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INSECTICIDAL EFFECT OF SOME INERT DUSTS AGAINST THREE OF STORED GRAIN INSECTS AT KAFR EL-SHEIKH GOVERNORATE

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ABSTRACT

Laboratory and field studies were conducted to evaluate the effect of three inert dusts, diatomaceous earth, kaolin and katelsous as wheat grain protectants against some stored grain insects, i.e., *Sitophilus oryzae*, *Rhizopertha domininca* and *Tribolium confusum*. Inert dusts were mixed with wheat grain in the laboratory at different concentrations. Data obtained from the laboratory experiment showed that the LC_{50}'s of diatomaceous earth, kaolin and katelsous were 0.234, 0.071 and 0.235% w/w, 6.033, 6.306 and 8.938% w/w and 0.495, 0.496 and 103.875% w/w against *S. oryzae*, *R. dominica* and *T. confusum*, respectively one day after treatment. Diatomaceous earth was more effective than the other tested materials where it achieved complete mortality for the three tested insects after two days of treatment at the rate of 0.5% w/w. Results also showed that kaolin and katelsous act slowly on the tested insects, where the higher rates of 8% w/w for kaolin and 0.4% w/w for katelsous gave complete mortality after one week post treatment. For the field study (at farmers' storages), the higher concentrations (0.5, 8 and 0.4% w/w) of the three dusts, diatomaceous earth, kaolin and katelsous, respectively obtained from laboratory experiment were admixed with wheat grain and stored for 4 months at the farms. For the field experiment, the results showed that diatomaceous earth gave 100%, 91.6% and 98.2% mortality against the three tested insects, respectively after 4 months of storage at a concentration of 0.5% w/w at 7^{th} day of exposure. Kaolin at 8% w/w showed that adult mortality decreased from 100% at zero time of storage after 5 days of exposure to 13.7%, 27.1% and 16.9 at 4 months of storage after the same period of exposure against the three tested insects respectively. At zero time of storage, katelsous at a rate of 0.4% w/w showed the percent mortalities of 100%, 100% and 95.7% against the three tested insects, respectively at 5 days of exposure. The residual effect after 4 months of storage decreased to 14.3%, 52.9% and 35.6% mortality against the three insects, respectively at the same time of exposure. In general the results obtained showed that the diatomaceous earth had the most activity followed by katelsous and kaolin against the three tested insects. Also, the degree of effectiveness decreased with the increasing of storage periods.

INTRODUCTION

Synthetic insecticides have been used since the 1950_s to control stored-products insects (Subramanyan and Hagstrum 1995).However, because of increasing concern over worker exposure, reduced efficacy due to resistant insect populations, pesticide residues in human and animal food, and environment protection, therefore alternative methods are needed to control stored-products insects. As an alternative to chemical control, diatomaceous-earth (DE) has been increasingly used over the last decade and is recognized as essential component of Integrated Pest Management (IPM) in stored-products Management (Korunic, 1999).DE is a soft rock that

is the fossilized remains of unicellular algae called diatoms. Depending upon geological source, it is almost pure amorphous.(IARC,1997). DE absorbs the insect cuticular waxes which causes death from desiccation (Ebeling,1971.,Rigaux *et al*., 2001). In addition, DE abrades the cuticle (Ebeling,1971). Inert dusts can be classified into different group depending on their composition and particle size. Non-silica dust and those composed of coarser grain silicates, such as kaolin have been used traditionally as grain protectants by small-scale farmers in the developing world (Golob,1997). The toxicity of acid-activated kaolin to adult population of *Sitophilus oryzae, Sitophilus zeamais, Tribolium castaneum,Cryptolestes pusillus,Oryzaephilus surinamensis and Rhyzopertha dominica* was assessed by admixing the material with paddy (Permual and Patourel 1990). Katelsous has tested as a carrier dust for conventional insecticides in Egypt (Mostafa and Al-Moagel,1989). The flour beetle, *T. confusum*, rice weevil, *S. oryzae* and lesser grain borer, *R. dominica* are three of major insect pests of stored grain in Egypt. The rice weevil, *S. oryzae* (L.) is a very serious pest of stored grain. This species infests kernels of various cereals (wheat, barley, rice, and maize), the female oviposits inside the kernel and larvae develop inside the grain kernel till adult completion (Ungsunantwiwat and Mills,1985, Baker,1988, Rees,1996). For the control of this species, fumigants or residual insecticides are usually applied. However, *S. oryzae* has developed resistance to various insecticides in several parts of the world (Champ and dyte,1976, Arthur,1996).The insecticidal efficacy of several DE formulations against this species has been discussed by several researchers, particularly during the past decade. *R. dominica* cause great damage to grain in storage (El- Nahal *et al*.,1982 and Daglish *et al.*,1996). Therefore, the present study was conducted to evaluate the effect of three inert dusts, DE, kaolin and katelsous against three stored wheat insects, *S. oryzae*, *R. dominica* and *T. confusum* at the middle delta region of Egypt, in governorate, Kafr El-Sheikh under the supervision of the regional council for research and agriculture extension, ARC, Ministry of agriculture.

