New Products to Improve Growth of Field Grown Easter Lily Bulbs

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Abstract

Easter lily bulbs for greenhouse forcing are produced in Del Norte County, California and Curry County, Oregon, USA. Lesion nematode, *Pratylenchus penetrans*, infestation of soil and roots seriously affects growth of field grown bulbs. During two years of field trials, commercially prepared formulations of several natural products were compared to the control and two commercial standards (1,3-dichloropropene applied preplant followed by fenamiphos at planting [DFE]; and metam-sodium [MS] applied preplant followed by Thimet [TH] at planting [MSTH]) to determine their value in the management of lesion nematode, and in improving plant health. Products tested included meadowfoam seed meal (MF), mustard bran (MU), *Quillaja* (QU), DiTera (DT), and the fungi *Paecilomyces lilacinus* (PL) and *Muscodor albus* (MA). Trials were statistically evaluated at P=0.05. Natural products were tested either alone, in combination with TH at-planting, at planting following MS or in combination with TH at planting following MS. In a 2004-2005 trial, the commercial standard DFE but not MSTH had a greater bulb circumference than the control. Nineteen treatments including ones with the natural products DT, QU, PL, MA MU, and MF had a greater circumference than the control and were equivalent to DFE. Twenty-six treatments had a greater foliage weight at harvest than the control and were equivalent to DFE and MSTH. DFE and 10 other treatments, but not MSTH, had greater bulb survival than the control. TH+MA had a lower level of lesion nematode within roots than the control. In a 2005-2006 trial, 11 treatments including ones with the natural products DT, QU, PL, MA and MF had a greater bulb circumference than the control and were equivalent to MSTH. MS+PL had lower survival than the control. Ten treatments, but not MSTH had a greater foliage weight at harvest than the control and were equivalent to DFE. MF and DFE had lower levels of lesion nematode within roots than the control. The natural product MA when used alone performed similarly to the commercial standards in both trials.

INTRODUCTION

Easter lilies have been the most important crop in Humboldt and Del Norte counties of California (CA) and Curry County, Oregon (OR), USA since the early 1940s. This is the only area of the United States where the Easter lily (*Lilium longiflorum* Thunb.) bulbs are grown commercially. Approximately 250 ha of bulbs are grown each year in a three to six year rotation with pastures for cattle and sheep grazing; thus ca 2,400 ha are required for the cropping system. Each year, more than 11-million bulbs are sold for forcing.

The industry is the area's largest employer and is important to the local economy. Yearly farm gate value of the crop is approximately five million dollars. Bulbs are sold to greenhouse operations nationwide for forcing to produce flowering plants at Easter. Quality of field grown bulbs is based on bulb circumference and appearance, with only bulbs with white scales having plentiful roots being saleable. Bulbs are grown for 2 to 4 years before they are large enough for sale. Land is prepared in May, fumigated in July, yearlings are planted from August through October, and bulbs are harvested the following August through October (Roberts et al., 1985). Basic principles of nematode control dictate that effective management requires a combination of clean planting stock and clean soil as well as an understanding of the biology of the pests involved. For more than 20 years, growers have actively sought alternatives to the use of pesticides for management of the crops' major pest, the lesion nematode (*Pratylenchus penetrans*) (Westerdahl et al., 2003). The objective of this study was to evaluate commercially prepared formulations of several natural products to an untreated control (UC) and commercial standards to determine their value in the management of lesion nematode, and the subsequent growth of bulbs.

MATERIALS AND METHODS

During two years of field trials conducted at the Easter Lily Research Foundation (ELRF) Research Station in Brookings, OR, commercially prepared formulations of several natural products were compared to the control and two commercial standards: 1) 1,3-dichloropropene (Telone II, Dow AgroSciences, Indianapolis, IN) applied pre-plant followed by fenamiphos (Nemacur 3, Bayer CropScience, Research Triangle Park, NC) at planting; and 2) metam-sodium (MS) (Amvac, Los Angeles, CA) applied pre-plant followed by Thimet (TH) (Amvac, Los Angeles, CA) at planting.

