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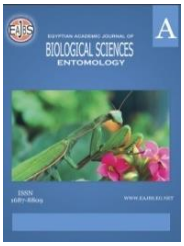

Used Five Inert Dusts to Control Two Insect Pests on Stored Rice Grains

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ABSTRACT

Rice grains are often infested by *Sitophilus oryzae* and *Corcyra cephalonica*, causing quality and quantity losses. In this study, the insecticidal effects of inert dust (diatomaceous earth(DE), calcium carbonate, kaolin(KA), rock phosphate and silica gel) on *S. oryzae* adults and *C. cephalonica* larvae were assayed. Four concentrations of each inert dust were tested at 2,3,4and5% on rice grains. Results indicated that diatomaceous earth and phosphate rock 5% lead to the highest insecticidal action with adult mortality of 98.3and96.6% for *S. oryzae* adults, 15 days post-treatment, respectively. As well, diatomaceous earth and phosphate rock 5% lead to the highest insecticidal action with larval mortality of 100.0%for *C. cephalonica* larvae after 7 days. On the contrary, treatment with 5%silica gel recorded the lowest toxicity to *S. oryzae* adults (65.66%) after 15 days of exposure. While calcium carbonate 5% resulted from the lowest toxicity *C. cephalonica* larvae(61.2%)after 7-day exposure. According to the obtained results, the highest reduction in the progeny of *S. oryzae* adults was registered in treatments with diatomaceous earth(5%)and kaolin(5%), being 91.4and91.3%, respectively. As for the highest reductions in the progeny of *C. cephalonica* larvae, in treatments with diatomaceous earth(5%)and phosphate rock(5%), those were 97.4and 97.2%, respectively. All treatments with inert dust caused a reduction of weight loss and damage of rice grains 60 days post-treatment in comparison with untreated grains. Results showed that all the tested inert dusts treatments except silica gel increased germination percentages of seeds than the control. The obtained results indicated that inert dusts may be considered, safe and available in the local environment, so, they are used as alternatives to insecticides for the control of *S. oryzae* and *C. cephalonica* infestations to stored rice grains.

INTRODUCTION

Rice is the second most valuable cereal crop in terms of area, globally. Also, as food, it is more for its higher nutritional value than many other cereals. Rice is an essential food for about half of the world's (IRRI, 2013). Storage of rice is most valuable in Egypt due to it is grown once a year during the summer season, and it is used throughout the

same year. For that reason, producers and some of consumers store their requirements to be available under different conditions. Over the years, insect damage to stored rice grains has been of great concern. Many insect pest species attack rice through storage, such as *Sitophilus oryzae* and *Corcyra cephalonica*.

Rice weevil is the main pest that causes damage and considerable loss to store milled and paddy rice if unchecked (Akhtar *et al.,* 2015). During direct feeding on rice kernels or indirectly by causing hot spots that induce moisture loss, rice weevils can damage stored grains (Batta 2004). In developing countries, this pest causes 15 %–100 % and 10–60 % pre- and post-harvest grain losses, respectively (Kumar and Kalita 2017).

The rice moth, *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) is a critical pest of rice, maize, groundnuts, spices, wheat, coffee, sorghum, cocoa beans and cotton seeds (Srivastava and Subramanian, 2016). Larvae form silken cocoons and feed by staying in, that way transforming whole grains into webbed mass and making them misfit for human consumption (Tripathi, 2018). Pesticides are used to reduce damage caused by pests to stored products (Rajendran and Sriranjini, 2008), but their indistinctive use results in the development of insecticide resistance, buildup of pesticide residues and detrimental effects on non-targets and the environment (Park *et al.,* 2003). This case can be solved by searching for safe alternative approaches.

The present study aimed to find out chemical insecticide alternatives for stored product insect control and subsequently, preserving the environmental pollution at the possible minimum level.