MATERIALS AND METHODS

The present work conducted to evaluate the efficacy of three inert dusts, diatomaceous earth, Kaolin and Katelsous as wheat protectants in laboratory and field experiments at Kafr El-Sheikh governorate,Egypt against three stored wheat insects, i.e., *Sitophilus oryzae*, *Rhizopertha dominica* and *Tribolium confusum*.

Materials used :

nert dusts :

- **Diatomaceous earth (D.E.):**
  - Commercial name : Protect-it (D.E. 90%)
  - Bulk density: 0.15 gm/cm^3
  - Source: It was purchased from Agrokaslet Co., Canada
- **Kaolin :**
  - Kaolin is a hydrated aluminum silicate.
  - It is fine white or grayish-white, insoluble in water and in organic solvents, and odorless.

- Source: It was purchased from El-Masria for Chemical and Farm Co., Egypt (Adwia).

- **Katelsous :**
  - It consists of triple phosphate rock 84% and sulphur 16%.
  - Bulk density : 0.70 gm/cm^3
  - Source: It was purchased from El-Masria for Seeds, Oils, Chemicals (korm) Co., Egypt.

Insects tested :

The original strains of all tested insects were obtained from the Department of Stored Product Pests, Plant protection Research Institute, Agricultural Research Center, Dokki, Egypt. Insect species were tested and their life cycles were identified according to the method mentioned by Badawy and Doraeham (1991).

Rice weevil, *Sitophilus oryzae* (L.) (Fam. Curculionidae)

The adults of rice weevil, *S. oryzae* were reared on wheat grains under the laboratory conditions of 26 ± 1°C, 65 ± 5% R.H. Insects were maintained in small glass jars, each contained 100 gm of wheat grains and 200-300 adult insects. Adults were left for two weeks for egg laying in the jars and were then removed. After two weeks, new insects were collected by sieving the culture to using for experiments.

Lesser grain borer, *Rhizopertha dominica* (F.) (Fam. Bostrichidae):

About 300 adults were added to a mixture of 150 gm wheat kernels and 10 gm wheat flour in small jar and covered with muslin. Jars were maintained under conditions of 34 ± 3°C and 70 ± 1 R.H. Adults were left for two weeks for egg laying in the jars and were then removed. After two weeks, newly insects were collected by sieving and were used for experimentation.

Flour beetle, *Tribolium confusum*(H.) (Fam. Tenebrionidae):

T. confusum were cultured in the laboratory and reared in small jar on a mixture of whole wheat flour enriched with beer's yeast (10:1w/w) as rearing medium and kept in the dark at 30± 3°C and 65 ± 5% R.H. Adults were left for two weeks for egg laying in the jars and were then removed. After two weeks, new adult emerged were collected by sieving and were used for experimentation.

Preparation of grains and determination of their moisture content:

Wheat grains, *Triticum aestivum,* var. Sakha 61, were used as a rearing medium, for the tested insects. Grains were sterilized by freezing at -18°C for 1 week to kill off any prior infestation. The moisture contents of these grains were measured by oven-drying duplicate samples each of 5 gm, at 130°C for 1 hour. The grains were stored in sealed polyethylene bags in a refrigerator at 5°C till required for experiments.

Methods :

Laboratory experiment :

Series of concentrations of different dusts were prepared by admixing a certain weight of the dust to 100 gm. of wheat grains in one pound glass jar to obtain the desired concentrations, for diatomaceous earth, Kaolin and Katelsous rates of 0.1, 0.2, 0.3, 0.4 gm./100 gm wheat, 1, 2, 4 and 8 gm./100 gm wheat, and 0.05, 0.1, 0.2 and 0.4 gm./100 gm wheat were used respectively.

Dusts were admixed thoroughly with grains to be completely homogenous. Thirty of newly emerged adults of each species (0-3 days old) were introduced to every glass jar and three replicates were made at each concentration level. Control groups were carried out following the same technique. After 1,2,3,5 and 7 days of exposure periods, the average mortality percentages counts were recorded and corrected by Abbott' formula(1925). Regression line were plotted on log-probit paper and data were statistically analysed.

