MELON RESEARCH BOARD
Research Report
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Project Title: Evaluating the Efficacy of Novel Nematicides to Prevent Root-Knot Nematode Damage in Melon

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Introduction

Root-knot nematodes (*Meloidogyne incognita* and *M. javanica*) are economically the most damaging plant-parasitic nematodes of cucurbits, including all types of melons. The nematodes are widespread throughout Central and Southern California and are especially damaging in lighter soil types (Siddiqui et al., 1973). Damage results from the invasion of melon roots by second-stage juveniles (J2) and their subsequent feeding on the cell contents. The roots are modified by the feeding nematodes to produce large numbers of big root galls, typical of root-knot nematode infestation. The damaged root systems are unable to sustain the demand of the plant for water and nutrients, resulting in stunted growth, early wilting and yield loss. Furthermore, root systems affected by the nematodes become more susceptible to further damage by soil borne fungi and bacteria. Few nematodes are needed to cause damage. DiVito et al. (1983) found in microplot trials in Italy that when 100 cc soil contained more than 19 root-knot nematodes at planting time, damage started to occur. In California, Ferris (1985) reported that even 1 nematode per 100 cc at planting time resulted in damage. Similar results were more recently obtained from greenhouse pot experiments and from field trials by Ploeg and Phillips (2001) who estimated damage thresholds for cantaloupe cv. Durango between 3.5 and 0.5 J2 per 100 g soil at planting.

All melons are excellent hosts for root-knot nematodes and there are no resistant cultivars. Although cultural methods can be helpful in reducing pre-plant nematode population levels, management of root-knot nematodes in commercial melon production has relied almost exclusively on the availability of soil fumigants and soil-applied nematicides. The current UC IPM guidelines for cucurbits recommend nematicide treatment of fields whenever root-knot nematodes are detected in pre-season samples (Westerdahl, 2000). However, increasing costs and regulatory restrictions have reduced the number of available options. Methyl bromide, a soil fumigant used against certain soilborne pathogens, plant-parasitic nematodes and weeds, has been implicated in stratospheric ozone depletion and is no longer available for use in the US (Noling and Becker, 1994). Currently, other soil fumigants are being re-evaluated in California, because they have been identified as major contributors to the release of VOC’s (volatile organic compounds) into the atmosphere, causing air pollution.

Ploeg and Phillips (2001) demonstrated in greenhouse trials that more than 2/3 of the final reduction in cantaloupe plant growth resulted from *M. incognita* attack during the first 2 weeks after seeding. Thus, it appears that management strategies aimed at preventing the initial early infestation of young melon plants may provide a means to avoid severe nematode damage. Biological compounds with little or no mammalian toxicity, applied at pre-plant may sufficiently lower the initial nematode levels, or prevent nematodes from immediately infecting newly germinated seedlings, to achieve this effect.

Several such products have been evaluated in this field trial and were compared to an untreated control and the nematicides Vydate and Basamid. Products that were tested included Sesamin EC (Brandt Consolidated Inc., Ill), which contains the oil from sesame seeds as the active ingredient. Sincocin™, sold by AgSci, TX, “is a liquid concentrate derived from plant extracts and fatty acids that reduces the feeding vigor of plant parasitic nematode species and stimulates certain predatory nematode species important in the biological control of damaging nematode populations. Unlike conventional nematicides, Sincocin™ does not suppress beneficial nematode species. Sincocin™ also improves a plant’s ability to withstand a variety of pathogens and environmental stresses” (source: AgSci website). The active ingredients of Nema-Q™ are saponins from the Chilean soap tree *Quillaja saponaria.* According to the company website, Monterey Ag Resources, the product kills nematodes by contact and by ingestion, while at the same time promoting plant root growth. The product is registered for root-knot nematode control on melons, and should be applied as a pre-plant drench, followed by post-plant drenches. SuperBio SoilBuilder™ sold by Advanced Microbial Solutions (AMS), Pilot Point, TX, is not specifically marketed as a nematicide or as a product to manage nematodes, but is a microbial soil amendment that aids in nutrient uptake of plant roots, improves soil structure and water retention, and can treat salinity problems. According to the AMS web-site, SoilBuilder™ also supports seedling development and improves root mass development. As such, it might improve the tolerance of plants towards nematode damage. SoilBuilder™ is a “fermented product, and contains naturally occurring beneficial soil microbes together with their liquid fermentation medium”. Melocon™ produced by Certis, is a biological nematicide that contains a naturally occurring fungus, *Paecilomyces lilacinus*, a highly effective parasite of all stages of development of common plant-infecting nematodes, especially the eggs and infectious juveniles (from Certis website). Two formulations of Melocon (WG and WP) were tested. Ecozin™is a Neem-based product (active ingredient: azadirachtin; AMVAC, Los Angeles, CA) and can be used to control nematodes in a large variety of crops, including root-knot nematodes on melons.

