Evaluating Effectiveness of Some Inert Dusts and Chemical Pesticides in *Tribolium castaneum* Coleoptera: Tenebrindae Under laboratory Conditions

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ABSTRACT

The toxicity of three types of inert dusts was tested by mixing them: kaolinite, silica and zeolite against adults of the red rust beetle, *Tribolium castaneum* (Coleoptera: Tenebrindae) using four concentrations: 5, 10, 20, 40 dust/kg wheat seeds, and each concentration had three replicates. The experiment was carried out in an incubator at a constant temperature and relative humidity in the laboratory of the Plant Protection Department, College of Agriculture, University of Basra. The readings were taken after (24, 48 and 72) hours of treatment under a probability level of (0.01), with a significant difference. The highest percentage of killing of *Tribolium castaneum* at a concentration of (40) grams within (72) hours was 100% compared to (48 and 24) at the same concentration, 93.00 and 83.00%, respectively. The germination percentage and root length were also tested using four concentrations as shown above, and the highest germination percentage was %65.17 at the (5) grams concentration, which was a significant difference from the germination percentage of wheat grains of 10, 40, and 20g, which amounted to 58.75, 52.25, and 54.00%, respectively. While the highest percentage for the control treatment at all concentrations was 93%, and the lowest for the silica treatment was 0.00 at a concentration of 40 grams. The highest average root length for the kaolin treatment was 2.50 cm, which differed significantly from the zeolite and silica treatment, amounting to (1.80 and 0.50) cm, respectively.

The results of the study also brought to light that different concentrations of the chemical pesticide, Viperidicide, were used against *Tribolium castaneum* (Coleoptera: Tenebrindae), using three concentrations: 2.5, 5, 7.5 g/emulsion/kg wheat seeds, and each concentration had three replicates. The experiment was carried out on the killing rate under laboratory conditions in the laboratory of the

Plant Protection Department, College of Agriculture, University of Basra. The readings were taken after (24, 48 and 72) hours of treatment under a probability level of (0.01), and with a significant difference, the highest percentage of killing of *Tribolium castaneum* (Coleoptera: Tenebrindae) at the concentration of 7.5 cm within (72) hours was 100% compared to (48 and 24) at the same concentration of 63.00 and 90.00% respectively. Besides, the root length was tested using three concentrations as shown. above . The highest average root length of Viperidicide pesticide was 2.03 cm at a concentration of 7.5 cm, compared to the lowest at a concentration of 5 and 2.5 cm, 1.86 and 1.50 cm for each, respectively. The germination rate was 100%.

INTRODUCTION

It is worth mentioning that grains are of great importance in global agriculture, and the wheat, *Triticum aestivum* L., occupies a high rank in terms of importance (Jashoran *et al*., 2004). It is currently considered one of the most important basic foodstuffs for humanity due to its connection to people's food security. Wheat and its products are the main source of carbohydrates and protein, supplying the world's population with about 20%. of their total dietary calorie needs (Shewry, 2007; Juarez et al. 2021; Shiferaw *et al*. 2013).

First of all, post-harvest grains are subject to long-distance commercial transportation and relatively long storage periods, as they and their products are considered durable food commodities, constitute the majority of commodities kept in storage, and represent the most important elements in the global food supply (Adel, 2016). Losses resulting from insects of stored materials have also been estimated. Cereals and oilseeds are estimated by the FAO to be 40% of global production, and in Iraq, about 10% (Ismail, 2018). There are more than (200) species of insects that attack stored crops and their products (Sriranjini and Rajendran, 2008), and beetles from the order Coleoptera constitute the largest percentage of them. Because, they are mainly responsible for heavy losses in grains. For example, losses due to infestation by these beetles reach 57% in Africa (Kumar and Kalita, 2017), the most important of which is the *Tribolium castaneum*

(Herbiest), whose larvae and adults attack both stored grains and their products, causing severe damage to stored foodstuffs (Lowe *et al*., 2000; Al-Jaber, 2006).

