SYSTEMIC ACTIVITY OF NEEM EXTRACT AGAINST THE BIRCH LEAFMINER

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Abstract. Pressurized micro-injection of neem seed extract into trunks of *Betula papyrifera* was evaluated for control of the birch leafminer, *Fenusa pusilla* (Lepeletier). Concentrations of 1.5 and 3.0% caused a significant decrease in foliar damage by birch leafminer when injected with the Mauget® microinjection system. Neem was as effective in reducing the number of adult leafminers reared from foliage of treated plants as Injecticide B® (bidrin) or Meta-Systox-R® . Phytotoxicity was not observed in any treatments. Micro-injections of neem may be an effective application technique as an integral part of IPM programs for controlling insect pests of trees.
Keywords. *Azadirachta indica, Fenusa pusilla, Betula papyrifera, injection, systemic movement*

Résumé. La micro-injection sous pression d'extraits de graines de"Neem" (*Azadirachta indica*) dans le tronc du *Betula papyrifera* fut testée pour contrôler la mineuse du bouleau, *Fenusa pusilla* (Lepeletier). Des concentrations de 1.5 et 3.0% ont causé une diminution significative des dommages foliaires dus à la mineuse du bouleau; le système de micro-injection Mauget fut utilisé. Le "Neem" fut aussi efficace pour réduire le nombre de mineuses adultes sur le feuillage des arbres traités que l'insecticide "Bidrin" ou Met-Systox-R. Aucune phytotoxicité ne fut observée lors des traitements. La micro-injection d'extraits de cette espèce pourrait être une technique efficace d'un programme de lutte intégrée pour contrôler les insectes sur les arbres.

Injection of systemic pesticides into the basal trunk area of trees has been used for several years to control insects and diseases (1, 12). The technique has been used to reduce infestations of several insects such as aphids, leafhoppers, borers and leafminers that feed both internally and on tree foliage (6, 7). Similarly, root collar injections of fungicides are frequently used to treat trees infected with the Dutch elm disease fungus (11). Injections for insect and disease management have thus far been made using synthetic systemic pesticides such as organophosphate insecticides (2) or benzimidazole fungicides (13). Biorational compounds such as plant-derived pesticides have not been investigated.

With increased concern about synthetic pesticides and environmental contamination, biorational compounds represent an attractive alternative.

Tree response to microinjection wounding has been investigated by Shigo et. al. (14). The development of the drill technique for low pressure microinjection has minimized wounding during administration of the chemicals (3). A modification of the delivery technique was developed by one of us (DFM) in which liquid is introduced and limited to the outermost 5 mm of xylem using 3 mm wide delivery tubes to facilitate less site trauma.

Neem *(Azadirachta indica)* seed extract (NSE), a naturally derived material from the seeds of the neem tree (Fig. 1), is repellent and/or toxic to a variety of insects (15), the insecticidal component of the extract known as azadirachtin is taken in systemically by herbaceous plants (5, 8, 9). Although found to be effective as a foliar spray against the birch leafminer *(Fenusa pusilla)* (10), there are no reports on the use of NSE as an injection to control this or any other tree insect pest.

The birch leafminer is a major threat to gray, paper and white birch throughout the northeast and midwest causing serious damage to foliage (Fig. 2). The adult sawfly oviposits its eggs singly in newly-formed, half-expanded leaves. As eggs hatch within the leaf, larva produce incipient small patches which later form large blotches that can produce serious damage (Fig. 3, 4). Mature larva exit from leaves and pupate in the soil (6). Adults normally develop in approximately three weeks (Fig. 5).

This study was designed to determine if injections of NSA has toxic or repellent activity against the birch leafminer on relative efficacy when compared to commonly used insecticides. We used the pressurized micro-injection system manufactured by J.J. Mauget Co. (Burbank California) for trunk applications. This is the first report using

1. Mention of a proprietary product does not constitute an endorsement by the authors or their employers.
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NSE as a xylem-injected insecticide.

