Elucidating the behavioral response of stored product insects to fungal volatiles in the wind tunnel and simulated warehouses

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Introduction

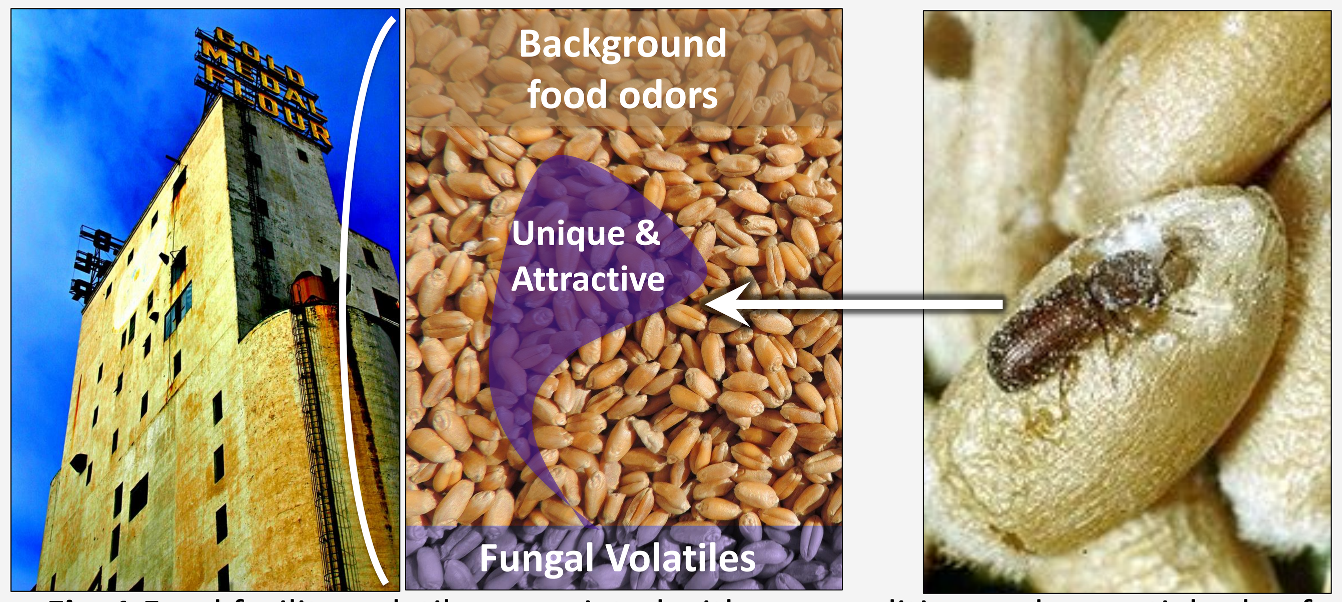

Fig. 1 Food facility, volatiles associated with commodities, and potential role of fungal volatiles in manipulating pest behavior.

- Post-harvest pest insects can cause significant amounts of damage to stored products in and around food facilities, reducing quantity and quality of grains.
- Post-harvest insects have been attributed to billions of dollars in agricultural loss via yield loss and the cost of mitigation measures[1].
- Early detection of insect pests is crucial to preventing infestations and losses since some species of stored product pests are becoming resistant to common control options[2].
- Numerous detection methods are available, but many are time consuming and ineffective[3], leading to a need for more effective and practical monitoring methods.
- Grain oils have been used to induce behavioral responses in the red flour beetle (*Tribolium castaneum)* and the lesser grain borer (*Rhyzopertha dominica)*[4], but fungal volatiles may be an even stronger attractant to these species.

Fig. 2 Habitus images of **A**) red flour beetle and **B**) lesser grain beetle.

Objectives

1) The goal of this experiment was to determine the attractiveness of select fungal volatiles in capturing adult *T. castaneum* and *R. dominica*

Materials and Methods

Source of Insects

- For each assay, 4-6 week old adult *T. castaneum* and *R. dominica* were used. These were maintained in a chamber set at 27.5°C, 60% RH, and 14:10 (L:D) h photoperiod.

