Elongate Hemlock Scale Control: Technical Report to Christmas Tree Promotion Board

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Introduction: Elongate hemlock scale (EHS) has been an issue in the eastern US since it was first introduced in the early 1900s. Primarily a pest of hemlocks, it has become a problem with firs and Douglas fir grown for Christmas trees. Though the pest seldom damages trees in western North Carolina, the presence of scales on trees and wreaths or roping restricts sale of those products to many states and countries that currently do not have this pest.

Chemical control studies have been on-going since the 1950s. More than 60 insecticides have been used against EHS with varying levels of success. Products that have recommended for growers to control scale include Safari (both foliar and trunk application), Movento, Dimethoate, Dimethoate mixed with either bifenthrin or Asana, horticultural oil, and Distance.

Control of this pest is difficult for several reasons. First, EHS is an armored scale and feeds on internal mesophyll cells. Because EHS doesn't feed in the vascular system, systemic insecticides don't work as well as they do on soft scales. Secondly, the life cycle of EHS is not synchronous. Scale control typically targets crawler release. Though EHS does have a peak crawler production in the spring as new shoots are elongating as well as in the fall, crawlers have been observed in western NC every month of the year. Thirdly, the parasitic wasp, *Encarsia citrina*, has been observed to control as many as 75% of females in western NC. Insecticide applications for any pest have the potential to negatively impact this important biological control which then allows for the quick rebound of scale numbers.

Two EHS control studies were conducted in 2019 and 2020 with CTPB support. The first was along-term scale control demonstration in grower's fields to control all pests including scales through the use of Sivanto for balsam twig aphid control and Safari for EHS control. The second was a pesticide screening of new potential products for scale control conducted in conjunction with Dr. Richard Cowles, Connecticut Research Station. Only controls from the North Carolina study are presented in this report.

LONG-TERM SCALE CONTROL DEMONSTRATIONS

Though control of EHS has become the primary goal of pest control for many North Carolina Fraser fir growers, scales are not the only pests that damage trees. The increased use of synthetic pyrethroids to control twig aphids in the past is one reason EHS has become so prevalent in the area.

Sivanto (active ingredient flupyradifurone) is a systemic insecticide proven effective for the control of twig aphids and the balsam woolly adelgid. In some cases, spider mite flare-ups have been observed, though typically natural control through mite predators occurs before trees are noticeable damaged. Unlike other materials, Sivanto has little impact on twig aphid predators, and limited effect on *E. citrina*. Safari (active ingredient dinotefuran) is a neonicotinoid that has proven effective against EHS. The hope is that by using these materials each year regardless of pest numbers, EHS incidence won't increase and perhaps decrease.

Materials and Methods: Three fields were selected in Avery County in NC. Fields varied in size from several hundred trees to just over an acre. Trees were treated with a high-pressure sprayer with Sivanto in April 2019, Safari in early July 2019, and were again treated in April 2020 with Sivanto and July 2020 with Safari. Comparisons were made to adjacent fields managed by the grower.

Both twig aphid control and EHS control were monitored at all locations both years. The presence of twig aphids and twig aphid predators was monitored during bud break by beating foliage over observation boards. Foliage was collected after aphid egg had been laid to determine the prevalence of eggs for the next growing season. Twig aphid damage estimates were based on percentage of foliage exhibiting needle curl. EHS control was monitored by estimating the percentage of trees with scales and rating whether the population was low, medium or high in sampled trees.

Results and Discussion: Years vary in their twig aphid pressure. There was little twig aphid damage region-wide in 2019 but much more in 2020. Using Sivanto results in good twig aphid control with the added bonus of reducing twig aphid egg numbers for the following growing season (Table 1), while maintaining natural enemies of pests. By comparison, growers did not get as good of control of twig aphids in 2020. The Avery-1 field was treated with bifenthrin which gave good control initially but resulted in final damage and high twig aphid counts because natural predators were also killed. In 2020, growers at both Avery-2 and Avery-3 used Sivanto for twig aphid control. At Avery-2 the grower used a mistblower for application and ended up without good coverage and which resulted in damage. At Avery-3 the grower applied the material after bud break, thereby limiting its effectiveness.

The Safari treatments have not 'cured' the pre-existing incidences of EHS. The Avery-1 site has little scale. At the Avery-2 site, virtually all trees have EHS. However, where we've been treating with Safari, no trees had more than just a light incidence, whereas where the grower was treating, there were many trees heavily infested. At the Avery-3 site, scale control was poorer in our treated sites. However at this site, there are large trees (>12 feet) with scale in an adjacent block which resulted in crawlers continuing to inundate these trees.

Table 1. Control of balsam twig aphids with Sivanto in long-term scale control studies.

