TOXICITY AND JOINT ACTION OF THE BOTANICAL INSECTICIDE NEEMAZAL-W WITH MALATHION TO THE COWPEA WEEVIL, *CALLOSOBRUCHUS MACULATUS* (F)

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Abstract

This work aims to study the toxicity and joint action of the botanical insecticide Neemazal - W (powder contains 10% Azadirachtin) with malathion against the cowpea weevil, *Callosobruchus maculatus* F. Results concerning the toxic effect of neemazal to *C.maculatus* adults showed that mortality percentages were proportionally increased with the concentration and exposure time. After 7 days from exposure, mortality values were 68.2, 77.3, 88.9, 100 and 100% at 50, 100, 250, 500 and 1000 ppm, respectively. In comparison, malathion 1% powder induced complete kill at its recommended dose after 3 days from treatment. Mortality values resulted from Katel Sous were 55.6% and 83.1% after 3 and 7 days post treatment, respectively. At the highest concentration of neemazal,F1 progeny of the insect was inhibited by 90.1%. Co-toxicity resulted from addition of the LC50 of malathion to neemazal indicated an additive effect with this insect species at all concentrations tested.

Meanwhile, neemazal showed significant reduction in the total number of eggs laid per female, reduced significantly the hatchability of the eggs at high concentration and did not affect significantly the emergence of the adults in comparison with the control.

Furthermore, the application of neemazal at the highest concentration, reduced the loss in weight of cowpea from 16.4% to 1.2% after two months from treatment. Consequently, it could be recommended to use the botanical insecticide neemazal alone/or in combination with malathion to protect cowpea from infestion by *C.maculatus* in frame of an integrated pest management system.

INTRODUCTION

The effect of several plant extracts and powders as pest control agents against some stored product pests studied by many investigators (Ivbijaro, 1984; Su, 1985; El-Sayed and Abdel-Razilk, 1987; Su, 1989; Taheya Mostafa, 1993; El-lakwah *et al.*, 1992 a & b, 1993, 1994, 1995, 1997).

The acute and chronic toxicities of botanic products (i.e. neemazal - F as a powder 33% and solution 5%) were tested on some stored product insects by (El-Lakwah *et al.*, 1993 a & b and c).

Many investigators studied the effectiveness of the organophosphorus insecticides against stored product insects (Abo El-Ghar and Badawy, 1961; Godavari-Boi *et al.*, 1964; Lemon, 1966; Strong *et al.*, 1969; Williame *et al.*, 1978; Pandey *et al.*, 1983).

The effectiveness of plant extracts plus insecticide mixtures were studied against some insects (El-Lakwah *et al.*, 1996 and Mohamed, 1997).

The present work is mainly concerned with toxicity and joint action of the botanical insectcide Neemazal-W (Powder contains 10% Azadirachtin with malathion to the cowpea weevil, *Callosobruchus maculatus* F.

MATERIALS AND METHODS

Insects: Laboratory strain of the cowpea weevil, *Callosobruchus maculatus* (F) was used in the experiments. Tests were performed at the stored product laboratory of Plant Protection Research Institute, ARC, Ministry of Agriculture.

Insecticides: The botanical insecticide Neemazal-W (Powder contains 10% Azadirachtin), provided by Trifolio-M-GMBH Company Germany, was tested. The organophosphorus insecticide malathion [diethyl-(dimethoxythiophosphoryl thio) - succinate] - (1% powder) and katel sous dust (16% sulphur + 84% Rock phosphate) produced by Kafr - el-Zayat Company, Egypt were also used.

Bioassay tests: Neemazal concentrations of 50, 100, 250, 500 and 1000 ppm active ingredient were prepared by adding 0.05, 0.1, 0.25, 0.5 and 1.0 g of the product, respectively to 100 g cowpea seeds in the jars and mixed well.

Malathion was investigated at its recommended dose (8 ppm) and also five concenrations were prepared in order to estimate the lethal concentrations for *C.maculatus* adults. Katel sous was used at 1% only as comparison to neemazal.