The description of the nematicide treatments and abbreviations used in the data table are listed in Table 1. Products tested in addition to standards were meadowfoam seed meal (MF) (Full Circle Ag, Aloha, OR); mustard bran (MU) (Uniroyal Chemical Company, Middlebury, CT); an extract of the soapbark tree *Quillaja* (QU) (Monterey Ag Resources, Fresno, CA); DiTera (DT) (a toxin produced by the fungus *Myrothecium verrucaria*) (Valent BioSciences Corporation, Libertyville, IL); the fungus *Paecilomyces lilacinus* (PL) (MeloCon, Certis, Columbia, MD); the fungus *Muscodor albus* (MA) (AgraQuest, Davis, CA); and a reduced rate of TH. Natural products were tested either alone or in combination with TH at-planting; at planting following MS or in combination with TH at planting following MS. Logistics did not permit testing all products in all combinations.

Experimental details were similar to those described previously (Westerdahl et al., 2003). Planting stock was 'Nellie White' bulblets hand-picked from stems of the previous year's crop and weighed ca. 7 g each. Bulblets were dipped for 1 h at 12°C in a freshly made fungicide solution of 0.72 kg a.i. pentachloronitrobenzene (Terraclor 400, PCNB, 40% pentachloronitrobenzene, Uniroyal Chemical Company, Middlebury, CT), 0.95 kg a.i. tetramethylthiuram disulfide (42-S Thiram, 42% tetramethylthiuram disulfide, Gustafson, Plano, TX), and 0.81 kg a.i. carboxin (Vitavax-34, Gustafson, Plano, TX) per 379 L of water and planted within 24 h of treatment. Bulblets were planted in October each year at the Easter Lily Research Foundation Station in Brookings, OR, in a field which is managed to provide a uniform population of *P. penetrans* by rotating lilies with clover. Bulblets were hand planted and harvested. Tractor drawn implements were used for land preparation, bed formation, and digging of bulbs (which were then picked up by hand) and was done with great precision to insure the integrity of the individual plots. Treatment effects were evaluated through estimations of nematode population densities in soil and root samples and assessment of crop quality. Soil samples from each replicate were taken at harvest in September to a depth of 30 cm with a 2.5 cm diameter soil tube (8 cores/sample).

Each of the two trials conducted consisted of 32 treatments in a randomized complete block design with three replicates per treatment. Plots were 1 row (1.02 m) wide by 6 m long. The circumference of each harvested bulb was measured and means per plot are presented. Following harvest, soil and root samples were transported to the University of California Davis Cooperative Extension Nematode Diagnostic Laboratory. Within one week, nematodes were extracted from soil using a modified semiautomatic elutriator and sugar flotation technique (Byrd et al., 1976). Nematodes were extracted from roots cut from the base of five bulbs per replicate. Roots were washed, weighed, and placed in an intermittent misting chamber for 72 h. Extracted nematodes were identified, then counted using a stereoscopic microscopic. Results were evaluated using analysis of variance and least significant difference (LSD) testing at $P \leq 0.05$.

RESULTS AND DISCUSSION

Severe pest pressure resulting from both nematode infested soil and infected planting stock results in growers using a dual nematicide application consisting of a preplant fumigant followed by an organophosphate at planting. Because of this, we chose to test natural products in combination with a fumigant or organophosphate to see if they could provide an improvement over, or replace a component of a standard treatment. DT, QU, and MU had been previously tested alone without success (unpublished) and so were not used alone in these trials. PL and MA had not been previously tested and so were tested both alone and in combinations.