MATERIALS AND METHODS

1-Rearing Technique of Stock Cultures:

The tested insects namely the rice weevil, *Sitophius oryzae* adults and rice moth, *Corcyra cephalonica* larval were applied in this research. Treatments were performed in the stored product pest's lab. at Plant Protection Dep., Fac. of Agri., Moshtohor, Benha Univ.. Cultures of two insect species remained under controlled conditions of 28 ± 1ºc and 65 ± 5% R.H at the rearing lab. room. Fresh rice grains were at first examined to be safe that they were in a good case and free of toxic residues, then kept at -18ºC for 2 weeks before application to eliminate any possible insect infestation. The initial population of *S. oryzae* was reared on a liter wide-mouthed glass containing rice grains. Openings of jars were covered with muslin fixed by rubber bands to permit ventilation and to prevent the escape of weevils. Stock culture was set by introducing (100-200) adults. Adults were permitted to oviposit on the grains and then removed one week later. Weevil adults (5-7 days old) were collected and used in most experiments. As for *C. cephalonica* those were placed in cylindrical glass jars (29 cm depth and 25cm diameter) covered with fine muslin cloth on the top. The culture was reared on coarsely crushed fresh rice grains. Newly emerged adults were transferred to oviposition glass chambers (35 mm diameter and 200mm height). Adults of *C. cephalonica* don't feed. Eggs were collected and placed in 250ml glass beakers until hatching (Tiwari, 2019). Hatched larvae were fed on coarsely crushed fresh rice grains jumbled with 5% (w/w) yeast powder and kept inside glass chambers for 15 days (Allotey and Azalekor, 2000).

2-Tested Dusts Used:

-Diatomaceous Earth (DE):

A dust powder obtained from Algae Diatoms in the form of rigid Rocky, Mountains which is composed of 88-90% silicon dioxide, particles of (10-15mm), an apparent density of 200-230gl, insoluble in water and free from foreign material produced by Hedley pacific ventures Ltd., fabrique par, Vancouver, Bc. Canada.

-Calcium Carbonate:

A dust powder consists of calcium carbonate ($CaCO_3$)

-Kaolin (KA)

Purchased from Al- Ahram Mining Co- (Giza, Egypt), consisted of Si O_2 (417-60%), Al_2O_3 (36.85%), TiO_2 (1.56%), Fe_2O_3 (0.40%), CaO (0.11%), MgO (0.01%), Na_2O (0.01%) and K_2O (0.01%) (Abdelgaleil, *et al.,* 2021).

-Rock Phosphate:

Inert dust of an inorganic compound and salt of phosphoric acid. Organic phosphates are esters of phosphoric acid; phosphorite rock is a non-detrital sedimentary rock that contains amounts of phosphate-bearing minerals. The phosphate content of phosphorite is in the range of 15 to 20%.

-Silica Gel:

It is granular, tough, and hard, it is more solid than common household gels like gelatin or agar. It has an average pore size of 2.4 nanometers and has a powerful affinity for water molecules.

3-Bioassay Experiments of Inert Dusts:

The insecticidal activities of inert dusts were tested against *S. oryzae* and *C. cephalonica* on rice grains. To evaluate the insecticidal effect of inert dusts, glass jars (200ml capacity) were applied. Uninfested 10g rice grains or coarsely crushed fresh rice grains were placed in each jar and blended by hand shaking for 2min with a weighed amount of tested dusts to give the required rate of each dust application (2, 3, 4, 5%), also, to ensure uniform coverage of grains with inert dusts before introducing adults of *S. oryzae* or larvae of *C. cephalonica*. After rice grains treatment with inert dusts, 20 adults of *S. oryzae* and 20 larvae of *C. cephalonica* were introduced to groups of each species in separate jars. All jars were transferred to incubators (25 ± 1ºC and 65 ± 5% RH). Three replicates were done for each rate of dust application as well as, the control treatment which was conducted using the same procedures without the dust. The numbers of dead rice weevil adults were counted after 5, 10 and 15 days of treatment and dead *C. cephalonica* larvae were counted after 1, 3 and 7 days. After that, all the dead and surviving adults were removed from rice grains and all jars were returned to the incubator at the same conditions to assess the progeny of both insect species after 60 days. The reduction percentage in the number of progenies after 60 days of treatment was determined according to the following formula of Tabu, *et al.,* (2012).

