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Impact of Temperature on Efficacy of Diatomaceous Earth (Silicosec) against *Rhyzopertha dominica* and *Tribolium castaneum*

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ABSTRACT

Diatomaceous Earth and grain moisture are the trending factors for stored grain insect pest's management that influence the mortality especially of *Rhyzopertha dominica* and *Tribolium castaneum*. For all tested insects treatments, higher temperature level in grains enhance mortality of stored grain insect pests. Every DE product has its own efficacy and this experiment contains use of SilicoSec. Effect of temperature on the efficacy of DE product as temperature 25oC mortality of *Tribolium castaneum* is (85%) and at temperature 30oC mortality is (97%) and at the same time mortality of *Rhyzopertha dominica* at temperature 25oC is (89.30%) and at temperature 30oC mortality (97.65).So at high temperature efficacy of DE product is high and low at low temperature. Doses of 200 ppm and 300 ppm gives more mortality results of both. The high doses can give high rate of mortality.

Keywords: Diatomaceous earth, SilicoSec, *R. dominica*, *T. castaneum*, Mortality, Temperature, Efficacy

INTRODUCTION

During storage, more than 20% wheat is damaged by insect pests and fungi, grains are highly susceptible to infestation by stored product insects (Rees, 2013). More than 600 species attacked on stored grains products causing the damage (Rajendran, 2008). Among the stored product pests, important insect pests are Red flour beetle, Khapra beetle, Lesser grain borer, Granary weevil, Psocids, Lepidopterous moths (Philip and Throne, 2010). The red flour beetle (*Tribolium castaneum*) is a cosmopolitan pest of stored commodities (Prakash *et al*., 1998). With high damage the flour changed to grayish and have pungent smell (Atwal and Dhaliwal, 2009). Presently many synthesized pesticides are used for the control of stored grain pests but the repeated use of these pesticides has made the pests resistant against these pesticides (Subramanyam and Hagstrum, 1999). Pesticide which are mostly used for crop protection can pollute environment and also have adverse effects on animals and human beings (Meena *et al*., 2006). Phosphine fumigation (mostly aluminum phosphide tablets used in store grains) has become increasingly limited in its use because of development of resistance in stored grain insects (Bell and Wilson, 2011). Diatomaceous earth (DE) is used as an opportunity to artificial pesticides as it has low mammalian toxicity (Korunic et al., 1996). The selection of insecticides that may be used to save grain commodities is constrained by using strict requirements to make sure protection for consumers, grain-handlers and livestock (White and Leesch, 1995). The usage of synthetic insecticides is under increasing scrutiny due to issues with environmental infection, atmospheric ozone-depletion (i.e., methyl bromide), there is developing a need for non-chemical pest management methods. Diatomaceous earth (DE) is used as an opportunity to artificial pesticides as it has low mammalian toxicity, does no longer affect give up-use quality (Korunic, 1996). DE consists of prehistoric skeletons of both freshwater and marine organisms, predominantly unmarried-cell algae called diatoms. Maximum DEs are 70±90% amorphous silicon dioxide with the balance being made from inorganic oxides and salts (Korunic, 1998). DE absorbs the cuticular lipids of insects, causing loss of life by way of desiccation. Temperature and moisture play a crucial function in the population dynamics of saved-product insect pests. A boom in the moisture content material of grain outcomes in a lower inside the efficacy of synthetic insecticides, as they degrade quicker (Szlendak, 1989). However, those tests were carried out with simplest supply of DE.

- **Objective**
- To check the mortality effect of Diatomaceous Earth (DE) Silicosec against *R. dominica* and *T. castaneum* at two different temperatures

MATERIALS AND METHODS

Experimental Site

The research project was carried out in the Stored Grain Laboratory at Department of Entomology, University of Agriculture, Faisalabad Pakistan. The material comprised of *DE (*SilecoSec*)* and insect (*Tribolium castaneum) & (Rhyzopertha dominica)*.

