Frontline EXPRESS
Canadian Forest Service, Great Lakes Forestry Centre

Bulletin No. 14

Natural Products Entomology

INTRODUCTION:

This study addresses the need for finding sound and effective options for managing forest insect pests in Canada in the face of the declining availability and popularity of conventional chemical insecticides. Many plants produce a diverse array of chemicals with toxic, insect growth regulating or feeding deterrent properties, which provide protection against insect attack. This study is aimed at identifying suitable natural products from plant and fungi sources, determining their activity on important forest insect pests and elucidating the mechanisms of action of candidates. Neem and spinosad are showing promise against most of the major defoliating insects. Neem is a botanical insecticide containing the active ingredient azadirachtin, derived from extracts of the seed kernels of the neem tree, *Azadirachta indica* A. Juss. It is highly active on sawflies such as the pine false webworm by both foliar and systemic applications. Spinosad is a mixture of a group of insect control molecules called spinosyns, which are produced by a new species of Actinomycetes, *Saccharopolyspora spinosa*. Spinosad is extremely active against many larval insect pests such as spruce budworm and gypsy moth. An abundant compound in red and silver maple with very active antifeedant effects on forest tent caterpillar has also been discovered and is being studied for use in pest management. The research and development on neem, which has led to its registration for use in Canada, is highlighted in this bulletin.

A neem tree bearing fruit

LOCATION/SITE:

Research has been conducted in both laboratory and field settings. Neem has been assessed in jack pine plantations north of Sault Ste. Marie, Ontario, on white pine near Owen Sound, Parry Sound, Paisley, Sault Ste. Marie and Markdale (all in Ontario), in red pine plantations near Craighurst and Sprucedale, Ontario, in black and white spruce seed orchards and plantations in Sioux Lookout, Dryden and Balsam Lake, in white cedar on St. Joseph Island, Ontario and in balsam fir stands near Cornerbrook, Newfoundland.

Neem tree seeds

RESULTS:

In the laboratory, neem seed extract containing azadirachtin was very active on 13 species of tree-defoliating lepidopteran and sawfly (Hymenoptera) larvae. Sawfly species were much more susceptible than lepidopteran species. In field trials, ground-based foliar applications of neem at 50 g azadirachtin/ha by motorized backpack mistblower or compressed air sprayer have proven effective against white pine weevil, pine false webworm and introduced pine sawfly on pines. Dosages of 100 g/ha gave acceptable protection from spruce budworm damage on spruce and fir. Ultra-low-volume aerial applications of EC formulations at 50 g/ha were effective against balsam fir sawfly on balsam fir and pine false webworm on red pine. Neem seed extracts also possess systemic properties against forest defoliators and leafminers when inoculated into the trunks of trees. In field trials against pine false webworm, trunk inoculations of small red pine trees with undiluted EC formulations at 0.05g azadirachtin per tree before egg hatch provided excellent protection of both old and new foliage. Trunk inoculations of large, 25-30 cm diameter at breast height (dbh), 20-m tall, red pine at 0.02 and 0.05 g azadirachtin per cm dbh also provide excellent protection. Dosages of 0.1-02 g/cm dbh in large white spruce were effective against

spruce budworm larvae. A dosage of 0.01 g/cm dbh greatly reduced cedar leaf miner populations on white cedar. Systemic neem applications are also persistent. Treatment of 20-cm dbh white pine at 0.1 g/cm dbh resulted in high mortality of introduced pine sawfly larvae for at least 77 days. Injections for pine false webworm control can be made before winter, at least 7 months before egg hatch the following spring. A novel device, the Systemic Tree Injection Tube has been developed to inject neem formulations into trees under pressure,quickly, easily and inexpensively.

Systemic injection of neem extract into red pine

CONCLUSIONS:

Azadirachtin has proven to be an effective, versatile bioinsecticide in ground, aerial and systemic applications for the management of several forest pests, particularly sawfly species in high value plantations. One commercial product, Neemix 4.5, is now registered for use on three sawfly species in Canada. Azadirachtin also provides a new control alternative for white pine weevil with a wider, later application window than conventional insecticides that may be preferable to pest managers. Azadirachtin is also the first botanical insecticide with demonstrated excellent systemic properties in trees.

MANAGEMENT INTERPRETATIONS:

Azadirachtin is the only alternative to conventional insecticides currently available for managing most sawfly pests and white pine weevil. This bioinsecticide is safe to mammals and birds. It does not pose a significant risk to most other non-target organisms including bees, fish and aquatic insects at effective dosages, and it degrades readily in the environment. The short residual life of azadirachtin-based insecticides when applied as a foliar application, although attractive from an environmental perspective, can be a significant limitation for forest management. This limitation may be overcome by applying neem formulations that can persist for a year or more, systemically into trees. For example, systemic applications into large pines for pine false webworm control is a promising approach for selective treatments, including seed orchards, small pockets of infestation, and ornamental trees in urban environments. The cost of neem insecticide formulations is higher than most conventional insecticides, but their low impact to non-target organisms makes them an attractive alternative. This is even more so with systemic applications, which further reduce any impacts to non-targets, or hazards to handlers.

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