Nimitz (MCW-2) for Management of Root-Knot Nematode on Annual Crops

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Abstract

In field trials conducted on carrots, cucumber and cantaloupe, Nimitz (MCW-2, fluensulfone 480EC) was evaluated (*P≤0.05*) for management of root-knot nematode (RKN) (*Meloidogyne javanica*). Each trial was a randomized complete block with 5 replicates per treatment. Treatments in all trials were Nimitz at 2, 3, 4, and 8 kg ai/ha, oxamyl at 4.7 L/ha, metam sodium at 589 L/ha, 1,3-dichloropropene (Telone II, 1,3-D) at 84 L/ha and an untreated control (UC). 1,3-D was injected 14 days preplant. Metam sodium, Nimitz and oxamyl were applied 7-days preplant followed by tilling to 10 cm, and sprinkler irrigation. Evaluations were conducted at harvest. The 3 and 8 kg rates of Nimitz had a higher percent of marketable carrots. All Nimitz rates and 1,3-D had fewer RKN. On cucumbers, 4 and 8 kg Nimitz had a greater number and weight of fruit. Nimitz at 8 kg had a lower root gall rating (RG). All treatments except 2 kg Nimitz had fewer RKN. On cantaloupe, 2 and 4 kg Nimitz, 1,3-D, and metam sodium had a greater fruit weight. Nimitz at 4 kg and metam sodium had a larger number of fruit. Nimitz at 3 kg had larger fruit. At 2 and 8 kg, Nimitz had a lower RG. All treatments had fewer RKN than UC. Based on the results of these trials, Nimitz shows promise for use in IPM programs for managing RKN on annual crops.

INTRODUCTION

Root-knot nematodes (*Meloidogyne* sp.) are widely distributed throughout California and are the most important nematode pest of annual crops such as carrot (*Dacus carotae*), and cucurbits (*Cucumis* sp., *Cucurbita* sp.). Current control methodology relies on the use of metam sodium, and 1,3-Dichloropropene (UC IPM Online, 2012). Three field trials were conducted to evaluate the effectiveness compared to an untreated control of Nimitz (MCW-2, fluensulfone) for management of root-knot nematode, on cantaloupe, carrots, and cucumber.

MATERIALS AND METHODS

In 2010, individual trials on carrots ('Imperator'), cucumber ('Dasher II'), and cantaloupe ('Durango'), each with the same eight treatments, were conducted in a randomized complete block design at UC South Coast Research and Extension Center, in Irvine, California, USA. The test sites were in a field with a history of root-knot nematode (*Meloidogyne javanica*, RKN) and tests were conducted to evaluate the effectiveness (*P≤0.05*) of Nimitz (MCW-2, fluensulfone) compared to an untreated control and standard chemical treatments. The previous crop was lima beans (*Phaseolus vulgaris*).

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Single row plots were 4 m long plus a 1-m buffer on either end. The soil type was a sandy loam (66% sand, 21% silt, 13% clay, 0.6% organic matter, pH 7.6, and CEC 0.68 milimhos/cm). Soil samples for nematodes were taken pre-plant to establish the presence of the population, and at harvest. Treatments in all trials were Nimitz (MCW-2, fluensulfone 480 EC, Makhteshim-Agan) at 2, 3, 4 and 8 kg ai/ha, oxamyl (Vydate L, Dupont) at 1.12 kg/ha, metam sodium (Amvac) at 561 L/ha, 1,3-dichloropropene (Telone II, 1,3-D, Dow AgroSciences) at 112 L/ha, and untreated control (UC). 1,3-D was injected 14-days preplant (May 26, 2010). Metam sodium, Nimitz and oxamyl, were applied 7-days preplant (June 2, 2010) via surface spray followed by tilling to a 10-cm depth, and sprinkler irrigation. All trials were planted from seed on June 10, 2010, and harvested at maturity.

Five weeks after planting, plants from each replicate were evaluated for total weight, shoot weight, weight of roots, and root gall rating (RG). Soil samples consisted of 12, 2.5-cm diameter cores per replicate to a 30-cm depth. Nematodes were extracted from 1 L soil by elutriation followed by sugar centrifugation (Byrd et al., 1976). RGs with 0 = no galling, and 10 = heavily galled were also conducted at harvest on cantaloupe and cucumber. At harvest on October 26, 2010, 0.91 m of row of carrots from each replicate was harvested and graded into 4 categories: 1) marketable without nematode damage, 2) marketable with nematode damage, 3) not marketable with nematode damage, and 4) not marketable without nematode damage. Carrots in each category were counted and weighed. Category 2 contained carrots with a non-forked taproot but galling on secondary feeder roots. For data analysis, categories 1 and 2 were combined to determine marketable carrots. All ripe cantaloupes were picked at harvest on September 27, 2010, and a total weight and number of fruit per replicate was obtained. During each of two cucumber harvests on September 9 and 27, 2010, the weight and number of mature fruit per replicate were determined. Data were analyzed with Analysis of Variance (ANOVA) followed by Fisher's Least Significant Difference Test, and by linear regression analysis. Percentage data was arcsine transformed prior to analysis.