% reduction = (1-x/y) x 100

Where x = number of adults emerging in treatment; y= number of adults emerging in control.

At the end of the observation period of progenies counting (60 days), the treated and untreated rice grains and coarsely crushed fresh rice grains of each jar were weighed to determine the grain weight loss due to insect infestations. Weight loss percentage was calculated to apply by the following formula:

% Weight loss = ((Wu–Wi)/Wu) × 100

Where, Wu=weight of uninfested wheat seeds; Wi=weight of infested wheat seeds of control and treatment.

4-Germination of Rice Grains After Treatments:

Three replicates of 50 grains each were taken randomly from each jar at the end of the testing period (60 days) and placed on a surface of thoroughly wetted cotton wool layers with water.

Germination of grains was determined one week later by counting the viable seeds. Germination percentage was calculated according to Atwater (1980) formula as follows:

GP = g/t × 100

Where GP = Germination percentage; g = number of germinated wheat seeds; t = total number of wheat seeds.

5-Statistical Analysis:

All different data obtained were subjected to a One-way analysis of variance using the SPSS (statistical package for the social sciences) computer program. Duncan's Multiple Range Test (DMRT) was used to detect differences between mean values at a 0.05 significance level (Steel, *et al.*, 1980).

RESULTS

1-Inert Dusts Toxicity on Adults' *S. oryzae* and Larval *C. cephalonica:*

Inert dusts toxicity in the adults *S. oryzae* and larval *C. cephalonica* is presented in Tables (1 and 2). It seems generally, that the mortality percent of both insect pest species was raised in all treatments with the rise of applied rate. Diatomaceous earth and phosphate rock 5% lead to the highest insecticidal action with adults' mortality of 77.7 and 70.0% for *S. oryzae* after 5 days, respectively; mortalities among adults increased and reached 98.3 and 96.6% after 15 days, respectively (Table 1). Also, diatomaceous earth and phosphate rock 5% caused the highest insecticidal activity against larvae as mortality reached 90.0and 73.3% for *C. cephalonica* larvae one day after treatment, respectively. Mortalities among larvae increased to reach 100.0% after 7 days (Table 2).

As for silica gel, it caused the lowest toxicity to *S. oryzae* adults (40.0%) after 5 days and (65.66%) after 15 days of exposure when treated with 5% concentration (Table 1). While calcium carbonate recorded the lowest toxicity to *C. cephalonica* larvae (48.8%) one day and (61.2%) 7days after exposure when treatment took place at a concentration of 5% (Table 2).

Table 1: Mean mortality (% ± SE) among *S. oryza* adults with application rates of different inert dusts and different periods on rice grains.

Tested dusts / Concentration (%)		Mean adult mortality (%) ± SE after		
		5 days	10 days	15 days
Calcium carbonate	2	10.3±1.5	17.7±0.4	19.3±0.3
	3	18.8±0.8	23.3±0.5	25.3±1.5
	4	35.5±1.7	55.5±0.4	70.0±0.5
	5	48.0±0.9	72.2±1.4	85.3±0.5
Kaolin	2	19.8±0.9	22.2±3.4	36.6±0.5
	3	44.4±2.3	55.5±5.1	66.6±0.3
	4	54.4±0.4	66.0±2.8	71.0±2.0
	5	62.7±2.4	80.8±7.7	90.6±1.2
Phosphate rock	2	36.6±3.2	46.6±3.3	50.0±0.4
	3	43.3±2.3	50.0±1.2	61.0±1.3
	4	53.3±4.4	63.3±3.3	75.1±0.8
	5	70.0±0.0	86.6±3.3	96.6±1.2
Diatomaceous earth	2	56.6±3.3	66.6±3.2	75.3±1.3
	3	63.3±4.1	76.5±4.3	81.6±2.1
	4	73.3±3.3	80.0±0.0	89.3±0.8
	5	77.7±3.5	86.6±3.3	98.3±2.1
Silica gel	2	19.9±1.2	25.5±1.1	33.0±0.0
	3	23.3±0.1	30.0±0.5	35.6±0.1
	4	30.0±1.0	36.0±0.9	47.7±0.6
	5	40.0±2.1	59.3±1.2	65.66±0.4
Control		0.0±0.0	0.0±0.0	0.0±0.0