Thirty adults (0-24 hr old) were introduced into each jar of 100 g food. The jars were covered with muslin cloth and fixed with rubber band. Three replicates for each concentration were used. Experiments were conducted at 30± 1^{o}C and 60± 5% RH. Mortality values were recorded after 1, 3, 5 and 7 days from treatment

and then the insects were excluded.

Mortality data were corrected by Abbott's formula (1925), and entered a probit analysis computer program after Noack and Reichmuth, 1978, in order to achieve the various LC values of the compounds.

F1 progeny was inspected after 45 days from treatment and inhibition of the progeny (%) was calculated as follows:

$$\frac{\text{No. of adults emerged in control-No. of adults in treatment}}{\text{No. of adults in control}} \times 100$$

The joint action of the LC_{50} of malathion plus neemazal at various concentrations was investigated after 24 hr. using the following equation adopted by Mansour *et al.* (1966).

$$\text{Co - toxicity factor} = \frac{\text{observed mortality (\%) - expected mortality (\%)}}{\text{expected mortality (\%)}} \times 100$$

This factor was used to calssify the results into three categories. A positive factor of 20 or more meant potentiation, a negattive factor of 20 or more meant antagonism, and any intermediate value i.e. between + 20 and - 20 was considered only an additive effect.

The weight loss of cowpea due to infestation with *C.maculatus* was also determined two months after treatment, by sieving the dusts and insects from the seeds. Then the moisture content of the seeds was measured using an electronic rapid moisture meter, and the weight loss of cowpea seeds was calculated as dry weight loss according to the following equation (Harris and lindblad, 1978).

$$\frac{\text{Initial dry weight of seeds-Seed dry weight after 2 months}}{\text{Initial dry weight of seed}} \times 100$$

The effect of neemazal at 50, 100 and 500 ppm on oviposition, inhibition of fecundity, hatching rate of eggs and adult emergence of *C.maculatus* was also studied at 30^{o}C and 60±5% RH, whereby the number of eggs laid daily by fresh emerged and mated female during an observation period of 5 days was recorded in comparison with the control. Inhibition of fecundity was calculated as follows:

$$\frac{\text{Total number of eggs per female in control-Total number of eggs per female in treatment}}{\text{Total number of eggs per female in control}} \times 100$$

Adult emergence was estimated according to the following equation (*C/F Mohamed,* 1992):

$$\frac{\text{Number of hatched eggs-Number of emerged adults}}{\text{Number of hatched eggs}} \times 100$$

RESULTS AND DISCUSSION

The toxic effect of Neemazal-W (powder contains 10% Azadirachtin) against *C.maculatus* adults in comparison to malathion and katel sous dusts is given in Table1

Results concerning the toxic effect of Neemazal indicate clearly, that the higher the concentration, the higher the mortality was. Mortality percentages were 6.7, 13.3, 16.7, 33.8, and 38.4% after one day from treatment. These values increased with increasing the time of exposure to reach 68.2, 77.3, 88.9, 100, and 100% at 50, 100, 250, 500 and 1000 ppm after 7 days post treatment, respectively.

Malathion exhibited at its recommended rate (8 ppm) higher mortality (98.9%) at one day and complete kill at 3 days post treatment.

In case of Katel Sous, these values were 4.4% and 83.1% after one and 7 days from tratment, respecively.

Inhibition of F1 progeny was from 51.4-90.9% and 58.1% for Neemazal, malathion and katel sous, respectively. The lethal concentrations and parameters of regression line estimates of malathion after 1 day and neemazal after 3 days from treatment for *C.maculatus* adults are presented in Table 2. Results show clearly that malathion was obviously more toxic against the insect species than neemazal. Although, the insects were exposed for 3 days with neemazal and only for one day with malathion, the toxicity of malathion at the LC_{50} level was approximately 100 times higher than neemazal. Data in Table 3 give toxic effects of the mixtures of the LC_{50} of malathion plus neemazal on mortalities and inhibition of F1 progeny of *C.maculatus*. Results reveal that, mortality recorded after hr. from treatment was increased with increasing concentration and was from 58-86.6% at the different

Table 1. Effect of Neemazal - W on mortalities and inhibition of F1 - progeny of *C.maculatus* in comparison to malathion and Katel sous dust.

