FIELD AND LABORATORY ASSESSMENT OF THE EFFICACY OF SOME INERT DUSTS AGAINST SOME STORED GRAIN INSECTS

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Abstract

Field and laboratory assessment of the efficacy and persistence of some inert dusts i.e. Silica aerogel (SG), Diatomaceous earth (DE) and Katel sous (KS) at 1 % (w./w.) was carried out for protecting wheat grains against some stored grain insects i.e. *Sitophilus oryzae*, *Rhizopertha dominica*, *Tribolium castaneum* and *Trogoderma granarium*. Treated wheat grains inside polyethylene and jute bags stored in open shounas up to three months in Ismailia and Gharbia governorates. The obtained results indicate that, adult mortality values decreased with increasing the period of storage. Tested inert dusts were more persistence on polyethylene bags than on jute bags. Protection of stored wheat grain was more successful in Ismailia governorate with than Gharbia at all storage periods. Katel-Sous and silica aerogel were more effective than Diatomaceous Earth in protecting stored wheat grain from insect infestation which gave complete and high mortality in polyethylene and jute bags at tow tested governorates. Adults of *Trogoderma granarium* were more tolerable than those of other studied insects to the action of tested inert dusts at tested bags and governorates. Tested dusts in both governorates and both bags did not impair germination of wheat grains.

INTRODUCTION

Currently, the best method for protecting grains against insect attack which cause both weight and quality losses during storage is to apply synthetic organophosphate insecticides. However, these insecticides are frequently unavailable, out of date, adult tolerance or too expensive and their misuse can induce a health hazard. Many producers do not use conventional insecticides, whether approved for use as a food additive or not, because of the toxicity of all such chemicals (Golob *et al*., 1996).

Inert dusts offer a safer alternative to synthetic organophosphate insecticides for grain protection. It exerts a physical effect on insects by absorbing waxes from the cuticle, which results in water loss, dehydration and death (Ebeling and Ashman, 1971). The effectiveness of certain dusts was evaluated by Kamel, *et al*. (1964); EL-Rafie, *et al*. (1975); Mahgaub (1987) and Mostafa (1989).

Therefore, the present study aimed to evaluate the efficiency of admixing inert dusts with wheat and storage in both polyethylene and jute bags under different storage conditions.

MATERIALS AND METHODS

The experiments were carried out in the laboratory of Stored Product Pest Depertment, Plant Protection Research Institute and stored different storage under conditions in Ismailia and Gharbia governorates in July 2011.

Grain protectants:

1-Silicaaerogel (S.G) 60 GF: A dust powder formulation was mixed with grain at 1% (w/w) const.

2- Diatomaceous earth (DE): A dust powder formulation containing 79% silica dioxide mixed with grain at 1% (w/w) concentration.

3- Katel-sous (K-S): A dust powder formulation containing 84% calcium triphosphate plus 16% sulpher, mixed with grains at its recommended rate of 1% w/w.

Grain sampling and evaluation:

Small jute and woven polyethylene bags (25×18 cm) were used. Untreated wheat grains were fumigated with phostoxin tablets to avoid pre-insect infestation before treatments with dust.

Samples of 1kg of untreated wheat grain were mixed with each of the mentioned grain protectants. The samples were packed for each bag and the two open ends were closed tightly to prevent external infestation. All samples were replicated 10 times for monthly inspection. Bags were stored for three months in shounas in both Ismailia and Gharbia governorates. Untreated samples bags were used as control.

Monthly inspection:

Four subsamples of 250 g of treated wheat were kept in glass jar after every month of storage. Fifty adults of the laboratory culture of stored grain insects, namely, *Sitophilus oryzae* L., *Rhizopertha dominica* F., *Tribolium castaneum* Hbst. and *Trogoderma granarium* were used as test insects and introduced singly in to the jars, then covered with muslin and kept at room temperature in laboratory condition for 1,3,5 and7 days. Mortality percentage were recorded for each insect at different exposure periods (during 1, 2, 3 months resp.). Four replicates of the untreated wheat were taken as control for each insect species.