Farm	2019			2020 – our treatments		2020 – grower treatments	
	Pretreatment aphid numbers (aphids/shoot)	Highest BTA damage % needle curl (summer)	BTA egg counts (summer)	Highest BTA damage % needle curl (summer)	BTA egg counts (summer)	Highest BTA damage % needle curl (summer)	BTA egg counts (summer)
Avery-1 Cartner	1.8	0 %	0.05	5 %	0.0	50 %	1.0
Avery-2 Horney	0.1	0 %	0.05	1 %	0.0	30 %	0.0
Avery-3 Edwards	0.9	0 %	0.05	5 %	0.3	50 %	0.05

EHS PESTICIDE SCREENING

Materials and Methods: Materials tested are listed below and include the active ingredient, the rate used, and the approximate cost/acre as determined in July 2020 in NC at a local pesticide dealer and assuming 200 GPA. The cost of adjuvants was not included:

- Safari (dinotefuran) – 8 oz/100 gallons – $ 120
- Safari + LI 700 adjuvant – 8 oz/100 gallons - $ 120
- Movento (spirotetramat) – 10 oz/acre - $ 73
- Distance (pyriproxyfen) – 12 oz/100 gallons - $ 176
- Mainspring + Capsil (cyantraniliprole) – 16 oz/100 gallons - $ 326
- Ventrigra (afidopyropen) – 7 oz/100 gallons - $ 206
- TriStar (acetamiprid) – 25.3 oz/acre - $ 253
- Aria (flonicamid) – 4.3 oz/100 gallons - $ 233
- Untreated check

Materials were applied in a heavily infested field in Carter County, Tennessee with a backpack mistblower on July 9, 2020. One gallon of spray was used on about 45 3 – 5 foot trees resulting in an estimated 42 gallons per acre.

Initial control was evaluated on August 7 (30 days after treatment) by collecting an infested branch from five trees. Ten needles of 2020 growth was collected from each branch and examined under a stereomicroscope to determine if the insects beneath the armored covering were alive or dead and if alive, their life stage and sex. Individuals were considered alive if they actively bled when their body was punctured with a probe. Female scales were considered parasitized if there was an emergence hole, a developing wasp, or the body of the scale was liquefied. A second evaluation was made on November 6 (121 DAT). At that time, needles were taken from both 2020 and 2019 growth. From counts, the number

of scales per needle on the 2020 growth, the percentage of dead scales, the percentage of dead females and percentage of female scales that were parasitized was calculated.

Results and Discussion: It's not easy to assess control of EHS. For most pests, determining the percentage of the pests that are dead is the most important measure. But to assess scale control, additional observations are important. The adult females are the hardest stage to control, so it's important to determine percentage of females killed. If materials kill off the parasitic wasp, EHS can quickly rebound, so it's important to maintain parasitism. If controls are working well, there will be fewer scales getting onto the new growth. Though treatments in this study were made in early July after scales had started to move on 2020 growth, they would have been nymphs and still easy to control. Comparing control parameters from the first to the second assessment shows how long controls are lasting.

Control at the two evaluation dates is reported in Table 2. Many scales were dead in the untreated check. This included parasitized females, but also many nymphs that were dead for an unknown reason.

Several products appear to give some control of scale. Control with Safari appear to improve over time. Adding the adjuvant to Safari did not improve control. Both Distance and TriStar resulted in slightly better control than with Safari. The lower parasitism rate for TriStar could be a problem for long-term control with this product. That is why it is important to carefully determine incidence prior to treating and to continue to monitor control over a period of several months.

Though several of these products show promise, they are also expensive. Further evaluation is advised.

Table 2. Control of elongate hemlock scale following a single insecticide treatment.

Material	30 DAT*				121 DAT**			
	# scales/ needle	% scales dead	% females dead	% females parasitized	# scales/ needle on 2020 growth	% scales dead	% females dead	% females parasitized
Safari	3.5	61 %	47 %	47 %	11.4	83 %	56 %	29 %
Safari + LI 700	8.3	56 %	83 %	63 %	10.6	80 %	62 %	27 %
Movento + LI700	7.3	58 %	71 %	50 %	5.6	46 %	54 %	35 %
Distance	7.0	56 %	90 %	67 %	10.4	87 %	77 %	24 %
Mainspring + Capsil	9.6	87 %	86 %	61 %	9.0	75 %	63 %	29 %
Ventigra	5.9	61 %	75 %	70 %	5.1	57 %	63 %	47 %
TriStar	10.8	90 %	70 %	28 %	10.4	90 %	78 %	10 %
Aria	7.8	58 %	86 %	66 %	2.8	65 %	65%	55 %
Untreated check	6.6	59 %	66 %	50 %	6.6	69 %	73 %	52 %

*Samples taken from 2020 growth only

**Samples taken from both 2019 and 2020 growth