EFFECTIVENESS OF SOME PLANT DUSTS AND INSECTICIDES AGAINST LESSER GRAIN BORER-*RHIZOPERTHA DOMINICA (F)* (COLEOPTERA: BOSTRYCHIDAE)

EL-LAKWAH, F.A.[1], A.A. DARWISH [1], R.A. MOHAMED [2] AND MANAR Y. ALY[2]

1 Plant Protection Dept. Fac. of Agric. Moshtohor-Benha University.
2 Plant Protection Research Institute, ARC, Ministry of Agric., Egypt

(Manuscript received 28 November 2010)

Abstract

The aim of this study was to investigate the efficacy of some plant dusts i.e. black pepper seeds dust (*Piper nigrum L.*); Cloves flowering buds (*Syzegium aromaticum*); Chili fruits dust (*Capsicum frutescens*); Cinnamon dust (*Cinnamonum zeylanicum*); Diatomaceous earth (DE) dust in comparison with katel-sous dust against *Rhizopertha dominica* (F.) at 30±1°C and 65±5% RH, also the efficacy of two organophosphorus insecticides namely malathion and piromiphos –methyl (Actellic) and one botanical insecticide (Neemazal T/S 1% Azadirachtin) was evaluated. The results indicated that adult mortality was concentration and exposure period dependent. Adult mortality was increased with increasing the dust concentration and exposure period.

The results of the various dusts against *Rhizopertha dominica* adults indicated that DE was the most effective followed by black pepper dust, cloves flowering dust, katel-sous dust and chili dust which was the least effective one. On the other hand the highest tested cinnamon dust concentration (6% w/w) resulted a lower mortality (less than 40%) even after two weeks from treatment.

Results of the toxicity index of the various tested insecticides against *Rhizopertha dominica* (F.), revealed that Actellic was the most effective followed by Malathion and Neemazal which was the least effective one.

INTRODUCTION

The lesser grain borer *Rhizopertha dominica* (F.), (Coleoptera: Bostrychidae) is a primary pest of cereal grains and other seeds; also feeds on dried potatoes, tapioca and herbs. Larvae and adults bore into grain eating out the entire starchy interior and the seed coat in places, leaving irregularly-shaped holes. Large quantities of floury dust are produced. Heavily infested wheat has a honey- like odour.

Neem products show a considerable potential in the control of stored product pests (Saxena *et al*., 1984). In this connection repellent effects are of importance. For instance, the treatment of jute sacks by using neem oil or AZ- rich products prevents the penetration of pasts for several months, for example of *Sitophilus spp*. and *Tribolium spp*. Neem oil shows a strong ovicidal effect in brucgids (Yadav, 1985),

but its antifeedant and other efficacies may also be important in controlling these legume pests (Ketkar, 1987).

Thus the aim of this work was to study:-

1- Investigate the efficacy of some plant dusts namely:- Black pepper (*piper nigrum*) (L.), cloves flowering buds (*syzygium aromaticum*), chili dust (*capsicum frutescens*), cinnamon (*cinnamonum zeylanicum*), Diatomaceous earth and katel sous against *Rhizopertha dominica* (F.).

2- Investigate the efficacy of some insecticides namely:- Neemazal T/S 1% azadirachtin, Actellic EC 50% (pirimiphos methyl) and malathion EC 57% against *Rhizopertha dominica* (F.).

MATERIALS AND METHODS

*** Insects:**

Laboratory strain of the *Rhizopertha dominica*(F.) the lesser grain borer, (Bostrychidae, Coleoptera) was used during this work. Insects were collected from the stores during 2006 and maintained at the stored product pests' laboratory of the plant protection Dept. Faculty of Agric., Moshtohor Benha University.

*** Insect cultures**

Adults were reared in glass jars of approx. 250 ml., each jar contained about 450 g. of wheat kernels for *R. dominica* and covered with muslin cloth and fixed with rubber band. Insect cultures were kept under controlled conditions of 30 ± 1ºC and 65± 5% R.H. at the rearing room of the laboratory. Wheat grains were treated well by freezing at -18ºC for 2 weeks before application to eliminate any possible infestation by any insect species. The moisture content of the grains was about 14%.

Adults samples were exposed to the various treatments for varying length of time. After the desired exposure period mortality assessment was performed. Mortality percentages were corrected by Abbott's formula (1925).

Grain protectants tested :-

Katel-sous (KS): A dust powder formulation (contains 84% calcium triphosphate plus 16% sulpher, produced by Kafr El-Zayat Company for Pesticides, Egypt), was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5 % (w/w) concentrations.

Diatomaceous earth (DE): Algae Diatomes in the form of rigid, rocky mountains and it was grounded into fine powder.

A dust powder formulation (contains 97% Silicon dioxide produced by Fabrique par, Hedley Pacific Ventures Ltd., Vancouver, B.C., Canada) was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5 % (w/w) concentrations.

ACTELLIC EC 50% (pirimiphos-methyl) (Organophosphorous compounds):

Actellic EC 50% produced by ICI plant protection, LTD, England. Wheat grains were treated with actellic at 10, 7.5, 5, 2.5 and 1.25 mg/l. all treatments were replicated three times. Mortality of adult insects was recorded after 1, 2, 3, 5, 7, 10 and 14 days.

MALATHION EC 57%: (Organophosphorous compound):

Malathion EC 57% produced by American Cynamid, U.S.A. Wheat grains were treated at 30, 20, 15, 10, 7.5, 5 and 2.5 mg/l. Mortality of adult insects was recorded after 1, 2, 3, 5, 7, 10 and 14days. Then the alive adult insects were removed after 14 days post- treatment and the grain was mentained at 30± 1ºC , 65±5% RH to obtain the F1 progeny after 30, 45, 60 and 75 days from treatment. Adult mortality was corrected using Abbot's formula and inhibition rate of F1 progeny was recorded as mentioned above.

