

Abamectin Systemic Tree Injections for Protection of Conifers Against Bark Beetles

Donald M. Grosman¹, Christopher Fettig², William W. Upton¹, and Marianne Waindle³

¹Texas Forest Service, Lufkin, TX 75902, Ph: 936-639-8170, email: dgrosman@tfs.tamu.edu and hupton@tfs.tamu.edu;

²Pacific Southwest Research Station, USDA Forest Service, Davis, CA, 95618, Ph: 530-759-1708, cfettig@fs.fed.us;

³J.J. Mauget, Arcadia, CA, 91006, Ph: 916-717-3009, mwaindle@sbcglobal.net.

Introduction

Pine bark beetles, including the mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins, and southern pine beetle (SPB), *D. frontalis* Zimmerman, are some of the more important forest pests in the United States (Billings et al. 2004) with local and regional outbreaks causing severe economic losses on a nearly annual basis. Other species of pine bark beetles, including the secondary pests *Ips avulsus* (Eichoff), *I. grandicollis* (Eichoff), and *I. calligraphus* (Germar), also are known to cause significant tree mortality particularly during severe drought periods in the southeastern U.S. (Wilkinson & Foltz 1982). The current abundance of susceptible trees and forests underlines the need to develop new methods to protect individual trees from bark beetle attacks.



Protection of individual trees with insecticides has historically involved applications to the entire bole of the tree using ground-based hydraulic sprayers (Fig. 1, photo left by C. Fettig). Spray applications may result in drift (Fettig et al. 2008), which can be detrimental to natural enemies and generally require the use of large equipment which can limit the ability to reach and treat target trees.

The systemic insecticide emamectin benzoate (Syngenta Crop Science) was found to be highly effective (2+ years) against *Ips* engraver beetles, (Grosman and Upton 2006), SPB (Grosman et al. 2009) and western pine beetle, *D. brevicornis* LeConte (Grosman et al. 2010). A closely-related systemic, abamectin (Syngenta), was efficacious against elm leaf beetle (Harrell and Pierce 1994). It is of interest to determine if abamectin is similarly effective in preventing the successful colonization of treated bolts by *Ips* engraver beetles. A second trial was later initiated to determine the efficacy of abamectin alone or combined with tebuconazole, a fungicide, for protecting individual trees from MPB attack and associated levels of tree mortality.

Materials & Methods

Trial 1: Loblolly pine (*Pinus taeda* L.) trees (180) were selected in a 20 YO pine plantation (Rayonier) in Polk county, TX. Thirty to forty trees were each injected with one of two treatments: abamectin (April and October 2008) at two different rates (0.16 and 0.32 g AI / cm dia., Abacide® 2, Mauget), or used as an untreated control.

The systemic insecticide (Aba) were injected with the Arborjet Tree IV™ microinjection system (Arborjet Inc., Woburn, MA.) into 4 points 0.3 m above ground to each study tree (Fig. 2).

At different intervals post-injection, 10 trees of each abamectin treatment were felled and a 1.5 m bolt section was taken from 3 m height of the bole. These bolts were exposed to *Ips* engraver beetles and wood borers for 3 weeks. In the laboratory, 20 10 cm X 50 cm bark samples (total = 1000 cm²) were removed from each bolt to determine the attack success of bark beetles and cerambycids (Table 1).

Trial 2: Ninety (90) (lodgepole pine, *Pinus contorta* L.) were selected in the Uinta-Wasatch-Cache National Forest. Three treatments, abamectin alone (ABA) (0.16 g AI / cm dia., Mauget), ABA + tebuconazole (T, a fungicide) (0.16 g AI / cm dia., Tebujet™ 16, Mauget), and an untreated control were randomly assigned to each of thirty trees. The control group was used to assess bark beetle pressure (based on mortality of untreated, baited trees) during 2010-2011.

The systemic insecticide (Aba) and fungicide (T) were injected with the Arborjet Tree IV™ into 8 points 0.3 m above ground to each study tree (Fig. 2). Injected trees were allowed about 10 months time to translocate chemicals prior to being challenged by baiting (MPB tree baits, Synergy Semiochemical Corp., Burnaby, BC, Canada).

Treatments were considered to have sufficient beetle pressure if ≥60% of the untreated control trees died from bark beetle attack. Insecticide treatments were considered efficacious when <20% of the trees died as a result of bark beetle attack (Shea et al. 1984; Fig. 4).

