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Trap Cropping 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. There are currently no control measures available to California homeowners other than prolonged fallow and 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 (Figure 1) (Fennimore et al., Westerdahl et al.).

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 or sugarbeet cyst are induced to enter and establish a feeding site (Figure 2). 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. It is likely, however, that this technique could be useful to home gardeners who have no access to chemical nematicides.

Materials and Methods

A trial with 5 replicates of 19 treatments 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 treatments were: Dry fallow + till, Dry fallow + Roundup, Wet fallow + till, Wet fallow + Roundup, Sesame + till, Sesame+Roundup, Sesame + Roundup + till, Carrot + till, Carrot + Roundup, Carrot + Roundup + till, Beans + till, Beans + Roundup, Beans + Roundup + till, Beet + till, Beet + Roundup, Beet + Roundup + till, Tomatoes + till, Tomatoes + Roundup, Tomatoes + Roundup + till. Following planting on June 20, 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. On June 25, trap crop seeds were emerging. On July 11, three weeks after planting (at approximately 400 nematode degree days), roundup alone and tillage treatments were conducted (Figure 3). Plots receiving roundup followed by tillage, were tilled on July 18. All plots were planted to carrots on July 25. The trial was sampled for nematodes pre-plant, to establish the level of the population, and at harvest on December 1 (Figure 4). 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. We utilized seeds of four common garden plants (carrot, bean, tomato, beet) plus sesame seed. Sesame seed is available from natural food stores and sesame has been shown to have some nematicidal properties (Peet). 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.

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. The timing that was tested in this trial for home gardeners is such that the crop will be terminated soon enough after germination that a dangerous level of nematode degree days will not be reached. 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.

Although it was not a focus of this project, weed seeds were also be germinated in the trap crop and wet fallow treatments (Figure 5). Therefore, this technique could also contribute to preplant weed control for home gardeners.

Compared to the untreated (dry fallow), carrot tilled ($P = 0.05$), sesame tilled ($P = 0.05$), and dry fallow plus roundup ($P = 0.05$) all provided an increase in the percent marketable carrots based on number of carrots compared to the untreated (Figure 6). With the exception of dry fallow plus Roundup, these same treatments also provided an increase in the percent marketable carrots based on weight of carrots compared to the untreated ($P = 0.05$) (Figure 7). Statistically ($P = 0.05$), several of the treatments provided better nematode control than the untreated (Figure 8).

A web page is being developed on the UC Davis Department of Nematology server (ucdnema.ucdavis.edu) to explain the trap cropping technique to home gardeners and present the results of the research. 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

Sesame and carrot appear to be the most promising of the trap crops tested. The trap crop plus till treatments seem to hold the most promise. The trap crop plus Roundup treatments as a group appear to hold the least promise, followed by the trap crop plus Roundup plus till.

Not all home gardeners have problems with plant parasitic nematodes, but for those who do, we have had little to offer in terms of nematode management. Trap cropping is a simple technique that 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.

Literature cited:

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

Fennimore, S. A., S. J. Richard and N. L. Flewelling. Crop Profile for Carrots in California. http://pestdata.ncsu.edu/cropprofiles/Detail.CFM?FactSheets__RecordID=285

Ferris, H. Nemaplex. http://plpnemweb.ucdavis.edu/nemaplex/Mangmnt/Covercrops.htm