Storage (Field) experiment :

To study the residual activity of the used grain protectants, diatomaceous earth (with rate of 0.5% w/w), Kaolin (with rate of 8% w/w) and Katelsous (with rate of 0.4% w/w), batches of 7 Kg of wheat grains were treated with the mentioned rates. Untreated 7 kg used as a control. All treatments (treated and control) were kept at storages of farmers in three replicates for every dust. Monthly samples were drawn for 4 months. One kg for every replicate was taken after thorough mixing in the laboratory and divided into several sets, each set consists of 3 replicates. Twenty newly emerged adults of *S. oryzae*, *R.dominica* and *T. confusum* were introduced into glass jar at 26°C and 60-70% R.H. Mortality counts were recorded daily until all insects died. Series of jars with the same technique were used for the control under the same conditions.

RESULTS AND DISCUSSION

Insecticidal activity of the tested dusts (Laboratory experiment) :

Three inert dusts, diatomaceous earth, kaolin and katelsous were evaluated against *S. oryzae*, *R. dominica* and *T. confusum* at different rates of applications. Dusts gave different percentages of mortalities which varied according to the concentrations and exposure periods. Tables (1, 2 and 3) indicated the following results:

a. Diatomaceous earth (DE):

1. The concentrations of 0.1 and 0.2% w/w of diatomaceous earth gave low mortality (16.7, 32.0%) after one day of exposure, while achieved 86.0% at the concentration of 0.5% against *S. oryzae*, at the same time, mortality obtained after 2 days of exposure, ranged from 86.7 to 100% with the all tested concentrations against the all tested insects (Table 1).
2. The concentration of 0.5% w/w gave 100.0% mortality after 2 days of exposure, against the three tested insects(Table 1).
3. Diatomaceous earth when used against *T. confusum* resulted in gradually increase in percentages of mortality reached to 78.9% one day after treatment at 0.5% w/w (Table 1). Arnoud *et al*. (2005) reached the same results when found that (DE) at concentration up to 400 ppm was most effective formulation to control red flour beetle populations.

The results in Tables (4,5 and 6) (Fig 1,2 and 3) showed that the *R. dominica* was more susceptible to DE(LC_{50} : 0.071%w/w) than of *S. oryzae* or *T. confusum* (LC_{50} : 0.234 and 0.235%w/w), respectively.

These results are in agreement with those of Athanassiou *et al*. (2007) who found that when three forms of DE were used alone or combination, they were less effective against *T. confusum* in comparison with the other two species (*S. oryzae* and *R. dominica*).

It apparent from (Table 1) that the rate of 0.5% w/w of DE could be recommended for protection of wheat grains whereas it gave a complete mortality to the three tested insects after 2 days of exposure.

Table (1): Initial toxicity of diatomaceous-earth against *S. oryzae, R. dominica and T. confusum.*

Concentration (% W/W)	Treated insect	Mortality % after the indicated exposure period (day)	
		1	2
0.1	*S. oryzae*	16.7	95.6
0.2		32.0	97.8
0.3		62.2	100
0.4		80	100
0.5		86	100
0.1	*R. dominica*	68.3	100
0.2		73.3	100
0.3		88.3	100
0.4		90.0	100
0.5		96.7	100
0.1	*T. confusum*	18.9	86.7
0.2		41.0	93.0
0.3		63.3	97.8
0.4		70.0	100
0.5		78.9	100

b. Kaolin :

It is obvious from Table (2) that the percentage of mortalities increased gradually 3 days after treatment against the three tested insects . The mortalities percentages of mortality were 15.0, 11.1 and 14.5% at the rate of 1% w/w kaolin, it reached 91.6, 92.2 and 96.5% at the rate of 8% w/w against *S. oryzae*, *R. dominica* and *T. confusum*, respectively after 3 days of exposure (Table 2).

In the other hand, results obtained in (Tables4-6, Fig 1-3) showed that *T. confusum* was more tolerant than the two other insects according to the LC_{50}s of the three tested insects. These results are in agreement with those of Permual and Patourel (1990) who found that *T. confusum* and *S. oryzae* were relatively tolerant when exposed for 72 hrs. on paddy treated with activated kaolin.

The rate of 8% w/w gave more than 90% mortality after three days of exposure for the three tested insects. Complete mortality was achieved after 7 days of exposure (Table 2). Therefore, the rate of 8% w/w of kaolin dust could be highly recommended for further field studies under natural environmental conditions to asses its protective and persistence capacity.

