet, M. http://www.cals.ncsu.edu/sustainable/peet/IPM/nematodes/c06nemat.html

Westerdahl, B. B., A. T. Ploeg, and J. O. Becker. Carrot nematodes. University of California, Carrot Pest Management Guidelines.
http://www.ipm.ucdavis.edu/PMG/r102200111.html

Web Sites Developed by the Principal Investigator

Cooperative Extension Information
http://ucdnema.ucdavis.edu/imagemap/nemmap/Ent156html/contents

Review Materials for Knowledge Expectations for Pest Control Advisors
http://ucdnema.ucdavis.edu/imagemap/nemmap/Ent156html/kenem/kenem.html

Online Textbook for UC Davis Course Nem 204 – Management of Plant Parasitic Nematodes
http://trc.ucdavis.edu/biosci10v/Ent156html/204nem/204INDEX

Lecture Notes for UC Davis Course Bis 10V – Virtual Biology Course for Non-majors
http://trc.ucdavis.edu/biosci10v/bis10v/index.htm

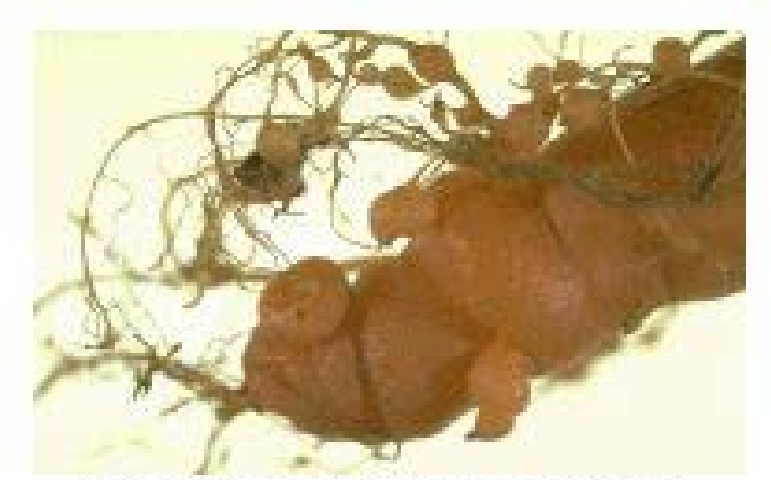
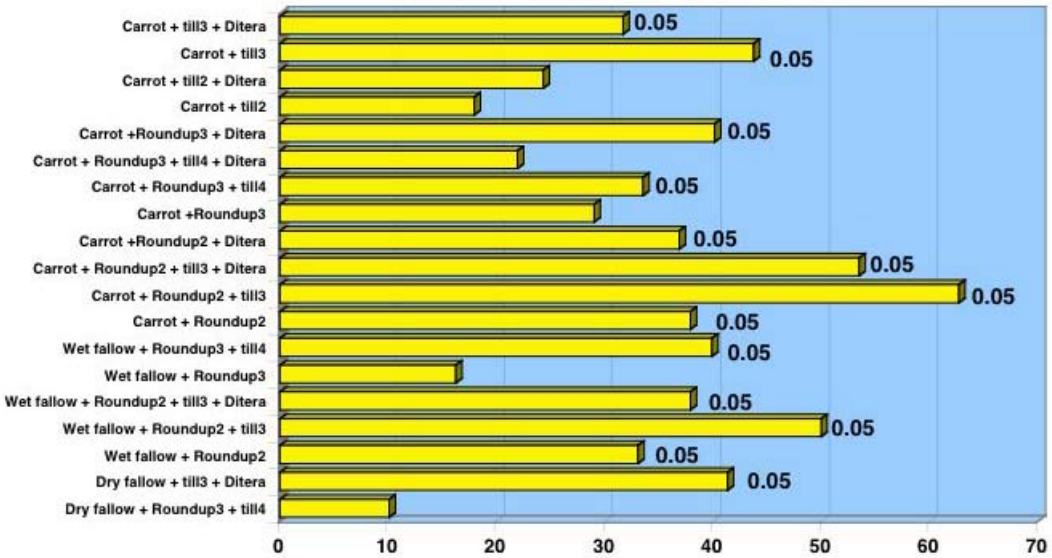


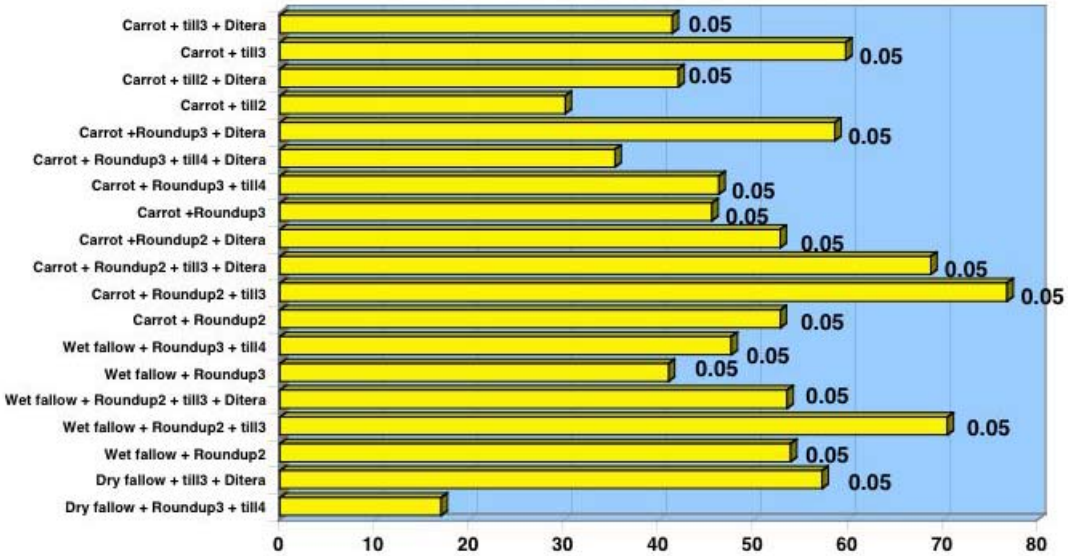
FIGURE 1. ROOT-KNOT NEMATODE DAMAGE TO CARROT

FIGURE 2. PERCENT MARKETABLE CARROTS (NUMBER) IN TRAP CROP PLUS BIONEMATICIDE TRIAL.



PROBABILITIES INDICATE DIFFERENT FROM UNTREATED ACCORDING TO FISHERS PROTECTED LSD FOLLOWING ARCSIN TRANSFORMATION

FIGURE 3. PERCENT MARKETABLE CARROTS (KG) IN TRAP CROP PLUS BIONEMATICIDE TRIAL.



PROBABILITIES INDICATE DIFFERENT FROM UNTREATED ACCORDING TO FISHERS PROTECTED LSD FOLLOWING ARCSIN TRANSFORMATION

FIGURE 4. ROOT-KNOT NEMATODE / LITER OF SOIL AT HARVEST IN TRAP CROP PLUS BIONEMATICIDE TRIAL.