Seasonal weather patterns greatly affect quality and size of bulbs even in the absence of nematode pests. For example, 'Nellie White' bulbs produced one year can be more than double the size of those produced in another year (Roberts et al., 1985). Trials conducted at the ELRF Station rotate through five different fields. Therefore, in addition to weather variations, there is additional variability in soil characteristics and nematode population levels. Even the standard products utilized by growers have shown year to year variability working better in some years than others (L.J. Riddle, pers. commun.). In spite of this inherent variability in physical and biological factors, our trials demonstrated that four of the five natural products tested (DT, MA, MU, PL) improved foliage weight or bulb circumference over the control in some treatments in both years of the trials. In a trial conducted during the 2004-2005 growing season (Table 2), the commercial standard DFE but not MSTH had a greater bulb circumference than the control. Nineteen treatments including ones with the natural products DT, QU, PL, MA MU, and MF had a greater circumference than the control and were equivalent to DFE. Twenty-six treatments had a greater foliage weight at harvest than the control and were equivalent to DFE and MSTH. DFE and 10 other treatments, but not MSTH, had greater bulb survival than the control. THMA had a lower level of lesion nematode within roots than the control. In a trial conducted during the 2005-2006 growing season (Table 2), 11 treatments including ones with the natural products DT, QU, PL, MA and MF had a greater bulb circumference than the control and were equivalent to MSTH. MSPL had lower survival than the control. Ten treatments, but not MSTH had a greater foliage weight at harvest than the control and were equivalent to DFE. MF and DFE had lower levels of lesion nematode within roots than the control.

CONCLUSIONS

In spite of the variability that naturally occurs in field trials conducted over multiple years, our results were fairly consistent. When used alone, the natural product MA performed similarly to the commercial standards in both trials. DT, MU, PL, and QU show potential for use in conjunction with a preplant fumigant. This is an important finding for producers to meet the overall goal of reducing pesticide use.

ACKNOWLEDGEMENTS

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Tables

Table 1. Description of nematicide treatments and abbreviations used in text and tables.

Abbreviation	Treatment			
	Preplant		At planting	
		Rate of product/ha (L)		Rate of product/ha
MSTH45	Metam-sodium	702	Thimet	45 kg
MSTH34	Metam-sodium	702	Thimet	34 kg
MS	Metam-sodium	702	-	-
MSTHDT	Metam-sodium	702	Thimet/DiTera	45/33.6 kg
MSDT	Metam-sodium	702	DiTera	33.6 kg
MSTHDTQU8.4	Metam-sodium	702	Thimet/DiTera/Quillaja	45/33.6/8.4 kg
MSDTQU8.4	Metam-sodium	702	DiTera/Quillaja	33.6/8.4 L
MSTHMU	Metam-sodium	702	Thimet/Mustard	45/263.6 kg
MSMU	Metam-sodium	702	Mustard	263.6 kg
MSTHPL	Metam-sodium	702	Thimet/MeloCon	45/9.2 kg
MSPL	Metam-sodium	702	MeloCon	9.2 kg/ha
MSTHMA	Metam-sodium	702	Thimet/Muscodor	45/7.287 kg
MSMA	Metam-sodium	702	Muscodor	7.287 kg
MSTHQU8.4MF	Metam-sodium	702	Thimet/Quillaja/Meadowfoam	45 kg/8.4 L/ 202 kg
MSQU8.4MF	Metam-sodium	702	Quillaja/Meadowfoam	8.4 L/202 kg
MSTHQU4.2	Metam-sodium	702	Thimet/Quillaja	43 kg/4.2 L
MSQU4.2	Metam-sodium	702	Quillaja	8.4 L
MSTHQU8.4	Metam-sodium	702	Thimet/Quillaja	45 kg/8.4 L
MSQU8.4	Metam-sodium	702	Quillaja	8.4 L
MSTHDTMF	Metam-sodium	702	Thimet/DiTera/Meadowfoam	45/33.6/202 kg
MSDTMF	Metam-sodium	702	DiTera/Meadowfoam	33.6/202 kg
MSMF	Metam-sodium	702	Meadowfoam	202 kg
TH45	-	-	Thimet	45 kg
TH34	-	-	Thimet	34 kg
THPL	-	-	Thimet/MeloCon	45/9.2 kg
PL	-	-	MeloCon	9.2 kg
THMA	-	-	Thimet/MeloCon	45/9.2 kg
MA	-	-	Muscodor	7.287 kg
MF	-	-	Meadowfoam	202 kg
DFE	1,3-Dichloropropene	314	Fenamiphos	23.4 L
FE	-	-	Fenamiphos	23.4 L
UC	-	-	-	-

Table 2. Effect of nematicide treatments on growth of Easter lilies and density of *Praylenchus penetrans*.

