Nematicide Treatments of Turfgrass Seed

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Abstract: Seed treatments of improved Kentucky bluegrass and fescue cultivars with carbofuran, oxamyl, and phenamiphos dissolved in acetone reduced seedling emergence, but treatments were not extremely phytotoxic. Phenamiphos was the most toxic, particularly at the 5,000 μg/ml concentration. Fresh weight of grass clippings 35 d following planting generally was greater in treatments than in controls except for the 5,000 μg/ml phenamiphos treatments on certain cultivars. All nematicide seed treatments reduced the number of *Pratylenchus penetrans* subsequently recovered from Pennlawn creeping red fescue roots 4–5 wk after treatment. The infusion of nematicides into grass seed with organic solvents appears to be an effective means of reducing nematode damage to turfgrass seedling with little environmental hazard.

Nematicide seed treatments for agronomic and vegetable crops have been proposed (1,2,4). The application of this technique for ornamental or turfgrass seed has not been evaluated. Such treatments, if effective, would require much less nematicide than soil treatment, thereby reducing cost and environmental hazards. However, one requisite for such a treatment would be lack of phytotoxicity. Following investigations on the phytotoxicity of nematicide soil treatments to various grass seed cultivars (6), a preliminary trial with nematicide seed treatments was conducted. The results of this trial and several reports (3,5) of nematicide seed treatment of wheat, rye, and other seed prompted us to evaluate this technique for turfgrass. An abstract on a portion of the research has been published (7).

MATERIALS AND METHODS

Seed from Kentucky bluegrass (*Poa pratensis* L.) cvs. Bonnieblue, Fylking, Glade, and Ram I; and fescues (*Festuca rubra* L.) cvs. Banner Chewings, Creeping Red, Jamestown, Koket Chewing, Koket, and Pennlawn Red were soaked for 30 s in 100 ml acetone solutions containing 500, 2,500, and 5,000 μg/ml technical-grade carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate), oxamyl (methyl 2-(dimethylamino)-N-[[(methylamino) carbonyl] oxy]-2-oxoethanimidothioate), or phenamiphos (ethyl 3 methyl-4-(methylthio) phenyl (1-methylethyl) phosphoramidate). Controls consisted of acetone-treated seed and an untreated check (no treatment). Seed were spread on paper towels following treatment and air dried at room temperature for 24 h prior to packaging. Packaged seed were stored for 10–14 d; subsamples of 100 seed were then estimated by weight for planting.

Seed were scattered evenly on the surface of methyl bromide-treated soil (3 soil:1 vermiculite) contained in 7.2-cm-d plastic cups. Four replicates for each treatment-concentration-cultivar combination were used. Cups were arranged in randomized blocks on a greenhouse bench. The experiment was repeated three times.

The effect of nematicide seed treatments on seedling emergence was determined by counting the number of seedlings which had emerged 14 d following planting. Fresh weight of grass clippings was determined 35 d after planting by clipping all plants at 1.9 cm height.

To evaluate the nematicidal efficacy of the infusion technique, seed of Pennlawn red fescue was treated with each nematicide concentration as previously described. Following seedling emergence, approximately 2,000 nematodes (*Pratylenchus penetrans* (Cobb) Chitwood & Oteifa) were added to each cup. Plants were harvested 4–5 wk following infestation, weighed, and the nematodes extracted from the roots by the modified Baerman method. All lesion nematodes recovered during 48 h extraction from each of four replicates were counted.

All data were subjected to an analysis of variance and significant differences among means were determined by Duncan's multiple-range test.

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Table 1. Percentage emergence of grass 14 d after seed treatment with nematicides.

			Nematicide									
	Controls		Carbofuran			Oxamyl			Phenamiphos			
			μg/ml									cv.
Cultivar	Untreated	Acctone	500	2,500	5,000	500	2,500	5,000	500	2,500	5,000	mean
Fescues												
Banner Chewings	80 a*	53 c	60 bc	63 bc	54 bc	51 c	62 bc	47 c	70 ab	46 c	25 d	55.4 B†
Creeping Red	45 a	32 cde	33 cde	34 cd	35 c	36 bc	27 def	25 ef	43 ab	22 fg	15 g	31.5 F
Jamestown	74 a	47 bc	57 b	58 b	37 cd	49 bc	50 bc	55 b	57 b	51 bc	30 d	51.2 C
Koket	53 a	33 de	44 bc	36 cd	35 cd	46 ab	35 cde	38 bcd	46 ab	40 bcd	27 e	39.4 E
Koket Chewings	78 a	51 bc	53 bc	52 bc	48 bc	44 bc	49 bc	40 cd	59 b	28 de	16 e	47.0 D
Pennlawn Red	75 a	54 bcd	47 de	56 bcd	52 cd	66 ab	55 bcd	52 cd	62 bc	39 e	24 f	52.9BC
Kentucky bluegrass												
Bonnieblue	56 a	45 abc	50 ab	42 bc	38 bcd	47 ab	41 bc	34 cd	46 abc	38 bcd	28 d	42.3 E
Fylking	53 ab	47 ab	52 ab	59 a	45 ab	52 ab	47 ab	49 ab	52 ab	44 b	43 b	49.4 CD
Glade	80 ab	64 cd	79 ab	82 a	76 abc	72 abcd	70 abcd	64 cd	68 bcd	62 d	50 e	69.7 A
Ram I	51 a	47 ab	46 ab	46 ab	40 abc	35 bc	36 abc	28 c	41 abc	38 abc	43 abc	40.8 E
Treat.-Conc. mean	64.6 A	47.3 DE	52.0 BC	52.7 BC	46.0 DE	49.8 CD	47.1 DE	43.1 EF	54.3 B	40.8 F	30.0 G	

*Mean of four replicates. Row means followed by the same lower-case letter are not significantly different ($P=0.05$) according to Duncan's multiple-range test.

