------ Raf. Jour. Sci., Vol.17, No.10 Biology, Special Issue, pp.26-33, 2006 ------

Inert Dusts to Control Adults of Some Stored Product Insects in Stored Wheat

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(Received 11/4/2006 , Accepted 31/5/2006)

ABSTRACT

The use of natural mineral inert dusts is considered one of the methods for protection of stored grains from insect pests infestation.

Four local rocky dusts were evaluated against four storage insects. Ninivite dust proved to be the most effective of the tested dusts and gave LC50 of 0.12, 0.14, 0.06 and 0.08% for each of *T. confusum, T. granarium, O. surinamensis* and *R. dominica* while bentonite dust showed the lowest effect and gave LC50 of 0.74, 0.85, 0.13 and 0.20 for the insect species, respectively. The tested dusts arranged in the follwing order: ninivite > kaolinite> montorillonite> bentonite.

The effect of ninivite dust to *O. surinamensis* was 2.41, 2.0 and 1.4 times more than T.g*ranarium* , T. confusum , and R.dominica , respectively. The use of ninivite dust to prevent insect infestation in stored grains is a successful alternative to insecticides.

المساحيق الخاملة لمكافحة بالغات بعض حشرات المواد المخزونة في الحنطة المخزنة

الملخص

إن استخدام المساحيق المعدنية الطبيعية الخاملة يعتبر إحـدى الطـرق الجديـدة لوقايـة الحبـوب المخزونة من الإصابة بالآفات الحشرية.

اختبرت أربعة مساحيق صخرية محلية ضد أربعة من حشرات المواد المخزونة . واظهر مسحوق صخر النينفايت كفاءة اكثر من بقية المساحيق المختبرة حيث أعطى أعلى قيم ت.ق50% وكانت 0.12 و 0.14 و 0.06 و 0.08 % لكل من خنفساء الطحين المتشابهة *T. confusum* وخنفـساء الخـابرا *T. granarium* وخنفساء سورينام *O. surinamensis* وثاقبة الحبوب الصغرى *R. dominica* بينما اظهـر مسحوق صخر البينتونايت فعالية اقل وأعلى قيم ت . ق 50% بلغـت 0.74 و 0.85 و 0.13 و 0.20 للحشرات المختبرة على الترتيب. وعليه كان ترتيب المساحيق المختبرة في تأثيرها على الحشرات وفـق التسلسل الآتي : نينفايت > كاولينايت > مونتموريلونات > بينتونايت.

اظهر مسحوق النينفايت لخنفساء سورينام تأثيراً يفـوق بمقـدار 2.41 و2.0 و 1.4 مـرة تـأثيره لخنفساء الخابرا وخنفساء الطحين المتشابهة وثاقبة الحبوب الصغرى على الترتيب، لـذا فـإن اسـتخدام مسحوق النينفايت يعتبر بديل ناجع عن المبيدات الحشرية لمنع الإصابة الحشرية في الحبوب المخزونة.

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INTRODUCTION

The development of resistance to several important insecticide grain protectants (Subramanyam and Hagstrum, 1995) and the need to avoid insecticides residues increase emphasis on testing and evaluation of non-toxic materials that can replace conventional insecticide in stored grain (Arthur, 1996). Recently physical control methods of insect pest have become prominent; one of these methods is the use of inert dusts (Field and Korunic, 2002 and 2003). The main advantage of inert dusts is their low mammalian toxicity, long-term protection, easier application and maintanance of grain quality (Korunic et al., 1996 and Allen, 1998).

Interest now focusing on desiccant or absorptive dusts. These dusts include materials such as diatomaceous earth, synthetic silica, silicophosphate, rock phosphate, sand, kaolinite, clay..etc. It is , however only in the last fifty years that specific attempts have been made to commercialize these materials for use in modern grain protection technology (Desmarchelier and Dines, 1987; Bhavangary *et al*. 1988; Golob, 1997; Newis and Ulriches, 2001a and 2001b and Al-Iraqi and Ramadan, 2004).

Desiccant dust puncturing the outer protective layers of the insects leaving them vulnerable to hydration and death. Therefore, they are very important and useful in hot season in Iraq.