Second, the Inert dusts, repellent materials, inert gases, extracts, vegetable oils, and oven ashes are considered among the most important elements and methods for integrated management of insect warehouse pests (Rajasri *et al*., 2014; Ketia et al., 2001 & Upadhyay & Ahmed, 2011). Silica dust was tested against adults of the *Sithophlus granaries* (L.) and adults of the similar flour beetle *Tribolium confusm* (Duv) at several concentrations of 0, 250, 750 and 1000 µg/g grain. Then a reading of the dead insects was taken (48 and 168) hours after they were exposed to the dust. The results made it clear that an increase in the number of dead insects with increasing concentration and time of exposure to the Silica dust: The wheat weevil revealed greater sensitivity to silica compared to the similar flour beetle (Aldryhim, 1990).

Moreover, the effectiveness of inert dusts relies on some unique physicochemical properties such as particle size, surface area, silica content, porosity, amount of absorption, grain type, insect type and stage, insect community density, and local environmental conditions such as temperature and relative humidity, in addition to the influence of other factors such as insect size, feeding rate of the insect, the thickness of the fat layer, and the rate of water absorption from the internal organs. It is significant to mention that such factors may contribute to the difference in death rates in the various treatments with these powders (Chelav *et al.*, 2013; Mahmoud et al., 2010; Jianhua *et al*., 2017; Frank, 2012). Also, Synthetic zeolite dust also resisted (7) types of warehouse insects, including the common southern cowpea beetle. The death rate for this insect reached 100% after an (72) hours of treatment, and the death rate increased with increasing concentration and time of exposure of the insect adults to the dust (Sehgal & Subramanyam, 2014).

Materials and Methodology

3.1 Study of Effect of Inert Dusts on Wheat Grains Mixed with Kaolin, Zeolite and Silica

All experiments were conducted in the laboratory of the Department of Plant Protection in the College of Agriculture, University of Basra, within an incubator at a constant temperature and relative humidity. The floor *Tribolium castaneum* were collected from the Basra silo warehouses of the Ministry of Commerce and Grain. Several farms were prepared to raise them using a natural food consisting of completely infested wheat grains. The grains were placed in glass bottles with a capacity of (250) liters, closed at the top with a filament cloth, and the nozzle was tied with a rubber band. Kaolinate $AL_4(SI_4O_{10})(OH)_8$ and silica were obtained from the State Company for Industry and Mining in Baghdad, while zeolite (SI_4AL_2) 2] $(SI_3AL_2]O_{10}]2$ was obtained from the Najaf desert.

3.1.1 Calculating Kill Rate of adults of the Flour Tribolium Castaneum After (24, 48, and 72) hours

Four concentrations were used for each type of dust after mixing the dusts together: 5, 10, 20, 40 g/kg wheat seeds. The experiment was carried out by placing (10) grams of wheat seeds in 250 liter glass bottles. The mouth of the bottle was covered with a mullet cloth tied with a rubber band, then three replicates were treated. At a specific concentration from the previous concentrations, 10 adult pairs of the *floor Tribolium castaneum* were placed in each replicate, 5:5 male: female, according to laboratory conditions. Readings were taken after (24, 48, and 72) hours of treatment.

3.1.2 Study of the effect of inert powders on seed germination rates and biometric measures of the activity of wheat grains prepared as seeds for agriculture:

Root length and germination percentage were calculated using the concentrations shown above.

3.2 Study of the effect of chemical pesticides on wheat grains mixed with the pesticide *Viperidicide*:

The study was carried out in the laboratory of the Department of Plant Protection in the College of Agriculture, University of Basra. Under laboratory conditions, the *four Tribolium castaneum*, were collected from Basra Silo stores.