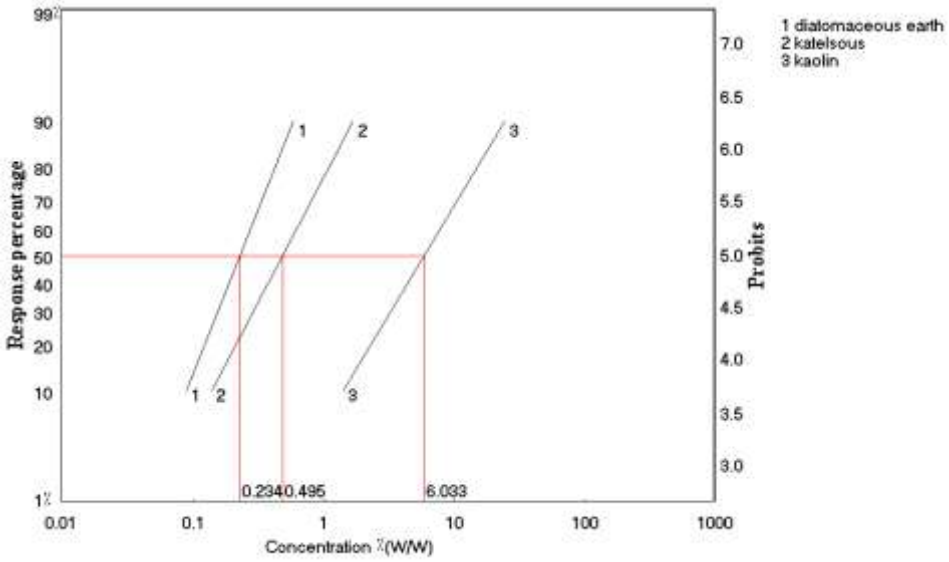

Fig. 1 : Probit regression lines for the toxicity of the tested inert dusts against adults of rice weevil, *S. oryzae* (L) after 24 hrs. exposure to treated wheat grains.

Table (2): Initial toxicity of kaolin against *S. oryzae, R. dominica and T. confusum.*

Concentration (% W/W)	Treated insect	Mortality% after the indicated exposure period (day)			
		1	3	7	14
1	*S. oryzae*	6.7	15.0	95.2	100
2		15.5	31.7	100	–
4		31.0	56.7	100	–
8		63.3	91.6	100	–
1	*R. dominica*	2.3	11.1	58.2	100
2		4.4	22.2	60.7	100
4		27.7	60.0	91.0	100
8		63.3	92.2	100	–
1	*T. confusum*	1.0	14.5	90.0	97.5
2		11.7	34.4	91.6	100
4		24.7	65.5	92.8	100
8		44.4	96.5	100	–

Table (3): Initial toxicity of katelsous against *S. oryzae, R. dominica and T.confusum.*

Concentration (% W/W)	Treated insect	Mortality % after the indicated exposure period (day)			
		1	3	7	14
0.05	*S. oryzae*	0.0	17.6	83.5	100
0.1		4.0	51.5	89.5	100
0.2		20.0	83.5	100	–
0.4		40.0	89.7	100	–
0.05	*R. dominica*	0.0	28.0	75.7	100
0.1		9.3	50.7	87.7	100
0.2		18.7	78.7	90.7	100
0.4		44.0	89.3	100	–
0.05	*T. confusum*	0.0	24.0	77.2	100
0.1		1.0	48.0	88.5	100
0.2		1.7	57.3	94.3	100
0.4		3.1	82.8	95.7	100

Table (4): Toxicity of the tested inert dusts against adults of Rice weevil, *Sitophilus oryzae* (L.), after exposure to treated wheat grains for 24 hrs.

Inert Dust	LC_{50} (%W/W)		LC_{90} (%W/W)		Slope	Relative potency[(1)] (%)
	Value	Fiducial limits	Value	Fiducial limits		
Diatomaceous earth	0.234	0.21 – 0.26	0.60	0.52 – 0.74	3.12	100.00
Kaoline	6.033	5.06 – 7.60	25.05	17.07 – 45.22	2.07	3.81
Katelsous	0.495	0.40 – 0.73	1.72	1.05 – 4.43	2.37	46.00

[(1)] **Relative potency = (LC_{50} of the most toxic insecticide / LC_{50} of the candidate insecticide) × 100**

Table (5) : Toxicity of the tested inert dusts against adults of Lesser grain borer, *Rhizopertha dominica* (F.), after exposure to treated wheat grains for 24 hrs.

Inert Dust	LC_{50} (%W/W)		LC_{90} (%W/W)		Slope	Relative potency[(1)] (%)
	Value	Fiducial limits	Value	Fiducial limits		
Diatomaceous earth	0.071	0.05 – 0.09	0.43	0.34 – 0.59	1.65	100.00
Kaoline	6.306	5.52 – 7.44	17.16	13.23 – 25.15	2.95	1.11
Katelsous	0.496	0.38 – 0.79	2.16	1.19 – 7.33	2.01	14.00

[(1)] **Relative potency = (LC_{50} of the most toxic insecticide / LC_{50} of the candidate insecticide) × 100**

Table (6): Toxicity of the tested inert dusts against adults of Red flour beetle, *Tribolium confusum.* (H.), after exposure to treated wheat grains for 24 hrs.

