Use of Foliar-Applied Neem (*Azadirachta indica* A. Juss.) Seed Extract for the Control of the Birch Leafminer, *Fenusa pusilla* (Lepeletier) (Hymenoptera:Tenthredinidae)[1]

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Abstract

The effect of 1.0% neem (*Azadirachta indica* A. Juss.) seed extract applied as a foliar spray against the birch leafminer (*Fenusa pusilla* (Lepeletier)) was compared to sprays of water and Metasystox-R™. Sprays were applied against the season's first generation, at oviposition (V-3-86) or early instar (V-10-86). Sprayed foliage was harvested and weighed at late instar, and adults were reared. The extract caused significantly more leafminer mortality than did water, and caused as much mortality as Metasystox-R™. Observations suggested that the extract took longer to kill leafminer larvae than did Metasystox-R™ thereby allowing for more foliar damage. There were no differences in efficacy between times of extract application.

Index words: *Fenusa pusilla*, *Betula papyrifera*, *Azadirachta indica*, botanical insecticide, Metasystox-R™

Introduction

The birch leafminer, *Fenusa pusilla* (Lepeletier) (Hymenoptera:Tenthredinidae) is a serious endemic pest of birches, *Betula* spp., in northeastern North America, often causing browning of foliage over the entire crown (4). Two or three generations occur each season; new foliage is attacked by each generation. Common control measures include use of systemic or contact pesticides to kill the larvae or adults, respectively (11), parasites for biological suppression (4), and host plant resistance (3).

The neem tree, *Azadirachta indica* A. Juss., is planted extensively in the Old World tropics and has been introduced into the Caribbean (5, 8). Neem leaves and seeds have long been used as sources of insect repellents and insecticides (5). Neem seed extract (NSE) acts as a feeding inhibitor and/or as an insect growth regulator disrupting development in a wide variety of insects (9). Its activity against leafmining flies in the genus *Liriomyza* on chrysanthemums (*Chrysanthemum morifolium* Ramat.) and bush lima beans (*Phaseolus limensis* var. *limenanus* Bailey) has been documented (2, 7, 10). The effect of NSE on hymenopterous leafminers has not been investigated. Our study was conducted to determine if NSE is active against the birch leafminer. This is one of the first reports of NSE used outdoors against an insect that attacks landscape trees.

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Materials and Methods

A 200 × 50 m (660 × 165 ft) nursery planting of paper birches (*Betula papyrifera* Marsh.) in Dansville, NY was used for this study. Vouchers of the plant material were placed in the Herbarium, U. S. National Arboretum, Washington, DC. The trees were 6 years old, 3–4 m (9.8–13.1 ft) tall, and were planted in clumps of 3, each group spread 1 m (3.2 ft) apart in 5 rows that ran the length of the planting. The planting had been heavily infested by birch leafminer in previous years (B. Fiori, pers. comm.). Many adults were seen on IV-27-86. Treatments were made at one of two times. On the first treatment day, V-3-86, few adults were seen, but ovipositional wounds on foliage were prevalent. Foliage at this time was approximately one-half fully expanded, and mines were not yet apparent. Fifteen trees on the east end of the planting were chosen and randomly assigned to 1 of 3 treatments (5 trees/treatment). Five branches at breast height showing ovipositional punctures were sprayed on each tree. Sprays were applied from the branch tip back approximately 0.5 m (1.6 ft). Plastic ribbon was tied on the branch to indicate the most proximal leaves sprayed. Sprays were applied with 1.0 l (0.26 gal) hand-held sprayers. The treatments were 1) water, 2) 1.0% NSE, and 3) Metasystox-R™ (MSR) (Mobay Chemical Corp.) at the labeled rate of 1.3 ml/l (1.5 pints/100 gal). The NSE solution was prepared by bringing 20 g (0.7 oz) of neem concentrate (sample A13-42845[AN 4.57]; Insect Chemical Ecology Laboratory, USDA/ARS, Beltsville, MD) up to 1.0 l (0.26 gal) with water. The concentrate contained 2,300 ppm azadirachtin, one of the insecticidal constituents in NSE (9). The solution of NSE was kept agitated during application to assure adequate mixing and uniform distribution on leaf surfaces. The upper surface of foliage was sprayed to drip. A replicate of the the treatments was made on the west end of the planting. On the second treatment day, V-10-86, mining had begun and young larvae (1st or 2nd instars) were found in mines. Fifteen newly chosen trees on the east end and 15 on the west end were sprayed as on V-3-86. A total of 300 branches on 60 trees were treated during the experiment.