In an attempt to find natural cheaper materials for the control of stored product insects of cereals, four local rocky dusts were evaluated against some storage insects in current study.

MATERIAL AND METHODS

Four local rocky dusts namely, ninivite, kaolinite , montmorillonite and bentonite were used for wheat grain application in the laboratory at four concentrations: 0.1, 0.2, 0.4 and 0.8%(w:w) against adults of four common storage insects confused flour beetle *Tribolium confusum* Duval, khapra beetle *Trogoderma granarium* Everts, *Oryzaephilus surinamensis* (L.) and lesser grain borer *Rhizopertha dominica* (F.). Adults of the test insects were obtained from laboratory cultures reared on flour wheat and brewer's yeast (20:1) for confused flour beetle, broken wheat for khapra beetle, rice grains for sow-toothed grain beetle and whole wheat for lesser grain borer in glass jar (600 ml.) maintained in incubator at 33 ±1ºC and 60 ± 5 % R.H.

Some pieces of each rock were crushed with electric grinder and then seived with sieve of 250 mm pore. 100 gm of wheat grains treated with different concentrations of dust were placed in a glass tube (3×7cm) and 10 of newly emerged adults from laboratory cultures were put on the treated grains. The mouth of the tubes was covered with muslin cloth. Three replicates were used of each concentration in addition to control. The tubes were incubated at 32±1oC and 50±5 % R.H. . Mortality percentage of the exposed adult beetles to wheat grains treated with different rates of inert dusts was evaluated after

48hrs. of application. An adjustment for mortalities in control was made by using the Abbott's formula (1925). For determination of LC50 For and LC50 standard probit methods were used (Finney, 1971).

RESULTS AND DISCUSSION

Types of dust, insect species and concentration of dust applied were all factors influenced the mortality of stored product beetles tested. Results concerning the effect of ninivite, kaolinite, montmorillonite and bentonite to *Tribolium confusum, Trogoderma granarium, Oryzaephilus surinamensis* and *Rhizopertha dominica* are shown in table (1) and graphically illustrated in figures (1 and 2). The mortality of the adult beetles of the four species of insects increased with the increase of concentration used. Results revealed that ninivite dust proved to be the most effective of the tested dusts to the four insect species and gave LC50 values of 0.12, 0.14, 0.06 and 0.08% for each of *T. confusum, T. granarium, O. surinamensis* and *R. dominica*, respectively. On the other hand, bentonite dust showed the lowest effect to four species and gave the LC50 values of 0.74, 0.85, 0.13 and 0.2 for the insect species, respectively.

Table 1: LC50 and LC95 of the four rocky dusts on wheat grain against adults of four stored product beetles.

Dust type		*T.confusm*	*T.granarium*	*O.Surinamensis*	*R.dominica*	Mean
Ninivte	LC50	0.12	0.14	0.06	0.08	0.1
	LC95	0.30	1.17	0.20	0.19	0.46
Kaolinite	LC50	0.45	1.25	0.11	0.07	0.47
	LC95	2.0	10.4	0.55	0.64	3.39
Montmo-rillonite	LC50	0.47	0.54	0.14	0.14	0.32
	LC95	2.70	3.10	0.60	0.70	1.77
Bentonite	LC50	0.74	0.85	0.13	0.20	0.48
	LC95	3.00	11.30	0.68	2.80	4.44
Mean	LC50	0.44	0.69	0.11	0.12	0.34
	LC95	2.00	6.49	0.50	1.08	2.51

Comparison of the relative effect table (2), the tested dusts can be arranged in the following descending order: ninivite>kaolinite >montmorillonite >bentonite. The data showed that ninivite was 1.49, 1.51 and 1.91 as effective as kaolinite , montmorillonite and bentonite, respectively. The effect of kaolinite was 1.01 and 1.29 times as that of montmorillonite and bentonite, respectively, while the effect of montmorillonite was 1.29 times that of bentonite . The difference in the insecticidal effect of the four dusts may be due to differences in their chemical components, physical properties and mode of action. Korunic (1998) revealed that diatomaceous earth shows differences in diatom species, physical properties and insecticidal efficacy. Inert dusts exert their effects through several mechanisms that result in dehydration, adsorption of cuticular lipid or by abrasion (Ebeling, 1971 and Korunic, 1998). The effectiveness of inert dusts insecticides may depend on the speed and amount of waxy cuticle that the dust can absorb. As some insects move on the grain storage area or on the stored grain, behavior also is a factor (Field et al., 2001). Different physiological effects may be produced when the insects become coated with film of dusts, thus film inhibits breathing through plugging of the spiracles (Glenn et al., 1999).

