EFFECT OF SURFACE TREATMENT OF GRAIN BAGS WITH THE BOTANICAL INSECTICIDE NEEMAZAL-T AND CERTAIN PLANT EXTRACTS ON WEIGHT LOSS OF STORED WHEAT AND MAIZE GRAINS DUE TO INFESTATION WITH *SITOPHILUS ORYZAE* (L.)

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Abstract

The effect of surface treatment of grain bags with the botanical insecticide Neemazal-T (a liquid formulation containing 5% Azadirachtin), the petroleum ether extracts of dill seeds and african chilli fruits in comparison to the organophosphorus insecticide actellic 5% EC (Pirimiphos-methyl) on insect population and weight loss of stored wheat and maize grains due to infestation with rice weevil *Sitophilus oryzae* (L.) was studied.

Results showed that weight loss of both wheat and maize grains was positively correlated to insect population and storage period. Insect population and weight loss of both wheat and maize grains were significantly reduced in the treated grain bags during storage period extended to 12 months in comparison to untreated one.

Weight loss and population of *S.oryzae* were generally less on maize than wheat grains. Actellic treatment resulted in comperatively lower weight losses in both wheat and maize grains than the plant extracts, while Neemazal was the least effective product.

INTRODUCTION

Cereal grains should handled and stored under conditions that minimize the opportunities for stored product pests to cause economic damage. This could be achieved by good design and maintenance of stores, regular inspection and quality control of stored commodities, good storage practices and performance of appropriate pest control measures.

In recent years, attention has been focused on the control of stored product insects with alternative pest control agents such as plant oils, plant extracts and

powders (Ivbijaro, 1983 and 1984; Su, HCF. 1984 and 1985; Su, HCF et al., 1988; Oji, 1991; El-Lakwah et al. 1993 a,b,c and 1997; Mostafa, 1993).

The organophosphorus insecticide actellic (pirimiphos-methyl) is active against populations resistant to malathion and dosages of 0.25-2 ppm on grain were found to kill all insects except *Rhizopertha dominica* (F.). within a week (Deighton, 1975).

The present study aims to evaluate the effectiveness of bag surface treatment with the botanical insecticide Neemazal-T (a liquid formulation containing 5% Azadirachtin), the petroleum ether extracts of african chilli fruits and dill seeds in comparison to pirimiphos-methyl (Actellic 50% EC) on population and weight loss of stored wheat and maize grains due to infestation with *S.oryzae*.

MATERIALS AND METHODS

Two types of grains; wheat Giza 157 and maize (early American variety) were chosen for this study. Adults of the rice weevil *Sitophilus oryzae* (L.) 7-14 days old were applied to induce infestation for the bags of both wheat and maize grains. Jute bags (22x31 cm) were filled with four kilograms of each types of grains, and kept in store room at 24±2°C and 55-65% RH. The moisture content of the grains was approximately 12% at the beginning of the experiment. Trials were triplicated.

Materials

- The organophosphorus compound pirimiphos-methyl (Actellic 50% EC), produced by ICI Agro. Chemical Co. England.

- The botanical insecticide Neemazal T (a liquid formulation containing 5% Azadirachtin) provided by Trifolio-M-GMBH-Co-Germany.

- Petroleum ether extracts of african chilli fruits (*Capsicum frutescens*).

Plant extracts were prepared as described by Abo El-Ghar and El-Sheikh, (1987).

Bioassay

The upper surfaces of the jute bags, filled with both wheat and maize grains were treated with the various products using a hand atomizer. Rate of application

was 10ml of each concentration per 0.2 m2 bag surface.

Concentrations

- Neemazal -T 5% was diluted with warm water to obtain 0.05 and 0.25% concentrations.

- Petroleum ether extracts of african chilli fruits and dill seeds were used at 10 and 5% concentrations.

- Actellic 50% EC was diluted in water to obtain 2% concentration.

Three applications were conducted at monthly intervals from the beginning of the experiment. Two hours after each application, 20 adults of *S.oryzae* were released on the surface of each bag at 0, 1 and 2 months storage period.