Study of the effect of *Viperidicide* pesticide, using three concentrations: (2.5, 5, & 7.5) liters. The experiment was carried out by placing (10) grams of wheat seeds in (250) liter glass bottles, covering the mouth of the bottle with a mullet cloth tied with a rubber band. Later, three replicates were treated with a specific concentration from the previous concentrations, where (10) adult pairs of the *Tribolium castaneum* were placed in each replicate, 5:5 male: female. According to laboratory conditions, readings were taken after (24, 48, & 72) hours of treatment. The root length and germination rate were calculated using the concentrations shown above.

STATISTICAL ANALYSIS

The data were organized for the studied characteristics of the experiments, then statistically analyzed according to the completely randomized design of the laboratory experiments as two-factor experiments, and the arithmetic means were compared according to the least significant difference (L.S.D.), with a probability level of (0.01) for laboratory experiments (Al-Rawi, 1980). For data analysis, the statistical program, *Genstat,* was used.

RESULTS AND DISCUSSION

Table (1) pinpoints The effect of kaolins, zeolites, and silica on the percentage of killing of the *Tribolium castaneum*, upon exposure to (24, 48, and 72) hours of treatment.

Kill Rate Within 24 hrs.					
Concentrations	**5 g.**	**10 g.**	**20 g.**	**40 g.**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	**%**	
Insects + wheat seeds + zeolite + kaolin + silica	**3.00**	**23.00**	**33.00**	**83.00**	47.33
LSD 0.01	**Coefficients** **6.455**	**Concentrations** **6455**	**Interference** **12.909**		
Kill Rate Within 48 hrs.					
Concentrations	**5 g.**	**10 g.**	**20 g.**	**40 g.**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	**%**	
Insects + wheat seeds + zeolite + kaolin + silica	**1300**	**33.00**	**43.00**	**93.00**	**60.66**
LSD 0.01	**Coefficients** **7.098**	**Concentrations** **7.098**	**Interference** **14.196**		
Kill Rate Within 72 hrs.					
Concentrations	**5 g.**	**10 g.**	**20 g.**	**40 g.**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	**%**	
Insects + wheat seeds + zeolite + kaolin + silica	**23.00**	**43.00**	**53.00**	**100.00**	**73.00**
LSD 0.01	**Coefficients** **3.431**	**Concentrations** **3.431**	**Interference** **6.862**		

As shown above in table (1), the highest percentage of killing was 100% with a concentration of 40 grams within 72 hours, compared to the lowest percentage at a concentration of 5 grams within 24 hours, which was 3.00%, while the highest percentage of killing was by the *Tribolium castaneum* with the treatment of insects + wheat seeds + zeolites. +Kaolin +Silica within 72 hours, which amounts to 73.00% compared to the treatment of insects +wheat seeds +zeolite +Kaolin +Silica within 24 and 48 hours, which amounts to 47.33 and 60.00%. From the

interaction, it was made clear that the highest percentage was 100% when treating insects +wheat seeds +zeolite. + silica at a concentration of 40 grams within 72 hours and treatment with insects + wheat seeds + zeolite +silica within 24 and 48 hours at the same concentration, 93.00 and 83.00% for each of them, respectively. While the lowest percentage of killing at concentrations of 5 and 10 grams when treating insects + wheat seeds + zewellite + kaolin + silica during 24 and 48 hours was 3.00, 23.00, 13.00, and 33.00 for each, respectively. The reason for the high killing rate may be attributed to scratching the cuticle layer of the insect as it moves between the treated seeds and the fine granules of the dust and its accumulation between the membranes separating the rings, which leads to the rapid evaporation of water and all body fluids, which causes the insect to dry out and die (Korumic & Fields, 2002; 2014, Akhtar & Mohd;, 2011, *et. al.*(Shams *et.al*. 2014) is in consistent with what the researchers previously found.