Experimental design and set-up

The field experiment was located at Kearney Agricultural Research and Extension Center (KARE), Parlier. The field was on a sandy-loam soil, and infested with the root-knot nematode *M. javanica.*

Individual plots consisted of 20 ft sections of a 60 inch wide bed. Plots were separated within rows by a 3 ft fallow section, and between rows by one fallow row. Melon variety Durango was planted at 1 ft spacing within rows. Five additional seeds were planted (off center) for mid-season galling analysis. Watering was through drip on top of beds. The experiment had a completely randomized block design with 5 replicates per treatment and a total of 10 treatments.

Treatment	Rate	Timing[1]	Method[2]
non treated control			
Basamid	7.5 lb/1,000 sqft	21 dbp	broadcast-incorporated
Vydate	2 gallons/acre	1 dbp	watering can-incorporated
Ecozin	50 oz/acre	1 dbp 21 and 35 dap	watering can-incorporated chemigation
Melocon WG	4 lb/acre	1 dbp 42 dap	watering can-incorporated chemigation
Melocon WP	0.5 lb/acre	1 dbp 42 dap	watering can-incorporated chemigation
Nema-Q	10,000 ppm in 600 gallons/acre	1 dbp 21 dap	watering can-incorporated chemigation
Sesamin	2 quarts/acre	1 dbp 21 dap	watering can-incorporated chemigation
Sincocin	3 oz/5,000 sqft	1 dbp 21 dap	watering can-incorporated chemigation
SoilBuilder	3 quarts/acre	1 dbp 21 dap	watering can-incorporated chemigation

[1]dbp: days before planting, dap: days after planting.
[2]watering can-incorporated: products applied over top of bed in 2 gallons water per plot, followed by incorporating into top 5 inches. chemigation was done by injecting products into the buried irrigation tubing. Prior to injecting the products water was run for 10 minutes to ensure all irrigation tubing was filled. Products were dissolved in 3 gallons (11.3 l) water, and pumps were adjusted to deliver 22 l/hr. to result in a 30-minute chemigation period. The suspension was continuously agitated during the 30 minute chemigation period. Chemigation was followed by a 10-minute irrigation period (water-only) to flush the lines.

Melons were seeded on 7/6/2011 and harvested on 9/19/2011. Nematode soil samples were collected from all plots before the treatments at planting, and at harvest. Samples were collected from each plot by taking 10 soil cores per plot (between 3-10 inches deep), and combining the 10 cores per plot to give a composite sample. Samples were transported to the lab and 100 g soil was extracted for nematodes using a Baermann funnel technique. Second stage root-knot nematode juveniles (J2) were counted. Plants were removed at mid-season (9/13/2010) to leave 20 plants per plot and the root systems of the five plants that were removed were examined for the presence of root galls (scale 0-10; no galls- 100% galled). At harvest, roots from the remaining plants in the center bed were dug, examined for galling, and the fruits were collected, counted and weighed.

Data were analyzed using ANOVA procedures. For statistical analysis, nematode data were log [x+1] transformed, percentages fruit in size category were arcsin-transformed, and means were separated using Fisher's protected LSD test at the 95% confidence level.

Results

Before starting any treatments, the average soil root-knot nematode levels (J2) were low, ranging between an average of 2 and 4 J2 per 100 g soil, and were not different between treatments. Not surprisingly, nematode populations increased in all treatments during the season. The Basamid had the lowest nematode populations at harvest, and was the only treatment that had a sigificantly lower nematode level at harvest compared to the non-treated control (Table 1).

Table 1. Average (n=5) root-knot nematode soil populations (J2/100g) pre-treatment at plant, and at harvest under 10 treatments. Melon Durango, KARE, 2011 growing season.

Treatment	pre-plant		at harvest	
NTC	3.8	ns	263	ab
BASAMID	3.6		17	c
VYDATE	4.0		96	b
ECOZIN	3.6		230	ab
MELOCON WG	3.4		132	ab
MELOCON WP	3.4		128	ab
NEMAQ	2.0		202	ab
SESAMIN	3.2		216	ab
SINCOCIN	2.6		262	ab
SOILBUILDER	2.6		465	a

*) different letters within a column represent significant differences at the 95% confidence level, non-transformed data shown, statistical analysis on log10(x+1) transformed data.