Table 2: Mean mortality (% ± SE) of *C. cephalonica* larvae with application rates of different inert dusts and different periods on rice grains.

Tested dusts / Concentration (%)		Mean larval mortality (%) ± SE		
		1 days	**3 days**	**7 days**
Calcium carbonate	2	33.3±3.3	48.4±3.5	55.5±0.2
	3	41.6±3.3	50.0±0.0	67.0±0.2
	4	50.0±5.7	63.3±3.3	73.3±0.8
	5	48.8±0.0	57.3±0.8	61.2±1.1
Kaolin	2	46.6±3.3	50.0±0.0	58.3±0.1
	3	51.1±1.2	57.3±2.2	60.0±0.6
	4	58.0±0.8	65.3±1.5	75.3±0.1
	5	70.7±0.9	86.6±3.3	93.5±0.1
Phosphate rock	2	47.3±0.7	53.3±3.3	61.0±0.1
	3	56.6±3.3	68.0±0.5	73.3±0.7
	4	66.6±3.3	73.3±3.3	83.3±0.1
	5	73.3±3.3	93.3±3.3	100.0±0.0
Diatomaceous earth	2	70.0±0.0	83.3±3.3	90.6±1.2
	3	80.0±0.0	86.6±3.3	93.3±1.1
	4	85.5±0.5	90.0±0.3	98.3±0.2
	5	90.0±0.3	95.5±0.5	100.0±0.0
Silica gel	2	43.3±0.0	53.3±0.8	65.5±0.6
	3	48.8±0.0	58.8±0.3	68.3±0.2
	4	66.6±0.4	66.6±0.8	75.0±0.7
	5	70.7±0.9	75.5±1.0	86.6±0.5
Control		0.0±0.0	0.0±0.0	1.1±0.0

2-Efficacy of Inert Dusts on Progeny Production of *S. oryzae and C. cephalonica:*

As shown in Table (3), treatment of rice grains with inert dusts caused a significant reduction in progeny production of both insect pest species 60 days post-treatment at all tested rates compared with mean progeny production in control of *S. oryzae* (516.0 ± 17.7 adults) and *C. cephalonica* (350.0 ± 7.7 adults). The lowest progeny of *S. oryzae* was getting treatments with diatomaceous earth (5%) and kaolin (5%) was 44.46±0.12 and 44.66±0.47 adults, respectively, indicating reductions in progeny by 91.4 and 91.3%, respectively. As presented data in the same table, the lowest progeny of *C. cephalonica* was obtained it treatments with diatomaceous earth (5%), kaolin (5%) and phosphate rock (5%) by percentages 9.0±1.4, 10.0±0.6 and 9.83±0.7, respectively, indicating reductions in progeny by 97.4, 97.1 and 97.2%, respectively.

Table 3: Progeny production (mean number of adults/jars ± SE) and reductions (%) of *Sitophilus oryzae* and *Corcyra cephalorica* 60 days post-treatment of exposure to rice grains with different application rates of inert dusts.

