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SYSTEMIC INSECTICIDES

For the Treatment of Southern Pine Beetle

Division of Lands and Forests – Forest Health

Southern Pine Beetle Response

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Background

In commercial southern pine forests, large-scale insecticide use for direct control of southern pine beetle (SPB) was withdrawn in the early 1970's due to its high cost, questionable effectiveness on a landscape scale, and harmful impacts on nontarget invertebrates, including SPB's natural enemies (Billings 2011). Chemical treatments are now limited to protecting only high-value, individual trees growing in unique environments or under unique circumstances (Fettig. et al. 2013), typically in recreational or residential settings. Mechanical control (cut-and-leave, cut-and-remove), which is rooted in SPB biology, behavior and host/beetle dynamics, has largely replaced chemical control in commercial forest settings.

Hydraulic bole spraying

Protection of high-value trees has generally involved the application of insecticides to the tree bole using a hydraulic sprayer. Although effective, bole sprays require the transport of sprayers and other large equipment, which can be problematic in forests where snow or poor road conditions may limit access. Also, many recreational sites (campgrounds) where bole sprays are applied occur close to ephemeral streams associated with spring runoff. This close proximity to streams limits applications in late spring due to no-spray buffer restrictions (Fettig et al. 2013). Bole sprays are only effective against SPB for short periods of time, about 3-6 months (Billings 2011).

Chemical options and efficacy

Several products with the active ingredients permethrin or bifenthrin are registered in New York State for the prevention of SPB and related bark beetle attacks. While limited research has occurred, permethrin appears to have longer residual activity than bifenthrin in small bolt assays (Strom & Roton 2009).

Carbaryl, a neurotoxin is still considered by many experts to be the most effective, economically-viable, ecologically sound insecticide available for protecting trees against pine beetle- induced mortality (Fettig et al. 2006, Hastings et al. 2001). However, in the southern and western U.S., carbaryl is considered ineffective for preventing southern pine beetle attacks and subsequent mortality (Fettig et al. 2009). This is linked to SPB insecticide tolerance, as the beetles efficiently convert carbaryl into metabolites which are rapidly excreted (Ragenovich & Coster 1974, Zhong et al. 1994).

Systemic insecticides

Systemic insecticides are showing promise as a safer, more portable and long-lasting alternative to bole sprays. These water-soluble chemicals can be injected directly into the trunk and transported by the phloem and xylem, killing or repelling insects that attempt to colonize or feed on the tree. Stem injections represent an essentially closed system that can eliminate drift and reduce nontarget effects and applicator exposure (Fettig et al. 2013). Earlier injection methods were fairly ineffective, until phloem-mobile active ingredients injected with pressurized systems were developed. These methods have been evaluated for southern pine beetle, mountain pine beetle, engraver beetles, spruce beetle and western pine beetle. Chemicals are pushed into small vesicles of the

sapwood (Sanchez-Zamora & Fernandez Escobar 2004). In most cases, applications take <15 minutes per tree (Fettig et al. 2013).

Chemical options and efficacy

Systemic insecticides emamectin benzoate, an avermectin derivative, and fipronil, a phenyl pyrazole, have shown the most promise in their capacity to reduce bark beetle colonization success and mortality in conifers. In 2004, Grosman and Upton conducted a trial in East Texas to evaluate the ability of these insecticides to protect loblolly pine against *Ips* engraver beetles. Both chemicals were highly effective at preventing both the colonization of treated bolts and the mortality of standing trees 3 and 5 months after injection (2006). Fipronil, however, was slower to diffuse through the tree than emamectin benzoate, and provided incomplete protection 4 weeks after injection. But, by 3 months post injection, the chemical had fully dispersed and provided full protection (Grosman & Upton, 2006).

After this initial success, injection trials were extended to the more aggressive *Dendroctonus* bark beetles. In Alabama and Mississippi, results from 2006-2007 conclusively showed that emamectin benzoate prevented successful attack by SPB. Emamectin benzoate effectively inhibited parent gallery construction, brood development, and emergence of both *Ips* engraver beetles and SPB from treated loblolly pines. Fipronil also considerably reduced mortality of treated trees compared with control trees, but reduced brood size to a lesser extent than emamectin benzoate (Grosman et al. 2009).

Although emamectin benzoate has shown efficacy at protecting conifers from bark beetle attack, it cannot protect trees from the blue-stain fungi that beetles introduce. Fettig and others (2013) tested the efficacy of bole injections of emamectin benzoate alone and combined with the fungicide propiconazole in protecting lodgepole pine (*Pinus contorta*) from the mountain pine beetle (*Dendroctonus ponderosae*). Their data indicated that injections of emamectin benzoate + propiconazole may have limited the progression of blue stain fungi in some trees, but the effect was masked by the proportion of trees killed. They also showed that emamectin benzoate is effective for protecting lodgepole pine from mountain pine beetle-induced mortality, but it is crucial that injections occur the year before the tree protection is needed. In this study, however, injecting emamectin benzoate + propiconazole afforded protection the same year if injections were applied before beetle flight. Injections may be applied any time of year that the tree is actively translocating, but sufficient time is needed to allow for full dispersal of the active ingredient within the tree before being attacked by the beetles. Under optimal conditions (good tree health, moderate temperatures, moist soil), this takes about 4 weeks (Grosman et al. 2009), but may take much longer in high elevation forests where low soil temperatures slow the absorption and transport of nutrients and water (Fettig et al. 2013).

TREE-äge, a systemic insecticide with the active ingredient emamectin benzoate, has shown protective value, and is available to professional arborists licensed to apply pesticides in New York State. The treatment lasts 2-3 years, but does not offer complete protection. Beetles are still able to attack the tree and vector the blue stain fungi which may cause tree decline or death.

Emamectin benzoate is a promising treatment for high-value trees at risk for SPB infestation, but more research is needed. Efficacy of treatments at different times of the year and in different climatic conditions need to be evaluated, as well as against other bark beetle-host tree complexes (Sanchez-Zamora and Fernandez Escobar 2000), like SPB in pitch pine. Also, the effects of emamectin benzoate on nontargets must also be assessed (Kreutzweiser et al. 2008). New tests have been developed that evaluate the concentration of emamectin benzoate and fipronil in conifer tissues. These new techniques need to be employed to determine movement of chemicals through the phloem, where southern pine and other bark beetles develop.

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