

Drip Irrigation as a Delivery System for Imidacloprid and Nematodes for Control of Scarab Grubs in Nursery Crops



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Introduction

In recent years, exotic white grubs (larvae Coleoptera: Scarabaeidae) have been found stunting and killing field-grown nursery crops in northern Ohio. Grubs injure and kill plants by feeding on the roots. European chafer (*Rhizotrogus majalis*) and oriental beetle (*Exomala orientalis*) are the two most common exotic scarabs found in the commercial nurseries where we work in northern Ohio. Imidacloprid has been effective against white grubs in turf, which has a relatively shallow root system compared to woody ornamentals. Efficacy of imidacloprid is dependent on applications of sufficient amounts of water to leach the material into the soil. However, applications of large amounts of water are difficult and not practical for nursery growers that use drip irrigation.

Objectives:

- Test the efficacy of imidacloprid and entomopathogenic nematodes + imidacloprid against scarab grubs in field-grown nursery crops when delivered through drip irrigation.
- Test subsurface application of nematodes + imidacloprid against scarab grubs in field-grown nursery crops.



Materials and Methods

General Methods. All trials were conducted in a commercial nursery in northern Ohio. The experimental design was randomized complete block with 3 replications per treatment. Three rows of field-grown dogwood (*Cornus kousa*) were used in each trial with each row a replication (Fig. 1A). Trees were assigned treatments randomly within rows. All trees were planted during spring of the year of the trial (ex. trees planted 2004 for the trial in 2004). Trials were evaluated by digging trees in fall and searching the extracted roots and soil for grubs (Fig. 2E). All grubs were identified to species and instar. The treatments applied through the drip line were injected into the line at the row through a valve system (Figs. 1B & 2B) designed by our ag-engineering group. Each tree was serviced by 1 pressure-compensating emitter (Fig. 1B). Rates of insecticides and nematodes are listed in Table 1.

2004

- This trial had 2 treatments (drip applied imidacloprid [Marathon II] and water only).
- The insecticide was applied at a preventive timing (1 July 2004).
- There were 6 trees per treatment per row.
- Trees were dug for evaluation 21 September 2004 (Fig. 2E).

2005

- Two trials were conducted this year.
- Trial-1 had 3 treatments: drip applied imidacloprid (M II), surface spray of imidacloprid (M II), and untreated (water only) (Fig. 2A & B).
- The insecticide treatments were applied at a preventive timing (11 July 2005)
- There were 10 trees per treatment per row.
- Trial-2 had 4 treatments: drip applied entomopathogenic nematodes (EPN) + imidacloprid (M II), subsurface applied EPN + imidacloprid (M II), surface drench of EPN + imidacloprid (M II), and untreated (water only) (Fig. 2B, C, & D).
- EPN species was *Heterorhabditis bacteriophora* GPS11.
- The EPN treatments were applied at a rescue timing (16 Aug. 2005)
- There were 4 trees per treatment per row.
- Post-treatment soil samples were taken from each tree (23 Aug) and *Galleria* larvae were used to test for the presence of EPN with infected larvae being a positive test.
- Trees were dug for evaluation 20 & 21 September or 4 October for trial-1 and trial-2, respectively.



Figure 2. Techniques used in the various trials.

- A) Surface spray Trial-1 2005
- B) Injecting materials into drip line all trials
- C) Subsurface application in EPN trial
- D) Surface-drench in EPN trial
- E) Evaluating numbers of grubs all trials

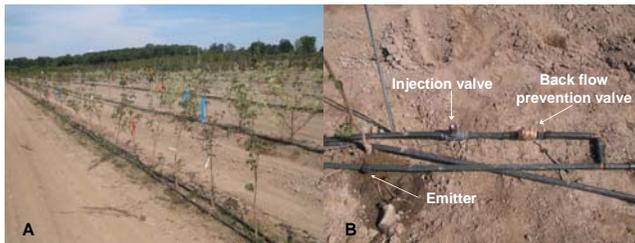


Figure 1. 2005 trial plot (A), and Injection valve system (B).

Table 1. Application rates of insecticides and nematodes

Year	Treatment	Label recommendation and calculation*	Insecticide or nematodes per tree
2004	Drip	rate based on 5-gallon pot	0.42 ml Marathon II
2005	Trial-1 Drip	same as 2004	0.42 ml M II
	Trial-1 Spray	uniform band 15 cm wider than actual root ball (45 cm band)	0.14 ml M II
	Trial-2 Drip	M II 1/4 Trial-1 rate	0.11 ml M II
	Subsurface	Nematodes H. b. ^	23,000
Surface-drench same nematode/M II rates all treatments			

*All rates were based on a root zone volume of about the size in a 5-gallon container.
 ^*Heterorhabditis bacteriophora*

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Results

- In 2004 and 2005 (Trial-1), all insecticide treatments reduced the numbers of scarab grubs compared to the untreated controls (Table 2).
- In 2004, we had some problems injecting the M II into the drip line in reps 1 and 2, which negatively affected grub control (grub numbers were only reduced 31% and 49%, respectively). However, in rep 3 we corrected the problem and reduced the number of grubs by 90% although the grub pressure was highest (12 grubs/tree in the control).
- All of the EPN + M II treatments (Trial-2) reduced the number of grubs compared with the untreated control (Table 3).
- EPN recovery in soil samples was highest in the subsurface and surface drench treatments with EPN detected in 83%, 75%, 25%, and 0% of the soil samples from the subsurface, surface drench, drip applied, and untreated treatments, respectively.
- Oriental beetle (*Exomala orientalis*) was the most common scarab in all trials (Table 4).
- The other species of scarabs found were European chafer (*Rhizotrogus majalis*), Asiatic garden beetle (*Maladera castanea*), and Japanese beetle (*Popillia japonica*).

Table 2. Results of imidacloprid trials

Year	Mean grubs per tree			% reduction of grubs	
	Untreated	Drip	Spray	Drip	Spray
2004	9.4a	3.6b	*	62.4%	*
2005	4.0a	0.67b	0.60b	83.4%	85.1%

Means within rows and years followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

* There was no spray treatment in 2004.

Table 3. Results of the nematode + imidacloprid trial

Treatment	Mean numbers of grubs per tree	% reduction of grubs
Untreated	5.1a	na
Drip applied	2.4b	54.1%
Subsurface	1.2b	77.0%
Surface drench	0.8b	85.2%

Means within columns followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

Table 4. Composition of scarab grub complex in the imidacloprid trials

Year	Treatment	Proportion of all grubs				Total grubs
		OB	AGB	EC	JB	
2004	Untreated	0.84	0.12	0.05	0.00	170
	Drip*	0.88	0.05	0.05	0.02	64
2005	Untreated	0.92	0.05	0.02	0.01	119
	Drip*	0.84	0.11	0.00	0.05	19
	Spray*	0.94	0.06	0.00	0.00	17

*Imidacloprid was applied through drip irrigation (Drip) or sprayed in a uniform band on both sides of the trees (Spray).
 OB = oriental beetle, AGB = Asiatic garden beetle, EC = European chafer, JB = Japanese beetle.