



Potential Risk of Red Flour Beetle Pest in Various Grain Stored Grains

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Abstract

Red flour beetles are major pests in the U.S. They can often be found in stored grain products, primarily flour [4]. They also seem to be heavily attracted to maize, another popular food source in many areas [1]. The red flour beetle can cause significant destruction in these stored grains through increasing mold, changing flour color, and eating/destroying much of what is stored [2]. Because of the major impact of these pests on these major stored grain sources, there has been much research on various ways of ridding or limiting the red flour beetle from our stored grains. Much of this research, however, focuses on maize or flour pest problems with little information on other popular stored grains. We decided to look into how diets of oats, pet food, and corn meal affected the generation and the potential for the red flour beetle to become pests in other stored grain products. By observing the difference in preference and reproduction, we can observe the potential risk to our other stored grain products becoming infested with red flour beetles. During our research, the red flour beetles seemed to prefer flour overall (except when given the choice of oats), but had similar reproduction patterns to the flour with corn meal and oats. Because of their preferences and reproduction rates red flour beetles can be a major concern for other stored grains, mainly in areas where no stored flour is in close proximity.

Purpose

The purpose of this research was to observe the potential risk of the red flour beetle becoming a serious pest in other stored grains than flour if introduced.

Questions, Hypotheses, and Predictions

Question: Does grain type play a significant role in the reproduction rates or diet preference of red flour beetles?

Hypothesis: Red flour beetles prefer flour over other grain diets.

Prediction: The red flour beetles will choose flour as a diet when given a choice and have better reproduction rates in flour vs. other diets.

Study System

The red flour beetle is reddish-brown in color (fig. 1). They are small in size, typically no larger than 4.4 mm long and 1.3 mm wide but can be as small as 2.3 mm long and 1.0 mm wide. They also have 3 terminal antennal segments that happen to be larger than the rest of their antennae segments [3]. Because of their ability to fly, the red flour beetle can easily move and infest larger areas such as neighborhoods and are not specifically tied to one location [4]. However, they tend to be found anywhere with floury grain materials and their ability to reproduce year-long in some areas contributes to problems with infestation [1].



Figure 1. Red flour beetle larvae crawling on glass petri dish (left); red flour beetle adults in a glass dish (middle); close up of red flour beetles on glass dish (right)

Methods and Experimental Design

We first tested the red flour beetle's preference of food by allowing the beetles to have a choice in which diet they prefer. We set up small petri dishes with one piece of paper that was cut and folded to about the size of a thumb print on opposite ends of the dish. Then, we filled each piece of paper with 0.1 grams of flour, corn meal, dry ground up pet food, and oats. Each of the three diets were placed opposite to flour (the control and the red flour beetle colony's typical diet) and all four diets were tested against no food as well (fig. 3 and 4). Five replications were done for each choice test. Then we put 10 beetles in the center of the dish, covered with a small glass tube for about 3 minutes before lifting the tube to release them (fig. 2). We then counted how many red flour beetles were on each side and in the center of the dish at the 35 minute mark.

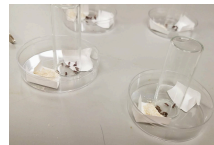


Figure 2. Beetles in glass tubes waiting to be released

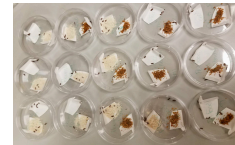


Figure 3. Sample of replications from two tests



Figure 4. Close up of choice experiment

We then tested to see how reproduction is affected if the red flour beetle has no choice in their diet. Using the same diets (flour, corn meal, dry ground up pet food, and oats), we weighed 3.12 grams of each diet and put them into separate small glass tubes (five replications of each diet) (fig. 5 and 6). Then we added 10 red flour beetle adults to each of the glass tubes. After one week, we removed the adults by pouring out the tubes, sifting adults from the food, and then returning the contents back into the original glass tubes (fig. 7). After four weeks of allowing the eggs to incubate at 25 C and 70% relative humidity, we sifted and recorded the larvae, pupae, and mold in each tube (fig. 8). Then, we returned the larvae, pupae, and food to their respective tubes and put them back in the incubator. After 3 more weeks, we sifted and counted the adults, larvae, and pupae in each tube.



Figure 5. Measuring no choice diets in weigh boat

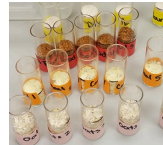


Figure 6. Diets separated into glass tubes



Figure 7. Pet food contents after 1 week, emptied to sift adults



Figure 8. Large mold content in pet food sample

Results

Mean Percent of Red Flour Beetles' Preference Between Two Foods

Choices (Choice 1 Vs. Choice 2)	% on First Choice	% on Second Choice
Flour Vs. Blank	56.0%	42.0%
Pet Food Vs. Blank	18.0%	78.0%
Corn Meal Vs. Blank	22.0%	66.0%
Oats Vs. Blank	60.0%	38.0%
Flour Vs. Pet Food	76.0%	20.0%
Flour Vs. Corn Meal	58.0%	38.0%
Flour Vs. Oats	24.0%	64.0%

Table 1. Mean percent of beetle's location after 35 minutes (excluding beetles in the middle of dish)

Average Number of Beetles, Pupae, and Larvae in No Choice Diet

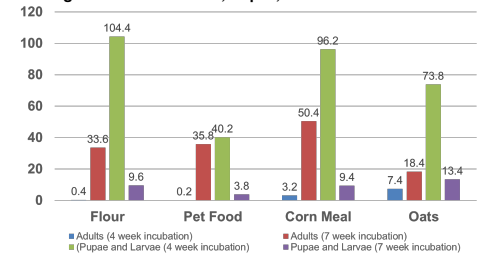


Figure 9. Average of 5 samples during 4 week and 7 week marks

During the no choice experiment, the beetles seemed to grow into adults at a faster rate in the oat diet than other diets. Corn meal had similar trends to the flour and the pet food seemed to have some of the least reproduction rates compared to the other diets (fig. 9). During the 4 week mark, we found no mold in the flour, a lot of mold in the pet food samples, 3 of 5 cornmeal samples with a lot of mold and the remaining 2 with some mold, and some mold on each oat sample.

Conclusions

If given the opportunity, red flour beetles can become significant pests of stored grains other than wheat flour (especially when flour is not present nearby). Some products such as corn meal and potentially oats should be of higher concern if red flour beetles are present since they will produce at similar rates to the beetles when placed in flour. Oats can also be a large concern due to the beetles' initial preference to the product instead of flour. Pet food has a significantly smaller chance than products like oats or finer ground products of being infested with red flour beetles' due to the lack of preference and low reproduction rates.

Future Directions

To further this research, we would grow a colony on these separate diets. The original colony we tested from had undergone several generations and was perhaps adapted to the flour diet. That adaptation may have affected their food preference behaviors. The ability to have multiple generations when grown on specific diets may influence changes in behavior. We would also test their growth in larger containers with more food since reproduction slowed down over time. The small container could have restricted their ability to keep producing on each diet.

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