Inert Dust	LC_{50} (%W/W)		LC_{90} (%W/W)		Slope	Relative potency[(1)] (%)
	Value	Fiducial limits	Value	Fiducial limits		
Diatomaceous earth	0.235	0.21 – 0.26	0.66	0.58 – 0.80	2.85	100.00
Kaoline	8.938	7.13 – 12.55	37.93	23.38 – 84.51	2.04	2.85
Katelsous	103.875	83.09 – 140.52	4691.71	2981.31 – 6651.22	0.77	0.23

[(1)] **Relative potency = (LC50 of the most toxic insecticide / LC50 of the candidate insecticide) × 100**

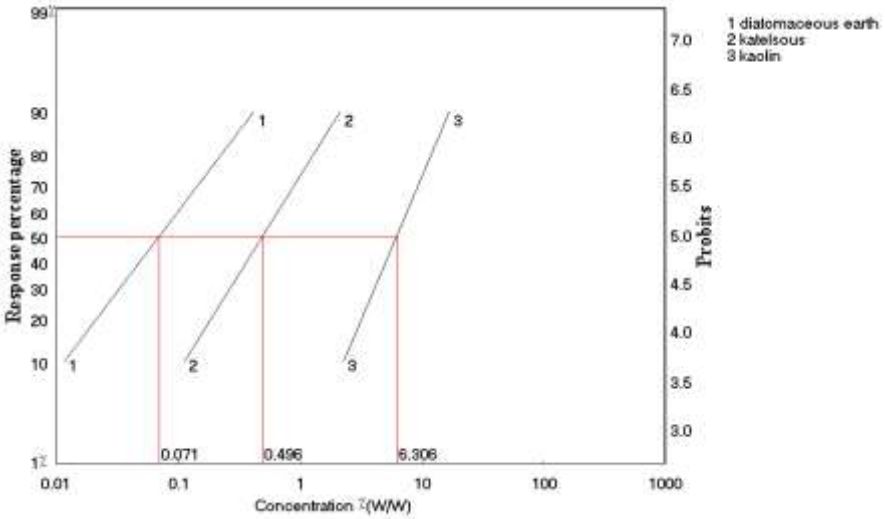

Fig. 2 : Probit regression lines for the toxicity of the tested inert dusts against adults of lesser grain borer, *R. dominica* (F) after 24 hrs. exposure to treated wheat grains.

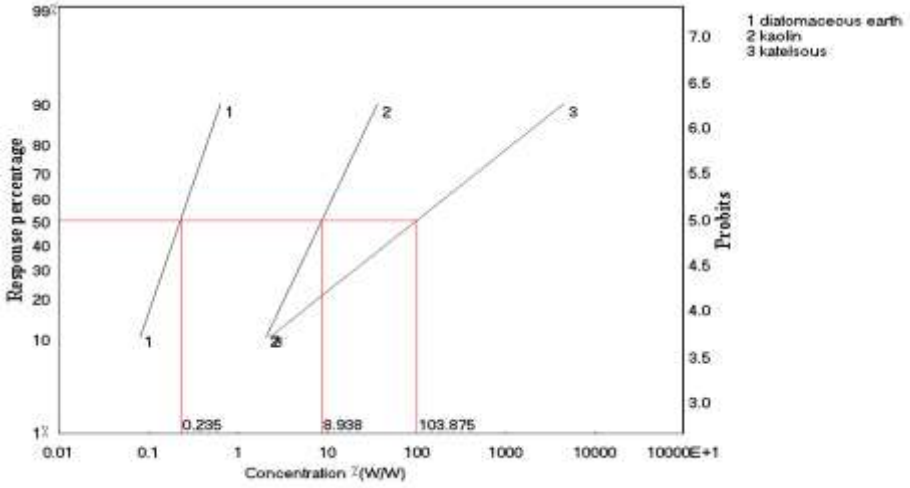

Fig. 3 : Probit regression lines for the toxicity of the tested inert dusts against adults of red flour beetle, *T. confusum* (H) after 24 hrs. exposure to treated wheat grains.

