

Application of Imidacloprid Through Drip Irrigation for Control of White Grubs in Field-Grown Nursery Crops

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Introduction

In recent years, exotic white grubs (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. The plants we have found killed by grubs are generally devoid of fibrous roots. Young plants appear more vulnerable to feeding injury by grubs than older, more-established plants. In 2003, we broke apart and carefully searched through the root balls of field-grown trees (14 *Amelanchier canadensis* and eight *Malus sargentii*) from a nursery in northern Ohio. These trees were planted in 2000 and had not been treated with insecticides to control grubs.

We found an average of 22 grubs per *Amelanchier* and 19 per *Malus*. The trees appeared healthy, but according to the grower, they were stunted and should have been much larger. More than 90% of those grubs were oriental beetle (*Exomala orientalis*). In 2001 and 2002, European chafer (*Rhizotrogus majalis*) grubs were found damaging nursery crops in the same county. Oriental beetle and European

chafer were the most common exotic species of white grubs found in the nurseries we surveyed in that county.

Preventive insecticides, such as imidacloprid (Marathon and Merit), are generally sprayed or broadcast on the soil surface to control white grubs in turf and field-grown nursery crops. However, efficacy is usually dependent on applications of sufficient amounts of water to facilitate movement of the chemical into the root zone. The root zones of nursery crops such as trees and shrubs usually penetrate deeper into the soil than turf. As a result, coverage of the root zones of nursery crops with insecticides is more difficult. Facilitating movement of insecticides into the soil is, therefore, especially critical for effective grub control in nursery crops.

In 2002, a nursery in northern Ohio sprayed imidacloprid on the soil in the rows of field-grown trees to control grubs. This nursery used drip irrigation and was unable to apply water other than through irrigation. The treatment was not effective, which was probably related to the limitations of the irrigation system. The small amounts of water and small area of soil coverage substantially limit the amount of insecticide that can be flushed from the surface into the soil.

The objective of this trial was to evaluate drip irrigation as a method of applying

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imidacloprid (Marathon II) to nursery crops for control of white grubs.

Materials and Methods

This experiment was conducted in a field production nursery in northern Ohio in 2004. The field we used was planted in May 2004. The only hosts for grubs in this field were the trees; there was no grass. The experiment was a completely randomized design.

On July 1, 2004, Marathon II (imidacloprid) was applied into the drip irrigation line of three rows of Kousa dogwood (*Cornus kousa* 'Starlite') in row 1 (replication 1) and 'Heart Throb' in rows 2 and 3 (reps 2 and 3, respectively). Each row was a replication of insecticide-treated and untreated control (irrigation water only) trees. The experimental trees were in randomly chosen pairs of adjacent trees with three pairs of each treatment per row. Two drip lines were installed on the soil surface and close to the middle line of each tree row, one for injection of insecticide, and the other for regular drip irrigation (Figure 1).

The drip lines were a 1.75 cm (0.690") OD and a 1.24 cm (0.490 ") ID polyethylene

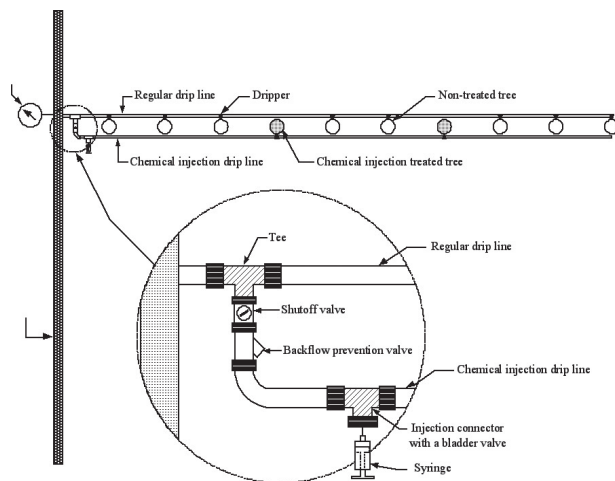


Figure 1. Schematic diagram of a regular drip irrigation line and a chemical injection drip irrigation line near a row of dogwood trees.

tubing and were connected to the main irrigation supply line. Pressure-compensating drippers (Part Number 01WPC2, NETA FIM USA, Fresno, Calif.) with a nominal flow rate of 1.89 LPH (0.5 GPH) per dripper were used to trickle water to trees. Drippers were installed in the two drip lines in such a manner that each tree received irrigation water from only one dripper. The insecticide-treated trees received irrigation from the chemical injection drip lines, and the control trees received water from the regular drip irrigation lines. Therefore, trees of both treatments were supposed to receive the same amount of water every time irrigation was applied.

Water was run through the lines for at least 20 minutes before application of the insecticide and remained on during the application. The total irrigation period was about two hours. A pressure gauge was installed on the main irrigation supply line to monitor water pressure during irrigation. Irrigation was applied at 16.5 psi for two hours a day on the condition that there was insufficient rainfall to wet the soil during that day. Because of abundant rainfall during spring and summer, irrigation in the trial rows was terminated for the season on July 29.