Materials and Methods

A 200 × 50 m nursery planting of paper birches *(Betula papyrifera* Marsh.) in Dansville, New York was used. Trees were seven years old, 3-4 m tall, and planted in clumps of three. Clumps were situated 1 m apart in five rows and ran the length of the nursery. The nursery had a history of heavy leafminer infestations (B. Fiori, pers comm.). Thirty clumps were randomly chosen for treatment. Treatments were made on May 1, 1987. At that time, adult leafminers were observed on the foliage which was approximately one-half fully expanded. The following five treatments were applied to five or six clumps per treatment, using pressurized Mauget® micro-injection capsules:

1. Distilled water (5 ml/capsule)
2. Mauget's Injecticide-B® (1.0 ml/capsule, technical Bidrin™, 82% active ingredient)
3. Mauget's Injecticide® (3.0 ml/capsule, Meta-Systox-R® (MSR) 50% active ingredient)
4. 3% NSE (5.0 ml/capsule)
5. 1.5% NSE (5.0 ml/capsule)

Capsules containing NSE were formulated by Dale Dodds of J.J. Mauget Company and were wt/wt aqueous dilutions of a NSE concentrate (provided by Dr. David Warthen, Insect Chemical Ecology Laboratory, USDA/ARS, Beltsville, MD.) that contained approximately 3.0 mg of azadirachtin per gram of concentrate. Azadirachtin is one of the insecticidal constitutents of NSE (14). Injections were made by drilling a 3.0 mm diameter hole into the basal trunk area of the largest tree in each test clump. A battery powered Maketa drill was used to produce the injection holes. Drilled wood was removed from the bit and sterilized prior to reinjection. The drilled hole was located in root flairs 1.0-2.0 cm above the soil line. The pressurized capsule was attached to the tree by a rigid plastic delivery tube that fit into the drilled hole. Capsules were 95% empty 24 hr after injection, and subsequently removed.

As a sixth treatment, Meta-Systox-R™ (Mobay Chemical Company, Kansas City, MO.) diluted to 25% with water was pressure injected at 10-12 psi into the soil around five clumps of trees to a depth of 10-15 cm using a Kioritz soil injector (Fig. 6). Approximately 15 ml were injected every 0.6 m on three circles around the clump at (a) the dripline, (b) halfway between clump and the dripline, and (c) this same distance outward from the dripline.

Observations for phytotoxicity (e.g. foliar burn or malformation) were made on May 19, 1987. Effectiveness of treatment was assessed by counting the number of leaves with large blotch mines on May 19, 1987. One hundred leaves were collected per replicate and assessed for the percentage leaf area infested. The percentage of leaves damaged was calculated. Last instar larvae were present in mines on the same day, and foliage was collected for adult rearing. Collections involved clipping five branches 0.5 m back from tip at 1.5 m height from each treated tree. All

Fig. 1. Foliage and seeds of the neem tree *(Azadirachta indica)*: source of neem extract. (Courtesy: H. Larew)

foliage from each branch was removed and fresh weight of foliage was measured. Foliage from each branch was placed on the surface of 2.5 cm-thick layer of slightly damp artificial growing medium, Jiffy Mix (JPA, Inc., West Chicago, Illinois), in a high-sided clear plastic tray. All trays were kept in a controlled environment room at 25°C + 2°C, with a photoperiod of 12:12 (L:D). Observations indicated that by May 26, 1987, larvae in leaves from water control trees had emerged from the leaves, settling into the medium to pupate. Following pupation, all leaves were removed from all trays (Fig. 7). To prevent emerging adults from escaping, plastic wrap was placed over the top of each tray and was secured with a rubberband. Adults were seen flying in the trays on May 30, 1987. By June 9 all adults had died and were counted. In order to compare adult counts between branches, the number of adults reared per 100 g of fresh leaf tissue was calculated and analyzed.

Statistical Analysis. Treatment means were compared using the general linear model and Duncan's (4) multiple range test at the P=0.05 level.

Results and Discussion

Foliar phytotoxicity was not observed on any treated tree. Assessment of foliar damage (Table 1) indicated that all treatments significantly reduced leafminer damage, but treatments types varied in the percentage of leaves damaged. Injecticide-B was responsible for the least amount of damage (1.6%). Ovipositing wounds were observed but no mine formation occurred. Soil-injected Meta-Systox-R and 3.0% NSE also reduced damage to less than 10%. Injecticide and 1.5% NSE were

Fig. 2. Extensive leaf mining damage on birch (Courtesy: B. Fiore)

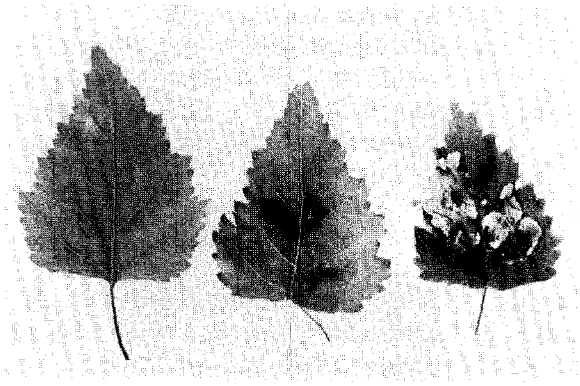

Fig. 3. Early development of leaf mines, later forming large disfiguring blotches. (Courtesy: B. Fiore)

