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Studying the effect of surfaces treated with inert dusts on *Callosobruchus maculatus* (Fab)

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Abstract
This study included the uses of certain inert powders on the South cowpea beetle (*Callosobruchus maculatus*). The adult and third larval stages were exposed to six inert components, comprised of three manufactured types (Etapolget, silica gel and caulenet) and three natural types (Diatomic soil, ninivite rock and gypsum ($CaSo_4.2H_2O$)). The inert powders were sprinkled on filter paper at concentrations of 2, 4, 6 g/m^2 and put in Petri dishes, the adult and larval stages were exposed to the inert dusts for three days. The results showed that the adult insects were more affected than the larval stage. The highest mortality rate of the adult was 99.99% for etapolget and silica gel at concentration of 6 g /m^2, followed by ninivite powder with mortality rate of 95.4%. The effect of the other used inert powders were ranged from moderate to weak. The highest mortality rate of the third larval stages were also for etapolget followed by silica gel with a mortality rate of 47.5% at a concentration of 6 g/m^2. Very few effects have been observed with the other powders. The conclusion is that the etapolget and silica gel are virtuous for protection of stored cowpea, therefor we recommend using it as an alternative to insecticides.

Keywords: Inert dust, *Surfaces treatment, Callosobruchus maculatus*

Introduction
The uses of inert dust is an alternative of pesticides. They also called as drying materials. These composed of inert smooth powders that kills insects by physical action more than chemical affection. These compounds cause corrosion or scratch to the portative wax layer of insect's wall that lead to death as a result of desolation [1]. Allen [2] had cleared that, the inert dusts that were used with grains, are chemically inactive products, but they have the ability to kill insects. And that the diatomic mineral which is an additive of food products is one of the main compounds of commercial inert dusts. Other minerals components such as hallosite, zeolite, lime and sand are used to protect grain products against stored grain pests [2]. The inert dusts are sometimes used as additives and mixed directly with stored grains, it can also be sprinkled or sprayed on surfaces or fumigated in grain storage towers or silos. Some types of inert dusts are used on buildings as a protective thin layer for its synergetic special effects with phosphine fumigants against stored grain pests [3]. Kanta *et al.* [4] mentioned that, when charcoal is sprinkled on the inner surface of rice stored sacks, it protects the product from rice weevil. And that the application of these inert dusts on surfaces of wheat sacks also protected it from pests for long periods of time [4]. What is unique and useful in inert powders is that, they are nontoxic, risk-free, provide continuous protection for stored products and do not interfere with other controlling techniques such as heat using, fumigation and aeration [5]. According to the mentioned above characteristics of inert dusts and the insecticide resistance phenomenon among stored grains pests, this study aims to find out the effect of some inert dusts on South cowpea third larva and adults.

Materials and Methods
1-Insect rearing: Infected cowpea seeds with *C. maculatus* were obtained from Kirkuk local markets in July 2018. 100 g of infected seeds were put in glass containers. The containers were then covered with several layers of gauze tissue which was fixed and tightened on the containers by an elastic rubber band to prevent the insects from getting out. After that the containers were incubated at 30±2Ċ and 70±5% moisture. The insect was leaved for two months to reproduce several generations [6]. The cultures were renewed from time to another to discard the molted skins, dead insects and waste products. Intact seeds were continuously added to the cultures.

2-Preparation of inert powders: Six types of inert powders were used in this study. Three were natural compounds (Diatomic soil, ninivite rocks, gypsum ($CaSo_4.2H_2O$), and three were manufactured (Caulenet, etapolget and silica gel ($H_2F_2S_4$.type 60)). The compounds were crushed and sieved by USA standard sieve No. 60 pore size 0.25 mm. The sieved powders were put in dark bottles until use.

3-Inert powders efficacy test against the insect: Filter papers 9cm diameter, type wattman no. 1 were treated with three concentrates (2, 4, 6 g/m^2) of the inert powders. The filter papers were then put in Petri dishes 63cm^2 size. Each concentrate was done in three replicates in addition to the control. 10 larva third age were put in each Petri dish and incubated at 30±2Ċ and 70±5% moisture. The mortality rate was evaluated using Abbott equation [7]. The test was repeated using 10 adult insects one day age instead of larval stage [8, 9].

4-Statistical analysis: The complete random designs (CRD) test and SAS were used to evaluate the variance between tested factors. Anova table (analysis of variance) was used also [10]. For comparison of results Duncan's test at 0.05 significance level was used [11].