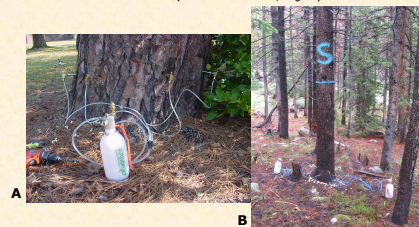


Figure 2. Tree injections using Arborjet's Tree IV™ in Texas, 2008 (A) and Utah, 2009 (B).

Results

Table 1. Effects of abamectin (Aba) injection treatments on the success of *Ips* engraver beetle adult attack, brood development, and success of cerambycid larvae in loblolly pine logs in Texas: 2008 - 2011.

Evaluation period	Season/Yr Injected	Treatment	N	No.	% of total chambers	Mean # of pupal chambers with egg galleries		Number of egg galleries		Length of egg galleries		No. of cerambycid egg niches on bark	Percent phloem area consumed by larvae	
						No.	% of Total	No.	% of Total	No.	% of Total			
5 month post-injection (Sept '08)	Spring 2008	Aba 0.32 g AI	11	0.3 *	6	4.5	0.0 *	0	0.2 *	0.0 *	0	0.5 *	4.3	0.1 *
		Aba 0.16 g AI	9	0.9 *	21	4.2	0.0 *	0	1.2 *	0.0 *	0	3.9 *	6.3	1.3 *
		Check	11	4.2	87	4.8	6.6	82	8.1	74.0	90	82.5	7.9	10.1
10 month post-injection (Aug '09)	Fall 2008	Aba 0.32 g AI	9	0.0 *	0	4.0	0.0 *	###	0.0 *	0.0 *	###	0.0 *	1.7	0.0 *
		Aba 0.16 g AI	8	0.0 *	0	3.9	0.0 *	###	0.0 *	0.0 *	###	0.0 *	1.9	0.0 *
		Check	10	3.2	81	4.0	9.4	100	94.4	94.9	100	94.9	4.4	7.7
16 month post-injection (Aug '09)	Spring 2008	Aba 0.32 g AI	10	0.0 *	0	4.6	0.0 *	###	0.0 *	0.0 *	###	0.0 *	0.9	0.0 *
		Aba 0.16 g AI	10	0.0 *	0	4.5	0.0 *	###	0.0 *	0.0 *	###	0.0 *	3.6	0.0 *
		Check	10	3.2	81	4.0	9.4	100	94.4	94.9	100	94.9	4.4	7.7
22 month post-injection (Aug '10)	Fall 2008	Aba 0.32 g AI	10	0.5 *	20	2.5	0.0 *	0	0.4 *	0.0 *	0	1.4 *	7.9	0.0 *
		Aba 0.16 g AI	10	0.2 *	9	2.2	0.0 *	0	0.3 *	0.0 *	0	1.7 *	5.6	0.1 *
		Check	10	3.2	81	4.0	9.4	100	94.4	94.9	100	94.9	4.4	7.7
28 month post-injection (Aug '10)	Spring 2008	Aba 0.32 g AI	10	0.3 *	12	2.5	0.0 *	0	0.3 *	0.0 *	0	0.8 *	5.9	0.0 *
		Aba 0.16 g AI	10	0.5 *	14	3.6	0.0 *	0	0.5 *	0.0 *	0	3.2 *	8.2	0.0 *
		Check	10	2.5	94	2.6	4.5	79	5.7	73.2	83	87.9	6.8	22.0
34 month post-injection (Aug '11)	Fall 2008	Aba 0.32 g AI	10	0.4 *	4	8.9	0.0 *	0	0.7 *	0.0 *	0	2.0 *	6.6	0.3 *
		Aba 0.16 g AI	9	0.3 *	4	7.9	0.0 *	0	0.4 *	0.0 *	0	1.2 *	5.6	0.2 *
		Check	10	3.2	81	4.0	9.4	100	94.4	94.9	100	94.9	4.4	7.7
40 month post-injection (Aug '11)	Spring 2008	Aba 0.32 g AI	9	0.1 *	2	5.7	0.0 *	0	0.3 *	0.0 *	0	1.0 *	4.0	0.0 *
		Aba 0.16 g AI	10	0.1 *	2	6.6	0.0 *	0	0.2 *	0.0 *	0	0.7 *	4.6	0.4 *
		Check	9	5.4	100	5.4	15.6	100	15.6	208.4	100	208.4	4.6	38.7

* Means followed by an asterisk in each column of the same time interval are significantly different from the check at the 5% level based on Fisher's Protected LSD.



Figure 3. Bolts collected from abamectin-injected (A), and untreated (B) study trees in Texas showing success of *Ips* spp. attack and colonization in 2009.

