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Toxicological and Biological Effects of Abamectin, Malathion and Three Plant Oils Singly and in Combination on Cowpea Weevil, *Callosobruchus maculatus* (F.).

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ABSTRACT

The toxicological and biological effects of abamectin, malathion and three plant oils (olive oil, peanut oil and linseed oil) singly and in three mixture ratios (5:95, 10:90 and 15:85) of the oils and insecticides, were evaluated on cowpea beetle, *Callosobruchus maculatus* (F.) infested cowpea seeds. Abamectin showed synergistic activity when combined with olive oil and peanut oil at the three mixing ratios recording co- toxicity coefficient values, (128.90, 276.08 and 371.55) and (110.85, 135.96 and 205.72), respectively. Malathion exhibited high synergistic activity with linseed oil at the three mixing ratios recording co toxicity coefficient values 174.56, 307.42 and 472.73, respectively. Also, malathion and peanut oil showed synergistic activity at 90:10 and 85:15 mixing ratios recording co toxicity coefficient value 114.95 and 163.80, respectively. The activity of abamectin and malathion singly or in mixtures with the three oils were significantly increased, particularly at the higher concentrations. Malathion combinations with olive oil and linseed oil were more effective than those with abamectin in reducing number of laid eggs. Abamectin in combination with olive or linseed oils was more effective than those of malathion in suppressing egg hatchability. It was reported that abamectin mixtures with the three tested oils were more effective than those with malathion in decreasing the number of emerged adults. A complete protection of treated seeds was achieved with the mixture of olive oil: abamectin at 10: 90 mixing ratio, peanut oil: abamectin at 5:95 & 10:90 mixing ratio, at the concentrations of 500 and 1000 ppm, respectively. It could be concluded that the use of plant oils combined with pesticides increase the mortality of the cowpea beetle stages, as well as decrease the use of the chemicals to save the environment from pesticide pollution.

Keywords: Stored seeds, joint action, plant oils, mixtures

INTRODUCTION

Cowpea seed weevil *Callosobruchus maculatus* (F.) considered one of the most important insect pests of legumes in field and stores. The cowpea weevil multiplies very rapid in storage, giving rise to a novel generation each month (Ouedrago *et al*., 1996). Cowpea weevil can completely injured all stored seeds, causing weight losses up to 60% (Kieta *et al*., 2000) , therefore, it is essential to decrease such losses by controlling pests on stored grains (Tapondjou *et al*., 2002).

To avoid some losses throughout storage the use of pesticides is considered one of the mandatory means. On the other hand, the choice of pesticides for storage of pest control is very limited because of the strict requirements for the harmless use of synthetic insecticides on or near foods. Severe problems have caused due to the continuous use of chemical pesticides such as insecticides resistance (Pacheco *et al*., 1990, Sartori *et al*., 1990). Tembo & Murfitt (1995) treated wheat grains with vegetable oil combined with pirimiphos methyl at half recommended dose and found that it was very effective against *Sitophilus granaries*.

The usage of vegetable plant oils has revealed a strong activity against *C. maculatus* which can be beneficial as another source of botanical pesticide (Abdelrazik *et al*., 2013), and the application of insecticide/oil mixture may minimize insecticides usage and reduced amount of used insecticides.

The use of botanical oils alone were less effective than commercial insecticides and the possibility of using botanical oils in combination with synthetic insecticide in simple mixture to be more attractive and effective (Don Pedro, 1989 a &b). Dilute malathion was more effective than malathion which applied topically concentrated on the desert locust (Ahmed & Gradiner, 1967).

From the previous results, this research was conducted to study the effect of three plant oils and two pesticides singly and in combination on the biological aspects of the cowpea beetle, *C. maculatus* infesting treated cowpea seeds, under laboratory conditions.

MATERIALS AND METHODS

Cowpea weevil rearing and cowpea seeds:

The culture of the cowpea beetle, *Callosobruchus maculatus* (F.) was obtained from the biological laboratory of the Economic Entomology Department, Faculty of Agriculture, and Menoufia University, Egypt where it was reared on cowpea seeds under laboratory conditions of 25±2C ° and 65±5% RH.

The cowpea seeds, *Vigna unguiculata* variety Dokki 331 were used for insect culture and experiments, which were previously sterilized by freezing at - 4 C° for one week to kill off any prior insect infestation, then left to dry in the room temperature and stored in sealed polyethylene bags in the refrigerator at 5 °C until required for experiments. (Abo Elghar *et al.,* 2003).