After 4, 5, 6, 7, 8, 9, 11 and 12 months storage period, the number of alive *S.oryzae* adults inside a sample of one liter volume of wheat or maize grains was inspected. Samples were returned back to the bags after inspection. The efficiency of the tested materials in reducing infestation and population of *S.oryzae* was calculated as percentage reduction of the adults population in the grain samples at the various storage periods as follows:

$$\% \text{ reduction} = \frac{\text{Adults number in control - Adults number in the treatment}}{\text{Adults number in control}} \times 100$$

Weight loss was also determined for both grain types at various storage periods using the standard volume/weight method after Harris and Lindblad, (1978). The weight loss of both grains was calculated as dry weight loss which by definition excludes moisture content changes. The moisture content of grains was determined by an electronic rapid moisture meter.

RESULTS AND DISCUSSION

The effect of surface treatment of the bags with Neemazal-T at 0.50 and 0.25% concentrations, petroleum ether extracts of dill seeds and african chilli fruits at 10% and 5% concentrations as well as actellic at 2% on adult population of *S.oryzae* and percent reduction for stored wheat grains is given in Table 1.

Table 1. Number of *S.oryzae* adults in wheat grains and % reduction at various storage periods.

Treatment	Conc. (%)	Number of adults in 1 L.volume of grain and % reduction at indicated storage periods (months)								
		4	5	6	7	8	9	11	12	Mean
Neemazal	0.50	14 (93.6)	18 (93.7)	119 (68.5)	130 (66.2)	146 (63.1)	221 (49.8)	964 (41.6)	1233 (34.2)	*356 (49.0)
T-5%	0.25	19 (91.3)	27 (90.6)	170 (55.0)	182 (52.6)	202 (49.0)	289 (34.3)	1244 (24.6)	1468 (21.7)	*450 (36.0)
Petroleum ether	10.0	8 (96.3)	13 (95.5)	18 (95.2)	29 (92.5)	34 (91.4)	67 (84.8)	988 (40.0)	1341 (28.4)	*312 (56.0)
extract of dill seeds	5.00	11 (95.0)	14 (95.1)	27 (92.9)	33 (91.4)	48 (87.9)	126 (71.4)	1280 (22.4)	1532 (18.3)	*384 (45.0)
Petroleum ether extract	10.0	8 (96.3)	10 (96.5)	13 (96.6)	18 (95.3)	32 (91.9)	58 (86.8)	640 (61.0)	856(54.3)	*204 (71.0)
of african chilli fruits	5.00	10 (95.4)	15 (94.8)	24 (93.7)	36 (90.6)	49 (87.6)	102 (76.8)	1176 (28.7)	1573 (16.1)	*373 (47.0)
Actellic 50% EC	2.00	6 (97.2)	9 (96.9)	11 (97.1)	14 (96.4)	18 (95.5)	26 (49.1)	280 (83.0)	540 (71.2)	*113 (84.0)
Control	--	218 (--)	266 (--)	378 (--)	384 (--)	396 (--)	440 (--)	1650 (--)	1874 (--)	703 (--)

% Reduction in adults population in brackets ( )

* L.S.D. = 246.5 at 1% level

Results show that the number of *S.oryzae* adults per 1 L. volume of wheat grains was obviously reduced in the various treatments at different storage periods compared to the control. It is evident that insect population was also concentrations dependent.

At the highest concentrations used, the overall mean insect population was 113, 204, 312, 356 and 703 per one liter volume of wheat grains during a storage period of 12 months for actellic; the extract of african chilli fruits; dill seeds extract; Neemazal-T and the control, respectively. The corresponding reduction values of the population were 84%, 71%, 56% and 49% for tested materials, respectively.

Data reveal also, that more than 90% reduction in the population was achieved at the highest concentrations up to 5, 8 and 9 months storage period for Neemazal-T, the two plant extracts and actellic, respectively. This value decreased gradually with increasing storage period to about 34%, 28%, 54% and 71% at 12 months storage for Neemazal-T, dill seeds extract, african chilli fruits extract, and actellic, respectively. Such result indicates that the bioactivity of the various tested materials markedly decreased after 3, 6 and 7 months from the last application for Neemazal-T, extracts of dill seeds and african chilli fruits, and actellic, respectively.