Golob (1997) reported that inert dusts particularly these based upon activated silica, are finding increasing use as storage protectants in the grain industry. He added that kaolin have been used traditionally as grain protectant by small scale farmers in the developing world.

c. Katelsous :

Katelsous gave relatively lower mortalities at all tested rates after 24 hrs. for the three tested insects (Table 3). These results are in agreement with those of El-Lakwa *et. al.* (2001) who evaluated the efficiency of Katelsous (K.S), diatomaceous earth (D.E.) and their joint action against *S. oryzae*, *R. dominica* and *T. castanum*. They found that katelsous, when used alone, gave relatively lower percentages of insect mortalities as compared with these resulting from the application of the mixture of diatomaceous earth and katelsous.

After three days of exposure, katelsous performed moderate protection particularly with the higher concentrations against the three tested insects. Higher rates (0.2 and 0.4% w/w) gave nearly complete mortality after 7 days of exposure for all insects (Table 3).

Mostafa and Al-Moagel (1989) reported that katelsous was more effective compared with permethrin and fenitrothion dusts against *Trogoderma granarium* beetle.

LC_{50}'s were 0.495, 0.496 and 103.875% w/w after one day of exposure when katelsous was used against *S. oryzae*, *R. dominica* and *T.* confusum, respectively(Tables 4,5 and 6, and Figs 1,2 and 3). This result showed that *T. confusum* was more tolerant than the two other insects. The present result coincided with those of Mostafa and Al-Moagel (1989) who found that all DE_S were less effective against *T. confusum*. El-Disouky (2002) studied the effectiveness of kaolinite and katelsous against *S. oryzae* at the concentration of 0.5 and 15% w/w, he reported that there were a significant differences in the mortality percentages after one and two weeks and katelsous was more effective than kaolinite.

On the bases of the above mentioned, results one may conclude that katelsous should be used at high concentration to achieve high percentage of mortality and to suppress the oviposition

II. Residual activity (Field experiment):

Further studies were conducted to evaluate the residual activity of the selected rates of 0.5, 8 and 0.4% w/w of DE, kaolin and katelsous, respectively. The results obtained from the field experiment were as follows :

a. Diatomaceous earth (D.E):

Data obtained in Table (7) indicate that DE mixed with wheat at rate of 0.5% w/w and stored for a period of four months suffered considerable decreasing in activity against *S. oryzae*, *R. dominica* and *T. confusum*

After one month of storage the mortality was 98.8, 97.8 and 89.3% for the three insects, respectively at the third day of exposure (Table 7), compared with 100 % mortality at the second day after exposure (Table 1). It was cleare that the degree of the effectiveness differed according to the storage period. After four months of storage the activity of DE considerably decreased, where the mortality % reached 66.7, 25.8 and 63.3% for the three insects, respectively, at the third day of exposure (Table 7).

Results obtained in Table (8) showed that there was more pronounced decreasing in activity with the longer periods of storage, where the loss of efficiency was increased from 1.2, 2.2 and 10.7% after one month to 33.3, 74.2 and 36.7% for the three tested insects, respectively 3 days of exposure after 4 months.

Table (7) : Residual activity of diatomaceous-earth at 0.5% w/w against the three tested insects after the indicated periods of storage.

Storage period (month)	Mortality % after the indicated exposure period (day)											
	1	3	5	7	1	3	5	7	1	3	5	7
	S. oryzae				*R. dominica*				*T. confusum*			
0	86.0	100	–	–	96.7	100	–	–	94.4	100	–	–
1	56.0	98.8	100	–	73.7	97.8	100	–	46.7	89.3	100	100
2	13.7	94.8	100	–	55.8	96.5	100	–	10.0	78.6	96.6	100
3	8.9	91.7	100	–	23.2	91.8	100	–	3.3	70.0	96.2	100
4	1.7	66.7	91.1	100	1.6	25.8	62.7	91.6	1.7	63.3	86.5	98.2

Table (8) : Percentage reduction in the efficiency of 0.5 % w/w diatomaceous-earth after different storage periods.

Treated insect	Reduction % in efficiency after different storage periods[(a)] (month)			
	1	2	3	4
S. oryzae	1.2	5.2	8.3	33.3
R. dominica	2.2	3.5	8.2	74.2
T. confusum	10.7	21.4	30.0	36.7

[(a)]Reduction% in efficiency = 100–% mortality at the third day of exposure after different storage periods.

b. Kaolin :

Data obtained in Table (9) indicate that kaolin mixed with wheat at rate of 8% w/w and stored for a period of 4 months suffered considerable decrease in the activity at the fifth day from exposure against the three tested insects throughout the storage periods.

Table (9) : Residual activity of kaolin at 8 % w/w against the three tested insects after the indicated periods of storage.