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

FIG. 2 LIFE CYCLE OF CYST AND ROOT-KNOT NEMATODES

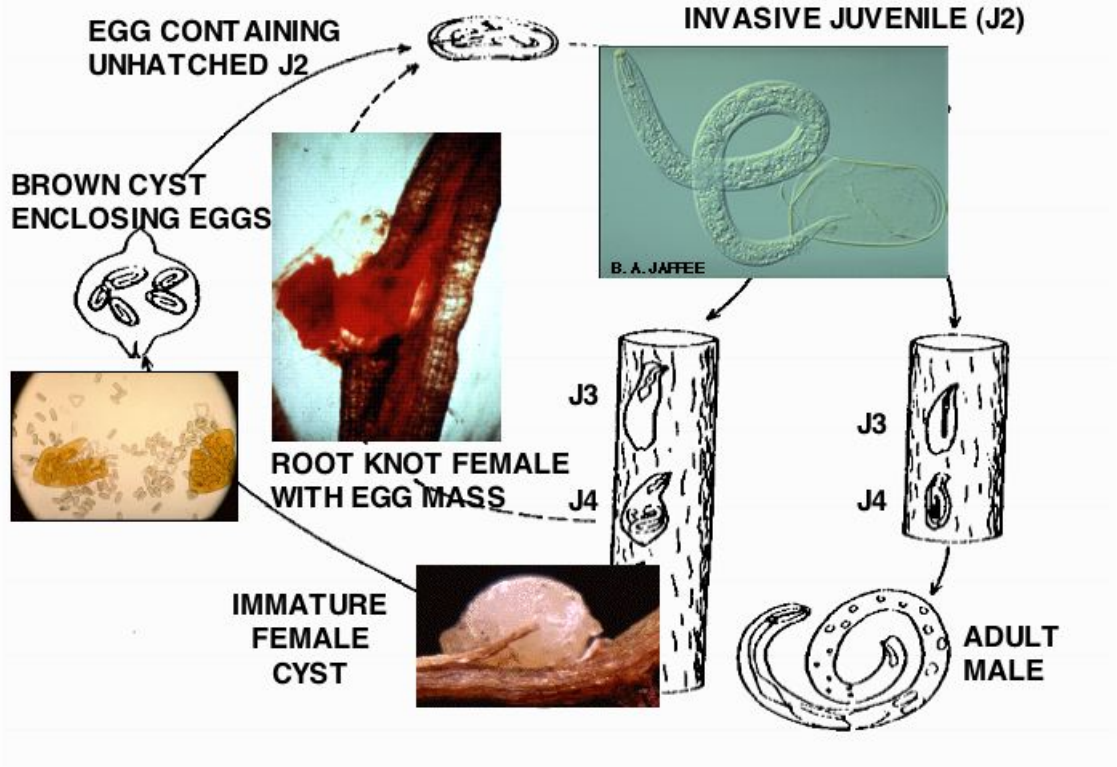


FIGURE 4. CARROTS
AT
HARVEST


FIGURE 5. CARROT
TRAP CROP PLUS
WEEDS

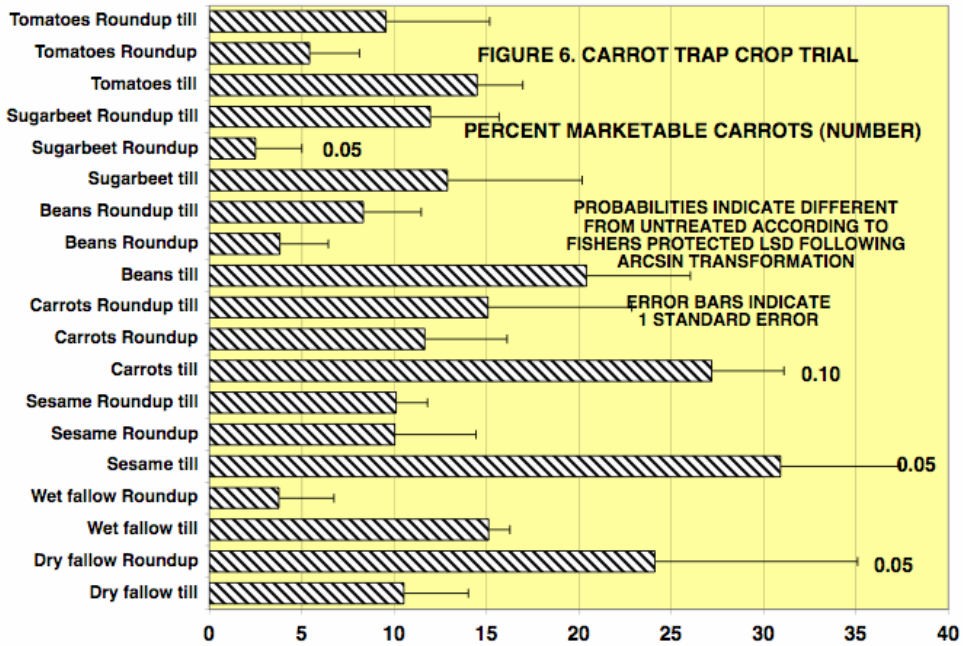
FIGURE 6. CARROT TRAP CROP TRIAL
PERCENT MARKETABLE CARROTS (NUMBER)
PROBABILITIES INDICATE DIFFERENT FROM UNTREATED ACCORDING TO FISHERS PROTECTED LSD FOLLOWING ARCSIN TRANSFORMATION
ERROR BARS INDICATE 1 STANDARD ERROR
Tomatoes Roundup till
Tomatoes Roundup
Tomatoes till
Sugarbeet Roundup till
Sugarbeet Roundup
Sugarbeet till
Beans Roundup till
Beans Roundup
Beans till
Carrots Roundup till
Carrots Roundup
Carrots till
Sesame Roundup till
Sesame Roundup
Sesame till
Wet fallow Roundup
Wet fallow till
Dry fallow Roundup
Dry fallow till
0.05
0.10
0.05
0.05
0
5
10
15
20
25
30
35
40