Average melon root–galling at mid season ranged from 0.7 (very minor galling) in the Basamid treatment to 2.3 (moderate) in the non-treated control. Apart from Basamid and Vydate, Ecozin, Nema-Q, and the two formulations of Melocon reduced root-galling compared to the non-treated control. At harvest, galling had increased in all treatments, and was still lowest in the Basamid treatment. Between mid-season and harvest, galling in Vydate plots increased to levels that were similar to the non-treated control. However, the lower mid-season galling in the Ecozin, Nema-Q, and the two formulations of Melocon was sustained throughout the growing season, and at harvest still lower than in the non-treated control. None of the treatments were as effective in reducing root-galling as Basamid (Table 2).

Table 2. Effect of 10 treatments on average (n=5) root-galling at mid-season and at harvest of melon Durango plants. KARE, 2011 growing season.

Treatment	galling mid-season		galling at harvest	
NTC	2.3	a	5.5	a
BASAMID	0.7	d	2.5	d
VYDATE	1.7	bc	5.2	ab
ECOZIN	1.8	bc	4.2	c
MELOCON WG	1.7	bc	4.1	c
MELOCON WP	1.8	bc	4.1	c
NEMAQ	1.6	c	4.3	c
SESAMIN	2.1	ab	5.2	ab
SINCOCIN	1.9	abc	4.4	bc
SOILBUILDER	2.1	ab	4.7	abc

*) different letters within a column represent significant differences at the 95% confidence level. Galling on a scale from 0=no galls to 10=100% of root system galled

Total yield (lb fruit) ranged between 3.8 and 3.0 lb per plant, but was not significantly different between the treatments. The average number of fruits per plant was not affected by the treatments (Table 3).

Table 3. Effect of 10 treatments on average (n=5) fruit yield (lbs and number) of melon Durango plants. KARE, 2011 growing season.

Treatment	FRUIT WEIGHT PER PLANT (LB)		NR. FRUIT PER PLANT	
NTC	3.4	ns	1.7	ns
BASAMID	3.8		2.0	
VYDATE	3.0		1.6	
ECOZIN	3.6		1.9	
MELOCON WG	3.3		1.6	
MELOCON WP	3.1		1.6	
NEMAQ	3.2		1.5	
SESAMIN	3.1		1.7	
SINCOCIN	3.1		1.6	
SOILBUILDER	3.2		1.7	

The percentage of marketable fruits ranged from 76% in the Melocon WG treatment to 62% in the Sesamin treatment, but differences in fruit size between treatments were not significant.

Table 4. Effect of 10 treatments on average (n=5) melon Durango fruit size. KARE, 2011 growing season.

Treatment	% cull	%23	%18	%15	%12	% market
NTC	31 ns	19 ns	23 ns	17 ns	11 ns	69 ns
BASAMID	31	18	27	18	8	69
VYDATE	32	22	22	17	7	68
ECOZIN	33	19	25	14	9	67
MELOCON WG	24	22	24	21	9	76
MELOCON WP	32	17	25	18	8	68
NEMAQ	28	17	23	19	13	72
SESAMIN	38	19	22	14	8	62
SINCOCIN	26	19	34	14	6	74
SOILBUILDER	28	20	34	10	8	72

*) there were no significant differences at the 95% confidence level in fruit size, non-transformed data shown, statistical analysis on arcsin-transformed data.

Discussion

Root-knot nematode infestation levels were relatively low at planting. In spite of this, melon plants developed moderate galling, particularly in the non-treated control. Significant treatment effects were observed on the severity of root-symptoms (galling), with several treatments resulting in less severe root-galling compared to the non-treated control. Particularly Ecozin, both Melocon treatments, and Nema-Q reduced root-galling of plants both at mid-season and at harvest. However, although a significant reduction was observed, plants from these treatments still exhibited moderately severe galling at harvest and were not as effective as Basamid. There was no evidence that, apart from Basamid, any of the treatments reduced the build-up of root-knot nematode levels.

Although Basamid resulted in the highest yields (lbs and nr fruit), there were no significant differences between any of the treatments in yield (lbs, size, number). This most likely results from the fact that initial root-knot nematode levels were relatively low, and not high enough to have caused significant yield reductions.