Tested dusts / Concentrations (%)		*Sitophilus oryzae*		*Corcyra cephalonica*	
		No. progeny 60 days post-treatment	**Progeny red. (%)**	**No. progeny 60 days post-treatment**	**Progeny red. (%)**
Calcium carbonate	**2**	125.00±0.58	75.8^{hi}	17.33±1.5	95.0^{bcde}
	3	103.00 ±0.33	80.0^{fgh}	15.0±0.4	95.8^{abcde}
	4	75.00±2.03	85.5^{cde}	14.0±2.1	96.0^{abcde}
	5	55.66 ±2.40	89.2^{abc}	11.33±1.1	96.8^{ab}
Kaolin	**2**	114.0±0.09	77.9^{ghi}	18.67±1.5	94.7^{cde}
	3	93.33±0.10	81.9^{efg}	14.67±0.4	94.9^{bcde}
	4	76.6±0.63	85.2^{cde}	12.33±1.2	96.5^{abcd}
	5	44.66±0.47	91.3^{a}	10.0±0.6	97.1^{a}
Phosphate rock	**2**	82.76±0.06	83.9^{def}	15.67±0.8	95.6^{abcde}
	3	77.00±0.11	85.0^{cde}	13.33±2.6	96.2^{abcd}
	4	69.00±0.16	86.5^{bcd}	12.20±0.4	96.6^{abc}
	5	57.77±0.015	88.8^{abc}	9.83±0.7	97.2^{a}
Diatomaceous earth	**2**	66.6±0.27	87.0^{abcd}	14.33±3.9	95.9^{abcde}
	3	58.33±0.29	88.7^{abc}	12.0±2.3	96.6^{abc}
	4	50.76±0.08	90.2^{ab}	11.33±1.1	96.8^{ab}
	5	44.46±0.12	91.4^{a}	9.0±1.4	97.4^{a}
Silica gel	**2**	193.60±0.18	62.5^{j}	20.33±0.58	94.2^{e}
	3	190.0±0.07	63.2^{j}	19.0±0.33	94.6^{de}
	4	130.0±0.18	74.8^{i}	17.67±1.67	94.9^{bcde}
	5	112.0±0.13	78.3^{ghi}	13.33±1.24	96.2^{abcd}
Control		516.0±17.7	0.00^{k}	350.0±7.7	0.00^{f}
***p*-value**		-	<.0001	-	<.0001

$^{a-J}$ Values within a column with different superscripts differ significantly at P <0.05. red.=reduction

3-Efficacy of Inert Dusts on Weight Loss in Rice Grains Caused by *S. oryzae* and *C. cephalonica:*

All treatments of inert dusts caused a reduction of weight loss and damage of rice grains 60 days post-treatment (Table 4) in comparison with weight loss of untreated grains, being 43.30 and 26.6% for *S. oryzae* and *C. cephalonica*, respectively. Data in the same table showed also, that the grains' weight loss reduced as the rate of applied inert dusts was raised. Monitoring was clear for all tested rates of dusts on either of the two tested pest species. Hence, reduction in grain weight loss may be related to the effect of dusts on adult mortality and the number of adults in produced progenies. Therefore, treatment by dusts may affect adults' food consumption. It was found that phosphate rock (5%) was the highest protective treatment for rice grains from weight loss at the rate of 10.0±0.2 with regards to *S. oryzae.* While diatomaceous earth (5%) resulted in the highest protection to rice grains from weight loss in the rate of 7.0±0.7 with regards to *C. cephalonica.*

Table 4: Mean weight loss (% ± SE) of rice grains 60 days post-treatment with different application rates of inert dusts.

Tested dusts / Concentrations (%)		*Sitophilus oryzae* Grain weight loss (%) 60 days post-treatment	*Corcyra cephalonica* Grain weight loss (%) 60 days post-treatment
Calcium carbonate	**2**	39.9^{bc}	18.8^{b}
	3	36.6^{d}	16.6^{c}
	4	33.3^{e}	13.50^{ef}
	5	30.0^{gh}	11.9^{fgh}
Kaolin	**2**	40.0^{bc}	16.6^{c}
	3	38.8^{c}	14.0^{de}
	4	32.8^{ef}	12.8^{efg}
	5	27.0^{i}	10.5^{hi}
Phosphate rock	**2**	41.5^{ab}	15.5^{cd}
	3	31.4^{fg}	13.0^{efg}
	4	28.8^{h}	11.6^{gh}
	5	10.0^{l}	9.30^{i}
Diatomaceous earth	**2**	20.0^{j}	19.0^{b}
	3	18.8^{j}	12.2^{efgh}
	4	15.5^{k}	9.8^{i}
	5	13.9^{k}	7.0^{j}
Silica gel	**2**	42.0^{a}	26.6^{a}
	3	38.8^{c}	20.0^{b}
	4	36.6^{d}	16.4c
	5	33.7^{e}	13.8^{de}
Control		43.0^{a}	26.6^{a}
***p*-value**		<.0001	<.0001