NEEMAZAL- T/S 1% Azadirachtin (botanical pesticide)

Neemazal (T) 1%, the botanical insecticide Neemazal-T, a liquid formulation contains 5% Azadirachtin, which is an extract of the neem tree seeds (*Azadirachta indica* A.Juss), was obtained from Trifolio- GMBH Company, Germany.

Neemazal is a slow acting naturally based anti-feeding insecticide. Wheat grains were treated at 400**,** 350, 300, 250, 200, 100 and 50 mg/l. Mortality of adult insects was recorded after 1, 2, 3, 5, 7, 10 and 14 days. Then the alive adult insects were removed after 14 days post- treatment and the grain was maintained at 30± 1ºC , 65±5% RH to obtain the F1 progeny after 30, 45, 60 and 75 days from treatment. Adult mortality was corrected using Abbot's formula and inhibition rate of F1 progeny was recorded as mentioned above

*** Bioassay tests:-**

To assess the insecticidal potential of the used dusts and insecticides test arenas consisted of glass jars (50 ml) were used. Each jar contained uninfested 30 gm of wheat kernels, which were thoroughly mixed by hand shaking with the weighed amount of the tested dust for the insecticides to give the required concentration. Batches of 30 unsexed adults (1 to 2 week-old) were introduced to the jars, with each species being tested separately. The jars were then covered with pieces of muslin, secured with rubber bands and kept under the aforementioned rearing conditions at the laboratory. All treatments were replicated three times. The contents of the jars were sifted through a 2 mm opening sieve to separate insects from the grains. The

numbers of live and dead adults were counted and mortality percentages were accordingly determined at 1,2, 3, 5, 7,10 and 14 days post-treatment, and the F1 progeny was estimated after 30, 45, 60 and 75 days post-treatment.

*** Plant dusts :-**

Black pepper dust:- *(Piper nigrum)*(L.) the dust was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5% (w/w) concentrations. The fruit contains volatile oil, piperine and a resin[1].

Chili dust:-(*Capsicum frutescens*) the dust was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5% (w/w) concentrations. The fruit contains capsaicin. (E)-N-(4-hydroxy-3-methoxybenzyl)-8 methylnon- 6- enamide.

Cloves flowering buds dust:- (*Syzygium aromaticum*) the dust was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5% (w/w) concentrations. Cloves flowering buds dust (*Syzygium aromaticum*), which contain casuarictin and eugeniin (Tellimagrandin II) **Okuda (1983).**

Cinnamon dust:- (*Cinnamonum zeylanicum*) the dust was mixed with wheat grains and tested at 6, 4, 2, 1 and 0.5% (w/w) concentrations. Dusts were tested after 1, 2, 3, 5, 7, 10 and 14 days. Then the alive adult insects were removed after 14 days post- treatment and the grain was maintained at 30± 1ºC , 65±5% RH to obtain the F1 progeny after 30, 45, 60 and 75 days from treatment. Adult mortality was corrected using Abbot's formula and inhibition rate of F1 progeny was recorded as mentioned above. Cinnamon dust (*Cinnamonum zeylanicum),* contain carpacin (Isosafrole methyl ether) Mohondas, (1969)

Tested seeds were bought from the local market and ground into fine powder in an electric mill. The powder was mixed with the insect feeding media to give the proper concentration.

*** Statistical Analysis:-**

A probit computer program was used for determining the dosage mortality response (Finney, 1971) for the dusts and insecticides, and also the lethal times for the gases.

RESULTS AND DISCUSSION

Effect of some plant dusts against lesser grain borer (*Rhizopertha dominica*) (F.) at 30± 1 °C and 65±5 % R.H:-

The results of the effect of Black pepper dust (*Piper nigrum* (L.)) on adult mortality and reduction in F1- progeny of *Rhizopertha dominica*(F.) at 30±1ºC and

65±5% R.H. are presented in Table 1. The results indicated clearly that mortality was concentration and exposure period dependent -The higher the concentration and the exposure period, the higher the mortality was. At 6% concentration mortality was 65.5% after 1 day exposure and increased to 99.9% at 14 days post treatment. At 4% concentration mortality was 56.6% at 1 day exposure and increased to 98 at 14 days post treatment. At 2% concentration mortality was 4.4% at 1 day exposure and increased to 90% at 14 days post treatment, At 1% concentration mortality was 2.2% at 1day exposure and increased to 60% at 14 days post treatment. At 0.5% concentration, mortality was 0% at 1 day exposure and increased to 40% at 14 days post treatment. Reduction in F_1 progeny was between 33.11-82.2% for the various tested concentrations of black pepper dust.

The lethal concentrations of black pepper dust against the adults of *Rhizopertha dominica* are given in table 2. The results showed that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 3 days post treatment the LC_{50} value was 2.2% (w/w), the corresponding value at 14 days was significantly decreased and amounted 0.7% (w/w).

The LC_{90} values was 7.1% (w/w) at 3 days and declined to 2% (w/w) at 14 days post treatment. The LC_{95} values was 10% (w/w) at 3 days and decreased to 2.5 %(w/w) after 14 days from treatment.

Table 1. Effect of Black pepper dust (Piper nigrum (L.))on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F) at 30 ± 1 °C and 65± 5% R.H.

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	65.5	79.9	88.8	96.6	97.3	98.7	99.9	20.3	82.2
4	56.6	65.5	84.4	92.2	96.6	97.7	98	26.3	77.1
2	4.4	16.63	25.5	43.3	49.9	88.4	90	41.6	63.7
1	2.2	6.63	13.3	23.3	28.8	50.9	60	49	57.2
0.5	0	4.4	12.2	17.7	22.2	36.4	40	76.6	33.11
Control	0	0	0	0	0	2.2	3.3	114.6	0

Table 2. Lethal concentration of Black pepper dust against the adults of *Rhizopertha dominica* (F.) at various exposure Periods.