Germination test:

At the end of storage period (after three months) germination test were made: hundred grains of stored treated wheat were replicated four times in order to estimate the number of germinated grains after five days for each dust treatment in both tested governorates.

Statistical analysis:

Bioassay as the percentage of mortalities of the four insects after exposure times were corrected for control response by Abbott's formula (Abbott, 1925).

RESULTS AND DISCUSSION

The activity of Silica gel (S.G), Katel-sous (KS) and Diatomaceous earth (DE) against various insect species were recorded in (Table 1, 2 and 3), resp.

Results concerning the effect of Silica gel S.G powder treatments on mortality of the tested insects at both Ismailia and Gharbia governorates were illustrated in (Table 1) and (Fig. 1). Complete and high protection against *Sitophilus oryzae*, *Rhizopertha dominica* and *Tribolium castaneum* infestation were observed when treated wheat stored in polyethylene bags for three months at Ismailia governorate (100, 100 and 92% respectively). The protection efficiency at Gharbia governorate was lower in percent mortality than Ismailia governorate. It gave 80, 77 and 79% for the three tested insects, respectively.

Complete and high protection percentage occurred only for the first two months when jute bags was used for storage at Ismailia governorate reaching 100, 97 and 91% respectively, meanwhile, mortality percentages at all storage periods were lower in Gharbia governorate in jute bags treatments which marked a sharp deterioration in Silica efficiency showed 71, 55 and 69% in the first three tested insects resp. at the third month.

In general, ploythelen bags were more ideal surface to protect grain wheat because of its non porous surface which able to retain the toxicity of the last meanwhile jute bags considered porous surface which lost its effeciancy.

Table (1) showed that *Trogoderma granarium* had a high resistance against Silica treatments which gave the lowest mortality percentage in both tested bags and tested governorates. This result agreed with those of Kamel *et al*. (1964) who stated that Silica aerogels as grain protectant was very effective in protecting the stored wheat against stored grain insects, due to the fluorides added to the Silica hydrogel in the process of manufacturing.

Diatomaceous earth in (Table 2) revealed that, at Ismailia governorate, complete and high protection against *S. oryzae*, *R. dominica* and *T. castaneum* infestation i.e. 100, 90 and 92% mortality observed for two months when using polyethylene bags. After three months, mortality percentage decreased up to 72, 52 and 46%, respectively.

At Gharbia governorate complete protection against the first three insects after one month of storage, moderate protection was observed during the next two months of storage in polyethylene bags (76, 59 and 69% respectively).

In jute bags, the same trend was noticed after 3 months (62, 44 and 50%) and (62, 34 and 59%) in Ismailia and Gharbia governorates, respectively.

Trogoderma granarium infestation was markedly decreased from 50% to 28% at Ismailia and from 49% to 22% at Gharbia, respectively during the three months of storage in polyethylene bags, meanwhile, jute bags treatment gave less protection (26 and 17%) in both tested governorates (Table 2 and Fig. 1).

The obtained results are in harmony with the results of EL-Lakwah *et al*. (1999) which proved that diatomaceous earth and Katel-sous were most effective on stored grain insects also, Stathers *et al*. (2002) who stated that diatomaceous earth was successfully preventing the potential high level of the loss of stored maize grain for 6 month of storage.

Katel-sous treatments illustrated in Table 3 and Fig. 1. It offer complete protection from insect infestation i.e. *S. oryzae*, *R. dominica* and *T. castaneum* for the three months of the storage using polyethylene bags in both tested governorates.

Jute bags revealed less in protection, so, mortality percentage decreased gradually up to third month.

Stathers *et al*. 2000, Mahgoub 1987, Khare and Agrawal (1972) mentioned that inert dusts were very effective against stored grain insects.

Katel-sous treatments on *Trogoderma granarium* offer moderate and low protection with insect infestation i.e. about 50% in polyethylene and 39 and 23% in jute bags at both governorates respectively after three months of storage.

Effects of tested inert dust on the germination of grains:

Results given in Table (4) indicated that under the conditions of the experiments the treated grains do not impair germination so, the grains retain its viability even after three months of storage.

The final goal of these experiments can be indicated that:

-Tested dusts were more effective under storage in Ismailia than Gharbia governorate. This indicated that high temperature of Ismailia governorate may be increased the efficiency of tested dusts.