Tested insecticides and plant oils:

The naturally derived pesticide abamectin (Vertemic 18% EC) and the organo phosphorous insecticide malathion (malathion 57 % EC)), in addition to three locally produced plant oils: peanut, *Arachis hypogaea*, olive, *Olea europaea*, and linseed, *Linum usitatissimum* oils, were tested against cowpea weevil singly and in combination with the evaluated insecticides. The oils were obtained from a chemical company as refined oils.

Toxicological studies:

Joint action of abamectin, malathion and three plant oils on *C. maculatus*:

To test the mortality of the adults of C. maculatus by abamectin, malathion and three plant oils when used as contact method, 60 g of cowpea seeds were sprayed with 10 ml of each concentration of tested compounds and plant oils alone and their mixture , five concentrations were used at 95:5, 90:10 and 85:5 (insecticides:oil) and left to dry. The sixty grams of treated seeds were divided into three replicates and transferred to 500 ml glass jars. Twenty adults (24 h old) were used for each replicate. A similar sample (60 g of cowpea seeds) were sprayed with water and left to dry and used as control. Glass jars were covered with fine mesh cloth.

Mortality was recorded after 24 h and corrected according to Abbott´s formula (Abbott, 1925). The LC_{50} values were computed by log probit analysis (Finney 1971). The co toxicity coefficient factor was computed according to Sun and Johanson (1960).

Biological effects :

To treat the cowpea seeds, 60 g were placed in a glass beaker 100 ml, then 10 ml of aqueous dispersion of the tested compound (oil or insecticide or their mixtures) at concentrations of 10, 50, 500 and 1000 ppm of 5:95, 10:90 and 15:85 ratios of oil: insecticide for each concentration was pipette on seed surface and mixed thoroughly by shaking for 10 min (Onolemhemhem, 2001). The treated seeds were spread above plates covered with polyethylene sheet and left to dry. A similar sample (60 g) of untreated seeds were sprayed with water and left to dry to be used as control .Twenty grams of each treated seeds were transferred to Petri dishes (10 cm diameter), and replicated three times.

Ten sexed pairs of *C. maculatus* (24 h old) were put in each Petri dish which contains the treated seeds and covered with glass cover, and allowed to lay eggs for 3 days .On the fourth day, adults were removed, and the number of laid eggs on treated seeds was counted. At the ninth day, the number of non-hatched eggs was recorded and hatchability percent was calculated.

Biological aspects

The hatchability percentage was calculated using the following formula:

$$\text{Hatchability\%} = \frac{\text{Mean no. of egg hatched}}{\text{Mean no. of egg laid}} \times 100$$

The Petri dishes of treated cowpea seeds infested with *C. maculatus* were kept in the laboratory under 25±2 C° and 65±5% RH until the emergency of all adults. The *C. maculatus* adults were daily counted from the beginning of the first emergency of adults along 2 weeks (Onolemhemhem, 2001). The percent of emerged adults waw calculated by the following equation:

$$\text{Emergence\%} = \frac{\text{Mean no. of emerged adult}}{\text{Mean no. of egg laid}} \times 100$$

After emergency of adults, seeds were weighed after excluding the faces and dust. The weight loss of seeds was calculated using the following equation (Khare and Johari, 1984):

$$\text{Weight loss\%} = \frac{\text{Initial dry weight - final dryweight}}{\text{initial dry weight}} \times 100$$

The reduction percentage of mean number of laid egg and emerged adults were calculated by the following equation:

$$\text{Reduction\%} = \frac{\text{Mean no. in control-mean no. in treatment}}{\text{Mean no. in control}} \times 100$$

Statistical analysis:

Decrease percentages in laid egg numbers, hatchability percentages, number of emerged adults, and weight loss % of cowpea seeds were calculated.

The data were statistically analyzed using (ANOVA) test at 5 % probability, where the measurements were divided using Duncan's Multiple Range Test (DMRT) through CoStat software program (Version 6.400).

RESULTS AND DISCUSSION

Joint action of tested insecticides and plant oil mixtures against adult stage of cowpea weevil:

The LC_{50} and co-toxicity coefficient factor of abamectin, malathion and three plant oil mixtures at 95:5, 90:10 and 85:15 mixing ratios (insecticides:oil) against adult stage of *Callosobruchus maculatus* were calculated and presented in Table (1). A synergistic activity was detected in abamectin+ olive oil and abamectin+ peanut oil at all mixing ratios recording LC_{50} values (470.71, 231.63 and 181.93) and (547.09, 469.90 and 328.12), respectively, and recording co-toxicity coefficient values (128.90, 276.08 and 371.55) and (110.8, 135.96 and 205.72), respectively. Furthermore, abamectin and linseed oil mixtures showed antagonistic effect except at 85:5 mixing ratio which exhibited synergistic activity recording co-toxicity coefficient value 119.95.