Compound	Concentration (ppm)	% Adult cumulative mortalities after indicated period (days)				F1-progeny after 45 days	Inhibition of F1 progeny %
		1	3	5	7		
Neemazal-w	1000	38.4	97.8	100	100	52	90.1
Neemazal-w	500	33.8	90.3	100	100	95	81.9
Neemazal-w	250	16.7	57.7	73.4	88.9	116	77.9
Neemazal-w	100	13.3	43.6	68.4	77.3	136	74.1
Neemazal-w	50	6.7	38.4	57.3	68.2	255	51.4
Malathion (1% powder)	8	98.9	100	100	100	27	94.9
Katel sous dust	1%	4.4	55.6	76.7	83.1	220	58.1
Control.	0.0	0.0	0.0	0.0	0.0	525	--

Table 2. Lethal concentrations and parameters of regression line estimates of malathion and Neemazal for *C.maculatus* adults.

Compound	Time of exposure	Lethal concentrations and their 95% confidence limits (ppm)			Slope ± SD	R
		LC50	LC90	LC50		
Malathion	1 day	1.2(0.9-1.4)	3.7(2.7-5.1)	5.2(3.5-7..6)	2.531±0.2	0.9831
Neemazal	3 day	106(80-140)	534(342-834)	845(483-1476)	1.823±0.4	0.9490

R = Correlation coefficient of regression line.

SD = Standard deviation.

concentrations used. Number of F1 progeny was significantly declined in comparison with the control. Inhibition of F1 progeny was from 83.6-97.8%. Co-toxicity resulted from addition of the LC50 of malathion to the various concentrations of neemazal for *C.maculatus* adults presented in Table 4 reveals an additive effect at all concentrations. Toxicity results of neemazal-W obtained during this study are in harmoney with the findings published for a similar formulation (Neemazal-F) with this insect species, *R.dominica*, *S.oryzae* and *T.castaneum* (EL-Lakwah *et al.*, 1993 a & b, 1994). Regarding the joint action of malathion with neemazal, similar results were reported for mixtures of pirimiphos-methyl plus *Lantana camara* and *Nerium oleander* extracts with *R.dominica* (El-Lakwah *et al.*, 1996) as well as for combinations of *Datura* leaves extracts plus malathion with *C.maculatus* (*Mohamed*, 1997). The effect of neemazal on oviposition (fecundity) hatchability and adult emergence of *C.maculatus* is summarized in Table 5. The total number of eggs laid per female during an observation period of five days was obviously reduced at the various concentrations of neemazal in comparison to the control. Reduction in eggs number (inhibition of fecundity) was accordingly 18.1, 36.1 and 44.4% at 50, 100 and 500 ppm, respectively. Hatchability achieved at higher concentrations was also lower than control. But, adult emergence did not show significant differences between the treated and untreated seeds. Results concerning the effect of neemazal at various concentrations on loss in weight of cowpea due to infestation with *C.maculatus*, in comparison to malathion and katel sous are given in Table 6. Data show that the application of neemazal reduced significantly the losses caused by *C.maculatus* after two months from treatment. The recorded losses were 7.6, 7.3, 7.0, 4.7 and 1.2% at 50, 100, 250, 500, and 1000 ppm, respectively. These values were 1.4%, 6.8% and 16.4% for malathion, Katel sous and the untreated seeds, respectively. Results indicate clearly that the loss in weight of cowpea seeds, treated with neemazal is concentration deppendent, and it was only 1.2% at 1000 ppm approximately equal to loss value resulted after treatment of the seeds with malathion at its recommended dose. Finally, it could be recommended to use neemazal alone or in combination with malathion to protect the cowpea seeds from infestation by *C.maculatus* in frame of an integrated management program.

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Table 3. Adult mortalities and inhibition of F1 progeny of *C.maculatus* resulted from mixtures of the LC50 of malathion plus Neemazal at various concentrations.

