Potential repellency of cedarwood oil from a novel extraction method to stored product insects

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Introduction

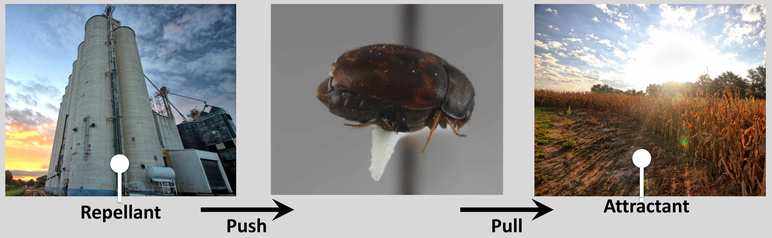
Producers lose 10-30% of crops during storage, processing, and marketing after harvest each year to stored product insects.[1,2] Globally, there has been a rise in insecticide resistance to phosphine, the most common fumigant for these pests.[3] As a result, producers need to diversify post-harvest IPM methods to preserve existing tools. One alternative strategy is push-pull, whereby a repellent is used to "push" an insect away from the commodity of interest, while also simultaneously "pulling" the insects to an alternate location away from the commodity using an attractant[4] (Fig. 1). This system notably requires a long-distance repellent. One potential repellent includes cedarwood oil, which has shown repellency to termites and ants.[5,6] A novel extraction process for this compound has been developed, which leaves many of its main constituents intact.[7] However, to date, this compound has never been assessed for repellency to post-harvest insects.

Objectives

Our goals were to:

1) Determine whether cedarwood oil is a long-distance repellent in the wind tunnel
2) Evaluate whether cedarwood oil is a contact repellent using video tracking (Ethovision)

Push-Pull Concept



Study Species

Rhyzopertha dominica

Sitophilus oryzae

Tribolium castaneum

Trogoderma variabile

Materials and Methods

Source Individuals. For all assays, 4-8-week-old *R. dominica* reared on tempered wheat, *T. castaneum* reared on flour (95%) and brewer's yeast (5%), *S. oryzae* reared on 13% tempered wheat, and *T. variabile* reared on pulverized dog food (300 g SmartBlend, Purina One), with rolled oats, and a moistened paper towel on top (all held at 27.5˚C, 60% RH, and 14:10 L:D).

Wind Tunnel Assay. Long-distance repellency was studied with 20 µL of cedarwood oil which was placed on a 70 mm filter paper in a petri dish and set 13.5 cm upwind of the stimulus edge of a 21.6 x 27.9 cm arena. The edge on which adults exited was recorded as either the stimulus edge (Fig. 2A), or non-stimulus (one of the other three edges). Trials lasted 2 min, and non-responders were excluded from the analysis. A total of thirty replicate adults were tested with cedarwood oil and another thirty were tested with a control of 20 µL deionized water for each species.

Ethovision Assay. Contact repellency was assessed in assays that were run under constant conditions in petri dishes (100 mm x 15 mm) lined with filter paper (85mm) that was secured with double-sided adhesive. Adults were individually tested in petri dishes, with one half of the petri dish containing 20 µl of cedarwood oil and the other half with 20 µl of deionized water. The movement of each insect was tracked using a network camera suspended above the petri dishes, which sent information to be processed by Ethovision Software ver. XT (Noldus, Inc., Leesburg, VA). The time spent on each half of the petri dish was recorded (Fig. 2D). A total of n = 18 replicate adults were tested per species.

Statistical Analysis. For the wind tunnel assay, chi-squared tests were performed on the proportion of insects leaving on the stimulus edge of the arena for each species. For the Ethovision trials, the mean time spent on each side of the petri dish was compared separately for each species.