Exposure Period(Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slop ± SD	R
	LC50	LC90	LC95		
3 days	2.2 (2-3)	7.1 (5-10.3)	10 (6.4-15.4)	2.5 ±0.72	0.9319
5 days	1.5 (1.2-2)	4.4 (3.2-6)	6 (4.1-9)	3 ±1.56	0.9549
7 days	1.3 (1.1-2)	4 (3-5)	5 (3.4-7)	3 ±0.70	0.9467
14 days	0.7 (0.6-0.9)	2 (1.5-2.4)	2.5 (2-3.4)	3.03±0.23	0.9849

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line.

The results of the effect of cloves flowering buds dust (*Syzygium aromaticum*) on adult mortality and reduction in F1- progeny of *Rhizopertha dominica*(F.) at 30 ± 1ºC and 65 ± 5% RH are tabulated in table 3. The results indicated clearly that mortality was concentration and exposure period dependent. At the highest tested concentration 6% w/w, mortality values were 45.5; 54.4; 59.3; 75.5; 84.4; 88.88 and 91.1% after 1, 2, 3, 5, 7, 10 and 14 days from treatment, respectively. At 4% concentrations , mortality values were 38.86, 49.95, 59.9, 78.86, 81.06, 84.4, 84.4% after 1, 2, 3, 5, 7, 10 and 14 days from treatment, respectively. At 2% concentration, mortality values were 22.2, 29.96, 41.06, 48.8, 53.3, 57.77, 60 after 1, 2, 3, 5, 7, 10 and 14 days from treatment, respectively. At 1% concentration, mortality values were 9.96, 15.5, 18.8, 22.16, 24.2, 26.6, 28.75% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 0.5% concentration, mortality values were 3.3, 6.6, 8.86, 12.2, 15.5, 15.5, 16.6% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. Reduction in F1 progeny was between 14.4-100% for the various tested concentration of cloves flowering buds.

The lethal concentrations of cloves flowering buds dust against the adults of *Rhizopertha dominica* (F.) are tabulated in table 4. The results showed that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 7days post treatment the LC_{50} value was 2% (w/w), the corresponding value at 14 days was significantly decreased and amounted 1.5% (w/w). The LC_{90} value was 7.5% (w/w) at 7days and declined to 5.6% (w/w) at 14 days post treatment. The LC_{95} value was 11.3% (w/w) at 7 days post treatment and decreased to 8.2% (w/w) after 14 days post treatment.

Table 3. Effect of cloves flowering buds dust (*Syzygium aromaticum*) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30±1ºC and 65± 5% R.H.

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	45.5	54.4	59.3	75.5	84.4	88.88	91.10	0	100
4	38.86	49.95	59.9	78.86	81.06	84.4	84.4	0.066	99.9
2	22.2	29.96	41.06	48.8	53.3	57.77	60	244.66	63.61
1	9.96	15.5	18.8	22.16	24.2	26.6	28.75	492.66	26.72
0.5	3.3	6.6	8.86	12.2	15.5	15.5	16.6	575	14.4
Control	0	0	0	0	2.2	3.3	3.3	672.33	0

Table 4. Lethal concentrations of cloves flowering buds dust against the adults of *Rhizopertha dominica* (F.) at various exposure Periods.

Exposure Period(Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slope ± SD	R
	LC_{50}	LC_{90}	LC_{95}		
7 days	2 (1.4 -2.2)	7.5 (5 -12)	11.3 (7-19.12)	2.05 ± 0.76	0.9884
14 days	1.5 (1.2 -2)	5.6 (4 - 8.10)	8.2 (5.2 -13)	2.2 ± 0.041	0.9947

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line.

The results of the effect of chili dust (*capsicum frutescens*) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica*(F.) at 30 ± 1ºC and 65 ± 5% RH are shown in table 5. The results indicated clearly that mortality was concentration and exposure period dependent. The higher the concentration and the exposure period, the higher the mortality was. At 6% concentration mortality value was 5.5% after one day post treatment and increased to 99%at 14 days exposure. At 4% concentration mortality value was 2.2% at 1day exposure and increased to 92% at 14 days exposure. Concentration at 2% mortality was3.3%at 1 day exposure and increased to 80.7% after 14 days post treatment. At 1% concentration mortality was 0% at one day exposure and increased to 78.7% at 14 days exposure. Concentration

at 0.5% mortality was zero % at 1 day exposure and increased to 40.3% after 14 days post treatment. Reduction in F1 progeny was between 10.60 -63.63% for the various tested concentration of chili dust.

The lethal concentrations of chili dust against the adults of *Rhizopertha dominica*(F.) are shown in table 6. The results showed that the lethal concentrations are exposure period dependent the higher the exposure period was the owner the values. At 7days post treatment the LC_{50} value was 2% (w/w) the corresponding value at 14 days was significantly decreased and amounted 0.59% (w/w). The LC_{90} value was 15.5% (w/w) at 7days and declined to 2.5% (w/w) after 14 days post treatment. The LC_{95} value was 28.1% (w/w) at 7days and decreased to 4% (w/w) after 14 days post treatment.

Table 5. Effect of chili dust (*Capsicum frutescens*) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30 ±1ºC and 65 ± 5% R.H.