Treatment	Foliage weight (5 plants) (g)		Bulb				*Pratylenchus penetrans*			
			Survival (out of 75)		Cicrcumference (cm)		Soil (n/1000 cm^3)		Roots (n/g)	
	04-05	05-06	04-05	05-06	04-05	05-06	04-05	05-06	04-05	05-06
MSTH45	146.0	146.0	67.7	73.3	14.1	16.1	267	50	127	75
MSTH34	160.0	176.0	72.7	73.3	15.2	16.2	1517	217	132	36
MS	162.7	146.0	72.3	71.3	14.3	15.9	1817	167	123	125
MSTHDT	134.7	189.7	73.7	70.7	14.8	16.1	1267	133	118	100
MSDT	169.7	147.0	69.3	70.0	15.1	15.8	1600	317	154	96
MSTHDTQU8.4	171.3	165.0	71.3	69.7	15.2	15.6	367	17	75	35
MSDTQU8.4	189.3	175.3	74.0	71.7	15.5	15.8	1150	333	114	147
MSTHMU	173.3	179.0	69.7	64.7	14.8	15.3	1367	100	103	61
MSMU	149.3	180.0	69.3	67.0	14.4	15.6	983	383	215	84
MSTHPL	133.3	172.3	71.3	71.3	14.0	16.5	867	83	138	50
MSPL	208.7	182.3	75.7	55.0	15.6	15.9	1083	317	59	106
MSTHMA	200.0	202.7	72.7	72.7	15.9	16.8	483	0	39	34
MSMA	173.3	194.0	74.7	71.3	16.0	16.6	217	100	77	120
MSTHQU8.4MF	159.3	158.7	72.0	70.0	14.2	15.4	483	133	89	65
MSQU8.4MF	156.7	196.7	72.3	71.0	14.8	15.9	1033	283	76	80
MSTHQU4.2	155.0	160.7	71.0	68.0	14.6	15.5	483	50	146	119
MSQU4.2	135.3	154.0	72.0	65.0	14.6	15.4	2233	783	188	332
MSTHQU8.4	157.7	174.0	74.7	73.0	14.5	15.7	433	100	86	87
MSQU8.4	135.3	137.0	70.3	66.3	14.1	15.6	1350	483	164	237
MSTHDTMF	142.7	186.0	73.0	66.0	14.3	15.7	550	183	117	82
MSDTMF	155.0	190.0	72.3	71.0	14.8	15.5	1700	417	224	168
MSMF	195.7	172.3	72.0	70.7	14.9	15.7	1433	350	259	192
TH45	146.7	197.7	68.0	70.3	14.3	15.7	33	150	32	70
TH34	108.7	150.3	71.7	66.0	13.1	15.6	1000	117	196	103
THPL	149.3	160.0	66.3	72.7	14.9	15.7	217	200	121	51
PL	110.0	141.7	66.0	69.7	13.3	14.9	333	233	60	98
THMA	160.7	196.7	72.3	68.7	15.4	15.8	0	33	6	63
MA	129.3	161.3	69.3	71.7	14.5	15.9	183	17	71	48
MF	90.3	151.0	66.7	71.0	13.0	15.8	717	17	37	29
DFE	178.0	184.7	73.7	69.3	15.7	15.5	100	0	12	4
FE	186.7	159.3	69.3	68.7	15.1	15.6	83	33	74	39
UC	59.7	130.3	67.0	68.7	12.6	15.1	650	150	125	141
LSD (0.05)	65.0	49.2	5.2	9.2	1.8	0.7	1231	271	117	110

Each figure is the mean of three replicates.