On V-22-86, most leafminers in water sprayed foliage were in the last instar period. All treated branches were cut off at the plastic ribbon at this time and were bagged separately and taken to Geneva, NY. Later the same day, all foliage was removed from each branch. Because of the large amount of foliage, the overlapping mines in many leaves, and the general observation that treatments did not affect number of mines, the number of mines was not counted. Instead, the impact of treatment on the number of adults reared from foliage was assessed. Fresh weight of foliage from each branch was determined so that rearings from branches with different amounts of foliage could later be compared. All the leaves from each branch were placed on the surface of a 2.5 cm (1 in) thick layer of a slightly damp artificial plant growing medium (Promix-BX™) (Premier Brands) in a high-sided plastic tray. Pupation occurred in the medium. Trays were kept indoors at 18–23°C (65–74°F). On V-31-86, leaves from all trays were discarded, and each tray was placed in a sealed plastic bag. Living adults were seen emerging from the medium on VI-10-86. On VI-22-86, emerged adults were counted and number of adults reared from each branch was calculated per g of leaf tissue. Voucher specimens of a few reared adults were placed in the U. S. National Collection, Smithsonian Institution, Washington, DC (Lot 86-07886). Treatment means for the experiments were compared statistically at the $P < 0.05$ level using Duncan's multiple range test (1).

Results and Discussion

Neem seed extract consistently decreased the number of reared adults per g of leaf tissue to levels statistically similar to MSR (Table 1). At harvest, branches sprayed with MSR showed very young aborted mines. Apparently this treatment killed leafminers quickly as early instars. NSE-caused mortality occurred later (at late instars or as pupae) with more foliar damage than observed with MSR. A higher concentration of NSE might kill birch leafminers more quickly. No phytotoxicity was observed in any of the treatments. If movement of adults from untreated trees into treated plots could be minimized, treatments with NSE might greatly reduce the local population of adults during a season in the 1–2 subsequent generations, and thus reduce damage. Further testing with nursery-wide application of NSE will be required to determine long term impact.

These results with a hymenopteran leafminer, along with those documenting neem's efficacy against a dipteran leafminer, *Liriomyza trifolii* (Burgess), (6, 7), suggest that NSE may be a useful material in limiting the larval stages of these and other leafmining insects on woody (birch) and herbaceous (chysanthemum) plants.

Significance to Nursery Industry

Birch leafminer is a common pest of birches in nurseries and landscapes. The results indicate that neem seed extract, a plant-derived insecticide, is toxic to the leafminers. Commercial formulations of the extract may be useful for suppressing populations of this insect. One such formulation, Margosan-O™ (Vikwood Ltd., 1221A Superior Ave., Sheboygan, WI), has received EPA registration for use against *Liriomyza* leafminers on non-food crops.

(**Ed. Note:** This paper reports the results of research only, and does not imply registration of a chemical under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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Table 1. Effect of foliar spray of neem seed extract (NSE) and Metasystox-R™ against the birch leafminer.

Time of application	Treatments	Means[z] Fresh wt leaves (g) East	West	Number reared adults East	West	Reared adults/ g leaf tissue East	West
Oviposition (V-3-86)	Water	25.9 a	33.3 a	26.2 a	15.1 a	0.97 a	0.54 a
	1% NSE	18.8 b(20)	23.3 b	2.8 b(20)	0.0 b	0.09 b(20)	0.00 b
	Metasystox-R[y]	16.8 b	26.1 b	0.0 b	0.0 b	0.00 b	0.00 b
First Instar (V-10-86)	Water	11.0 a(24)	16.5 a	19.4 a(24)	45.4 a	1.80 a(24)	3.00 a
	1% NSE	11.0 a(24)	14.3 ab(24)	0.0 b(24)	0.1 b(24)	0.00 b(24)	0.01 b(24)
	Metasystox-R[y]	10.5 a	11.8 b	0.0 b	0.0 b	0.00 b	0.00 b

[z]Means within column followed by the same letter or letters are not significantly different at the 5% level according to Duncan's multiple range test. N = 25 unless otherwise indicated in parentheses.