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	5.5	18.8	35.5	63.3	76.6	95.5	99	32	63.63
4	2.2	11.1	14.4	55.5	69.9	91.06	92	37.33	57.57
2	3.3	7.7	12.2	41.06	44.4	78.7	80.7	52.33	40.53
1	0	4.4	8.86	25.5	38.8	56	78.7	72.33	17.80
0.5	0	3.3	7.7	15.5	20.9	30	40.3	97.33	10.60
Control	0	0	0	0	0	3.3	4.4	88	0

Table 6. Lethal concentrations of chili dust against the adults of *Rhizopertha dominica* (F.) at various exposure periods**.**

Exposure Period (Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slope± SD	R
	LC_{50}	LC_{90}	LC_{95}		
7 days	2 (1.4 - 3)	15.5 (7-35)	28.1 (10.3 -77)	1.4 ± 0.45	0.9851
14 days	0.59 (0.42- 0.8)	2.5 (2 - 4)	4 (2.4 - 6)	2.04 ± 0.32	0.9533

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line

The result of the effect of cinnamon dust (*cinnamonum zeylanicum*) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica*(F.) at 30±1ºC and 65±5% RH are presented in table 7. The results indicated clearly that mortality was increased by increasing the dust concentration and the period of exposure. At 6% concentration mortality was 12.2% at one day exposure and increased to 22.2% at 5 days exposure, and it was 32.3% at 10 days, which increased to 39.9% after 14 days post treatment. At 4% concentration mortality values were 8.86% at one day exposure and increased to 17.7% at 5 days exposure, and it was 24.43% at 10 days, which increased to 26.63% after 14 days post-treatment. At 2% concentration, mortality values were 1.1% at one day exposure and increased to 14.4 % at 5 days exposure and it was 16.66% at 10 days, which increased to 24.4% after 14 days post-treatment. At 1% concentration, mortality values were zero % at 1 day exposure and increased to 6.6 at 5 days exposure and it was 10% at 10 days, which increased to 15.55 after 14 days post-treatment. At 0.5% concentration, mortality values were zero at 1 day exposure and increased to 7.7% at 5 days exposure and it was 8.8% at 10 days, which increased to 14.4% after 14 days post-treatment. Reduction in F1 progeny was between 8.6-68% for the various tested concentration of cinnamon dust.

The results indicated clearly that the efficacy of cinnamon dust against the adults of *Rhizopertha dominica* was moderately lowed (between 14.4 – 39.9%).

Table 7. Effect of cinnamon dust (*Cinnamonum Zeylanicum*) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica(F.)*

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	12.2	13.3	16.6	22.2	27.7	32.3	39.9	147	68
4	8.86	9.96	12.2	17.7	22.16	24.43	26.63	297	36
2	1.1	8.8	13.3	14.4	15.55	16.66	24.43	311	33
1	0	4.4	5.5	6.6	8.8	10	15.55	410.3	11.5
0.5	0	4.4	5.5	7.7	8.7	8.8	14.4	424	8.6
Control	0	0	0	0	2.2	2.2	3.3	464	0

The results of the effect of diatomaceous earth dust on adult mortality and reduction in F1-progeny of *Rhizopertha dominica*(F.) at 30± 1ºC and 65±5% R.H. are presented in table 8. The results indicated clearly that mortality was increased by increasing the dust concentration and the period of exposure .At 6% concentration mortality was 56.63 % at 1 day exposure and increased to 100% after 14 days post treatment. At 4% concentration mortality was 42.2% at 1 day exposure and increased to 100% after 14 days post treatment. At 2% concentration mortality was 32.2% at 1 day exposure and increased to 100% after 14 days post treatment. At 0.5% concentration mortality was 8.8% at one day exposure and increased to 100% after 14 days post treatment.

Results indicated complete adult mortality after 14 days post-treatment for the various tested DE concentrations. The lethal concentrations of diatomaceous earth against the adults of *Rhizopertha dominica*(F.) are shown in table 9 :-

Reduction in F1 progeny was between 92-99% for the various tested concentration of diatomaceous earth dust.

The results showed that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 2 days post treatment the LC_{50} value was 1.3% (w/w), the corresponding value at 3 days was significantly decreased and amounted 0.435% (w/w). The LC_{90} value was 5.3 % (w/w) at 2 days post treatment and decreased to 3.3% (w/w) at 3 days post treatment. The LC_{95} value was 7.9% (w/w) at 2days post treatment and declined to 5.9% (w/w) after 3 days post treatment.

Table 8. Effect of Diatomaceous earth dust on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30 ± 1ºC and 65 ± 5% R.H.

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	56.63	92.2	93.3	64.4	99	100	100	2	99
4	42.2	76.6	91.06	95.5	95	98.8	100	0	100
2	32.2	77.7	89.9	92.2	92	98.86	100	7.3	99
1	13.3	41.06	73.3	77.7	88	98.8	100	9	99
0.5	8.8	15.5	45.5	49.9	85	100	100	49.9	92
Control	0	0	0	0	2.2	2.2	3.3	622.3	0

Table 9. Lethal concentrations of Diatomaceous earth dust against the adults of *Rhizopertha dominica* (F.) at various exposure periods.

Exposure Period(Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slope ± SD	R
	LC_{50}	LC_{90}	LC_{95}		
2 days	1.3 (1.03 – 2)	5.3 (4- 8)	7.9 (5 -13)	2.1 ± 0.24	0.9655
3 days	0.435 (0.24 - 0.77)	3.3 (2.1 - 5.4)	5.9 (3.1– 11.4)	1.5 ± 0.77	0.9499
7 days	0.076 (0.0081-0.61)	1.13 (0.63-2.04)	2.5 (1.2-5.3)	1.06±0.16	0.9176

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line.

The results of the effect of katel-sous dust on adult mortality and reduction in F1-progeny of *Rhizopertha dominica*(F.) at 30±1ºC and 65±5% RH are given in table 10. The results indicated clearly that mortality was increased by increasing the dust concentration and the period of exposure at 6% concentration mortality was 8.86% at one day exposure and increased to 98.8% after 14 days post treatment. At 4% concentration mortality was 7.7% at 1day exposure and increased to 80.8% after 14 days post treatment. At 2% concentration mortality was 4.4% at 1 day exposure and increased to 70.8% after 14 days post treatment. At 1% concentration mortality was 3.3% at 1 day exposure and increased to 56.6% after 14 days post treatment. At 0.5% concentration mortality was 1.1% at 1 day exposure and increased to 46.6% after 14 days post treatment. Reduction in F1 progeny was between 1.38-92% for the various tested concentration of Katel sous dust.