Table (2): Effect of kaolin, zeolite, and silica on the percentage of wheat germination as seeds

Concentrations / Coefficients	5 g. %	10 g. %	20 g. %	40 g. %	Average effect of coefficients
Kaolin	**76.67**	**66.67**	**63.33**	**60.00**	**66.67**
Zeolites	**73.33**	**63.33**	**60.00**	**56.67**	**63.33**
Silica	**16.67**	**13.33**	**0.00**	**0.00**	**7.50**
Control	**93.00**	**93.00**	**93.00**	**93.00**	**93.00**
Average effect of concentrations	**65.17**	**59.17**	**54.17**	**52.50**	
LSD 0.01	**Coefficients**	**Concentrations**	**Interference**		
	6.84	**6.84**	**13.6 9**		

Table (2), brought to light results describing the percentage effect of the concentrations of inert dusts (kaolin, zeolite, and silica) on the germination of wheat grains as seeds appears, as the highest rate of germination percentage was 65.17% at the concentration of 5 grams, which was a significant difference from the percentage of germination of wheat grains of 10, 20, and 40 grams, which was 10, 20, and 40 grams. 58.75, 52.25, and 00.54% for each of them, respectively. While the highest percentage for the control treatment was 93% and the lowest was 7.25% for silica powder. As for the effect of the interaction, the highest

percentage for the control treatment at all concentrations reached 93% and the lowest for the silica treatment was 0.00 for a concentration of 40 g. As results above disclosed, it is noticeable that there is a relationship between the concentrations and the inert dusts (kaolin, zeolite, and silica), and this is consistent with what was confirmed by (Alwan, 2023). The effect of zeolite and silica gel on the W_1S_2 water requirement technology, where the highest values for the ability to bind water and the ability to absorb water, and the lowest values are the relative insufficiency of saturation and exudation of plasma membrane, which arrived at 86.66, 10.14%, 5.35, 15.33%, 45.94, and 41.28%, respectively.

Table (3): Effect of zeolite, kaolin, and silica on root length of wheat seedlings

Concentrations / Coefficients	5 g. %	10 g. %	20 g. %	40 g. %	Average effect of coefficients
Kaolin	**2.10**	**2.30**	**2.60**	**3.10**	**2.50**
Zeolites	**1.50**	**1.70**	**1.90**	**2.10**	**1.80**
Silica	**0.90**	**0.70**	**0.50**	**0.00**	**0.50**
Average effect of concentrations	**1.50**	**3.70**	**1.60**	**1.70**	
LSD 0.01	**Coefficients**	**Concentrations**	**Interference**		
	0.1183	**0.1025**	**0.2050**		

Table (3) suggested that the highest average root length was for the kaolin treatment, which amounted to 2.50 cm, which differed significantly from the zeolate and silica treatment, which amounted to 1.80 and 0.50 cm, respectively. The highest root length for the 10 grams concentration, which amounted to 3.70 cm, which differed significantly from the rest of the concentrations for powders and adult The lowest was at the concentration of 5 grams, which was 1.50 cm, while the interaction between the type of powder and the type of concentration indicated that the highest root length was at the concentration of 40 grams and at the kaolin dust, which was 3.10 cm, compared to the lowest at the concentration of 40 grams and at the silica dust, which was 0.00 cm. Both Al-Khudr et. al (2017) indicated the impact of zeolite on the properties of soils affected by salinity and alkalinity in two separate and different soils, where the zeolite treatment (30 tons/ha) excelled in reducing soil salinity, as the percentage of decrease in the ECe value reached 15 and 23% compared to the control for the two medium-salinity and high-salinity soils grown with white corn, respectively.