Concentration (ppm)	% Adult mortalities after 24 hrs	F1 progeny after 45 days	Inhibition of F1 progeny %
1000	86.6	8	97.8
500	78.9	50	86.6
250	71.7	55	85.2
100	65.3	57	84.7
50	58.0	61	83.6
control	1.1	372	--

Table 4. Co-toxicity resulted from addition of the LC50 of malathion to the various concentrations of Neemazal for *C.maculatus* adults.

Concentration (ppm)	% Adult mortalities after 24 hrs from treatment		Co-toxicity factor	Type of joint action
	Neemazal alone	Neemazal+ Insecticide		
1000	38.4	86.6	-2.0	d
500	33.8	78.9	-5.9	d
250	16.7	71.7	7.5	d
100	13.3	65.3	3.2	d
50	6.7	58.0	2.3	d

d = additive effect.

Table 5. Effect of Neemazal on oviposition, fecundity, hatchability, and adult emergence of *C.maculatus*.

Concentration (ppm)	Daily number of eggs laid per female at the following days					Total number of eggs/ female	Inhibition of fecundity %	Hatching rate %	Adult emergence %
	1	2	3	4	5				
500	17	13	7	2	1	40	44.4	57.02±12.1	64±12.6
100	16	15	9	4	2	46	36.1	57.38±9.4	66.9±19.5
50	18	17	16	5	3	59	18.1	66.04±6.8	74.5±12.8
control	18	17	17	13	7	72	-	80.6±8.7	75.1±14.0

Table 6. Effect of Neemazal at various concentrations on loss in weight of cowpea due to infestation with *C.maculatus* in comparison to malathion and katel sous.

Treatment	Concentration (ppm)	loss in weight after 2 months (%)
Neemazal-W 10% powder	1000	1.2
	500	4.7
	250	7.0
	100	7.3
	50	7.6
Malathion 1% powder	8	1.4
Katel sous dust	1%	6.8
Untreated cowpeas	--	16.4

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السمية والتأثير المشترك للمبيد النباتي نيمازال مع مبيد الملاثيون علي حشرة خنفساء اللوبيا

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أجريت هذه البحث بهدف دراسة السمية والتأثير المشترك للمبيد النباتي نيمازال (مسحوق يحتوي علي ١٠٪ أزادير اختين) مع مبيد الملاثيون علي حشرة خنفساء اللوبيا.

وتبين مع نتائج سمية النيمازال أن نسب الموت المتحصل عليها للحشرات الكاملة لخنفساء اللوبيا تزداد بزيادة التركيز ومدة التعريض.

وكانت قيم نسب الموت بعد ٧ أيام من المعاملة للتركيزات المختبرة ٥٠، ١٠٠ ، ٢٥٠، ٥٠٠ ، ١٠٠٠ جزء في المليون هي ٦٨,٢ ، ٧٧,٣ ، ٨٨,٩ ، ١٠٠ ، ١٠٠٪ علي التوالي.

وعند إستعمال التركيز الموصي به من مسحوق مبيد الملاثيون ١٪ كمقارنة فقد أعطي نسبة موت مقدارها ١٠٠٪ بعد ثلاثة أيام من المعاملة، أما قاتلسوس ١٪ فقد أعطي نسبة موت مقدارها ٥٥,٦٪، ٨٣,١٪ بعد ثلاثة وسبعة أيام علي التوالي.

وقد أعطت نتائج التأثير المشترك لخاليط النيمازال مع التركيز النصفي المميت لمبيد الملاثيون تأثيرا إضافيا مع جميع التركيزات المختبرة.

كما نتج من معاملة بذور اللوبيا بالنيمازال حدوث نقص معنوي في نسبة الخروج للحشرات الكاملة مقارنة بالكنترول.

وقد أدي إستعمال النيمازال بتركيز ١٠٠٠ جزء في المليون إلي خفض الفاقد الوزني لبذور اللوبيا من ١٦,٤٪ إلي ١,٢٪ بعد شهرين من المعاملة.

وعلية فإنه يجدر التوصية باستعمال مبيد النيمازال بمفرده أو مخلوطا مع مبيد الملاثيون كمادة واقية لبذور اللوبيا من الأصابة بحشرة خنفساء اللوبيا وذلك في إطار نظام مكافحة متكامل.