Results and Discussion

The results in table 1 revealed that the mortality rates were significantly varied with inert powder types, the concentration and with insect stages. The adult insects were significantly more effected than the third stage larva. The overall rate of adult mortality was 55.4% while the mortality rate of larvae was 18.15%. This may be due to the presence of dense hair on larva body that prevents inert dust particles from getting in contact with larva skin or cuticle. This result was agreed with what was found by Al-Iraqi and Ramadan [3]. The higher inert dust concentration the higher mortality rates recorded in both adult and larva. The increased rate of larva mortality was 11.72, 16.81, 26.9 for each of 2, 4, 6 g/m^2 respectively. The increased mortality rate in adult stage was less and not significant compared to that seen in larva stage. The mortality rate was 49.4, 52.16, 55.3 3% for each of 2, 4, 6 g/m2 respectively. The results of the statistical analysis had showed significant differences between the used inert powders on mortality rates. The significantly more effective powder was etapolget on both adult and larval stages with mortality rates of 70.06, 98.75% for each stage respectively. The caulenet was the less effective powder on mortality rate which was 7.4, 30.5 respectively for each of adult and larva. The other used powders had very weak mortality rates, totally it was not exceeded 20%.

Table 1: Mortality percentage mean of third larval stage and adults

Stage	Con. mg/m^2	Inert dusts							Mean average
		Gypsum	Etapolgat	Diat. soil	Ninivite	Slicagel	Caulente	Average	
Third larva	1	8.36 K-m	60.52 C - g	7.23 K -m	16.51 i-m	10.44 i-m	0 m	11.72 C	18.15 B
	2	16.94 i-m	71.22 b- f	14.47 i-m	8.93 k-m	28.52 j-m	3.60 m-I	16.81 C	
	3	9.81 K-m	93.80 abc	16.33 K – m	23.21 g-m	47.50 f-k	17.52 i-m	26.93 B	
Average		11.11 EFG	74.06 B	13.11 EFG	19.75 DEF	19.74 DFF	7.40 fc		
Adult	1	38.44 f – j	95.34 ab	84.88 abc	49.85 d-h	86.84 abc	22.51 f-j	49.11 A	55.40 A
	2	40.73 f – k	98.99 a	77.71 a-e	82.45 a-d	73.66 a-c	31.71 f-k	52.16 A	
	3	43.70 f – k	99.99 a	78.66 a-e	95.40 ab	99.99 a	40.70 f-k	55.33 A	
Average		41.22 C	98.75 A	80.41 B	74.41 B	88.88 AB	30.50 CD		

The numbers which have similar letters not differed significantly at 0.05 by Duncan's test.

The result in table 2 showed that the etapolget was best on killing insects. The highest mortality rate was 86.64% and that differed significantly from the other used compounds. Followed by silica gel with mortality rate of 75.82%, ninivite 46.87% and diatomic soil with a mortality rate of 46.05%. From the other side the concentration of 6 g/m^2 was the most effective one with a mortality rate of 55.54% which significantly differed from that of 2, 4, g/m^2 with mortality rate of 32.39, 50.59% for each concentration respectively. Generally the etapolget powder recorded the highest rate of mortality (77.93, 85.1, 96.89%) for each of 2, 4, 6 g/m^2 respectively. Subramanian and Hagstrum [12] had revealed that, the most important characteristic of inert dust that related with their great effect, is their high degree of permeability and their ability to absorb wax particles of insect cuticle causing death from desiccation. And that these compounds will not loss their effectiveness with time except when they get wet. They have a low rate of moisture absorbing. Treating the inner surface of wheat bags has protected the product for a long time [13]. The protective role of inert powders has been also confirmed by Kanta *et al*., they showed that the treatment of concrete or wooden surfaces of buildings with powders of inert dusts will strongly protect them from insect pests [4].

Table 2: Efficacy of interaction between used inert dusts and concentrations on mortality percentage mean of third larval stage and adults after three days exposer.

Inert dusts	Concentration mg/m^2			Average
	2	4	6	
Gypsum	23.40 i-m	28.83 g-m	26.75 f-j	26.32 DC
Etapolget	77.93 a-c	85.10 a-b	96.89 a	86.64 A
Diatomaceous soil	47.05 d-h	46.09 e –i	47.49 c –e	46.05 C
Ninivite	33.18 f-j	45.69 d-h	59.30 b-d	46.87 B
Silica gel	48.64 d-g	51.09 e-i	73.74 e-i	57.82 B
Caulenet	11.20 k-m	17.60 m	29.11 I- m	34.55 E
Average	32.39 B	50.59 B	55. 54 A	

The numbers which have similar letters not differed significantly at 0.05 by Duncan's test

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