Table 1. Toxicity and co-toxicity coefficient of mixtures of abamectin, malathion and three plant oils on adult stage of Cowpea weevil (*C. maculatus*).

Mixtures	Mixing ratios	LC50 (ppm)	Slope	Confidence limits	Co toxicity coefficient
	95:5	470.71	1.015±0.186	275.831-1041.426	128.90
Abamectin.+ olive oil	90:10	231.63	1.141±0.183	146.349-394.876	276.08
	85:15	181.93	1.169±0.181	115.608-297.536	371.55
	95:5	547.09	1.061±0.159	346.428-951.894	110.85
Abamectin +peanut oil	90:10	469.90	1.138±0.164	305.577-769.107	135.96
	85:15	328.12	1.027±0.149	205.749-543.978	205.72
	95:5	951.36	1.134±0.217	591.518-1809.321	63.70
Abamectin + linseed oil	90:10	858.44	1.137±0.212	535.665-1576.656	74.31
	85:15	561.31	0.833±0.159	305.305-1172.866	119.95
	95:5	1808.3	0.954±0.175	1083.03-3756.425	25.86
malathion +olive oil	90:10	789.22	1.018±0.161	487.797-1307.279	62.24
	85:15	440.78	0.949±0.143	255.653-728.461	118.25
	95:5	832.66	1.094±.214	471.818-2210.184	56.12
malathion +peanut oil	90:10	428.49	0.995±0.182	250.84-934.421	114.95
	85:15	317.87	0.967±0.175	186.960-648.795	163.80
	95:5	267.57	0.995±0.182	250.84-934.421	174.56
malathion + linseed oil	90:10	160.03	0.854±0.165	137.413-523.531	307.42
	85:15	109.92	0.828±0.163	71.890-273.162	472.73

As for mixtures of malathion and plant oils Table (1) results clearly show that the mixtures of malathion and linseed oil recorded high synergistic effect at all mixing ratios where the LC_{50} values were 267.57, 160.03 and 109.92 with co- toxicity coefficient values 174.56, 307.42 and 472.73. On the other side, the mixture of malathion and olive oil recorded antagonistic effect nearly at all mixing ratios except 85:5 mixing ratio which exhibited synergistic activity. The combinations of malathion and peanut oil show synergistic activity at 90:10 and 85:5 mixing ratios recording co- toxicity coefficient values 114.95 and 163.80, respectively, while 95:5 mixing ratio showed antagonistic action and co-toxicity coefficient 56.12.

The obtained results are confirmed with those of Tembo and Murfitt (1995) who found significant mortality by groundnut, rape seeds and peanut oils, alone and in combination with pirimiphos-methyl at rates 1/2, 1/3 or 1/4 from recommended rate against *Sitophilus granaries* compared to check. Also, Sridevi and Dhingra (1996, 2000) evaluated the efficacy of deltamethrim and in mixture with linseed ,neem and citronella oils at four ratios (1:1, 1:2, 1:4, 1:8) against susceptible and resistant strains of *T. castaneum* adults by direct spray and film residue methods and found that all vegetable oils had additive action. The usage of vegetable plant oils has revealed a strong activity against *Callosobruchus maculatus* which can be beneficial as another source of botanical pesticide (Abdelrazik *et al*., 2013), and the application of insecticide/oil mixture may minimize insecticides usage and reduced amount of used insecticides.

Biological and toxic effects of tested insecticides and plant oils alone and in combination against cowpea weevil (*C. maculatus*):

Data in Table (2) indicated that the concentrations 10,50, 100, 500, 1000 ppm of the three oils were significantly inhibited the females of *C. maculatus* from laying eggs on treated cowpea seeds compared to control treatment and 10 ppm concentrations of the tested oils (LSD 5% = 19.8). The highest reduction percentages in the numbers of laid eggs were (76.1, 83.4, and 91.2 %) at the treatments of olive oil, peanut oil and linseed oil, respectively under 1000 ppm concentration in comparison with untreated check.

Regarding to the hatching percentages of the eggs, there were no significant differences between evaluated oils and check except 1000 ppm of olive oil and linseed oil, 500 and 1000 ppm for peanut oil and check where the difference was not significant (LSD 5% = 7.1) where the highest hatching percentages were recorded at 10 and 50 ppm of linseed oil and check resulting 98.5, 96 and 99 %, respectively.