†Treatment-concentration means or cultivar means followed by the same upper case letter are not significantly different ($P=0.05$) according to Duncan's multiple-range test.

Table 2. Fresh weight (g) of grass 35 d following seed treatment with nematicides.

Cultivar	Controls		Nematicide									cv. mean
			Carbofuran			Oxamyl			Phenamiphos			
			µg/ml									
	Untreated	Acetone	500	2,500	5,000	500	2,500	5,000	500	2,500	5,000	
Fescues												
Banner Chewings	25 b*	19 c	26 bc	28 b	42 a	40 a	37 a	26 bc	42 a	29 b	22 bc	30.8 DE†
Creeping Red	25 b	23 b	24 b	38 a	37 a	36 a	23 b	19 b	36 a	25 b	21 b	27.7 E
Jamestown	22 c	22 c	32 abc	34 ab	27 bc	28 bc	29 abc	38 a	30 abc	36 ab	31 abc	29.8 DE
Koket	27 abc	21 c	34 ab	35 ab	26 bc	28 abc	34 ab	36 a	35 ab	36 a	36 a	31.6 CD
Koket Chewings	32 abcd	22 d	31 abcd	29 bcd	34 abc	35 ab	37 ab	31 abcd	40 a	31 abcd	24 cd	31.4 D
Pennlawn Red	30 bc	26 c	21 c	29 bc	45 a	45 a	30 bc	25 c	40 ab	26 c	32 bc	31.7 BCD
Kentucky bluegrass												
Bonnieblue	31 b	28 b	39 ab	46 a	29 b	33 ab	30 b	33 ab	35 ab	47 a	34 ab	34.8 ABC
Fylking	22 c	29 bc	38 ab	47 a	41 ab	39 ab	23 c	32 bc	33 abc	41 ab	41 ab	34.9 AB
Glade	36 abcd	23 d	45 ab	45 ab	31 cd	30 cd	32 bcd	33 bcd	47 a	47 a	38 abc	37.0 A
Ram I	27 cd	33 bcd	29 bcd	45 a	40 ab	30 bcd	26 cd	23 d	31 bcd	39 ab	38 abc	32.6 BCD
Treat.-Conc. mean	27.9 D	24.4 E	31.8 BC	37.5 A	35.2 A	34.5 AB	30.1 CD	29.3 CD	36.8 A	35.5 A	31.6 BC	

*Mean of four replicates. Row means followed by the same lower case letter are not significantly ($P=0.05$) different by Duncan's multiple-range test.

†Treatment-concentration means, or cultivar (cv) means followed by the same upper case letter are not significantly ($P=0.05$) different according to Duncan's multiple-range test.

RESULTS AND DISCUSSION

Seedling emergence of improved fescue and Kentucky bluegrass seed treated with nematicides dissolved in acetone was reduced to below that of the control. The decreased emergence varied with cultivar, nematicide, and nematicide concentration. The nematicide concentration and cultivar interaction for emergence was significant in all trials, hence data for one trial are given according to nematicide and cultivar (Table 1). Emergence among untreated cultivars varied significantly.

All three nematicides were relatively nonphytotoxic at 500 μg/ml concentrations, based on seedling emergence 14 d after planting. Tip necrosis of grass blades resulted on all fescue and bluegrass treated with 5,000 μg/ml carbofuran. Phenamiphos was the most phytotoxic nematicide, causing considerable reduction in fescue emergence, particularly at the 5,000 μg/ml concentration. This same concentration of phenamiphos was reported to suppress emergence of wheat and rye (3).

The mean fresh clipping weight of grass 35 d after planting was measured for each cultivar-nematicide-concentration combination. The nematicide concentration and cultivar interaction was significant in all trials; data are presented in Table 2. Sufficient grass growth occurred by 35 d after treatment that, except for the tip necrosis noted with carbofuran, the seed treatments could be considered nonphytotoxic. In many instances the fresh weight of grass from treated seed exceeded that of the controls. The increase in fresh weights may be attributed to less competition among the fewer seedlings in the treated series than in the controls.

All nematicide seed treatments were equally effective in reducing the number of lesion nematodes recovered from Pennlawn creping red fescue 4–5 wk after treatment (Table 3) in each of three trials. Acetone treatments resulted in 60% fewer nematodes than from the no treatments, whereas all nematicides resulted in 70–90% reduction in nematodes recovered from grass roots. In these trials the 2,500 and 5,000 μg/ml phenamiphos reduced the emergence and fresh weight of grass. The necrotic tips of grass resulting from the carbofuran treatment were again evident.

Table 3. Lesion nematodes recovered from Pennlawn creeping red fescue following seed treatment.

Treatment	Concn. μg/ml	Nematodes/g fresh weight
None		32.2 a*
Acetone		11.1 b
Carbofuran	500	2.7 c
	2,500	1.8 c
	5,000	1.7 c
Oxamyl	500	2.0 c
	2,500	3.0 c
	5,000	1.8 c
Phenamiphos	500	1.8 c
	2,500	2.0 c
	5,000	2.7 c

*Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple-range tests.

Rodriguez-Kabana et al. (3) demonstrated the nematicidal effectiveness of these same chemicals against *Tylenchorynchus claytoni* and *Hoplolaimus galeatus* when applied as seed treatments to wheat and rye. They suggested the method might prove effective under field conditions. Results of our studies confirm the possibility of utilizing the infusion technique for the application of nematicides to turfgrass seed. Other solvents and nematicides, as well as these nematicides at lower concentrations, may prove useful under field conditions to reduce the injury from plant-parasitic nematodes to grass seedlings with a minimum hazard to the environment.

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