Collection of Insects

Insects were collected from different godowns located in Layyah district.

Rearing of Insects

The insect culture was maintained in jars placed in the incubator at 30±2°C and 60± 5% R.H to get the homogenous population. The culture medium was wheat flour sterilized at 60 °C for 60-90 minutes. 100 beetles from the heterogeneous population were liberated in 250gm of wheat flour placed in different jars. The jars were covered with muslin cloth, tied with rubber bands to avoid the escape of beetles. Beetles were allowed to remain in the culture medium for 3 days for egg laying and then removed from jars with the help of sieves and fine camel hair brush for continuation of culture. The flour containing eggs was placed again in the same jars. This newly emerged culture was considered as homogeneous for the use of experimentation.

Bioassay

Different concentrations of DE (0, 100, 200 and 300 ppm) were used in the experiment; 0 ppm described the control treatment. Flour was then divided into 50-g lots and placed in jars. Test insects, 25 *T. castaneum* and 25 *R.dominica* were introduced into each jars. Each species was tested separately with 3 replications. The jars were held at constant temperature (25 and 30^{o}C) and relative humidity (65±5% R.H)

Statistical Analysis

Mortality noted in *Rhyzopertha dominica* and *Tribolium castaneum* was computed using Abbot's formula

- **Corrected Mortality (%) = $\left(\frac{Mo - Mc}{100 - Mc}\right) \times 100$**

Mo = Mortality observed in treatments

Mc = Mortality observed in control

The data was subjected to analysis of variance (ANOVA) using the 'statistic 8.1'

RESULTS AND DISCUSSION

Table 1: Impact of Silicosec on the mortality (± SE) of *T. castaneum* at 25˚C

Mortality ± SE			
Days of Exposure	**100ppm**	**200ppm**	**300ppm**
1	65.21 ± 2.79 c	69.23 ± 2.77 d	71.21 ± 2.79 c
2	71.25 ± 2.75 b	73.27 ± 2.73 c	77.24 ± 2.76 b
5	72.67 ± 2.33 b	77.87 ± 2.13 b	84.22 ± 2.78 a
9	75.00 ± 2.00 a	81.00 ± 0.00 a	85.0 ± 0.00 a

Table 2: Impact of Silicosec on the mortality (± SE) of *T. castaneum* at 30˚C

Mortality ± SE			
Days of exposure	**100 ppm**	**200ppm**	**300 ppm**
1	70.23 ± 2.77 c	75.00 ± 2.34 c	77.25 ± 2.75 c
2	75.00 ± 2.00 b	76.00 ± 2.12 c	88.00 ± 2.98 b
5	81.00 ± 2.00 a	81.22 ± 2.78 b	89.23 ± 2.77 b
9	82.00 ± 2.34 a	85.21 ± 2.79 a	97.00 ± 0.00 a

Table 3: Impact of Silicosec on the mortality (± SE) of *R. dominica* at 25˚C

Mortality ± SE			
Days of exposure	**100ppm**	**200ppm**	**300ppm**
1	68.21 ± 2.79 d	71.23 ± 2.77 c	79.21 ± 2.79 c
2	71.25± 2.75 c	79.27 ± 2.73 b	83.24 ± 2.76 b
5	78.67 ± 2.33 b	83.87 ± 2. 13 a	84.22 ± 2.78 b

9	82.00 ± 2.66 a	84.00 ± 2.91 a	89.30 ± 2.70 a

Table 4: Impact of Silicosec on the mortality (± SE) of *R. dominica* at 30 ˚C

Mortality ± SE			
Days of exposure	**100ppm**	**200ppm**	**300ppm**
1	53.23 ± 2.77 d	74.23 ± 2.77 d	91.22 ± 2.78 c
2	67.22 ± 2.78 c	82.21 ± 2.79 c	94.22 ± 2.78 b
5	74.23 ± 2.77 b	89.27 ± 2.77 b	96.22 ± 2.78 a
9	88.23 ± 2.77 a	95.25 ± 2.75 a	97.65 ± 2.65 a