The results showed clearly that at the recommended rate of katel-sous (1% w/w), the obtained mortality value of *Rhizopertha dominca* adults after 14 days post-treatment was only 56.6%, whereas the lethal concentration of katel-sous needed for 95% kill was 5.7% w/w (Table 11). This result indicated that *Rhizopertha dominca* - adults were less susceptible to katel-sous.

The results showed also that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 7 days post treatment the LC_{50} value was 1.21% (w/w), the corresponding value at 14 days was significantly decreased and amounted 0.75% (w/w).The LC_{95} value was 14.03 % (w/w) at 7 days post treatment and declined to 5.7% (w/w) after 14 days post treatment.

Table 10. Effect of Katel-sous dust on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30±1ºC and 65±5% R.H.

Conc. % w/w	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
6	8.86	18.83	54.4	88	90.2	92.2	98.8	45	92
4	7.7	17.7	34.4	70.3	72.8	79.9	80.8	56.3	90
2	4.4	9.9	21.06	55.53	60.6	68.8	70.8	165	72
1	3.3	6.6	8.86	25.4	42.2	44.4	56.6	411	29
0.5	1.1	4.4	4.4	19.9	31.3	36.6	46.6	571	1.38
Control	0	0	0	0	1.1	2.2	3.3	579	0

Table 11. Lethal concentrations of Katel-sous dust against the adults of *Rhizopertha dominica* (F.) at various exposure periods**.**

Exposure Period(Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slope ± SD	R
	LC_{50}	LC_{90}	LC_{95}		
7 days	1.21 (0.9 – 1.6)	8.2 (4.5 - 15)	14.03 (7 -30.2)	1.5 ± 0.11	0.9721
14 days	0.75 (0.5 -1.02)	3.6 (2.4 -5.4)	5.7 (3.4 – 10)	1.9 ± 0.7	0.8918

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line**.**

Table (12) indicated that the toxicity index of the various investigated dusts against *R. dominica* –adults indicated that Deatomaceons Earth (DE) dust was the most effective material against the adults of *R. dominica*, followed by black pepper, cloves flowering buds, Katel-sous and chili dust was the least effective dust. On the other hand application of cinnamon dust at the highest tested concentration (6%) resulted in lower mortality values (less than 40%) even after 14 days from treatment. In this respect, El-lakwah, *et al*. (1992) studied pulverized black pepper seed in the laboratory for toxicity, reduction of F_1 progeny and repellency effect against adults of *Sitophilus oryzae* (L.), *Rhizopertha dominica* (F.) and *Tribolium castaneum* (erbst.). Data showed that black pepper powder was very toxic to *S. oryzae* and gave complete

protection to stored wheat after 7 days from the treatment. The results indicated that black pepper powder could be used as a protectant for grain against certain stored product insects, also Nikpay, (2006) reported that, diatomaceous earths (DE) are among the most promising alternative to synthetic insecticides. In stored product protection, (DE) have proved effective as structural treatments to storage facilities. DE at 5 g/m^2 was effective against *R.dominica* and *T.castaneum*.

Also, the obtained results are in harmony with the findings obtained by other investigators (El-Lakwah, *et al.* 1992; El-Lakwah, 1997; El-Kashlan, 1999 and El-Lakwah *et al.,* 2001).

Table 12. Toxicity index of various tested dusts against the adults of *Rhizopertha dominca* (F.) at 30 ± 1°C and 65 ± 5 % R.H.

Treatment	Lethal concentration at 7 day (w/w%)		Toxicity index		SLOPE ± SD	R.
	LC_{50}	LC_{90}	LC_{50}	LC_{90}		
Diatomaceous earth dust	0.076	1.13	100	100	1.06±0.16	0.9176
Black pepper dust	1.3	4	5.8	28.25	3±0.70	0.9407
Cloves flowering dust	2	7.5	3.8	15.06	2.06±0.76	0.9884
Katel sous dust	1.21	8.2	6.2	13.78	1.5±0.11	0.9721
Chili dust	2	15.5	3.8	7.29	1.4±0.45	0.9533
Cinnamon dust	--	--	--	--	--	--

I.8. Effect of botanical insecticide Neemazal-T/S 1% Azdirachtin against *Rhizopertha dominica* (F.) at 30±1ºC and 65% ±5% R.H.

The result of the effect of Neemazal – T/S 1% azadirachtin on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30± 1ºC and 65± 5% R.H. are presented in table 13. The results indicated clearly that mortality was increased by increasing the pesticide concentration and the period of exposure. At 400 ppm concentration, mortality values were 82.16, 90, 98.9, 99, 99.8, 99.9, 99.9% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 350 ppm concentration, mortality values were 47.7, 67.7, 83.3, 94.4, 97.7, 99, 99.7% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 300 ppm concentration, mortality values were 37.7, 43.2, 63.3, 82.2, 89.9, 91.1, 96.6% after 1, 2, 3, 5, 7, 10 and 14 days from

treatment. At 250 ppm concentration, mortality values were 22.2, 29.9, 47.7, 52.2, 65.5, 83.3, 88.86% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 200 ppm concentration, mortality values were 19.9, 25.5, 41.06, 44.4, 45.5, 62.16, 81.06% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 100 ppm concentration, mortality values were 1.1, 2.2, 6.6, 6.6, 9.9, 33.3, 84.8% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. At 50 ppm concentration, mortality values were zero, 0, 3.3, 4.4, 7.7, 15.5, 41.1% after 1, 2, 3, 5, 7, 10 and 14 days from treatment. Mortality values at 14 days post-treatment were between 41.1-99.9% for the different tested concentrations of Neemazal.