Experiment Preparation

- For all assays, 20 adult *T. castaneum* and *R. dominica* were collected from colony jars the day of the experiment and placed into petri dishes with a piece of cardboard (which served as a refuge).

Fungal Volatiles

- Fungal volatiles consisted of 20 µL of the following compounds added to a 70 mm filter paper and placed either in a petri dish (100 x 15 mm; wind tunnel) or Trécé Storgard Dome trap (Trécé, Inc., Adair, OK; release-recapture assay): commercially available Storgard Oil (TSO; Trécé, Inc.; positive control), geosmin, 3-octanone, octanal, 3-methyl-1-butanol, trans-3-octen-2-one, and ethyl acetate.

Wind Tunnel Assay:

- Attraction was assessed for each volatile in a laminar flow wind tunnel. The volatiles were placed 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, or non-stimulus (one of the other three edges). Trials lasted 2 min, and non-responders were excluded from the analysis. A total of N = 60 or 30 adults were tested for *T. castaneum* or *R. dominica*, respectively.

Release-Recapture Assay in Simulated Warehouse:

- Assays were run in a sterile plastic container measuring (86.3 x 39.4 x 30.5 cm L:W:H) placed in simulated warehouses under constant conditions (30°C, 65% RH, 16:8 L:D).
- For each replicate release, 20 adults were placed in one corner, while a dome trap baited with a randomly assigned fungal volatile was placed in the opposite corner. Adults were given 24 h to respond, and the number of insects recaptured inside the trap were counted. A total of n = 6 replicates were performed per treatment

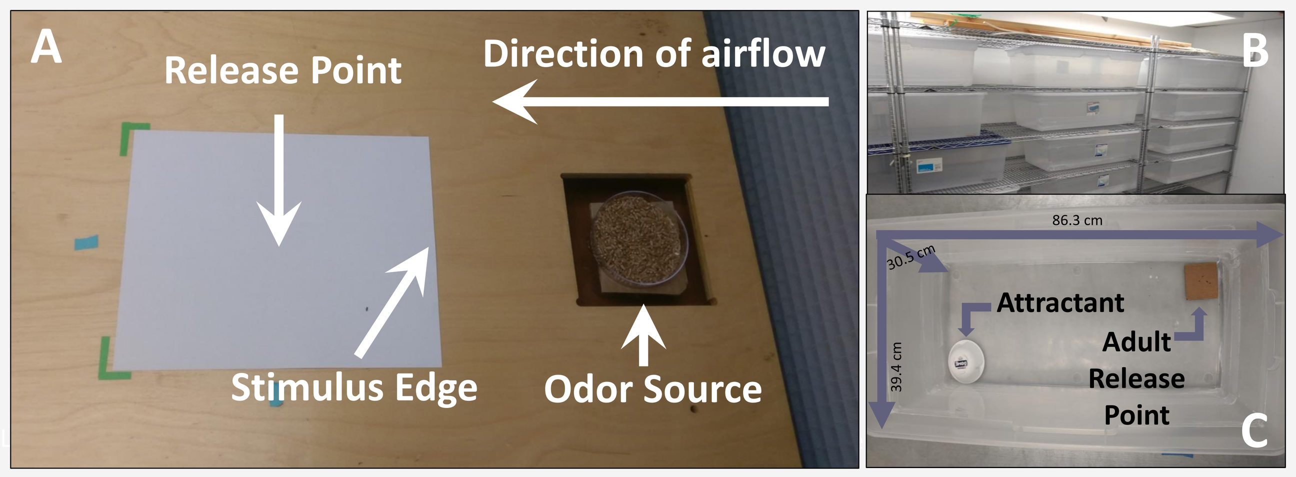

Fig. 4 Wind tunnel assay setup, and **B)** Release-recapture assay setup, with an **C)** individual bin's arrangement.

References

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[4]Phillips, T. W. et al. (1993) Behavioral responses to food volatiles by two species of stored-product Coleoptera, *Sitophilus oryzae* (Curculionidae) and *Tribolium castaneum* (Tenebrionidae). Journal of Chemical Ecology 19: 723-734.