Table (4): Effect of pesticide on kill percentage of Tribolium castaneum, upon exposure to 24, 48, and 72 hours of treatment

Kill Rate Within 24 hrs.				
Concentrations	**7.5 cm**	**5 cm**	**2.5 cm**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	
Insects + wheat seeds + pesticide	**63.9**	**37.3**	**12.50**	**37.90**
LSD 0.01	**Coefficients**	**Concentrations**	**Interference**	
Kill Rate Within 48 hrs.				
Concentrations	**7.5 cm**	**5 cm**	**2.5 cm**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	
Insects + wheat seeds + zeolite + kaolin + silica	**20.00**	**50.00**	**90.00**	**53.33**
LSD 0.01	**Coefficients**	**Concentrations**	**Interference**	
	9.48	**9.48**	**12.42**	
Kill Rate Within 72 hrs.				
Concentrations	**7.5 cm**	**5 cm**	**2.5 cm**	**Average effect of coefficients**
Coefficients	**%**	**%**	**%**	
Insects + wheat seeds + zeolite + kaolin + silica	**60.00**	**63.00**	**100.00**	**74.33**
LSD 0.01	**Coefficients**	**Concentrations**	**Interference**	
	4.085	**4.085**	**7.076**	

As manifested in table (4), the highest percentage of killing at a concentration of 7.5 cm within 72 hours was 100%, compared to the lowest rate at a concentration of 2.5 cm within 24 hours, which was 12.50%, while the highest percentage of killing of adults of the *Tribolium castaneum* was treated with insects + wheat seeds. + pesticide within 72 hours, arrived at 74.33 compared to the treatment of insects + wheat seeds + pesticide within 24 and 48 hours, which reflected 37.90 and 53.33. From the interaction it was evidenced that the highest percentage was 100% at the concentration of 7.5 cm during 72 hours and the treatment of insects + wheat seeds + The pesticide within 48 and 24 hours at the same concentration

of 90.00 and 63.00% for each, respectively. It is consistent with Bunyan et al. (2019) that the effect of the pesticide acetapride on the percentage of deaths of the southern cowpea insect, *Callosobruchus maculates*, reached 100% compared to the pesticides sulfur, stronic, and carbaryl, which were 57.22, 35.55, and 10%, respectively.

Table (5): Impact of pesticides on root length

Concentrations	7.5 cm	5 cm	2.5 cm	Average effect of coefficients
Coefficients	**%**	**%**	**%**	
Insects + wheat seeds	**2.03**	**1.86**	**1.50**	**1.78**
LSD 0.01 for concentration 0.22				

As demonstrated in table (5), the highest root length of *Viperidicide* pesticide was proven at the concentration of 7.5 cm (2.03 cm), compared to the lowest at the concentration of 5 and 2.5 cm (1.86 and 1.50 cm for each, respectively). This is confirmed by Kadhim (2016). Applying sulfur fertilizer leads to improving production levels, especially quality, such as oilseeds and fodder crops. Its use aims to successfully grow crops and thus prevent economic losses.

DISCUSSION

Stomach poisons kill an insect after being swallowed or absorbed through the digestive tract, where it deposits protein in the cells. They are used either as spraying or fogging, such as arsenic compounds. Fluorine compounds are generally used for insects with biting mouthparts (Ismail, 2009). In the experiments of this paper, inert dusts of kaolins, silica, zeolite, and chemical pesticides were used to combat *Tribolium castaneum* with the aim of rationalizing the use of chemical pesticides and searching for safe alternatives in pest control due to the increased residual effect of chemical pesticides in the environmental environment, where in many cases they reach very dangerous levels. In addition to the various harms these compounds cause to warm-blooded animals, and most importantly, pests develop strains resistant to these pesticides (Korumic et al., 1996; Opit, 2012; Rajashekar et al., 2012; & Ahmad, 2011) to evaluate the efficiency and to know the difference. Among chemical pesticides and dusts, the use of natural amendments and organic fertilizers improves the physical and

chemical properties and fertility of the surface layer of the soil, and thus provides a good environment for plant growth in terms of increased moisture content and abundant nutrients. Another amendment that has received great interest in improving the physical and chemical properties of the soil is zeolite. (2002, et al. Yamada).