Table 2 : The relative effect of the four rocky dust on wheat grains for adults of stored product beetles.

Dust type	**Average % kill for all concentrations**	**Relative effect**
Ninivite	86.32 a	1.96
Kaolinite	57.66 b	1.31
Montmorillonite	57.16 b	1.29
Bentonite	43.99 c	1.00

Results obtained indicated that, based on LC50’s values, the effect of ninivite dusts to *O. surinamensis* was 2.41, 2.0 and 1.4 times more than *T. confusum* and *R. dominica*, respectively. Sensitivity of *R. dominica* to montmorillonite was 16.44 times as that of *T. granarium,* 5.92 times as that of *T. confusum* and 1.44 times as that of *O. surinamensis* ,while *T. confusum* was 2.77 times more sensitive to montmorillonite than *T. granarium* .

Effectiveness of kaolinite dust to *R. dominica* and *O. surinamensis* was 3.35, 3.85 times more than to *T. confusum and T. granarium* whereas *T. confusum* was 1.14 times as for *T. granarium.* Similarly, bentonite dust was more effective to *O. surinamensis* than to *R. dominica, T. confusum* and *T. granarium,* the corresponding folds of increased effectiveness were 1.53, 5.69 and 6.53 times, respectively.

The relative effective effect of the four species of beetles towards the inert mineral dusts tested indicated that not all insects have the same sensitivity to the inert dusts, it was found that *O. surinamensis* was more sensitive to the dusts than *R. dominica, T. confusum* and *T. granarium,* respectively. Fields and Korunic (2003) revealed that *Oryzaphilus spp.* was more sensitive than *Rhizopertha dominica and Tribolium spp.,* respectively to diatomaceous earth.