-Generally, adult mortality values decreased with increasing the time of storage.

-Natural inert dust, Katelsous and Silica gel were more effective than diatomaceous earth in protecting stored wheat from insect infestation.

-Adults of *T. granarium* are more tolerable than those of *S. oryzae*, *R. dominica* and *T. castaneum* to the action of tested dusts at tested bags and governorates.

-Tested dusts in both governorates do not impair germination of wheat grains.

It can be concluded from the present studies that, tested inert dusts were more persistent in polyethylene bags than in jute bags due to the no penetration of tested dusts through polyethylene surface to outside, thus residue can be retain in the enclosed grain, so, treatment of polyethylene fabrics against infestation will proved a useful protective technique.

Finally, large scale experiments under the natural storage conditions of Egypt to study the effect of inert dusts as grain protectants are progressing.

Table 1. Persistence of Silica aerogel (1%w/w) as a grain protectant for wheat grain stored in polyethylene and jute bags in open shounas at Ismailia and Gharbia governorates.

Tested governorate	Tested insects	Polyethylene bags			Jute bags		
		Corrected mortality after (in months)					
		1	2	3	1	2	3
Ismailia	*S.oryzae*	100	100	100	100	100	83
	R.dominica	100	100	100	100	97	81
	T. castaneum	100	94	92	100	91	80
	T. granarium	65	58	59	58	50	40
Gharbia	*S.oryzae*	91	87	80	88	80	71
	R.dominica	89	81	77	87	70	55
	T. castaneum	89	83	79	85	74	69
	T. granarium	47	42	31	26	17	13

Table 2. Persistence of diatomaceous earth (1%w/w) as a grain protectant for wheat grain stored in polyethylene and jute bags in open shounas at Ismailia and Gharbia governorates.

Tested governorate	Tested insects	Polyethylene bags			Jute bags		
		Corrected mortality after (in months)					
		1	2	3	1	2	3
Ismailia	*S.oryzae*	100	100	72	100	80	62
	R.dominica	100	90	52	93	86	44
	T. castaneum	100	92	46	94	68	50
	T. granarium	50	47	28	48	39	26
Gharbia	*S.oryzae*	100	76	76	98	74	62
	R.dominica	100	59	56	100	56	34
	T. castaneum	100	69	69	100	77	59
	T. granarium	49	29	22	33	34	17

Table 3. Persistence of Katel-sous (1%w/w) as a grain protectant for wheat grain stored in polyethylene and jute bags in open shounas at Ismailia and Gharbia governorates.

Tested governorate	Tested insects	Polyethylene bags			Jute bags		
		Corrected mortality after (in months)					
		1	2	3	1	2	3
Ismailia	*S.oryzae*	100	100	100	100	94	84
	R.dominica	100	100	100	96	74	76
	T. castaneum	100	98	98	94	87	72
	T. granarium	50	49	49	48	42	39
Gharbia	*S.oryzae*	100	100	100	98	86	72
	R.dominica	100	98	100	87	84	61
	T. castaneum	100	100	100	92	72	74
	T. granarium	50	48	50	31	27	23

Table 4. Effect of tested inert dusts on germination of wheat grains.

Tested governorate	Tested insects	Polyethylene bags	Jute bags
		Percentage germination	
Ismailia	Silica aerogel	93	95
	Ditomaceous earth	98	96
	Katel-sous	96	95
	Untreated control	98	96
Gharbia	Silica aerogel	95	97
	Ditomaceous earth	93	95
	Katel-sous	95	95
	Untreated control	97	98