The lethal concentrations of Neemazal- T/S 1% azadirachtin against the adults of *Rhizopertha dominica* (F.) are shown in table 14. The results showed that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 5 day post treatment the LC_{50} value was 173 ppm, the corresponding value at 7 day was significantly decreased to 148 ppm, and decreased to 81.2 ppm at 14 day post treatment. The LC_{90} value was 344% at 5 day exposure and decreased to 285% at 7 day exposure and decreased to 185 ppm at 14 day post treatment. The LC_{95} value was 418 ppm at 5 day exposure and decreased to 343 ppm at 7 day exposure and decreased to 234 ppm at 14 day post treatment.

In this respect El-Lakwah *et al.,* 1993 reported that *R. dominica* adults were least susceptible to Neemazal-F powder than *S.oryzea* adults.

Table 13. Effect of Neemazal T/S 1% azadirachtin on adult mortality and reduction in F1 progeny of *Rhizopertha dominica* (F.) at 30 ± 1ºC and 65 ± 5% R.H.

Conc. (ppm)	% Adult mortality after indicated period (days)							Average No. Of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
400	82.16	90	98.9	99.0	99.8	99.9	99.9	189.3	75.6
350	47.7	67.7	83.3	94.4	97.7	99.0	99.7	245	68.42
300	37.7	43.2	63.3	82.2	89.9	91.1	96.6	248.6	67.96
250	22.2	29.9	47.7	52.2	65.5	83.3	88.86	268	65.46
200	19.9	25.5	41.06	44.4	45.5	62.16	81.06	328.3	57.6
100	1.1	2.2	6.6	6.6	9.9	33.3	48.8	448.6	42.19
50	0	0	3.3	4.4	7.7	15.5	41.1	460.6	40.64
Control	0	0	0	0	1.1	2.2	2.2	776	0

Table 14. Lethal concentrations of Neemazal-T/S 1% Azadirachtin against the adults of *Rhizopertha dominica* (F.) at various exposure periods.

Exposure Period (days)	lethal concentrations (ppm) and their 95% confidence limits			Slope ± SD	R
	LC_{50}	LC_{90}	LC_{95}		
5 days	173 (158-189)	344 (305 -388)	418 (362 -483)	4.3 ±1.8	0.9301
7 days	148 (136-162)	285 (255 -317)	343 (302 -389)	4.5 ± 2.6	0.9131
14 days	81.2 (71.4 -92)	185 (163 -210)	234 (201 -272)	3.6 ± 1.6	0.9149

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line.

I.9. Effect of organophosphorus pesticide Actellic EC 50% (pirimiphos methyl) against *Rhizopertha dominica* (F.) At 30±1ºC and 65 %± 5% R.H.

The results of the effect of Atellic EC 50% (pirimiphos methyl) on adult mortality and reduction in F1–progeny of *Rhizopertha dominica* (F.) at 30 ± 1ºC and 65±5% RH are tabulated in table 15. The results indicated clearly that mortality was increased by increasing the pesiticide concentration and the period of exposure. At 10 ppm concentration mortality was 21.06% at one day after treatment and increased to 96.66% at 14 days post treatment. At 7.5 ppm mortality was 11.1% at 1 day exposure and increased to 85.5% after 14 days post treatment. At 5 ppm mortality was 7.7% at 1 day exposure and increased to 50% at 14 days post treatment. At 2.5 ppm mortality was 1.1% at 1 day exposure and increased to 36.6% at 14 days post treatment. At 1.25 ppm mortality was 1.1% at 1 day and increased to 19.8% after 14 days post treatment. The results showed that adult mortalities of *Rhizopertha dominica* were between 19.8-96.66% at the various concentration of pirimiphos methyl after 14 days post-treatment.

The lethal concentrations of Actellic EC 50% against the adults of *Rhizopertha dominica* (F.) are tabulated in table 16. The results showed that the lethal concentrations are exposure period dependent. The higher the exposure period was the lower the values. At 5 days post treatment the LC_{50} value was 5.8 ppm, the corresponding value at 7 days was significantly decreased and amounted 4.9 ppm and decreased to 3.1 ppm at 14 days post treatment. The LC_{90} value was 20.6 ppm at 5

days exposure and decreased to 20.1 ppm at 7 days and decreased to 8.9% at 14 days post treatment. The LC_{95} value was 29.6 ppm at 5 days post treatment and declined to 12.1 ppm after 14 days from treatment.

Table 15. Effect of Actellic EC 50% (Pirimiphos methyl) on adult mortality and reduction in F1-progeny of *Rhizopertha dominica* (F.) at 30±1ºC and 65± 5% R.H.

Conc . (ppm)	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
10	21.06	46.6	69.9	77.7	79.88	81.11	96.66	3.6	95.6
7.5	11.1	35.5	46.6	68.8	70.3	74.4	85.5	13.6	78.6
5	7.7	17.7	24.4	31.11	33.3	36.6	50	52.6	44.6
2.5	1.1	3.3	6.6	8.8	23.3	31.06	36.6	67	18.4
1.25	1.1	5.5	7.7	13.32	15.5	18.8	19.8	73.6	5.7
Control	0	0	0	0	2.2	3.3	3.3	65.3	0

Table 16. Lethal concentrations of Actellic EC 50% (Pirimiphos methyl) against the adults of *Rhizopertha dominica* (F.) at various exposure periods.