A chemical injection connector was designed and installed at the beginning edge of each chemical injection drip line (Figure 1). The injection connector was assembled with a 1/2" thread PVC tee (Lasco Fittings, Inc., Brownsville, Tenn.); a 1/2" NPT electric wire connector (Kleinhuis North America, Inc., Worthington, Ohio); and a volleyball bladder valve (Figure 2). A 50 mL Pro-Pistol™ pistol grip syringe (Model 1005, Neogen Corporation, Lexington, Ky.) with a 0.9 mm (0.035") inside diameter needle was used to inject pesticide into the bladder valve of the injection connector.

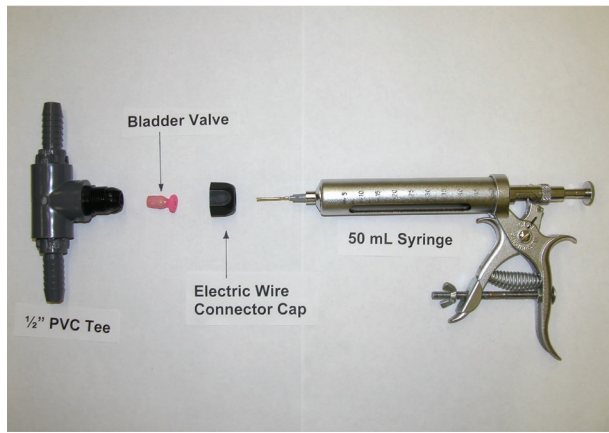


Figure 2. Chemical injection connector assembly and the syringe used to inject pesticide into drip lines.

The first dripper in the insecticide injection line was at least 6.1 m (20') away from the injection connector, so the insecticide had enough time to uniformly mix with water inside the drip line before reaching all six drippers. A backflow prevention valve was installed between the beginning edge of the insecticide line and the injection connector, to prevent insecticide flowing upstream to the regular drip line or main irrigation supply line.

The rate of insecticide was based on the highest labeled rate for 7-gallon containers (0.67 ml per tree, 4 ml per row). The root zones of the trees were estimated to be about the size of a 7-gallon container. In the first two rows (replications 1 and 2), we used undiluted Marathon II in the applicator (syringe). We put enough insecticide into the applicator for two rows (10 ml to apply 4 ml per row).

However, there was a considerable portion of leakage from the needle at the valve. We decided this was caused by a combination of back-pressure from the line, applying a low amount of compressible liquid formulation, and not emptying the applicator. Therefore, for the third row (replication 3), we mixed insecticide (4

ml) with water for a total volume of 40 ml in the applicator. Then we dispensed the entire volume, which resulted in no apparent leakage.

This trial was evaluated on September 21, 2004. The trees were dug by hand, the root balls were broken apart, and the soil and roots were carefully searched for grubs. The grubs collected from each tree were saved separately in plastic cups with snap-on lids then transported to the laboratory to determine species. Mean grubs per treatment and tree were computed. Numbers of grubs per treatment were analyzed by analysis of variance.

Results

We found four species of exotic grubs — Oriental beetle, European chafer, Asiatic garden beetle (*Maladera castanea*), and Japanese beetle (*Popillia japonica*) — in the root zones of the trees in this trial (Table 1). Most of the grubs (85%) were Oriental beetle. The other species found, in descending order of frequency, were Asiatic garden beetle, European chafer, and Japanese beetle (1 grub). Marathon reduced the number of grubs by 62% compared to the untreated trees (Table 2).

We had some application problems related to the volume of solution applied in replications 1 and 2 (there was more leakage in row 1 than 2 and a 31% and 49% reduction of grubs, respectively), and the treatments were less effective in those rows than in replication 3 (90% reduction). Because of the leakage of insecticide, the trees in rows 1 and 2 did not receive as high a dose as those in row 3, which probably influenced the efficacy of the treatment in those rows.

Overall, the application system and insecticide treatment were effective. Even with the difficulties in rows 1 and 2, for all

rows together, we were able to reduce the numbers of grubs from 9.4 per tree in the untreated trees to 3.6 in the treated.

We plan to conduct further research in 2005, using this system to apply various treatments to control white grubs in nursery crops.

Acknowledgments

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Disclaimer

Mention of proprietary products or companies is included for the reader's convenience and does not imply any endorsement or preferential treatment by either USDA-ARS or The Ohio State University.

Treatment	Total Grubs	Percentage of All Grubs Found ^a			
		OB	AGB	EC	JB
Marathon II	64	88.1	5.1	5.1	1.7
Untreated	170	83.7	11.8	4.6	0.0

^a Species designations: OB = oriental beetle, AGB = Asiatic garden beetle, EC = European chafer, JB = Japanese beetle.

Treatment	Mean Number of Grubs (\pm SE)	Mean Grubs per Tree (\pm SE) ^b	Percentage Reduction of Grubs in Treated vs. Untreated Trees
Marathon II	21.3 (\pm 7.3)	3.6 (\pm 1.2)	62.4%
Untreated ^a	56.7 (\pm 8.8)	9.4 (\pm 1.5)	
df	1,4	1,4	
F	9.5	9.6	
P	0.037	0.037	

^a Received water only, applied through drip irrigation.
^b There were three pairs of trees per treatment per row with each row a replication.

