

Behavioral Response of *Rhyzopertha dominica*, Lesser Grain Borer, to Wheat Volatiles

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Abstract

The lesser grain borer is a grain pest that eats and damages grain products such as rice, corn, wheat, and millet (Edde, 2012). The lesser grain borer has a tendency to reproduce rapidly and explode into big infestations under optimal conditions, which become hard to control (Johnson, 2000). Controlling these infestations has been moderately successful with the use of pheromones, which attract the beetles (El-Azi, 2011). The purpose of this research is to pinpoint the lesser grain borer's potential preference of different wheat volatiles it is given, and find the strongest response. The hypothesis is that certain samples that have higher moisture, a stronger odor, or an added pheromone that could elicit the strongest response to the volatiles than samples that do not have these conditions. The results obtained from this research indicate that our hypothesis is fairly correct, showing the aged, wet wheat with an added pheromone had the highest preference among all samples tested. The significance of this research should bring the gap closer between effectively controlling the lesser grain borer and grain safety, which will maximize the product, reduce the potential hazards to human health, and be the framework for other similar problems with grain pests around the world.

Purpose of Research

To study the behavioral response and preferences of lesser grain borer to different wheat volatiles.



Questions and Hypotheses

Research Question: Do lesser grain borer adults respond to different grain stimuli more significantly than others? Do pheromones strengthen their interests in the grain stimulus?

Hypothesis: The lesser grain borer is known to have moderate responses to pheromone-laid traps, as well as a preference to grain stores with higher humidity, or a stronger odor. This would lead to a hypothesis that the wet aged wheat or the wheat samples with a pheromone in them would elicit a stronger response compared to all other wheat samples.

Study System

- *Rhyzopertha dominica* (Fabricius), commonly known as the lesser grain borer, is a primary pest of stored grains such as corn, rice, millet, and wheat and is found worldwide (Edde, 2012).
- Their lifespan is approximately 180 days at 35 C and 75% r.H. (Rees, 2007).
- Adults are a reddish brown color with elongated bodies, ranging about 2.1-3.0 mm in length and usually reside in mills, grain bins and farm storage, and food warehouses (Edde, 2012; Rees, 2007).
- Female lesser grain borers lay their eggs on stored grain, which then hatch and the larvae burrow into grain kernels, and continue to develop into adulthood, whereby they emerge from the grain as adults (Edde, 2012).
- During development, the lesser grain borer creates a massive amount of frass and significant amounts of damage to grain, which can spiral into large infestations (Johnson, 2000).
- Many scientists have come up with various ways to reduce and control these infestations, with one example to the control the infestations is with the use of pheromones and food attraction to trap these beetles before they reach wheat silos or other storage areas (El-Azi, 2011).

Materials and Methods

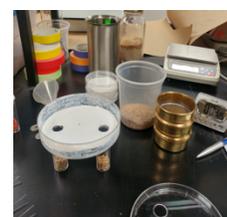
Materials:

- 150 x 25 mm petri dishes with two 20 mm holes drilled equal distance apart, with fitted filter paper set on the bottom.
- 9 dram vials containing wheat samples.
- Wheat Samples:
 1. Crimped wheat: 13.2% moisture
 2. Wet, aged wheat: 19% moisture, aged at 30 C and 60% r.h. for 8-10 days
 3. Pre-conditioned wheat: used for rearing previous cultures of lesser grain borer
 4. Crimped wheat + pheromone
 5. Wet, aged wheat + pheromone
 6. Pre-conditioned wheat + pheromone
- Lesser grain borer adults, 1-2 week old adults from lab colony.



Methods:

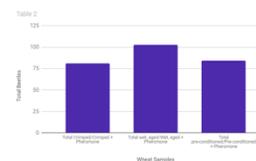
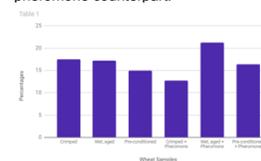
1. Lesser grain borer adults were sifted in a No. 12 (1690 micron) sifter to separate them from the wheat in colony jar.
2. 5 grams of wheat from any of the six options are filled into two vials and then the 150 mm petri dish was set on top of them, aligning the 20 mm holes with the top of the vials.
3. In a single trial, five adults were randomly chosen and set in the middle of the 150 mm petri dish and timed for five minutes to explore and choose a vial.
4. After five minutes, the beetles were then counted in each of the vials, and were also counted if they chose neither, identified as non-responders. The non-responsive beetles were not in either vial by staying within the 25 mm petri dish.
5. The samples are chosen to be paired against one another in a set of five(ex: 1 vs. 2, 1 vs. 3, 1 vs. 4, 1 vs. 5, 1 vs. 6, 2 vs. 1, 2 vs. 3, etc.) When all of the samples have been paired against each other once, it was considered a set. There were a total of 18 sets done, with each sample being paired was repeated 3 times to reduce bias. The vials were also switched around after each set(if the sample one was in the left vial, it was in the right vial when the experiment was repeated and so on), and a new colony of beetles was used for each set.



Results

Table 1: Percent of adults that chose among each type of wheat sample.

Table 2: The comparison of the three types of wheat, combined with their added pheromone counterpart.



- The wet, aged wheat with an added pheromone stood out as the most preferred wheat sample, while the crimped wheat with a pheromone was the least preferred.
- The total wet, aged wheat and wet, aged with added pheromone combination was far superior to the other two combinations, with a total of 103 beetles that chose that sample, 84 that chose the pre-conditioned and pre-conditioned with added pheromone combination, and 81 for the crimped wheat and crimped wheat with added pheromone combination.

Conclusions

- The aged, wet wheat with added pheromone stood out with the strongest preference from the lesser grain borers. Combined with the original wet, aged wheat sample, it stands apart from the other samples by a very large margin. This can be used to further more research done to pinpoint what about the wet, aged wheat that the beetles prefer.
- The pheromone added to the samples in comparison to the samples that did not have pheromones showed a small difference between the two, but could suggest that the odor of the wheat is as important as the pheromone in the beetles' preference.

Future Directions

- The project can be replicated step by step, but this time the lighting can be manipulated in a way that best replicates the lighting the lesser grain borer in the field experience.
- The project can be replicated step by step but with the same sample, which would be the aged, wet wheat sample, but at different moisture levels and exposure times.
- The research can also go in a direction that focuses on the season the experiment is taking place, which may show differences in winter seasons, non-growing seasons for the wheat, breeding seasons, etc.

References

1. Edde, Peter A. "A Review of the Biology and Control of *Rhyzopertha dominica* (F.) the Lesser Grain Borer." *Journal of Stored Products Research*, vol. 48, 2012, pp. 1-18., doi:10.1016/j.jspr.2011.08.007.
2. El-Azi, Shadia E. Abd. "Control Strategies of Stored Product Pests." *Journal of Entomology*, vol. 8, no. 2, 2011, pp. 101-122., doi:10.3923/je.2011.101.122.
3. Johnson, Doug. "Insect Pests of Stored Grain: Lesser Grain Borer." *Recognizing Insect Larval Types | Entomology*, July 2000, entomology.ca.uky.edu/ef137.
4. Rees, David. "Insects of Stored Grain: A Pocked Reference." CSIRO Publishing, Collingwood VIC, Australia, 2007, pp. 13.



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