Data reveal also that actellic was the most effective compound for decreasing *S.oryzae* infestation followed by the extracts of african chilli fruits and dill seeds. Meanwhile, Neemazal-T was the least persistent and least effective.

The effect of surface treatment of the bags with the aforementioned various materials on adult population of *S.oryzae* and percent reduction for stored maize grains is summarized in Table 2. Results indicate that the number of *S.oryzae* adults per 1 L. volume of maize grains was increased with rising storage period and was also concentration dependent. The overall mean population was markedly reduced in the different treatments in comparison to control. At the highest concentrations used, the mean adult population was 72, 150, 160, 196 and 283 per one liter volume of maize grain during a storage period of 12 months for actellic, the extract of african chilli fruits, dill seeds extract, Neemazal-T, and untreated bags, respectively. The corresponding values for the population reduction were 74.6%, 47.0%, 43.5% and 30.7% for the tested materials, respectively.

Data reveal high reduction values for actellic up to the 9th month storage (77-

Table 2. Number of *S.oryzae* adults in maize grains and % reduction at various storage periods.

Treatment	Conc. (%)	Number of adults in 1 L.volume of grain and % reduction at indicated storage periods (months)								
		4	5	6	7	8	9	11	12	Mean
Neemazal T-5%	0.50	24 (77.6)	43 (72.4)	137 (44.3)	201 (28.7)	203 (33.0)	297 (20.2)	300 (22.5)	360 (11.8)	*196 (30.7)
	0.25	43 (59.8)	66 (57.7)	198 (19.5)	230 (18.4)	245 (19.1)	306 (17.7)	318 (17.8)	389 (4.7)	*224 (20.8)
Petroleum ether extract of dill seeds	10.0	18 (83.2)	38 (75.6)	120 (51.2)	184 (34.8)	200 (34.0)	215 (42.2)	243 (37.2)	259 (36.5)	*160 (43.5)
	5.00	26 (75.7)	39 (75.0)	166 (32.5)	210 (25.5)	243 (19.8)	263 (29.3)	266 (31.3)	288 (29.4)	*188 (33.6)
Petroleum ether extract of african chilli fruits	10.0	26 (75.7)	48 (69.3)	128 (48.0)	136 (51.8)	184 (39.3)	213 (42.7)	218 (43.7)	249(39.0)	*150 (47.0)
	5.00	38 (64.5)	74 (52.6)	152 (38.2)	170 (39.7)	192 (36.6)	231 (37.9)	244 (36.9)	282 (30.9)	*173 (38.9)
Actellic 50% EC	2.00	6 (94.4)	8 (94.9)	12 (95.1)	18 (93.6)	60 (80.2)	86 (76.9)	188 (51.4)	195 (52.2)	*72 (74.6)
Control	--	107 (--)	156 (--)	246 (--)	282 (--)	303 (--)	372 (--)	387 (--)	408 (--)	282 (--)

% Reduction in adults population in brackets ( )

* L.S.D. = 46.9 at 1% level

95%), while these values ranged 72-78%, 76-83% and 69-76% after five months storage at the highest concentrations of Neemazal-T, dill seeds extract and the extract of african chilli fruits, respectively. These values decreased to approximately 12%, 37%, 39% and 52% after 12 months storage for Neemazal-T, dill seeds extract, african chilli fruits extract and actellic, respectively.

Results indicate that actellic was the most effective compound in reducing insect infestation and population in the stored maize grains followed by the two plant extracts then Neemazal-T.

In this respect, Deighton (1975) mentioned that actellic is active against populations resistant to malathion and dosages of 0.25-2 ppm on grain were found to kill all insects except *R.dominica* (F.) within a week. In field tests in England, it gave complete control of *S.oryzae* (L.); *Oryzaephilus surinamensis* (L.), *cryptolestes ferrugineus* (Steph.) and *Tribolium castaneum* (Herbst.) for over 11 months.

In the present study actellic protected the wheat grains for at least 7 months storage period post treatment. Acetone extract of dill seeds was toxic and highly repellent to *S.oryzae* (Su-HCF, 1985) and the major components of the extract are Carvone and dill apiole (Su, HCF and Horvat, 1988).