DISCUSSION

Increased temperature would increase insect movement, causing increased contact with the DE and greater cuticular damage. Higher temperatures and increased movement would also increase water loss via the spiracles due to increased respiration. Losses via the spiracles are estimated to be three times greater than losses of water through the cuticle for a desert tenebrionid (Zachariassen, 1991). Also rate of cuticular transpiration rises only slightly with temperature until the transition temperature which for most insects is above 30^{o}C (Wigglesworth, 1972). However, increased temperature would also increase feeding and therefore moisture replacement through the food and production of metabolic water. The synthesis of cuticular waxes may be faster at higher temperatures because of temperature effects on the biochemical pathways. Unlike the synthetic insecticides, DE is inert and does not degrade in a temperature-dependent fashion. Within a grain bulk, the relative humidity will change slightly with temperature. For stored wheat there is about a 3% reduction in relative humidity for each 10^{o}C increase in temperature. However, these changes would be too small to be responsible for the effects we observed.

Stored-product insects show a wide range of susceptibility to DE (Aldryhim, 1993). A few studies have addressed why there are dierent susceptibilities among species. We observed that *R.dominica*is the most susceptible insect, had more DE attached to its cuticle than *T. castaneum*, the least susceptible. General resistance to desiccation, either through better water retention, better water acquisition, or greater tolerance of desiccation could also be responsible for these differences in susceptibility.

In table 1 and 2 in case of *Tribolium castaneum* mortality of *T. castaneum* at 25˚C (85.00%) and at 30˚C (97.00%) after 10 dayS time period and at maximum concentration of DE. This shows that as temperature is increased mortality of *T. castaneum* was also increased and similarly the effect of concentration was negligible, at high concentration maximum mortality was recoded. All concentrations give significant results after all days.

In table 3 and 4 in case of *R. dominica* mortality of *R. dominica* at 25˚C (89.30%) and at 30˚C (97.65 %) after 10 days time period and at maximum concentration of DE. This shows that as temperature is increased mortality of *R. dominica* was also increased and similarly the effect of concentration was negligible, at high concentration maximum mortality was recoded. All treatments give significant result after the given time of intervals.

Current recommendation for *R. dominica* is to apply 300 ppm of SilicoSec for wheat. When Wheat immediately harvested the temperature of grain storage structures usually remains between 25 and 35^{O}C and with higher moisture content. Our results suggest that higher concentrations of SilicoSec could control *R. dominica* in these situations and it is better to control *R.dominica* because this is a primary stored grain insect pests and attack only on healthy grains. Also, higher concentrations of DE would cause greater reduction in bulk density, but this may not be a concern for the lower grades of wheat.

SUMMERY & CONCIUSION

Table 1 and 2 shows that the Impact of Silicosec on the mortality (± SE) of *T. castaneum* at 25˚C and 30˚C is maximum after 9 exposure days and at maximum concentration. Table 3 and 4 shows that the Impact of Silicosec on the mortality (± SE) of *R. dominica* at 25˚C and 30˚C is maximum after 9 exposure days and at maximum concentration**.** Our ultimate goal is to determine under what conditions DE can be used to control stored-product insect pests in farm and elevator storage facilities. This study has shown that there are many factors that determine if control will be obtained; concentration, duration, type of DE, insect species, temperature. Temperature can be measured, and they might be adjustable depending upon the equipment available. The application rate are determined by the applicator, but may be constrained by costs or adverse effects on the grain's physical properties when using DE at higher concentrations. Laboratory studies such as this and the others cited here are useful in determining the parameters needed to control stored-product insects, but these must be verified in experiments carried out in commercial storage facilities.

CONFLICT OF INTEREST: None

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