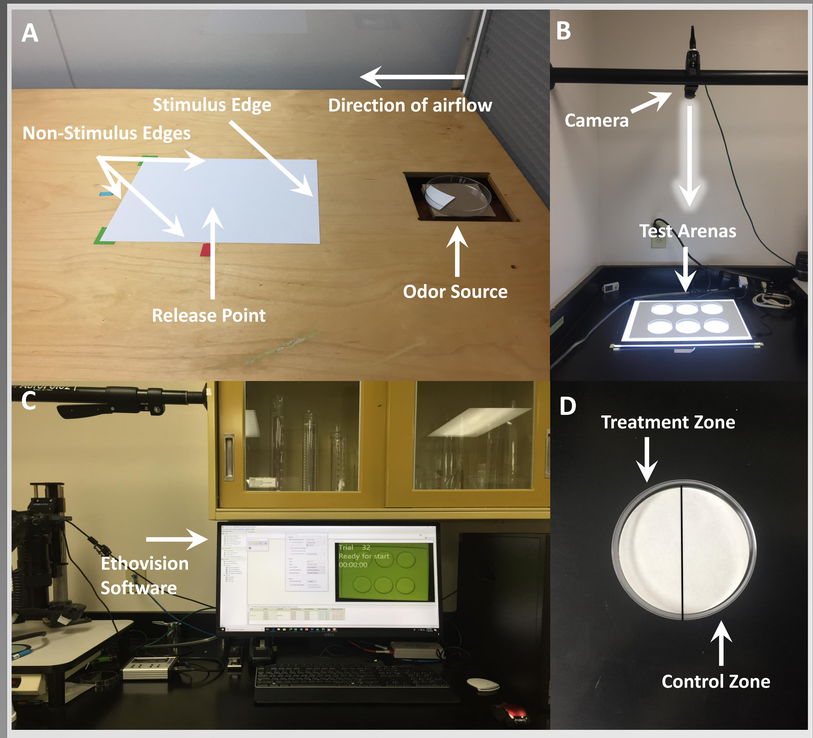


Fig. 2 **A)** Wind tunnel assay setup, and **B)** Ethovision assay setup, with the **C)** Ethovision software on computer, and **D)** treatment setup.

Literature Cited

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[4]**Eller, F. J., R. K. V. Meer, R. W. Behle, L. B. Flor-Weiler, and D. E. Palmquist**. **2014**. Bioactivity of Cedarwood Oil and Cedrol Against Arthropod Pests. Environmental Entomology. 43: 762–766.
[5]**Cook, S. M., Z. R. Khan, and J. A. Pickett**. **2007**. The Use of Push-Pull Strategies in Integrated Pest Management. Annual Review of Entomology. 52: 375–400.
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[7]**Eller, F. J., R. K. V. Meer, R. W. Behle, L. B. Flor-Weiler, and D. E. Palmquist**. **2014**. Bioactivity of Cedarwood Oil and Cedrol Against Arthropod Pests. Environmental Entomology. 43: 762–766.

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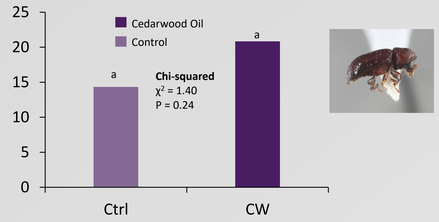
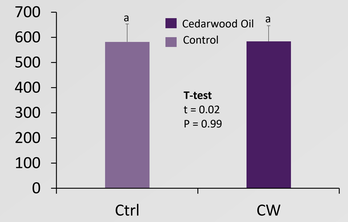
Results & Discussion

Wind Tunnel Assay

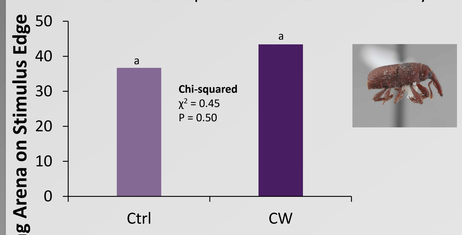
- Cedarwood oil exhibited no repellency to *R. dominica* in either assay.

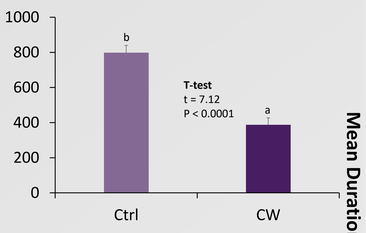


Ethovision Assay

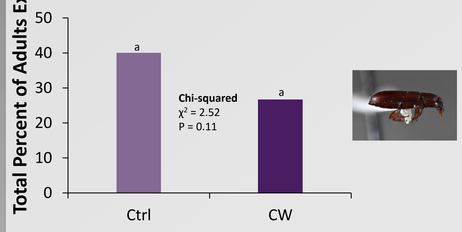


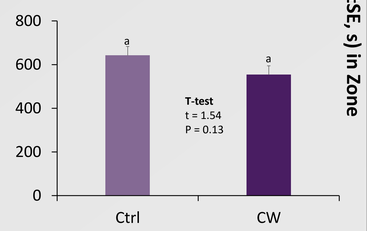
- While cedarwood was not a long-distance repellent to *S. oryzae* in the wind tunnel, it acted as a contact repellent in the Ethovision assay.



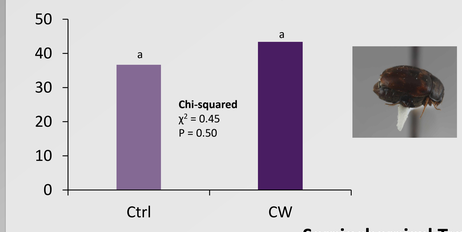


- Cedarwood oil was not a long-distance repellent nor a contact repellent to *T. castaneum*.





- Cedarwood oil was not repellent to *T. variabile* in either assay.



Conclusions & Future Work

Cedarwood oil is not a good candidate for long-distance or contact repellency for post-harvest insects. However, CW acted as a robust contact repellent for *S. oryzae*, warranting further study for inclusion in packaging. Follow up experiments should evaluate a wider array of other compounds for inclusion in a push-pull strategy.