The toxic effect of dill seeds extracts against *S.oryzae* was studied by El-Lakwah et al., (1993 c); who reported that both acetone and petroleum ether extracts of dill seeds had shown moderate mortality values and high reduction in F1 progeny at all tested concentrations.

Dusts or extracts of the insecticidal plant *Piper guineense* were shown to be active in the protection of maize grain against *S.zeamais* (Oji, 1991). Prakash et al., (1993) evaluated some botanical pesticides against *S.oryzae* and mentioned that neem seed oil and *Piper nigrum* seeds powder were effective in reducing the adult populations and weight loss of grains. The acetone extracts of both black pepper and green pepper corn gave good protection of wheat against infestation by *S.oryzae* (Su, HCF, 1984).

In tests in Nigeria, maize grains mixed with dry ground seeds of neem *Azadirachta indica* at 0.5, 1 and 2.5g/20g maize were protected from damage by *S.oryzae* for 6 months in storage (Ivbijaro, 1983).

Results of the toxic effect of petroleum ether extract of the african chilli

fruits against *S.oryzae* (EL-Lakwah et al., 1997) revealed that mortality was increased with increasing concentration and time of exposure. After 15 days from treatment, complete mortalty was obtained at concentrations from (0.625-10% W/V). Also, 100% inhibition of the F1 progeny was recorded at all concentrations.

Results of a study conducted by El-Lakwah et al., (1993 a) on the acute and chronic toxicities of Neemazal-F against some stored product insects showed that the bio-activity of the compound against *S.oryzae* adults was increased gradually to reach approximately 2,2,13,30,52,77 and 87% mortality after 15 days from tretment at 5,50,100,200, 400,800 and 1600 ppm, respectively. Increasing the concentration up to 6400 ppm resulted in complete kill after 7 and 15 days. It was also found that complete inhibition of F1 progeny took place at all concentrations tested except the lowest two, at which the inhibition percentages were only zero and 11.8%. Similar results were achieved when the toxic effect of a powder formulation of Neemazal-F against *S.oryzae* was studied, indicating high mortality values (48-100%) at all tested concentrations (5-6400 ppm) after 15 days post-treatment, (El-Lakwah et al., 1996 b).

Results of percentages weight loss of wheat grains after various treatments given in Table 3 show clearly that the application of the various materials resulted in a considerable drop of the losses in wheat tested compared to control. The rate of decrease was 27, 15.5, 12.1 and 11.4% at the highest concentration used for actellic, african chilli fruits extract, dill seeds extract and Neemazal-T, respectively. Meanwhile, a pronounced increase in the weight loss was recorded with increasing storage period and insect population in the grains.

Percentages of weight loss for stored maize grains, resulted following certain surface treatments of bags at different storage period are given in Table 4. Data indicate that the bag surface application of the various materials reduced loss of stored maize grains by about 5-22% during 12 months storage period. Losses obviously increased with increasing storage period and were also concentrations dependent.

At the highest concentrations used, percent weight loss of maize grains after 12 months storage was 6.0%, 13.7%, 17.2%, 19.4% and 27.8% for actellic, african chilli fruits extract, dill seeds extract, Neemazal-T and untreated grain bags, respectively. The rate of decrease in the losses was 21.8%, 14.1%, 10.6% and 8.4% for the aforementioned materials, respectively. These results, indicate that actellic was the most effective compound in reducing losses caused by *S.oryzae* in

Table 3. Percentage weight loss for wheat grains resulted following certain surface treatments of bags at various storage periods.

Treatment	Conc. (%)	% Weight loss of wheat grains at indicated storage periods (months)					
		6	8	9	11	12	% Decrease in weight loss after 12 months
Neemazal	0.50	2.0	2.6	6.2	24.5	28.4	11.4
T-5%	0.25	2.3	3.5	6.3	26.2	29.5	10.3
Petroleum ether	10.0	0.6	1.4	4.6	20.4	27.7	12.1
extract of dill seeds	5.00	1.7	2.5	4.9	21.3	27.9	11.9
Petroleum ether extract	10.0	0.9	1.3	5.6	17.7	24.3	15.5
of african chilli fruits	5.00	1.1	2.4	7.2	23.9	31.9	7.9
Actellic 50% EC	2.00	0.3	0.8	4.3	9.0	12.8	29.0
Control	--	9.3	13.8	20.1	33.9	39.8	---

maize grains followed by the extracts of african chilli fruits and dill seeds, while Neemazal-T was the least effective.

