Insecticide toxicity, application efficacy, and degree-day modelling of an emergent Christmas tree pest, the Douglas-fir twig weevil (*Cylindrocopturus furnissi*)

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Introduction

The Douglas-fir twig weevil (*Cylindrocopturus furnissi*) is a problem on virtually all species of Christmas trees grown in the Pacific Northwest. Historically it has been a sporadic problem on Douglas-fir Christmas trees, particularly on trees planted on sites that are prone to moisture stress. However, during the past few years, this pest has emerged as a significant export issue and affects growers' ability to develop a quality tree for both domestic and export markets. It is also affecting the marketability of noble fir boughs in low elevation production stands.

~3 mm

Twig weevil is the number one insect pest causing load rejections into Mexico. From 2014 to 2018 over 50% of the rejected Christmas tree loads shipped from Oregon to Mexico were rejected due to twig weevil. In an effort to develop a pest management strategy on adult weevils, the most susceptible life stage to contact insecticides, we:

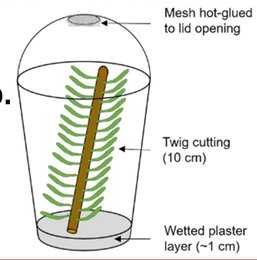
- **Conducted laboratory experiments to determine which commonly used pesticides are most effective in killing twig weevils**
- **Compared the effectiveness of aerial vs grand-based application of esfenvalerate (Asana XL) in killing twig weevils, and**
- **Developed a degree-day model for adult emergence**

Pesticide Efficacy

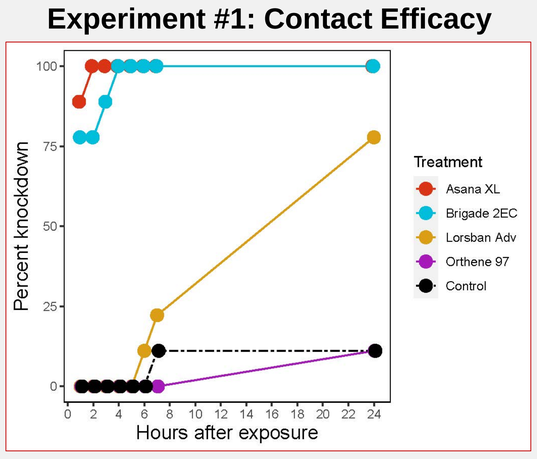
Contact Efficacy Experiment: 50 total weevils were dabbed with a Q-tip, which was saturated with one of five solutions: each of the four candidate insecticides mixed to label rate or water (control). Knockdown of weevils was monitored for 24 hours.

	Product name	Active ingredient
●	Asana XL	Esfenvalerate (Pyrethroid)
●	Brigade 2EC	Bifenthrin (Pyrethroid)
●	Lorsban Advanced	Chlorophyrifos (Organophosphate)
●	Orthene 97	Acephate (Organoposphate)

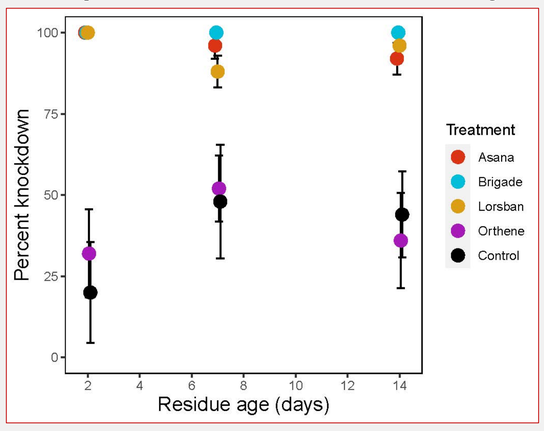
Residual Efficacy Experiment: Treatments were assigned to branches on 16-year-old, open grown Douglas-fir trees in a randomized block design. Second year twig growth segments were sprayed either with an insecticide or a control (water) 14, 7, and 2 days prior to experimentation. This resulted in 15 treatment combos, replicated five times for 75 total twigs to be assessed. Twigs were cut and put in experimental bioassay cup enclosures. Five weevils were then released in each cup. Knockdown was assessed after 24 hours. After this period, the treated twigs were removed and untreaded twigs were put into every cup to assess weevil recovery after insecticide exposure.