RECOMMENDATIONS

1. It is recommended mixing inert dusts (kaolin, zeolite, and silica) together for use in the field to resist pests, insects, and rot.
2. It is recommended increasing inert dusts (kaolin, zeolite, and silica) together increases the killing rate of the Coleoptera order. *Tribolium castaneum* Order: Coleoptera.
3. It is recommended adding inert dusts (kaolin, zeolite, and silica) together increases soil fertility, reduces salinity, and helps make some nutrients available in the soil to increase productivity. It is added as fertilizer to improve soil properties.
4. It is recommended adding inert dust (kaolin, zeolite, and silica) increases the shoot and root system and grain weight.

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تقيم كفاءة بعض المساحيق الخاملة والمبيدات الكيميائية في مكافحة كاملات خنفساء الصدئية *Tribolium castaneum* Order:Coleoptera Family: Tenebrindae

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المستخلص

اختبرت سمية ثلاثة انواع من المساحيق الخاملة بخلطها :الكاولينايت والسيليكا والزيوليت ضد بالغات خنفساء الصدئية الحمراء *Tribolium castaneum* (Coleoptera:Tenebrindae) باستخدام اربعة تراكيز :5 ،10،20، 40، مسحوق/كغ بذور الحنطة ولكل تركيز ثلاثة مكررات. نفذت التجربة ضمن الحاصنة عند درجة حرارة ورطوبة نسبية ثابتة في مختبر قسم وقاية النبات بكلية الزراعة جامعة البصرة. اخذت القراءات بعد 24و48و72ساعة من المعاملة تحت مستوى احتمال 0.01،وبفارق معنوي فكانت اعلى نسبة قتل لبالغات الخنفساء الصدئية عند التركيز 40غم خلال 72ساعة كانت 100% مقارنةً مع 48 و 24 عن نفس التركيز 93.00 و83.00 %على التوالي . كما اختبرت نسبة الانبات وطول الجذير باستخدام اربعة تراكيز كما المبين اعلاه وكانت اعلى نسبة انبات 65.17 %عند التركيز 5غم والذي فرق معنوياً عن النسبة المئوية لانبات حبوب الحنطة 10، 40 ، 20 غم والبالغة 58.75 ، 52.25 ،54.00 %على التوالي. في حين اعلى نسبة مئوية لمعاملة السيطرة عند جميع التراكيز 93 % واقلها عند معاملة السيليكا 0.00 عند التركيز 40 غم وكانت اعلى معدل طول الجذير لمعاملة الكاولين 2.50 سم والتي اختلفت معنوياً عن معاملة الزيولايت والسيليكا والبالغة 1.80 و 0.50 سم على التوالي..

كما اظهرت نتائج الدراسة انه عند استخدام تراكيز مختلفة من المبيد الكيميائي الفابريد ضد بالغات حنفساء الصدئية الحمراء *Tribolium castaneum*(Coleoptera:Tenebrindae) باستخدام ثلاثة تراكيز :2.5 ،5 ،7.5 غ/مستحلب /كغ بذور الحنطة ولكل تركيز ثلاثة مكررات . نفذت التجربة نسبة القتل ضمن الظروف المختبرية في المختبر قسم وقاية النبات بكلية الزراعة جامعة البصرة. اخذت القراءات بعد 24و48و72ساعة من المعاملة تحت مستوى احتمال 0.01،ولفارق معنوي فكانت اعلى نسبة قتل لبالغات الخنفساء الصدئية عند التركيز7.5سم خلال 72ساعة كانت100% مقارنةً مع 48و24 عن نفس التركيز90.00و63.00 % على التوالي كما اختبرت طول الجذير باستخدام ثلاثة تراكيز كما المبين اعلاه . وكانت اعلى معدل طول جذر لمبيد الفابريد عند التركيز 7.5سم 2.03سم مقارنةً مع اقلها عند التركيز 5و2.5سم 1.86و1.50سم لكل منهما على التوالي .اما نسبة الانبات كانت 100%.