Exposure Period (days)	lethal concentrations (ppm) and their 95% confidence limits			Slope ± SD	R
	LC_{50}	LC_{90}	LC_{95}		
5 days	5.8 (4.7 -7.1)	20.6 (13 -33)	29.6 (16.8 - 52)	2.3 ± 0.66	0.9021
7 days	4.9 (4 - 6.2)	20.1 (12.2 -35.0)	30.1 (16.3 - 59)	2.05 ± 0.32	0.9358
14 days	3.1 (3 - 4)	8.9 (7-12)	12.1 (8.5 -17.3)	2.8 ± 0.57	0.9371

R = Correlation Coefficient of regression line.

SD = Standard deviation of the mortality regression line.

I.10. Effect of the organophosphorous pesticide malathien EC 57% (malathion) against *Rhizopertha dominica* (F.) at 30±1ºC and 65±5% R.H.

The results of the effect of malathion EC 57% on adult mortality and reduction in F1- progeny of *Rhizopertha dominica* (F.) at 30±1ºC and 65±5% R.H. are presented in table 17. The results indicated clearly that mortality was increased by increasing the pesticide concentration and the period of exposure. At 30 ppm concentration, mortality was 7.7% at 1 day after treatment and increased to 81.1% at 14 days post treatment. At 20 ppm concentration, mortality was 6.6% at 1 day exposure and increased to 70.9% at 14 days exposure period. At 15 ppm concentration, mortality was 6.6% at 1 day exposure and increased to 60.2% at 14 days post treatment. At 10 ppm concentration, mortality was 4.4% at 1 day exposure and increased to 50.2% at 14 days exposure period. At 7.5 ppm concentration, mortality was 4.4% at 1 day exposure and increased to 45.7% at 14 days post treatment. At 5 ppm concentration, mortality was 2.2% at 1day exposure and increased to 42.3% after 14 days post treatment. At 2.5 ppm concentration, mortality was 1.1% at 1 day exposure and increased to 36.6% at 14 days post treatment.

The lethal concentrations of malathion EC 57% against the adults of *Rhizopertha dominica* (F.) are tabulated in table 18. The results showed that the lethal concentrations are exposure period, dependent. The higher the exposure period was the lower the values. At 14 day post treatment LC_{50} value was 7.2, LC_{90} value was 98.6, LC_{95} value was 207 ppm. The results of the lethal concentrations indicated clearly that *Rhizopertha dominica* adults were resistant to malathion. On the other hand, pirimiphos methyl (Actellic) was more effective against this insect species than malathion.

Results of the toxicity index given in table (19) revealed that Actellic was the most effective insecticide against *Rhizopertha dominica* adults followed by malathion and Neemazal was the least effective one.

In this respect El-Lakwah *et al.* (2000) reported that *Rhizopertha dominica* was the most tolerant species to pirimiphos-methyl in comparison to *Sitophilus oryzae* and *Tribolium castaneum*. Also *Rhizopertha dominica* was high resistant to malathion.

Meanwhile, the efficacy of the botanical insecticide Neemazal-W powder contains 10% Azadirachtin was studied alone by El-Lakwah, (1997) and in mixtures with the LC_{50} of malathion and sumithion on mortality and reduction in F_1 - progeny of *Rhizopertha dominica*. The results showed that insect mortality was increased with increasing exposure period and concentration of the compounds. Toxicity data revealed that *R. dominica* – adults were high resistant to malathion and less resistant

to sumithion. Co-toxicity resulted from addition of the LC_{50} of malathion (14.5 ppm) to Neemazal at various concentrations for *R. dominica* showed an additive effect at all tested concentrations. In case of the mixture of sumithion plus Neemazal, an additive effect was obtained at higher concentrations (500, 1000 ppm), but at 50, 100 and 250 ppm an antagonistic effect was achieved. Thus, it could be recommended to apply Neemazal as grain protectant against stored product insects in frame of an integrated pest management system and to stop the use of malathion if the grain was infested with *R. dominica* due to its high resistant to this insecticide.

Also El-Kashlan, 1999 reported that *R. dominica* was highly tolerant to malathion.

Table 17. Effect of malathion EC 57% on adult mortality and reduction in F1 progeny of *Rhizopertha dominica* (F.) at 30 ± 1ºC and 65 ± 5% R.H

Conc. (ppm)	% Adult mortality after indicated period (days)							Average No. of emerged adults after 75 days	% Reduction in F1-progeny
	1	2	3	5	7	10	14		
30	7.7	9.9	16.6	27.7	36.6	56.6	81.1	225	44.6
20	6.6	8.8	14.4	26.6	33.3	51.06	70.9	263.3	35.15
15	6.6	8.8	12.2	16.6	25.5	49.96	60.2	324	20.19
10	4.4	7.7	11.1	15.5	24.4	47.73	50.2	365	10.09
7.5	4.4	5.5	8.8	12.2	21.1	42.2	45.7	378.3	6.82
5	2.2	3.3	5.5	9.9	14.4	39.96	42.3	383.3	5.59
2.5	1.1	2.2	3.3	7.7	13.3	35.53	36.6	394.4	2.85
Control	0	0	0	0	0	2.2	3.3	406	0

Table 18. Lethal concentrations of malathion EC 57% against the adults of *Rhizopertha dominica* (F.) at 14 day.

Exposure Period (Days)	lethal concentrations (%w/w) and their 95% confidence limits			Slope ±SD	R
	LC_{50}	LC_{90}	LC_{95}		
14 day	7.2 (5.5-9.4)	98.6 (42.9-227)	207 (71-606)	1.12 ± 0.11	0.9475

SD = Standard deviation of the mortality regression line.

R = Correlation coefficient of regression line.

Table 19. Toxicity index of the tested pesticide against the adults of *Rhizopertha dominica* (F.) after 14 days from treatment.