$^{a-k}$Values within a column with different superscripts differ significantly at P <0.05.

4-Efficacy of Inert Dusts on Germination of Rice Grains:

Germination percentages of rice grains treated with different application rates are given in Table (5). Results showed that all tested dusts except silica gel raised germination percentages more than the control (46.6 ± 3.5%). It seems, generally, that germination percentages increased in calcium carbonate, kaolin, phosphate rock and diatomaceous earth with the increase in application rate. The highest germination percentages were found in treatments with calcium carbonate 5% (77.7 ± 1.6%). The lowest germination percentage found in treatments with silica gel (5%) was 35.5 ± 2.4%.

Table 5: Effect of different inert dusts on germination (%) of rice grains 60 days post-treatment

Tested dusts	Rice grain Germination (%) Rate of application			
	2	**3**	**4**	**5**
Calcium carbonate	61.0 ± 1.3	67.7 ± 8.3	71.0 ± 0.1	77.7 ± 1.6
Kaolin	51.00 ± 8.4	56.6 ± 4.6	63.3 ± 6.6	70.0 ± 2.2
Phosphate rock	44.4 ± 3.6	52.0 ± 10.5	61.6 ± 12.6	72.2 ± 2.0
Diatomaceous earth	42.2 ± 0.3	44.5 ± 2.0	46.2 ± 3.9	46.7 ± 2.6
Silica gel	46.6 ± 2.6	45.5 ± 0.1	41.0 ± 4.7	35.5 ± 2.4
Control	46.6 ± 3.5			

DISCUSSION

The insecticidal efficacy of different dusts has been described by several researchers (Mahdi and Khalequz Zaman, 2012; Lu *et al.*, 2017).

Also, the demonstrated results agree with Sonja *et al.,* (2018) who estimate the effect of three inert dusts (kaoline, diatomaceous earth and vermiculite) against adults of *Sitophilus oryzae*. diatomaceous earth and kaoline caused 86.7-98% mortality of *S. oryaze* 7 days post-exposure at the highest rates while; the mortality reached 100% of *Plodia interpunctella* after 7 days, of exposure to DE and KA.

Results of El-Sayed *et al.,* (2010) explain that diatomaceous earth was more effective than the kaolin against *S. oryzae.*This study agreed with Georgia and Christos (2023) who indicated that diatomaceous earth and Zeolite caused 100% adult mortality for *Sitophilus oryzae*, *Hryzopertha dominica* and *Tribolium confusum* after 7 days of exposure at the highest dose.

Many researchers explained that the insecticidal efficacy of inert dusts depends on SiO_2 content (Ziaee and Ganji, 2016; Liska *et al.,* 2017).

Also, El-Lakwah and Gharib (2005) tested the toxicity of diatomaceous earth with two application rates (0.3 and 0.6% w/w) against *T. castaneum*, *R. dominica* and *S. oryzae* of adults and noticed that diatomaceous earth generally enhanced mortalities of all tested insects.

Gad *et al*., (2022) studied inert dusts, zeolite and kaolin at 100, 500 and 1000 mg/kg against *callosobruchus maculatus* (f.) and *C. chinensis* L. results indicated that the highest application rates increased mortality percentages and induced strong progeny reduction and total protection of cowpea seeds against damages caused by both insect species for 60 days.