Storage period (month)	Mortality % after the indicated of exposure periods (day)											
	1	3	5	7	1	3	5	7	1	3	5	7
	S. oryzae				*R. dominica*				*T. confusum*			
0	63.3	91.6	100	–	63.3	92.2	100	–	44.4	96.5	100	–
1	1.7	73.3	95.0	100	10.5	27.1	80.0	88.7	0.0	26.8	36.6	71.4
2	5.0	8.7	25.9	54.7	5.0	42.1	77.1	86.4	0.0	11.7	28.8	42.8
3	0.0	7.7	12.2	24.0	3.3	6.5	33.3	86.0	0.0	8.3	25.0	39.2
4	0.0	1.7	13.7	16.1	1.6	8.7	27.1	43.8	0.0	5.4	16.9	22.5

The percentages of mortalities were 73.3, 8.7, 7.7 and 1.7% for *S. oryzae* while was 27.1, 42.7, 6.5 and 8.7% and 26.8, 11.7, 8.3 and 5.4% for *R. dominica* and *T. confusum* after 1, 2, 3 and 4 months at the third day of exposure, respectively.

Data in Table (10) showed that the period of storage significantly affect the efficiency of kaolin, where the loss of efficiency was increased from 0.0, 11.3 and 28.6% after one month to 83.9, 56.4 and 77.5% after four months of storage.

Table (10): Percentage reduction in the efficiency of 8 % w/w kaolin at after different storage periods.

Treated insect	Reduction % in efficiency after different storage periods[(a)] (month)			
	1	2	3	4
S. oryzae	0.0	45.3	76.0	83.9
R. dominica	11.3	14.0	14.0	56.4
T. confusum	28.6	57.2	60.8	77.5

[(a)] Reduction % in efficiency = 100 – % mortality at the third day of exposure after different storage periods.

c. Katelsous :

Data obtained in Table (11) showed that the percentages of mortalities for *S. oryzae*, *R. dominica* and *T. confusum* at the first, third, fifth and seventh day of exposure, decreased with increasing the storage period of katelsous treated wheat for 4 months using the rate of 0.4% w/w where mortalities% were reduced from 100% to 45.0%, 100% to 66.6% and 100% to 64.3% during storage period from zero time to 4 months for the three tested insects, *S. oryzae*, *R. dominica* and *T. confusum*, respectively, at the 7th day of exposure.

Table (11) : Residual activity of katelsous at 0.4% (w/w) against the three tested insects after the indicated periods of storage.

Storage period (month)	Mortality% after the indicated of exposure periods (day)											
	1	3	5	7	1	3	5	7	1	3	5	7
	S. oryzae				*R. dominica*				*T. confusum*			
0	40.0	89.7	100	100	40.0	92.3	100	100	2.0	82.8	95.7	100
1	3.3	79.3	92.9	94.3	28.8	66.6	87.5	90.9	16.7	44.6	78.9	85.0
2	3.3	17.3	41.3	77.3	26.3	37.0	75.0	86.4	1.7	19.6	71.2	74.3
3	0.0	23.0	40.3	63.1	1.8	31.0	55.0	81.9	1.7	15.0	62.5	70.6
4	0.0	5.0	14.3	45.0	0.0	24.5	52.9	66.6	1.7	8.3	35.6	64.3

Data in Table (12) showed that there was a reduction in the efficiency with the increasing period of storage, where the decreasing in the efficiency were 55, 33.4 and 35.7% for the three tested insects, respectively at the end of experiment.

Table (12): Percentage reduction in the efficiency of 0.4 % w/w katelsous at after different storage periods.

Treated insect	Reduction % in efficiency after different storage periods[(a)] (month)			
	1	2	3	4
S. oryzae	5.7	22.7	36.9	55.0
R. dominica	9.1	13.6	18.1	33.4
T. confusum	15.0	25.7	29.4	35.7

[(a)] Reduction % in efficiency = 100 – % mortality at the third day of exposure after different storage periods.

Various studies on the efficacy of inert dusts have been reported. Activated kaolin clays (aluminum silicate) have been shown to be effective

against a range of stored product beetle pests (Permual and patourel,1990; Swamioppan *et al*.,1976). A relatively new DE of marine origin, Insecto, has been extensively assessed in USA (Subramanyam *et al*.,1994). The tested materials have low mammalian toxicity (Quarles, 1992) and can be applied directly to the grains (Korunic, 1998). (Ebeling, 1971) reported that selected genetically by the action of these dusts, so that physiological resistance will not occur.