Table 2. Effect of olive , peanut and linseed oils on eggs, hatchability, emerged adults and food consumption of *C. maculatus* infested treated cowpea seeds

Concentration (ppm)	Mean no. laid eggs/female	Reduction %	Hatchability (%)	Mean no of emerged adults	Reduction %	weight loss of seeds (%)
Olive oil						
10	357 b	7.03	92.9 abc	112 d	50.3	55.7 a
50	252 c	34.4	90.7 abc	90 ef	60.0	53.8 a
100	246 c	35.5	90.5 abc	72 fgh	68.1	53.2a
500	130 g	66.2	88.4 abc	61 ghi	72.9	52.8 a
1000	91.7 hi	76.1	86 bc	52 hi	76.9	30.5cd
Peanut oil						
10	345.3 b	10.1	93.3 abc	143 c	36.5	43.1 b
50	226 d	41.2	93.0 abc	97 de	56.9	37.2 bc
100	180 e	53.1	92.1 abc	81 efg	64.1	29.5 cde
500	99 h	74.2	84.7 bc	69 ghi	69.4	21.6 ef
1000	63.7 j	83.4	83 c	48 i	78.7	13.9 f
Linseed oil						
10	353.3 b	7.9	98.5 a	161 b	28.6	22.6 def
50	199.3 c	48.1	96 ab	101 de	55.2	17.8 f
100	154.7 f	59.7	91 abc	93 de	58.7	15.7 f
500	75 ij	80.5	88 abc	62 ghi	72.5	13.9 f
1000	33.7 k	91.2	84 bc	22 j	90.2	12.7 f
Untreated	384 a	-	99.0 a	225.3a	-	56.0 a
LSD (0.05)	19.8		7.1	15.3		6.5

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

Statistical analysis of the data on the mean number of emerged adults (Table 2) revealed that all tested oils were significantly differences compared with untreated (LSD 5% = 15.3), where the lowest mean number of emerged adults was recorded with linseed oil treatment at 1000 ppm giving 22 adults compared with 225.3 adults at control. The highest reduction percentage in the numbers of emerged adults was recorded at the treatment of linseed oil 1000 ppm recording 90.2 %.

Furthermore, statistical analysis of the data Table (2) indicate that there were significant differences in the weight loss percentages between control and all other treatments except that of olive oil (10, 50, 100, 500 ppm) (LSD 5% = 6.5). The least weight loss percentages of seeds were recorded at the treatments of linseed oil ranging between (12. 7 - 22.60 %), moreover it was only 13.9 % at the treatment of peanut oil at 1000 ppm.

The oil plants reduce oviposition rate and suppress adult emergence of bruchids and reduce seed damage rate which confirmed with those obtained by (Tapondjou et al., 2002, Swella and Mushobozy, 2007). The survival of immature stages of C. chinensis was completely inhibited by the neem and sesame oils as well as adult emergence and appeared to be most promising as seed protectant against the insect. In addition Ahmed et al. (1999) found that, the survival of immature stages of C. chinensis was completely inhibited by neem and sesame oils as well as adult emergence. Also, (Adebowale and Adedire, 2006) reported that oil coating seeds prevent C. maculatus eggs to firmly attach to the seed coat and inhibit larval penetration into seed. Finally, Mulatu and Gebremedhim (2000) showed that Adzuki bean beetle, Callosobruchus chinensis was completely preventing from egg laying on stored faba bean seeds, and no bruchids emerged from the laid few eggs by oils of Azadirachta indica, Milletiaie ferruginea and Chrysanthemum cineraraefolium.

Effect of the tested insecticides against cowpea weevil:

Data presented in Table (3) indicated that all the concentrations of the two insecticide (abamectin and malathion) were significantly inhibited the females of C. maculatus from laying eggs on cowpea seeds in comparison with untreated (LSD 5% = 16.6),while there were no significant differences between the highest concentrations of malathion (100, 500, 1000 ppm).

The highest reduction percentages in the numbers of laid eggs were (98.3 %) at the treatments of malathion under 1000 ppm concentration in comparison with untreated check.