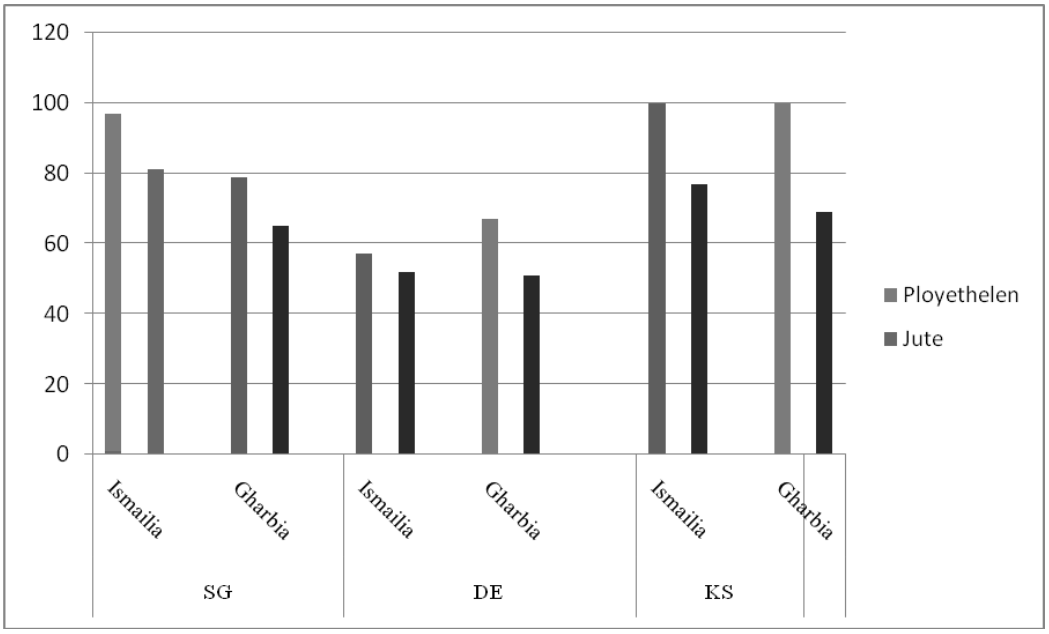

Fig. 1. Mean of corrected mortality of *S. oryzae*, *R. dominica* and *T. castaneum* after three months of treated wheat stored mixed with Silica aerogel, Ditomaceous earth and Katel-sous dusts.

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التقدير الحقلى والمعملى لكفاءة بعض المساحيق الخاملة ضد بعض حشرات الحبوب المخزونة

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معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – الجيزة.

تم إجراء تقييم حقلى ومعملى لدراسة كفاءة بعض المساحيق الخاملة وهى السليكا الغروية، التربة الدياتوميه، قاتلسوس بتركيز ١% وزنا وذلك لحماية حبوب القمح من الإصابة بحشرات سوسة الأرز، ثاقبة الحبوب الصغري، خنفساء الدقيق الكستنائيه وخنفساء الصعيد، حيث وضع القمح المعامل داخل أكياس من البولى إثيلين و الجوت وتم تخزين هذه الأكياس فى الشون المفتوحه بمحافظتى الإسماعيلية والغربية وذلك لمدة ثلاثة أشهر تم بعدها نقل الأكياس للمعمل لإجراء التقييم المعملى الحيوى حيث أخذت عينات من القمح الخاص بكل فترة على حدى للفحص المعملي بعد مرور هذة الفترة وهي ١ و ٢ و ٣ شهور وقد أوضحت نتائج البحث ما يلى:

- انخفضت نسب موت الحشرات بزيادة مدة التخزين.
- كان التخزين فى أكياس البولى إثيلين أكثر كفاءة فى المحافظة على بقاء وتأثير المادة المختبره داخله عما هو فى أكياس الجوت.
- كان التخزين فى محافظة الإسماعيلية أكثر نجاحا من محافظة الغربية.
- مسحوق قاتلسوس والسليكا كانا أكثر كفاءة فى حماية الحبوب حيث اعطيا حماية كاملة وشبه كاملة للقمح داخل أكياس البولى إثيلين بينما اعطى مسحوق التربة الدياتوميه كفاءة وحماية أقل للقمح المخزن داخل البولى إثيلين وايضا فى محافظة الغربية.
- حشرة وخنفساء الصعيد كانت من أكثر الحشرات تحملا للمواد المختبره بينما كانت سوسة الأرز وكذلك ثاقبة الحبوب الصغري أكثرهم حساسية.
- اثبتت المواد المختبره أنه لاتأثير لها على إنبات الحبوب حيث احتفظت حبوب القمح بحيويتها تماما.