The obtained data reveal clearly that weight loss of both wheat and maize grains was positively related to the population density of the insects in the grains and the period of storage.

Weight loss and population of the *S.oryzae* were generally less in mize than in wheat grains. The achieved results are in harmony with the findings of other investigations (El-Lakwah et al., 1993 d; El-Lakwah and Laborius, 1995).

In a study, the infestation rates and weight losses of some stored commodities were determined during the period from October 1989 to September 1991 in the Kalyubia Governorate (El-Lakwah et al., 1993 d). Results showed that, the highest infestation rate was recorded in merchant stores, whereby it was 5.74, 4.18 and 8.92% for wheat grain, maize grain and broad beans, respectively.Weight loss was ranged 0.03-0.77% for cereal grains and 1.41-2.81% for grain pulses.

In another study conducted by El-Lakwah and Laborius (1995), results showed that weight losses of wheat stacks stored in the shounas varied generally from one shouna to another and ranged 2-12.4% with a mean value of 6.5%. Results indicated also that, the longer the storage period of the stack, the higher the losses.

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Table 4. Percentage weight loss for maize grains resulted following certain surface treatments of bags at various storage periods.

Treatment	Conc. (%)	% Weight loss of maize grains at indicated storage periods (months)					
		6	8	9	11	12	% Decrease in weight loss after 12 months
Neemazal T-5%	0.50	2.1	3.7	7.3	16.4	19.4	8.4
	0.25	2.6	4.4	7.8	18.2	22.5	5.3
Petroleum ether extract of dill seeds	10.0	1.3	3.3	8.2	15.4	17.2	10.6
	5.00	1.5	4.4	8.3	16.0	18.8	9.0
Petroleum ether extract of african chilli fruits	10.0	0.2	1.6	4.3	12.5	13.7	14.1
	5.00	1.3	3.5	8.1	13.2	14.6	13.2
Actellic 50% EC	2.00	0.1	0.5	1.2	4.7	6.0	21.8
Control	--	4.2	6.9	12.9	25.0	27.8	---

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تأثير المعاملة السطحية لأجولة الحبوب بالمبيد النباتى نيمازال وبعض المستخلصات النباتية على فقد الوزن فى الحبوب المخزونة للقمح والذرة الشامية الناتج عن إصابتها بسوسة الأرز

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أجرى هذا البحث بغرض دراسة تأثير المعاملة السطحية لأجولة الحبوب لكل من المبيد النباتى نيمازال (سائل يحتوى على ٥٪ أزادير اختين) ومستخلصات الإثير البترولى لثمار الشطة وبذور الشبت مقارنة بمبيد الأكتيلك (مركز قابل للاستحلاب ٥٠٪) على فقد الوزن فى حبوب القمح والذرة الشامية المخزونة نتيجة لإصابتها بحشرة سوسة الأرز. وقد بينت نتائج هذه الدراسة أنة توجد علاقة موجبة بين مقدار الفاقد الوزنى للحبوب والكثافة العددية للحشرة ومدة تخزين الحبوب. وأدى استعمال هذه المواد إلى انخفاض معنوى فى تعداد الحشرة وفى الفقد فى الوزن لحبوب القمح والذرة الشامية طوال فترة التخزين مقارنة بالأجولة غير المعاملة. ووجد أن معدل الفقد فى الوزن والكثافة العددية للحشرة فى حالة حبوب القمح أكبر منة فى حالة حبوب الذرة الشامية. وكان مقدار الفقد فى الوزن للحبوب المعاملة بمبيد الأكتيلك أقل بوضوح عنه فى معاملات المستخلصات النباتية والنيمازال الذى كان أقل هذه المواد المختبرة تأثيراً فى خفض تعداد سوسة الأرز على الحبوب أثناء التخزين وكذلك أقلها فاعلية فى خفض الفقد فى وزن الحبوب نتيجة لأصابتها بالحشرة