[y]At recommended rate of 1.3 ml/l.

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Effects of Irrigation Frequency and A Water-Absorbing Polymer Amendment on Ligustrum Growth and Moisture Retention by a Container Medium[1]

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Abstract

Amending a 2 pine bark : 1 Canadian peat : 1 sand (by vol) container medium with 0, 1.2, 2.4, 3.6 or 6 kg/m^3 (0, 2, 4, 6 and 10 lbs/yd^3) of a water-absorbing polymer, Moisturite[3], did not influence the volume of water held at tensions less than 100 cm (39 in). Greenhouse-grown *Ligustrum japonicum* wilted when irrigated (920 ml/application; 31 oz) every 12 days; however, more frequent irrigation treatments (every 6 and 3 days) reduced shoot and root dry weights. Dry weights were not affected by polymer amendment rates nor were container medium temperatures different 1, 2 or 3 days after irrigation.

Index words: moisture-release curve, water stress, pine bark, peat, sand

Introduction

Water management is one of the most critical factors in production of quality container-grown plants. A proper balance between available water and aeration is essential (2, 3, 4). A container medium with adequate drainage is required for the rainy season with many consecutive days of rainfall, but this medium will require frequent irrigation during dry periods. The cost and availability of water during drought periods place constraints on nursery operators.

Water-absorbing polymers have been used in an effort to increase container media waterholding capacity (1, 5, 8). These polymers may be synthetic or hydrolyzed starch polymers. Banko (1) reported fall garden mums were larger and had more flower buds under reduced irrigation when the pine bark : sand (4:1 by vol) medium had been amended with Terra-Sorb 200[4], a starch polymer, at 1.2 kg/m^3 (2 lbs/yd^3). Gibson and Whitcomb (5) evaluated Terra-Sorb 200 as a substitute for peat in a pine bark based medium and found that 1.2 kg/m^3 (2 lbs/yd^3) resulted in good shoot and root growth of *Ulmus parvifolia* and *Juniperus procumbens*, but 2.4 kg/m^3 (4 lbs/yd^3) reduced root growth of juniper under the given irrigation management. *Ilex* 'Nellie R. Stevens' and *Cupressocyparis leylandii* 'Haggerston Grey' were grown under 5 irrigation regimes (2 times daily to every 4 days) outdoors in a pine bark based medium amended with 2 water-absorbing polymers or bentonite clay (8). Irrigation at the longest interval did not stress the test plants and the polymer amendments did not affect growth.

An experiment was conducted to evaluate the effects of 5 rates of a water-absorbing polymer and 3 irrigation frequencies on *Ligustrum japonicum* growth. The effects of the polymer on growth medium moisture retention were also determined.

Materials and Methods

Ligustrum japonicum rooted cuttings were potted June 24, 1985 in 3 l (#1) nursery containers with a medium of 2 parts pine bark : 1 part Canadian peat : 1 part builders' sand (by vol). The medium was amended with Perk[5] and dolomitic limestone at 1.8 and 3 kg/m^3 (3 and 5 lb/yd^3), respectively and Moisturite, a water absorbing polymer, at rates of 0, 1.2, 2.4, 3.6 or 6 kg/m^3 (0, 2, 4, 6 and 10 lbs/yd^3). Moisturite is a starch-grafted polyacrylate polymer manufactured by Celanese, Inc. Sufficient growth medium amended with the water-absorbing polymer was prepared for determination of a moisture release curve.

Additional containers were filled with the medium amended with 0, 1.2, 2.4 or 3.6 kg (0, 2, 4 and 6 lbs/yd^3) of water-absorbing polymer per m^3 and brass cylinders (8.5 cm dia × 6 cm ht) (3.3 in dia × 2.4 in ht) were inserted into the medium. These containers were watered daily for 2 weeks before the cylinders with intact, naturally compacted medium were extracted. These sample cylinders were placed in Tempe pressure cells[6] and water was added to saturation. After saturation was assured, each pressure cell with saturated sample was weighed. The pressure cells were weighed

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[3]Manufactured by Celanese, Inc., Louisville, KY.

[4]Distributed by Industrial Services International, Inc., Bradenton, FL.

[5]Micronutrient formulation by Estech, Inc., Winter Haven, FL.

[6]Manufactured by Soilmoisture Equipment Corp., Santa Barbara, CA.