INSECTICIDAL EFFICACY OF A DIATOMACEOUS EARTH SILICOSEC AGAINST RED FLOUR BEETLE *TRIBOLIM CASTANEUM* (HERBST) ON STORED WHEAT

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ABSTRACT

The insecticidal efficacy of the diatomaceous earth (DE) formulation SilicoSec against the adults of *Tribolium castaneum* was evaluated in the laboratory of Department of Entomology, University of Arid Agriculture, Rawalpindi. The experiment was conducted on wheat grains, by treating them at dose rates of 75, 100 and 125 ppm at 30^{o}C and 60% r.h. The insect mortality was recorded after 14 and 21 days exposure interval, whereas, the emergence of progeny was examined after 56 days. In summary, the SilicoSec was found effective against *T. castaneum* with maximum mortality after 21 days and was also effective in controlling the production of progeny at application rate of 125 ppm.

Key words: Diatomaceous earth, SilicoSec, *Tribolium castaneum*, stored wheat

INTRODUCTION

Grain losses due to insect pests is a serious problem through out the world. The use of synthetic chemicals against these pests are unsuccessful in controlling them because of increased resistance in pests (Subramanyam and Hagstrum, 1995). To meet the environmental problems such as pollution, diseases, resistance in pests etc., use of botanicals and plant extracts is getting the attention because of low hazards to human life. Diatomaceous Earths is emerging as a new group of natural products and is an extract of fossilized diatoms. DEs can be directly applied to stored grains, because of very low mammalian toxicity (Quarles, 1992). Diatomaceous earths can be of different origin, that is some are fresh water, some are marine water and their efficiency also varies because of different chemical composition (Golob, 1997; Korunic, 1998). Mechanism of action of DE involves mechanical abrasions, and dissolving thin cuticular, lipid layer which results in water loss from the body of insects. Because of desiccation and water loss insects become knocked down and they are more vulnerable to death (Korunic, 1997). DE does not affect milling, baking processes and malting properties of treated grains (Korunic *et al.*, 1996). Environmental Protection Agency (EPA) of USA recognizes DEs as safe and food additives and several references are available about the use of DE in laboratory and field trials in many countries of the world (Cook and Armitage, 2002). There are several factors that affect the efficacy of diatomaceous earths, including some abiotic factors such as temperature, moisture content in grains, relative humidity and exposure interval along with application methods, dose rate also counts for several different insects. DE can applied as top dressing in bulk storage of grains and structure treatments (Dowdy, 1999; Dowdy and Fields, 2002). The specific objectives of this study were to examine the insecticidal effect of a DE formulation (SilicoSec), effect on the emergence of F_1 and also to identify the application rates that would lessen damage to the stored wheat.

MATERIAL AND METHODS

The experimental trials were conducted in the laboratory of Department of Entomology, University of Arid Agriculture, Rawalpindi during the year 2005.

Rearing of insects:
Insects were collected from warehouses of Punjab Food Department, Rawalpindi. The culture of *Tribolium castaneum* was maintained under controlled laboratory conditions before the experiment with out any exposure to the insecticides.

Formulation and bioassay:
SilicoSec is a DE formulation of freshwater origin, and contains approximately 92% SiO2, 3%Al2O3, 1%Fe2O3, and 1% Na2O. The average particle size is between 8 and 12 mm. The DE sample was stored in the laboratory at ambient conditions, until the beginning of experiments (approximately for 1 month) (Athanassiou *et al.*, 2003). 2.0 kg of clean and insect free grains (wheat) were used. 500 gm wheat were weighed and put in a big jar then were treated with 75 ppm of DE SilicoSec and shaken manually for a minute until dust settled down. These treated grains were distributed in small glass vials as 100 gm grains each and vials were covered with muslin cloth. Keeping these 5 vials aside, the same procedure was adopted for all the treatments. 50 insects of *Tribolium castaneum* of mixed ages and sex were released in each vial including the control vials. The vials were kept in incubator at 30^{o}C and 60% r.h. Mortality data was recorded after 14 and 21 days by counting all the alive

and dead insects. Then all the alive and dead insects were removed and vials were kept under same conditions to observe the emergence of F_1 after 56 days.

Data analysis:

Adult mortality was corrected for natural mortality in untreated controls by using Abbott's (1925) formula. The data were submitted to a one-way analysis of variance (ANOVA). Means were separated by using the Tukey-Kramer (HSD) test, at probability level 0.05 (Sokal and Rohlf, 1995).

RESULTS

After 14 days exposure interval there were F = 12.00, P = 0.001 and for 21 days, these values were F = 5.29, and P = 0.02. The mortality of *T. castaneum* adults after 14d of exposure to SilicoSec was 91.60% at the highest dose i.e. 125 ppm, however, there was a 94.40% mortality after 21d of exposure interval.