Present findings agree with the findings of Jadhav (2006) who found that Kaolin was more efficacy than sawdust, Neem seed and sand dust against *Sitophilus oryzae*. Most explanation for the activity of inert dusts that kill insects is by removing or absorbing the epicuticular lipid layers causing excessive water loss through the cuticle. Also, the cuticular waxes are absorbed by inert dusts (Johnson, *et al.,* 2014; Kabir and Wulgo, 2014; Korunic, *et al.,* 2014; Zhang *et al.,* 2014).

The present results agree with Amin *et al.* (2017) who studied the activity of some inert dusts against adults of *Sitophilus oryzae* and mentioned that tested materials increased adult mortality and reduced the count of progeny. Otherwise, tested materials affected significantly the grain weight loss. In addition, all tested dusts attained some protection from treated grains therefore, germination of grains treated with these dusts increased.

Declarations:

Ethical Approval: Ethical Approval is not applicable.

Competing interests: The authors declare no conflict of interest.

Contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have thoroughly reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

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Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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ARABIC SUMMARY

أستخدام خمس مساحيق خاملة لمكافحة آفتين حشريتين على حبوب الأرز المخزنة

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تصاب غالبا حبوب الأرز بحشرتين سوسة الأرز وفراشة الأرز مسببه خسائر في نوعية وكمية حبوب الأرز المخزنة. فى تلك الدراسة تم تقييم التأثيرات الحشرية للمساحيق الخامله وهي (التربة الدياتومية، كربونات الكالسيوم، الكاولين، الصخر الفوسفات والسيليكا جيل) على الحشرة الكاملة لسوسة الأرز ويرقات فراشة الأرز. تم إختيار أربع تركيزات من كل مسحوق خامل بنسب (2و 3 و4 و5%) فى حبوب الأرز.

أشارت النتائج إلى أن التربة الدياتومية وصخر الفوسفات بتركيز 5% الأكثر فاعلية فى موت الحشرة الكاملة لسوسة الأرز, حيث وصلت نسب الموت إلى 98.3 و96.6%، على التوالي بعد 15 يومًا من المعاملة. كما أعطت أيضا التربة الدياتومية وصخر الفوسفات بتركيز 5% نسب موت وصلت إلى 100.0% ليرقات فراشة الأرز بعد 7 أيام.على العكس من ذلك، سجلت معاملة السيليكا جيل بـتركيز5% أقل سمية للحشرة الكاملة لسوسة الأرز حيث بلغت نسبة الموت 65.66% بعد 15 يوم من التعرض. بينما أظهرت كربونات الكالسيوم بتركيز5% أقل سمية ليرقات فراشة الأرز 61.2% بعد التعرض لها لمدة 7 أيام.

وفقا للنتائج التي تم الحصول عليها، تم تسجيل أعلى انخفاض في النسل الناتج من حشرة سوسة الأرز في المعاملات بالتربة الدياتومية (5%) والكاولين (5%)، حيث بلغ 91.4 و91.3% على التوالي. أما أعلى نسبة انخفاض في نسل حشرة فراشة الأرز في المعاملات بالتربة الدياتومية (5%) وصخر الفوسفات (5%) فقد بلغت 97.4 و97.2% على التوالي. أدت جميع المعاملات بالمساحيق الخامله إلى تقليل الضرر وفقدان الوزن لحبوب الأرز المعاملة بعد 60 يومًا مقارنة بالحبوب غير المعاملة. أظهرت النتائج أن جميع معاملات بالمساحيق الخامله المختبرة باستثناء السيليكا جيل أدت إلى زيادة في نسب إنبات البذور مقارنة بالكنترول. من النتائج المتحصل عليها يمكن القول بأن المساحيق الخامله تعتبر آمنه ومتوفرة فى البيئة المحليةلذلك تستخدم كبدائل للمبيدات الحشرية فى مكافحة حشرتين سوسة الأرز وفراشة الأرز لحبوب الأرز المخزنة.