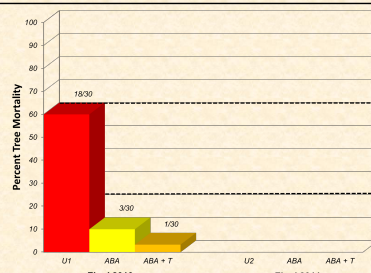


Figure 4. Effects of abamectin ± tebuconazole injection treatments on lodgepole pine, *Pinus contorta*, mortality caused by mountain pine beetle, *Dendroctonus ponderosae*, Uinta-Wasatch-Cache National Forest, Utah.

Trial 1: Evaluation of bolts collected from treated and untreated loblolly pine trees in 2008 - 2011 indicated that a similar number of *Ips* engraver beetles attacked the bolts regardless of treatment (Table 1). However, the success of the *Ips* in constructing galleries (> 2.5 cm) or producing brood was significantly less for both injection treatments, regardless of season, compared to the checks (Fig. 3). Similarly, the number of cerambycid egg niches was similar for all treatments, but there were significantly less phloem consumed by larvae in the injected logs.

Trial 2: Nearly all baited trees were heavily attacked by MPB within 3 weeks. A final assessment for the 2010 season was conducted in September 2011 and showed heavy mortality (60%, 18 of 30) of untreated lodgepole pine trees (Fig. 4). Mortality of trees treated with ABA alone and ABA + fungicide in the fall of 2009 were 10% and 3%, respectively. Thus, both treatments were below the 20% threshold. A final assessment for the 2011 season is planned for summer 2012.

Conclusions

The results of Trial 1 indicate that abamectin injection treatments can provide good protection against *Ips* engraver beetles and wood borers for 3+ years. There was no difference in efficacy of the two rates. An additional trial is under way to determine the efficacy of lower rates of abamectin (0.08 and 0.04 g AI / cm dia.) against *Ips* engraver beetles and wood borers.

In response to the initial results (after 5 months) in the Texas trial, the second trial was established in Utah to evaluate treatment efficacy against MPB. Based on the established criteria of when 60% mortality of check trees occurred, abamectin injections successfully prevented mortality of standing pines from MPB for at least one year after treatment. This is the second published report documenting that a systemic insecticide is capable of protecting individual pines from a *Dendroctonus* species - emamectin benzoate was the first (Grosman and Upton 2006). The experimental design utilized (Shea et al. 1984) in these trials provided an extreme test of the ability of the tested systems to protect individual trees. Tree injections would be most applicable for high value trees in urban or recreation areas. These trees rarely would face the beetle pressure created by baiting. The success of abamectin at the Utah site under this type of challenge indicates this insecticide have utility in tree protection.

Spring applications of emamectin benzoate using just four application points was marginal for MPB (Grosman et al. 2010). However, fall applications of abamectin when applied at closer spacing (8 points) did provide very good protection. Thus, closer spacing and/or a longer distribution period appears to be necessary for good protection against MPB. Also, it appears that the addition of a fungicide may reduce the success of blue stain fungi colonization. It is not yet apparent if the combination treatment improved protection compared to abamectin alone. The Utah trial will be monitored in 2012 to evaluate the duration of efficacy of abamectin alone and combination treatments of abamectin and fungicide.

Acknowledgments

We thank L. Spivey, B. Kavanagh, N. Battise (Texas Forest Service); S. Munson, and C. Halesy (USDA Forest Service) for assistance. This research was supported, in part, by Mauget grants 2008-2011 and the Forest Pest Management Cooperative. We appreciate the chemical donations made by Mauget and injection equipment loans by Arborjet, Inc.

Literature Cited

Billings, R.F. et al. 2004. *Unasylva* 55: 15-21.
 Fettig C.J. et al. 2008. *J. Environ. Qual.* 37: 1170-1179.
 Grosman, D.M., and W.W. Upton. 2006. *J. Econ. Entomol.* 99: 94-101.
 Grosman, D.M. et al. 2009. *J. Econ. Entomol.* 102: 1002-1009.
 Grosman, D.M. et al. 2010. *West. J. Appl. For.* 25: 181-185.
 Harrell, M.O. and P.A. Pierce. 1994. *J. Arboriculture.* 20: 1-3.
 Shea, P.J., et al. 1984. *J. Ga. Entomol. Soc.* 19: 427-432.
 Wilkinson, R.C., and J. L. Foltz. 1982. *GA Forestry Commission GA Forest Research Paper No. 35.*



Eastern six-spined engraver *Ips calligraphus* Germar
 Mountain pine beetle *Dendroctonus ponderosae* Hopkins