RESULTS

Treatments were evaluated at ($P \leq 0.05$) compared to UC. At harvest, there were no differences among treatments in the total number or weight of carrots (data not shown), The 3 and 8 kg rates of Nimitz had a higher percent of marketable carrots based on weight (Table 1). The 8 kg rate also had a higher percent of marketable carrots based on number of carrots. At 5-weeks after planting, there were no differences among treatments with respect to plant, shoot or root weight (data not shown). At 5-weeks, all treatments except oxamyl had a lower RG than UC (Table 1). At harvest, all Nimitz rates and 1,3-D had fewer RKN.

Although no differences in growth of cucumber plants were evident at harvest, at 5-weeks after planting, there was a trend for Nimitz treatments to have smaller plants; and for 1,3-D to have larger plants than UC (data not shown). At both the first and second harvest, and in total, 4 and 8 kg Nimitz had a greater weight and number of cucumber fruit than UC (Table 2). At the first harvest, the 3 kg Nimitz treatment also had a greater weight of cucumber fruit than UC, and 1,3-D had a greater number of fruit than UC. At 5 weeks after planting, all treatments had a lower RG than UC (Table 3). At harvest, only 8 kg Nimitz had a lower RG than UC. All treatments except 2 kg Nimitz had fewer RKN.

At 5-weeks after planting, on cantaloupe, 1,3-D and metam sodium had a greater plant and shoot weight than UC (data not shown). Oxamyl had a greater, and Nimitz had a lower root weight than UC (data not shown). At harvest, no differences in plant growth were evident, and 2 and 4 kg Nimitz, 1,3-D, and metam sodium had a greater fruit weight than UC (Table 4). Nimitz at 4 kg and metam sodium had a larger number of fruit. Nimitz at 3 kg had larger fruit. At 5-weeks after planting, all treatments had a lower RG than UC. At 2 and 8 kg, Nimitz had a lower RG at harvest. All treatments had fewer RKN at harvest.

CONCLUSIONS

In all three trials conducted on carrots, cucumber and cantaloupe, Nimitz treatments increased yields, reduced RG, and reduced numbers of RKN in soil. Linear regression analysis demonstrated positive yield relationships and negative RG and RKN relationships as rates of Nimitz increased from 0 to 8 kg ai/ha (Table 5). Fifteen of the 22 regression equations derived from the data presented in Tables 1 to 4 are straight lines with slopes significantly different from zero. Yield data, nematode data, and regression relationships all indicate that Nimitz is a promising new product for management of RKN on annual crops.

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Tables

Table 1. Effect of four rates of Nimitz and three chemical standards on quality of carrots at harvest, early season damage to roots, and number of root-knot nematode junveniles in soil at harvest.

Treatment	Percent marketable carrots/0.91 m of row		Root gall rating on a 0-10 scale at 5 weeks after planting	Juveniles of root-knot nematode/L of soil
	Number[1]	Weight (kg)		
Untreated	12.8b	14.3c	2.0a	2098a
2 kg Nimitz	37.0ab	43.9abc	0.4b	340b
3 kg Nimitz	37.2ab	52.5ab	0.2b	314b
4 kg Nimitz	31.4ab	42.5abc	0.4b	500b
8 kg Nimitz	43.4a	56.6a	0.2b	657b
1,3-D	41.3ab	49.6abc	0.2b	492b
Metam sodium	27.5ab	31.8abc	0.4b	810a
Oxamyl	16.6ab	20.7bc	1.4a	1376ab

[1] Each figure is the mean of 5 replicates. Means not followed by the same letter are significantly different from each other according to fisher's Protected Least Significant Difference Test at $P \leq 0.05$.

Table 2. Effect of four rates of Nimitz and three chemical standards on weight and number of cucumbers at harvest.

Treatment	Weight of fruit (kg)/4 m of row			Number of fruit/4 m of row		
	First Harvest[1]	Second harvest	Total	First harvest	Second harvest	Total
Untreated	0.38d	0.24c	0.62cd	1.6d	1.8cd	3.40cd
2 kg Nimitz	0.74cd	0.43bc	1.17cd	2.4cd	2.4cd	4.80cd
3 kg Nimitz	2.20bc	0.83bc	3.03bc	6.0bc	4.2bc	10.20bc
4 kg Nimitz	2.91ab	1.46b	4.37ab	7.8ab	6.6b	14.40b
8 kg Nimitz	3.94a	2.70a	6.64a	11.2a	10.6a	21.80a
1,3-D	1.58bcd	0.22c	1.80cd	5.8bc	2.2cd	8.00bcd
Metam sodium	0.52d	0.16c	0.68cd	1.6d	0.8cd	2.40d
Oxamyl	0.28d	0.05c	0.34d	1.4d	0.2d	1.60d

[1] Each figure is the mean of 5 replicates. Means not followed by the same letter are significantly different from each other according to fisher's Protected Least Significant Difference Test at $P \leq 0.05$.