In conclusion, The obtained results showed that the diatomaceous earth had the most activity followed by katelsous and kaolin against the three tested insects. Also, the degree of effectiveness decreased with the increasing of storage period. *R. dominica* was more susceptible to DE, kaolin and katelsous than *S. oryzae* and *T. confusum*, while *T. confusum* was the most tolerant against the three tested materials. Finally the present study suggests that the three inert dusts used may comply well with criteria of the proper protectants against stored grain insects where these agents materials have low mammalian toxicity and can be applied directly to the grain by using the same technology as that used for residual insecticides, in addition because the action of these materials is not dependent on metabolic pathways, it has been postulated that insects will not be selected genetically by the action of these dusts, so that physiological resistance will not occur.

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التأثير الإبادي لبعض المساحيق الخاملة على ثلاث من حشرات المخازن بمحافظة كفرالشيخ

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اشتمل هذا البحث على دراسات معملية وحقلية لتقييم تأثير ثلاثة مساحيق خاملة وهى التربة الدياتومية والكاؤولين وقاتل سوس كمواد واقية لحبوب القمح من الإصابة الحشرية لثلاثة أنواع من حشرات الحبوب المخزونة وهى سوسة الأرز وثاقبة الحبوب الصغرى وخنفساء الدقيق المتشابهة. تم خلط المساحيق مع حبوب القمح في المعمل بتركيزات مختلفة وتم تسجيل نسب الموت للحشرات وحساب التركيز القاتل لـ 50% (LC_{50}) والتركيز القاتل لـ 90% (LC_{90}) وميل خط السمية (Slope) والقدرة النسبية لهذه المساحيق. أظهرت النتائج المتحصل عليها من التجارب المعملية أن التركيز القاتل لـ 50% للتربة الدياتومية هو 0.234، 0.071، 0.235% وزن/ وزن ضد سوسة الأرز وثاقبة الحبوب الصغرى وخنفساء الدقيق المتشابهة على التوالي بعد يوم واحد من المعاملة. كما أظهرت النتائج أن التركيز القاتل لـ 50% للكاؤولين وقاتل سوس كان 6.033 ، 6.306 ، 8.938% وزن/ وزن و 0.495 ، 0.496 ، 103.88% وزن/ وزن على التوالي بعد يوم واحد من تعريض الحشرات الثلاث المختبرة عن التوالي. وأوضحت النتائج أن التربة الدياتومية كانت أكثر تأثيراً من المركبات الأخرى المختبرة حيث أدت إلى الموت الكامل للحشرات المختبرة بعد يومين من التعريض عند تركيز 0.5% وزن/ وزن في حين أدى تأثير كل من الكاؤلين وقاتل سوس إلى الموت الكامل للحشرات المختبرة بعد أسبوع من التعريض عند تركيز 8 ، 0.4% وزن/ وزن على التوالي. واستخدمت أعلى التركيزات تأثيراً على الحشرات المختبرة في الدراسة الحقلية (في مخازن المزارعين) وهى 0.5، 8، 0.04% وزن/ وزن والتي تم الحصول عليها من التجارب المعملية لكل من التربة الدياتومية والكاؤولين وقاتل سوس على التوالي حيث خلطت بالقمح الذي تم تخزينه في مخازن المزارعين لمدة 4 شهور. كما أوضحت نتائج التجارب الحقلية في مخازن المزارعين أن الأثر الباقي للتربة الدياتومية بعد أربعة شهور من التخزين وصل إلى نسبة موت 100% ، 91.6% ، 98.2% ضد الحشرات الثلاثة المختبرة على التوالي بعد 7 أيام من التعريض كما أظهرت النتائج أيضاً أن درجة الفعالية بهذه المركبات تتناقص مع زيادة فترات التخزين حيث أظهرت النتائج أن الكاؤولين عند تركيز 8% وزن/ وزن أدى إلى نسبة موت تراوحت من 100% عند أول المعاملة (بدون تخزين) بعد 5 أيام من التعريض إلى 13.7%، 27.1%/ 16.9% بعد 4 شهور من التخزين ضد الحشرات الثلاث المختبرة على التوالي. كما أن قاتل سوس عند معدل 0.4% وزن/ وزن أدى إلى نسبة موت 100% ، 100% ، 95.7% ضد الحشرات الثلاث المختبرة على التوالي عند أول المعاملة (بدون تخزين) بعد 5 أيام من التعريض في حين وصل الأثر الباقي له بعد 4 شهور إلى موت 14.3% ، 52.9% ، 35.6% للحشرات الثلاثة المختبرة على التوالي.

وبصفة عامة فإن نتائج هذا البحث أظهرت أن التربة الدياتومية هي الأكثر فعالية ضد الحشرات المختبرة يليها قاتل سوس والكاؤولين. وأيضاً انخفضت درجة فعالية المواد المختبرة مع زيادة فترة التخزين.

قام بتحكيم البحث

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