One of the objectives of this study was to evaluate the number of emerging individuals in F_1 generation after the exposure of grains with diatomaceous earth, and the results showed a marked difference among treated and untreated grains.

ANOVA parameters for progeny production after 56 days interval were F = 827.60, P = 0.00. Highest number (mean) of individuals observed in untreated wheat was 49, whereas, three doses were quite efficient in controlling progeny production, in wheat grains and it showed minimum value of 0.40 at highest dose (125 ppm).

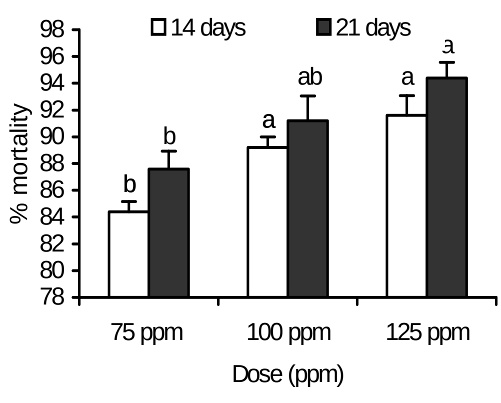

Fig.1: Mortality (%) (mean ± SE) of *T. castaneum* adults with different dose rates of SilicoSec after 14 and 21 days of exposure (means within the same grain type followed by same letter are not significantly different; Tukey-Kramer HSD test at *P* = 0.05)

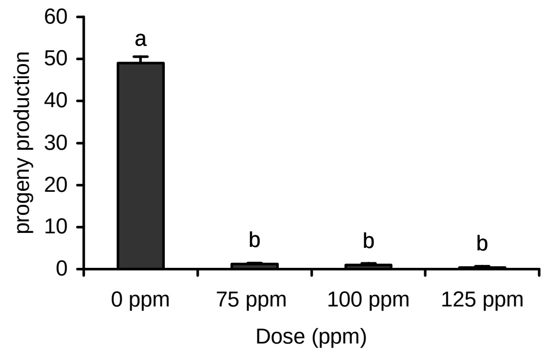

Fig.2: Progeny production of *T. castaneum* (mean number of adults ± SE) on treated and untreated wheat grains with SilicoSec after 56 days exposure interval (means within the same grain type followed by the same letter are not significantly different; Tukey-Kramer HSD test at *P* = 0.05)

DISCUSSION

Our present study on the evaluation of insecticidal effect of diatomaceous earth against *T. castasneum* proved those results, which are in accordance with the previous, laboratory studies conducted in different parts of the world. Several formulations of diatomaceous earths are available today to be used against different pests in several countries of the world like USA, UK, Africa and Canada etc. but no literature is still found from Pakistan for the use of diatomaceous earths. Results showed high mortality rate for *T. castaneum*, showing its greater susceptibility for diatomaceous earth (DE) SilicoSec. Mortality increase was observed with increasing dose concentration and exposure interval when temperature and relative humidity was maintained constant at 30^oC and 60% r.h. Effectiveness of DE depends on several factors like increase in moisture content decreases the efficiency of diatomaceous earth, because insect becomes able to pick up less DE, so suffers from less water loss. When DE particles absorbs moisture from the atmosphere, their efficiency decreases and so DE is more effective against stored product beetles at high temperatures and when insects are more mobile there is more water loss (Vayias and Athanassiou, 2004). A product of DE is generally not equally effective on different grain commodities (Athanassiou and Kavallieratos, 2005). Some insects are more vulnerable than others due to their anatomy and physiology. Those with large surface area to volume ratios (often smaller insects) are more susceptible. Insects that have lots of body hair to pick up particles are more susceptible than smooth beetles such as *T. confusum* (Carlson and Ball, 1962). Insects such as the cockroach that is protected by low-melting grease are more susceptible than insects with hardened, waxy cuticles. Exposure interval also affects the efficacy of DE but the important thing is that 60% loss of water from the body of insect is required for its death, which makes 28-35% of insect body weight (Ebeling, 1971). Diatomaceous earth gives residue free food, which is the requirement today. Quarles (1992) reports about the effectiveness of DE against several different insects including aphids, brown mites, red spider mites, twig borers, oriental fruit moths, and codling moths in orchards or chalcid weevils in alfalfa.

To minimize progeny production is another objective of DE formulations, our present study shows that DE is useful in controlling the progeny production in controlled laboratory conditions and next trials should be on large-scale farms to check the efficacy of diatomaceous earths under natural environmental conditions of Pakistan.

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