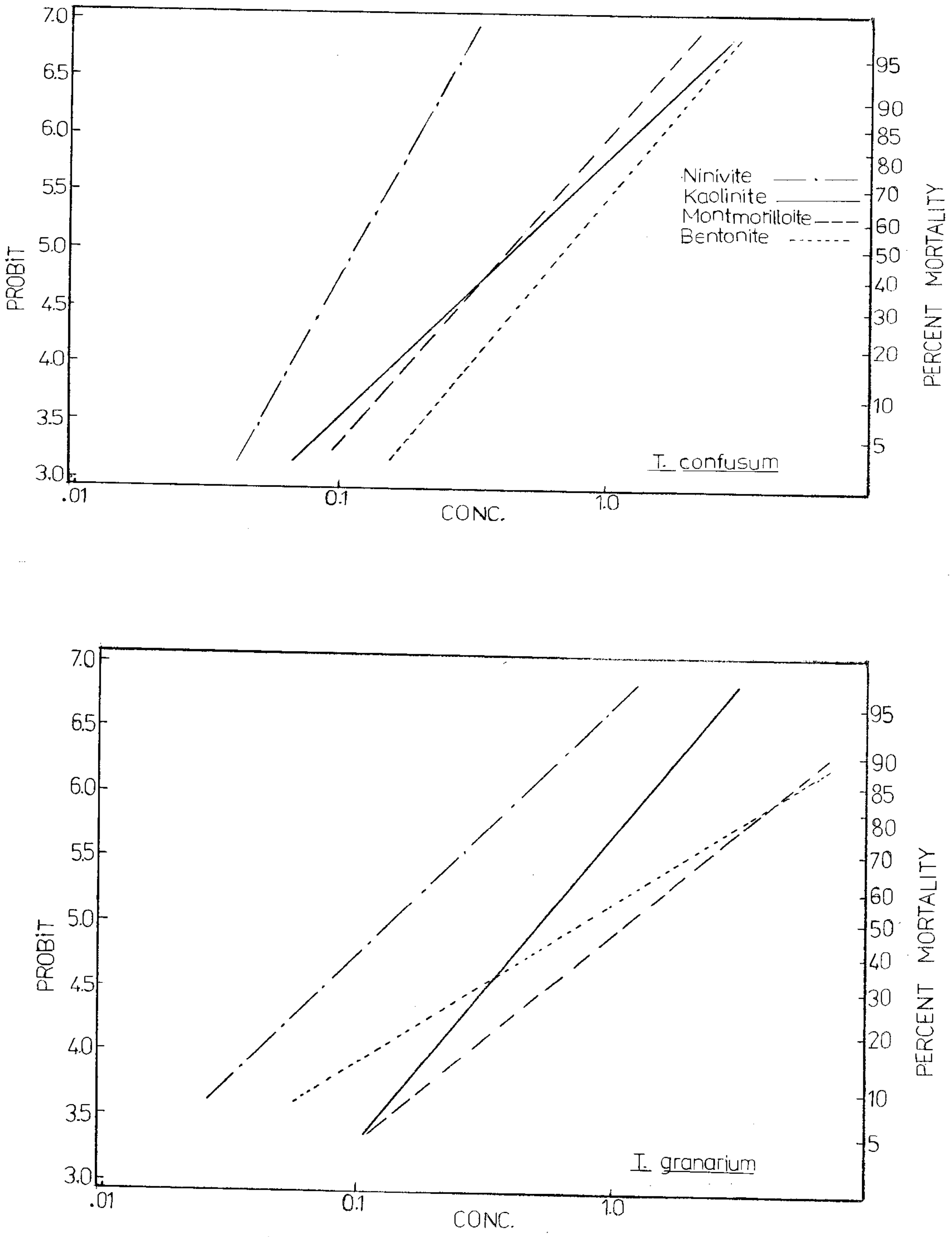

Figure 1 : Ldp Line of the four rocky dusts on wheat grains against adults of *T. confusum and T. granarium.*