Table 3. Effect of four rates of Nimitz and three chemical standards on galling of cucumber roots at 5 weeks after planting, and at harvest; and on number of root-knot nematode juveniles in soil at harvest.

Treatment	Root gall rating on a 0-10 scale at		Juveniles of root-knot nematode/L of soil
	5 weeks after planting[1]	Harvest	
Untreated	6.2a	9.8a	1008a
2 kg Nimitz	1.6bc	7.0ab	418ab
3 kg Nimitz	0.8c	8.5ab	340b
4 kg Nimitz	0.8c	7.2ab	97b
8 kg Nimitz	0.4c	6.6b	412b
1,3-D	3.0b	8.2ab	400b
Metam sodium	3.4b	8.3ab	189b
Oxamyl	3.0b	7.4ab	175b

[1] Each figure is the mean of 5 replicates. Means not followed by the same letter are significantly different from each other according to fisher's Protected Least Significant Difference Test at $P \leq 0.05$.

Table 4. Effect of four rates of Nimitz and three chemical standards on weight and number of cantaloupe at harvest, on galling of roots at 5 weeks after planting, and at harvest; and on number of root-knot nematode juveniles in soil at harvest.

Treatment	Weight of fruit (kg)/ 4 m of row		Number of fruit/ 4 m of row	Root gall rating on a 1-10 scale at		Juveniles of root-knot nematode/ L of soil
	Total[1]	Average		5 weeks after planting	Harvest	
Untreated	1.23b	0.56b	2.25b	7.00a	9.75a	3190a
2 kg Nimitz	4.19a	0.79ab	5.75ab	1.20c	4.13b	495b
3 kg Nimitz	3.89ab	0.84a	5.00ab	1.40c	7.00ab	1400b
4 kg Nimitz	4.14a	0.73ab	6.00a	0.75c	7.00ab	1545b
8 kg Nimitz	3.75ab	0.76ab	5.00ab	1.00c	4.33b	580b
1,3-D	4.20a	0.72ab	5.75ab	1.40c	8.00a	270b
Metam sodium	4.54a	0.61ab	7.50a	3.60b	8.38a	1290b
Oxamyl	3.16ab	0.62ab	5.00ab	4.40b	10.00a	1467b

[1] Each figure is the mean of 5 replicates. Means not followed by the same letter are significantly different from each other according to fisher's Protected Least Significant Difference Test at $P \leq 0.05$.

Table 5. Relationships of yield and nematode data (y variables) to rate of Nimitz (x variable, 0, 2, 3, 4, and 8 kg ai/ha).

Y variable	Regression equation	r^2	*P*
	Carrot trial		
Yield data			
Percent marketable number	y=21.9+3.1x	0.140	0.066
Percent marketable weight	y=27.0+4.4x	0.182	0.034
Nematode data			
5 weeks RG	y=1.3-0.2x	0.315	0.004
RKN at harvest	y=1208.0-125.4x	0.077	0.179
	Cucumber trial		
Yield data			
Weight of fruit (kg)			
First harvest	y=0.43+0.47x	0.482	0.000
Second harvest	y=0.02+0.33x	0.403	0.001
Total	y=0.44+0.80x	0.506	<.0001
Number of fruit			
First harvest	y=0.16+0.03x	0.551	<.0001
Second harvest	y=1.11+1.18x	0.480	0.000
Total	y=2.56+2.46x	0.559	<.0001
Average size of fruit (kg)			
First harvest	y=0.16+0.03x	0.242	0.013
Second harvest	y=0.08+0.02x	0.279	0.007
Total	y=0.13+0.03x	0.302	0.005
Nematode data			
5 weeks RG	y=4.02-0.61x	0.458	0.000
Harvest RG	y=9.02-0.34x	0.208	0.029
RKN at harvest	y=667.12-62.38x	0.079	0.173
	Cantaloupe trial		
Yield data			
Total weight (kg)	y=2.65+0.23x	0.085	0.213
Total number	y=3.94+0.25x	0.060	0.297
Average size of fruit (kg)	y=0.68+0.02x	0.047	0.359
Nematode data			
5 weeks RG	y=4.04-0.49x	0.389	0.261
Harvest RG	y=8.14-0.50x	0.215	0.039
RKN at harvest	y=2263.41-241.59x	0.242	0.028