Experiment #1: Contact Efficacy



Experiment #2: Residual Efficacy

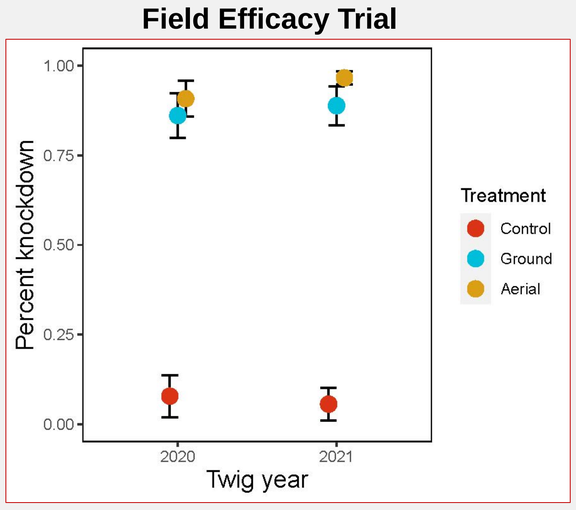


Asana and Brigade were the most efficacious in knocking down adult twig weevils, both on contact and after feeding on twigs applied with the products two weeks prior. In Experiment 1, Asana and Brigade both knocked down all weevils within four hours, whereas the other insecticides failed to knockdown the entire population within the 24-hour period. In Experiment 2, Asana, Brigade, and Lorsban all had excellent residual knockdown on weevils up to 14 days, whereas Orthene failed to perform better than the water control.

Aerial vs. Ground Applications

The efficacy of helicopter and ground-based applications of Asana XL, applied at the labeled rate of 9.6 oz in 10 gallons of water per acre, was determined in a replicated trial conducted in two plantations of 5- to 7-foot-tall Douglas-fir Christmas trees. One day after applications, a bioassay experiment was conducted by placing twig samples of the 2020 and 2021 growth from treated and unsprayed trees in a bioassay cup chamber. Following a 24h starvation period, five twig weevils were then introduced per cup. After 24 hr the number of dead or incapacitated weevils (i.e. knocked down) in each cup was determined. Afterward, the number of twig weevil feeding wounds (indicating feeding activity) was counted on each twig under a stereo microscope.

Field Efficacy Trial



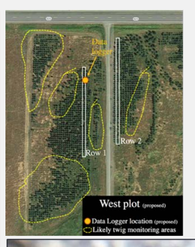
Degree-day Model

Monitoring development of flagging symptoms in 2020 and 2021

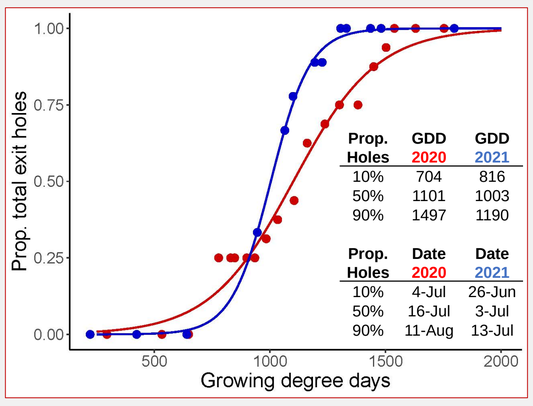
- **Initial development in late March**
- **Main period early May – early July**

Monitoring adult emergence in 2020 and 2021

- **Adults emerge from late June to mid-August**
- **Mid July was main period of emergence**



Degree-day model for both 2020 and 2021



⟸Tables displaying the growing degree days (GDD) and dates where 10%, 50%, and 90% of adult emergence occurred, as estimated by the models for each year.

The number of growing degree days (base 50 F, January 1st biofix, single sine method) for 50% of the adult weevil population to emerge ranged from 1000 to 1200, with the entire emergence window ranging from 500 to 1500. The 50% emergence threshold is likely the best time to initiate sprays, because the residual activity from a single application of products such as Asana and Brigade should last until adult emergence is nearly complete.

Future Research

The limited difference in the efficacy of Asana in killing twig weevils exposed to 1-yr-old vs. 2-yr-old shoots in our 2021 field trial was surprising given that 2-yr-old shoots are often not directly exposed to the open sky. Water-sensitive spray cards will be used in 2022 to compare the spray deposit on cards that are positioned next to 1-yr-old and 2-yr-old shoots to better understand the 2021 efficacy data.

Selected Reference

Joe DeFrancesco, Joe and Katie Murray. 2009. Pest management strategic plan for Christmas trees in Oregon, Washington, and Idaho. Summary of a workshop held on February 2nd and 3rd, 2009 Aurora, Oregon. https://ipmdata.ipmcenters.org/documents/pmsps/OR-WA-IDChristmasTreesPMSP.pdf

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