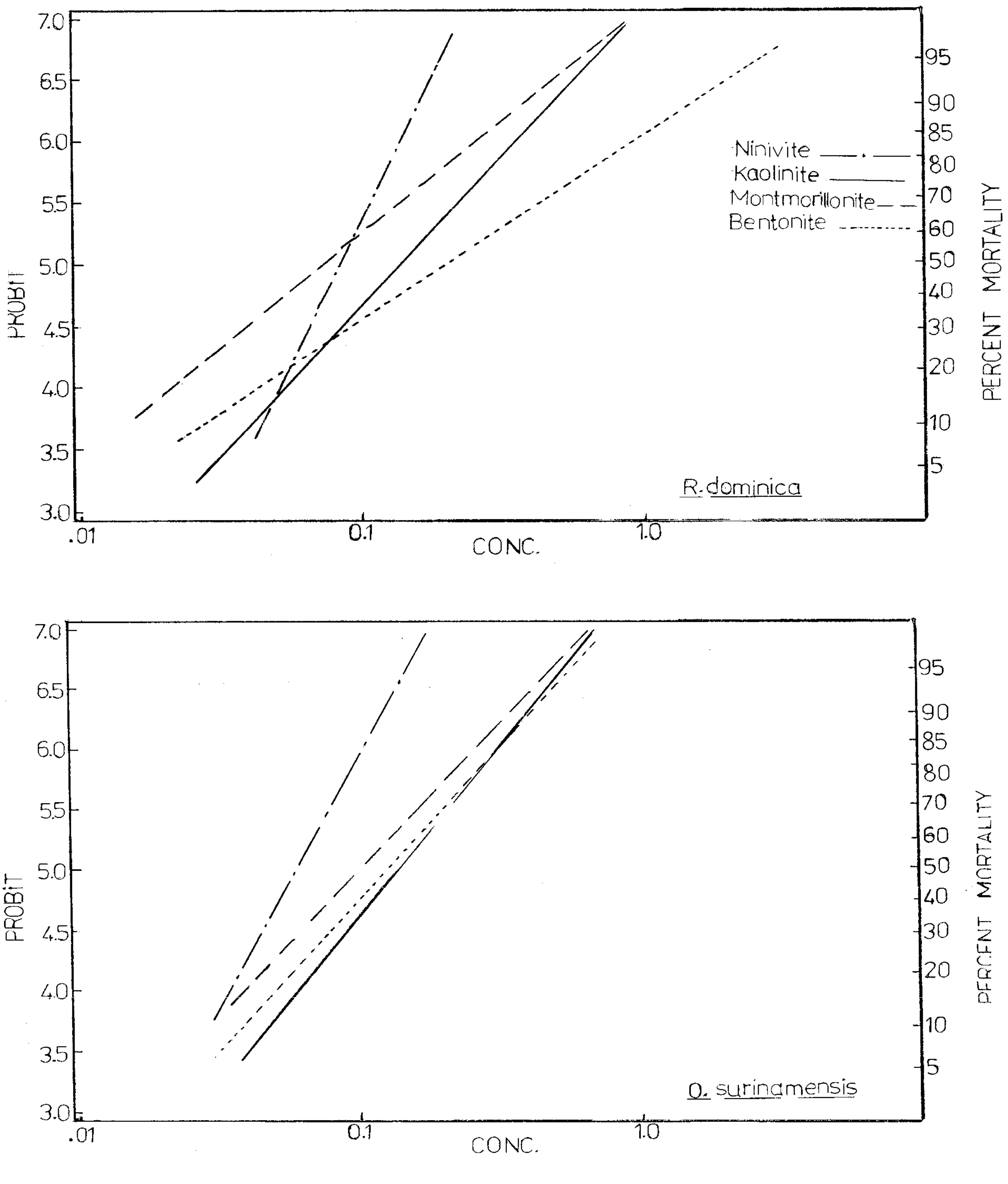

Figure 2 : Ldp Line of the four rocky dusts on wheat grains adults of against *R. dominica and O. surinamensis*

Also Quales, 1992 found that the treatment with dust was most effective for hairy insects such as *R. dominica and O. surinamensis*, that have lots of body hair to pick up particles, than for smooth-surfaced insects like *T. confusum*.

The sensitivity of *O. surinamensis* was 1.10, 4.04 and 6.27 times as that of *R. dominica, T. confusum and T. granarium*, respectively, while *R. dominica* was 3.64 and 5.65 more sensitive than *T. confusum and T. granarium. On the other hand, T. confusum was* 1.55 times more sensitive than *T. granarium* . The protective cuticle wax varies among insect species; some insects have a harder cuticle while other have a softer cuticle, therefore most natural inert dust being more effective against some species and less effective against others.

The most important feature in the context of ninivite is its very high capability of water or lipid absorption (water absorption 93.4-104.7% AL-Naqib and AL-Dabbagh, 1993) in which the powder absorbed water or lipid from the insect in short time leading to death. In addition, ninivite major component is silica (Jassim and AL-Naqib, 1989 Table 3) and hardness scale from 6-7 on Moho scale of mineral hardness. The latter criterion works as a good abrasive agent for the outlined surface cover. Consequently, the relative effect of ninivite is high as compared with the other three materials, kaolinite, montorillonite and bentonite, respectively. This can be attributed to the dense structure of kaolinite compared with the absorbed montmorillonite on the surface of bentonite and the bentonite itself. Both characters of ninivite hardness and structural density of kaolinite lead to a conclusion that the former two materials acted as exfoliation agents against insect cuticle and then the effect of water or lipid absorption acts later. From this study it could be concluded that the use of some inert dust to prevent insect infestation in stored grain is a successful alternative to insecticides.

Table 3: Chemical components of the four rocky dusts.

Dust type	SiO2	Al2O3	TiO2	Fe2O3	L.O.I.-55oc
Ninivite	94.60	0.70	-----	0.30	2.10
Kaolinite	54.20	26.86	1.03	1.97	13.81
Montmorillonite	53.40	17.60	0.24	8.22	10.91
Bentonite	64.31	18.86	0.26	2.45	8.00

From Jassim and Al-Naqib (1989).

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