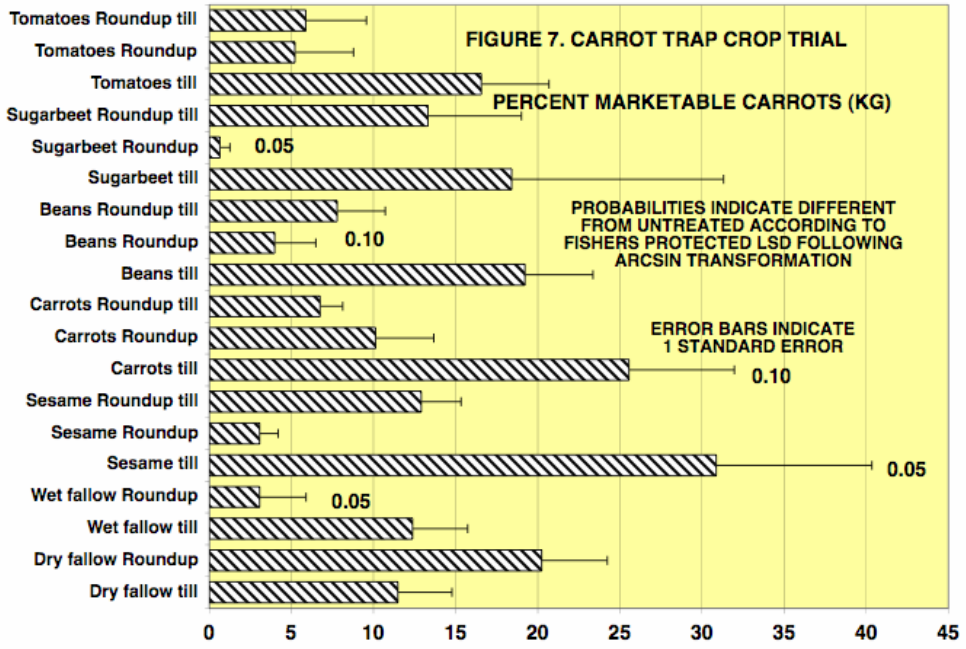
FIGURE 7. CARROT TRAP CROP TRIAL
PERCENT MARKETABLE CARROTS (KG)
PROBABILITIES INDICATE DIFFERENT FROM UNTREATED ACCORDING TO FISHERS PROTECTED LSD FOLLOWING ARCSIN TRANSFORMATION
ERROR BARS INDICATE 1 STANDARD ERROR
Tomatoes Roundup till
Tomatoes Roundup
Tomatoes till
Sugarbeet Roundup till
Sugarbeet Roundup
Sugarbeet till
Beans Roundup till
Beans Roundup
Beans till
Carrots Roundup till
Carrots Roundup
Carrots till
Sesame Roundup till
Sesame Roundup
Sesame till
Wet fallow Roundup
Wet fallow till
Dry fallow Roundup
Dry fallow till
0.05
0.10
0.10
0.05
0.05
0
5
10
15
20
25
30
35
40
45

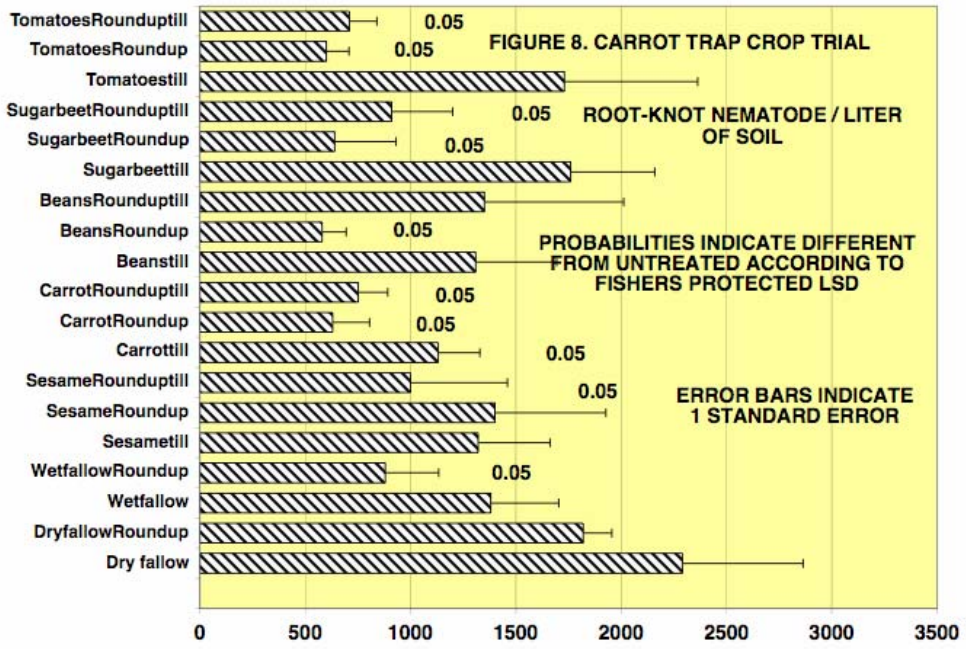
FIGURE 8. CARROT TRAP CROP TRIAL
ROOT-KNOT NEMATODE / LITER OF SOIL
PROBABILITIES INDICATE DIFFERENT FROM UNTREATED ACCORDING TO FISHERS PROTECTED LSD
ERROR BARS INDICATE 1 STANDARD ERROR
TomatoesRounduptill
TomatoesRoundup
Tomatoestill
SugarbeetRounduptill
SugarbeetRoundup
Sugarbeettill
BeansRounduptill
BeansRoundup
Beanstill
CarrotRounduptill
CarrotRoundup
Carrottill
SesameRounduptill
SesameRoundup
Sesametill
WetfallowRoundup
Wetfallow
DryfallowRoundup
Dry fallow
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0
500
1000
1500
2000
2500
3000
3500