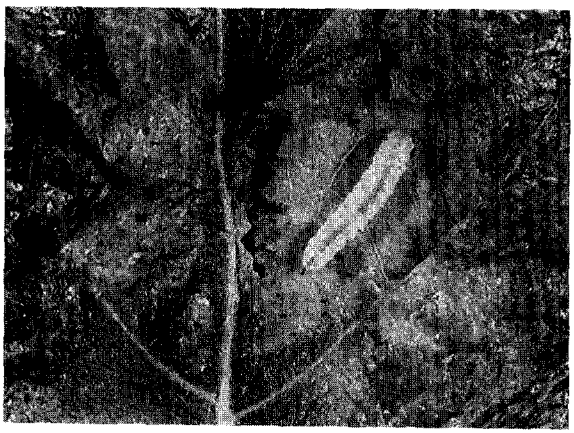

Fig. 4. Leaf mining larva feeding within birch leaf. (Courtesy B. Fiore)

Fig. 5. Adult birch leaf miner. (Courtesy: B. Fiore)

less effective but resulted in significantly less damage than in controls.

All treatments produced significant decreases in the number of adults reared per 100 g of leaf tissue (Table 1). Treatments with Injecticide B, soil-injected Meta-Systox-R, or 3.0% NSE resulted in the lowest adult counts, whereas treatments with Injecticide or 1.5% NSE proved slightly less effective. Although mortality of different larval stages was not followed, the low amount of damage on foliage from 3.0% NSE-treated trees indicated that young instars were killed before they could develop into larger blotch-forming older instars. Thus, microinjections may prove more effective in minimizing damage than slower acting foliar neem sprays (10).

The fact that NSE moved from the point of basal stem injection to the foliage demonstrates for the first time that NSE has systemic insecticidal activity in woody plants. Precise and carefully administered injections of NSE can provide a new and less toxic integrated pest management option in protecting landscape trees from insect pests.

Fig. 6. Kioritz Soil insecticide injection unit. (Courtesy: Mobay Corp.)

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Table 1. Effect of systemic insecticides on birch leafminers

	Means[1]		
Treatment	*% Damaged leaves*	*Number of reared adults/ 100g fresh leaves*	*N*[2]
1.5% NSE	14.0b	11b	5
3.0% NSE	7.8c	3b	6
Injecticide-Bidrin	1.6d	4b	5
Injecticide-Meta-Systox-R	16.7b	25b	6
Soil-Injected Meta-Systox[R]	3.8cd	2b	5
Water	40.8a	160a	6

1. Means within column followed by the same letter do not differ significantly (P=0.05; Duncan's (4) multiple range test).
2. N equals the number of trees treated and sampled, five branches per tree.

Fig. 7. Transformation of leaf mining larva into mature pupa. (Courtesy: B. Fiore)

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Abstracts

KLETT, J.E. 1988. **Crabapple evaluation update.** Colorado Green 4(3):12-14.

Crabapples have a long history of evolution which was led to the rise of over 700 variety and cultivar names. However, many of these have never been properly described and some of the names are not taxonomically valid. Therefore, the Department of Horticulture at Colorado State University, Fort Collins, elected to participate in a national research project. The department is one of 20 sites cooperating to evaluate approximately 50 different crabapple taxa for disease resistance; fruit color, size and retention; flower color; form and specific growth habits. This study also will help standardize crabapple descriptions on a nationwide basis, and ultimately provide guidance to homeowners and members of the green industry through publication of an easy-to-follow procedure for the best selection of the crabapple for a given application.

RITTERBUSCH, D.F. 1988. **Anchors away.** Colorado Green 4(2):32-37, 40-42.

The questions concerning guying have perhaps created more controversy over the years than in any other area of landscaping. In an attempt to clarify some of the controversy, Colorado Green conducted a survey of landscape professionals to obtain their preferences in these areas. It was the concensus of our survey respondents, that the make-shift and marginal products of yesterday should be discarded for the newer products that have been specifically designed for guying trees. The initial costs of these products may be slightly higher, but that is far outweighed by their reliability, safety and ability to be reused.