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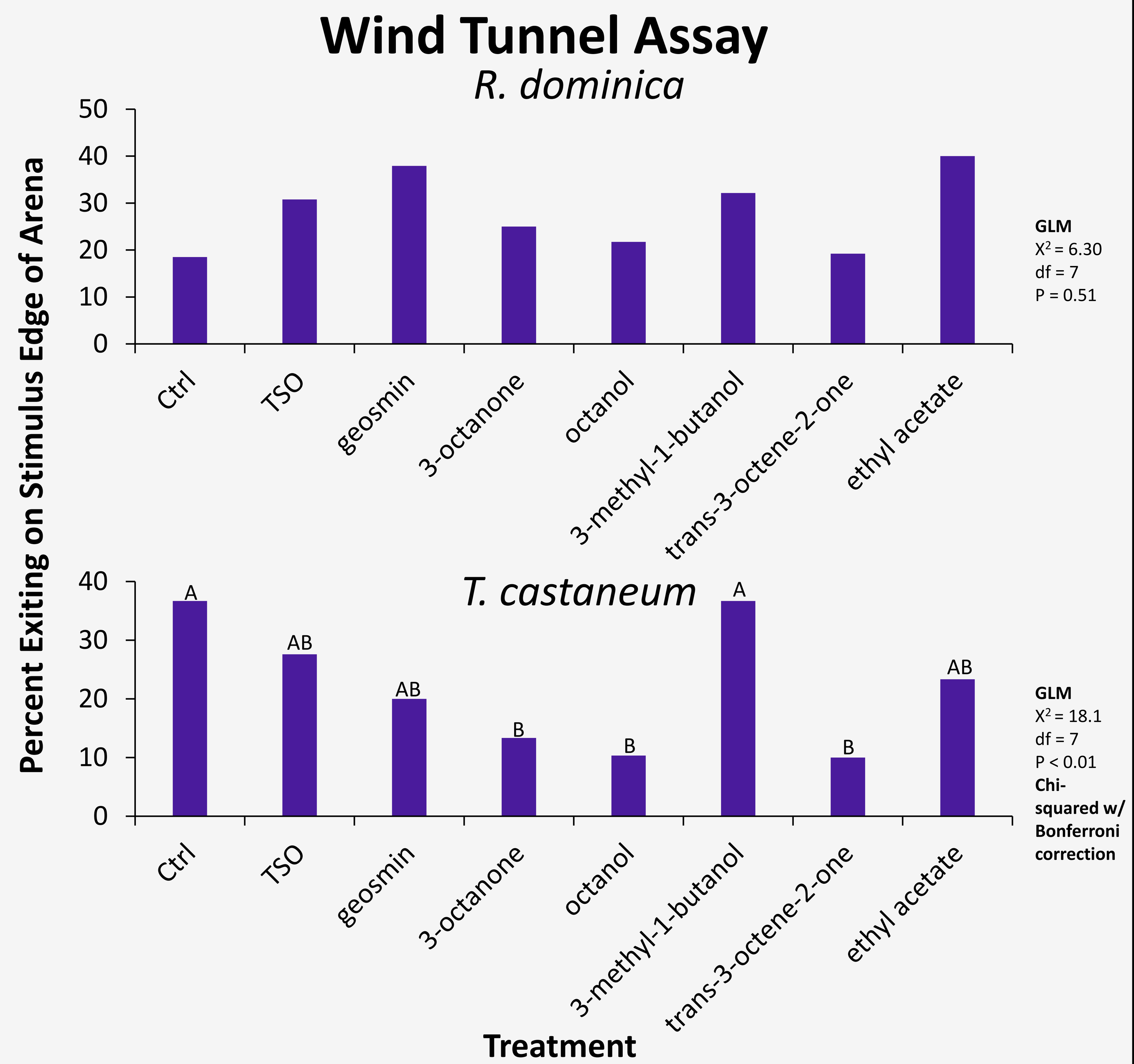
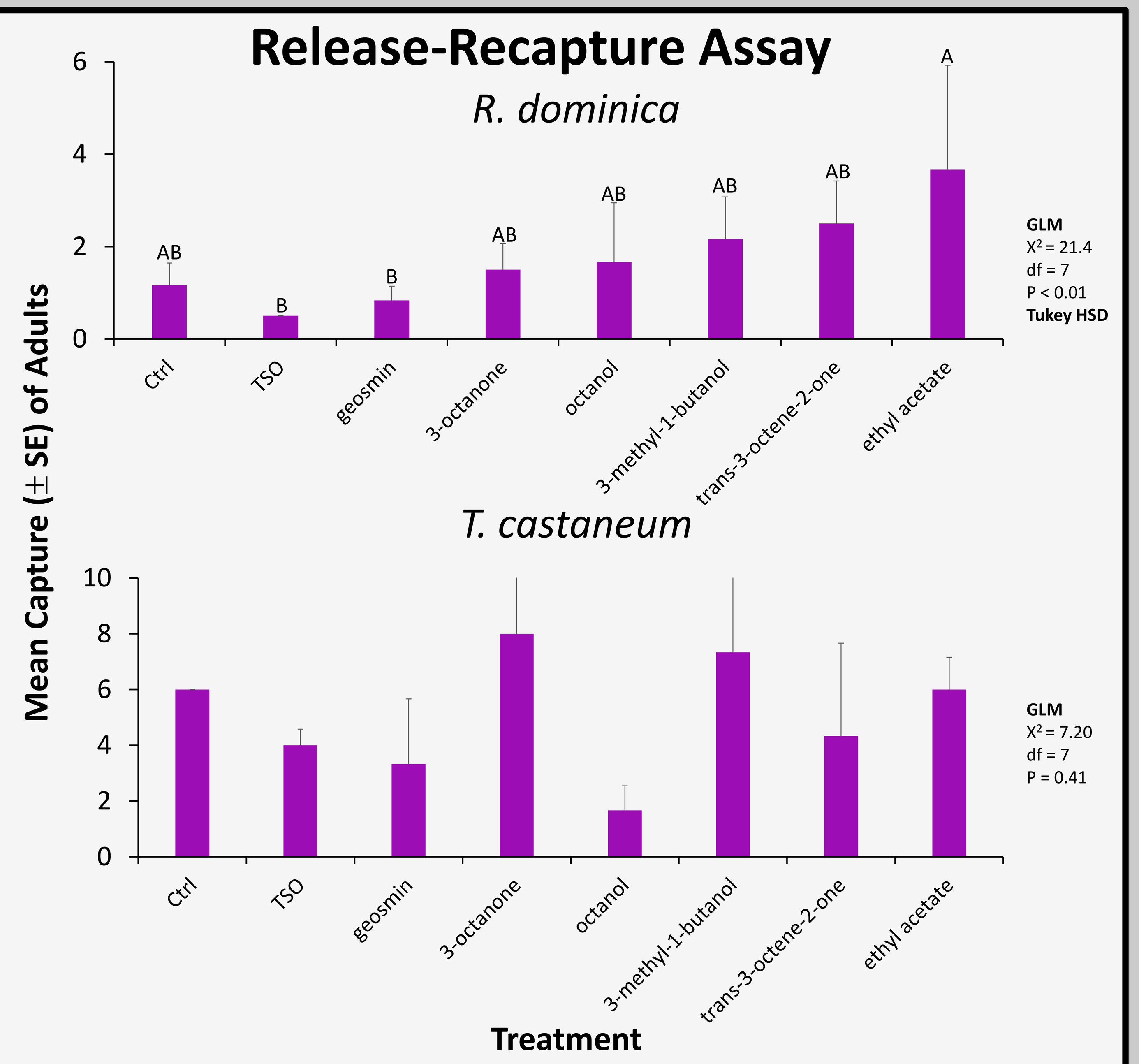
Results and Discussion





Conclusions and Future Directions

- Responses to the various fungal volatiles varied by insect species and assay.
- 3-octanone, octanol, and and trans-3-octen-2-one may be potential repellents to *T. castaneum* and deserve further investigation.
- Further replication is required to determine if geosmin and ethyl acetate are effective attractants for *R. dominica*. Ultimately, this study provides valuable baseline data for assessing volatiles to manipulate pest behavior.