Pesticide	Lethal concentration after 14 days		Toxicity index		Slope ± SD	R.
	LC_{50} ppm	LC_{95} ppm	LC_{50}	LC_{95}		
Actellic	3.1	12.1	100	100	2.8±0.57	0.9371
Malathion	7.2	2.07	43.05	5.84	1.12±0.11	0.9475
Neemazal	81.2	234	3.8	5.2	3.6±1.6	0.9149

REFERENCES

1. Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. J. Econ. Ent. 18: 265-269.
2. El-Kashlan, I. H. 1999. Toxicity of malathion versus other control agents against certain stored product insects. Annals of Agric. SC., Moshtohor, vol. 37 (1): 629 – 637.
3. El-lakwah, F. A. M., Omnia M. Khaled and A. A. Darwish. 1992. Toxic effects of pulverized Black pepper (*Piper nigrum*.L) on some stored product insects. Annals of Agric. Sc., Moshtohor, vol. 30(4).
4. El-Lakwah, F. A., A. E. Abd El-Aziz and I. H. El-Kashlan. 2000. Joint action and effectiveness of black pepper seeds extract with modified atmospheres against some stored product insects. Annals of Agric. Sc., Moshtohor,vol.38(4):2529-2542.
5. El-Lakwah, F. A. M. 1997. Toxicity of the botanical insecticide neemazal-w(powder contains 10% azadirachtin) alone, and in mixtures with two insecticides against the lesser grain borer Rhizopertha dominica (F.). Annals of Agric. Sc. Moshtohor, Vol. 35(4):2583-2594.
6. El-lakwah, F. A. M., R. A. Mohamed and I. H. El-kashlan. 2001. Effectiveness of some grain protectants alone /or under controlled atmosphere of carbon dioxide against the lesser grain borer, *Rhizopertha aominica* (F.)(Coleoptera: Bostrychidae). Annals of Agric. Sc., Moshtohor, vol. 39(3). : 1741 – 1754.

7. El-lakwah, F. A. M., A. A. Darwish, M. M. Khattab and A. E. Abd –El Aziz. 1993. Acute and chronic toxicities of neemazal–F against some stored product insects. Annals of Agric. C., Moshtohor, vol. 31(1).
8. Finney, D. J. 1971. Probit analysis 3rd ed. Cambridge Univ. Press, Cambridge, England., pp 333.
9. Ketkar, C. M. 1987. Use of tree-dervied non-edible oils as surface protectants chinensis.
10. Mohonds, J. 1969. Aust. J. Chem. 22, 1803. (Cited from Jeffery *et. al*. 1996.
11. Nikpay, A.: 2006. Assessing the effectiveness of five diatomaceous earth formulations on steel surfaces as structural treatments, against two species of Coleoptera in festing stored grain: International Pest Control. 2006. 48: (6), 310 – 313. 28 ref.
12. Okudak, T. J. 1983. Chem. Soc., Perkin Trans., 1965. (Cited from Jeffery et al., 1996.
13. Saxena, R. C., H. D. Justo and Jr., P. B. Epino. 1984. Evaluation and utilization of neem cake against the brown planthopper, *Nilaparvata lugens* (Homoptera: Delphacidae). J. Econ. Entomol. 77: 502-507.
14. Yaday, T. D. 1985. Antiovipositional and ovicidal toxicity of neem (*Azadirachta indica* A. Juss) oil against three species of callosobruchus. Neem News. 2:5-6.

فاعلية بعض المساحيق النباتية والمبيدات ضد حشرة ثاقبة الحبوب الصغرى

فارس أمين اللقوة [1] ، أحمد عبد الغفار عبده درويش[1] ، رفعت عبد الشافى محمد [2] ، منار يوسف أمين [2]

١. *قسم وقاية النبات – كلية الزراعة بمشتهر – جامعة بنها – مصر*
٢. *معهد بحوث وقاية النبات– مركز البحوث الزراعية – وزارة الزراعة – مصر*

تهدف هذه الدراسة إلى تقييم فاعلية بعض المساحيق النباتية وهى :- مسحوق بذور الفلفل الأسود ومسحوق براعم أزهار القرنفل ومسحوق ثمار الشطة ومسحوق القرفة ومسحوق التربة الدياتومية مقارنة بمسحوق قاتلسوس.

وقد أجريت هذه الدراسة ضد ثاقبة الحبوب الصغرى على 30 ° ± 1 درجة مئوية و 65 ± 5% رطوبة نسبية . وكذلك تقييم فاعلية أثنين من المركبات الفوسفورية العضويةوهما الملاثيون وبريميفوس ميثيل (الأكتيليك) ومبيد نباتى (نيمازال 1% Azadirachtin) ضد حشرة ثاقبة الحبوب الصغرى عند درجات حرارة30 ° ± 1 درجة مئوية ورطوبة نسبية 65 ± 5%. وقد أظهرت النتائج الآتى :

يزداد معدل موت الحشرات الكاملة بزيادة فترة التعريض والتركيز

ولقد أوضحت نتائج المساحيق المختلفة المستخدمة ضد الأطوار الكاملة لحشرة ثاقبة الحبوب الصغرى أن مسحوق التربة الدياتومية هو الأكثر فاعلية يليه مسحوق بذور الفلفل الاسود ثم مسحوق براعم أزهار القرنفل ثم مسحوق قاتلسوس والأقلهم فاعلية هو مسحوق الشـــــ طة. ومن ناحية أخري وجدنا أن اعلى تركيز (6%) لمسحوق القرفة قد أعطى معدلات موت منخفضة أقل من 40% وذلك بعد أسبوعين من المعاملة .

وقد أوضحت نتائج دليل السمية للمبيدات الحشرية المختلفة ضد الاطوار الكاملة لحشرة ثاقبة الحبوب الصغرى أن مبيد الأكتيليك هو الأعلى فاعلية يليه الملاثيون وأقلهم فاعلية هو مبيد النيمازال.