Table 3. Effect of abamectin and malathion concentrations on eggs, hatchability, emerged adults, and food consumption of *C.maculatus* infest treated cowpea seeds

Concentration (ppm)	Mean no. laid eggs/ female	Reduction %	Hatchability (%)	Mean no of emerged adults	Reduction %	Weight loss of seeds %
Abamectin						
10	150 c	60.9	94.3 ab	49 bc	78.3	21.2 b
50	130 d	66.2	88 bcd	36 cde	84.0	17 bc
100	115.6 de	60.9	85 cd	24 ef	89.3	14.7 cd
500	106 e	72.4	78 e	19 ef	91.6	11.7 cd
1000	81.5 f	78.8	63 f	7 f	96.9	10 cd
Malathion						
10	172 b	55.2	96.76 a	54 b	76.0	14.7 cd
50	82.7 f	78.7	94 ab	42 bcd	81.4	12.3 cd
100	26.7 g	93.1	92.3 abc	31 de	86.2	9 d
500	14.7 g	96.2	86.1 cd	22 ef	90.2	4 e
1000	6.7 g	98.3	81 de	9 f	96.0	2 e
Untreated	384 a	-	99.0 a	225.3a	-	56.0 a
LSD (0.05)	16.6		5.5	12		4.8

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

Regarding to the hatching percentages of the eggs, there were significant differences between all concentrations of abamectin and untreated check (LSD 5% = 5.5) except at 10 ppm. The least hatchability percentages were recorded at malathion treatment of 1000 ppm resulting 63 % comparing with 99 % at check treatment.

Statistical analysis of the data on the mean numbers of emerged adults (Table 3) revealed that there were significant differences between all tested concentrations of the two insecticides and untreated (LSD 5% = 12), where the lowest mean number of emerged adults was recorded with abamectin and malathion treatments at 1000 ppm giving 7 and 9 adults, respectively without significant differences compared with 225.3 adults at untreated control. The highest reduction percentage in the numbers of emerged adults was recorded at the treatment of abamectin and malathion treatments at 1000 ppm recording 96.9 and 96 %, respectively.

The statistical analysis of the data in Table (3) indicate that there were significant differences in the weight loss percentages between control treatment and all insecticide concentrations (LSD 5% = 4.8). The least weight loss percentages of seeds were recorded at the treatments of malathion ranging between (2-14.7 %) comparing with 56 % at control, while it was ranged between 10- 21.2% at abamectin treatments. These results are in harmony with those of Mohamed *et al.* (2009) who reported that avermectin compound in concentrations of 0.5, 2.5 ppm and untreated seeds averaged hatchability of *C. maculates* by 69.73, 44.81 % and 90.05 %, respectively.

Combined effect of insecticides and tested oils on *C. maculatus*:

The results in Table (4) show the effect of the mixture ratios of the tested insecticides and plant oils on the mean number of laid eggs by cowpea weevil female. Statistical analysis of the data Table (4) indicated that the numbers of laid eggs were significantly differences compared with control and all other treatments.

Table 4. Effect of abamectin and malathion at three mixture ratios with olive, peanut and linseed oils on deposit eggs / female of C. maculatus

Conc. (ppm)	Mean no. of laid eggs/female (Reduction %)					
	Olive oil		Peanut oil		Linseed oil	
	Abamectin	Malathion	abamectin	Malathion	abamectin	malathion
oil : insecticide 5:95						
10	42 b (88.1)	160 b (58.3)	110 b (71.3)	110 b (71.4)	300 b (21.9)	114 b (70.3)
50	20 c (94.8)	82 e (78.7)	57.3 d (85.1)	65 d (83.1)	130 c (66.2)	62.7 c (83. 7)
100	11.3 c (97.1)	31 g (91.9)	27.3 ef (92.9)	59 d (84.6)	117.3 c (69.4)	41.3 d (89.2)
500	8.7 c (97.7)	19 ghi (95.1)	16 efg (95.8)	38 ef (90.0)	47.3 de (87.7)	32.3 d (91.6)
1000	5.7 c (98.5)	12.33 hi (96.8)	6 g (98.4)	16 gh (95.4)	12 e (96.9)	10 e (97.4)
oil: insecticide 10:90						
10	44 b (88.5)	130 c (66.2)	105 bc (72.7)	100 bc (73.9)	141.3 c (63.2)	6 e (98.4)
50	35 b (90.9)	51 f (86.8)	32 e (91.7)	44 e (88.5)	120 c (68.7)	3 e (99.2)
100	15 c (90.1)	27 gh (92.9)	20.7 efg (94.6)	20 gh (94.8)	47.3 de (87.7)	2.3 e (99.4)
500	6.3 c (98.3)	16 hi (95.8)	10 fg (97.4)	10 h (97.4)	42.7 de (88.9)	2.3 e (99.4)
1000	5.3 c (98.6)	8 i (97.9)	4 g (98.9)	7 h (98.2)	11.3 e (97.1)	1 e (99.7)
oil: insecticide 15:85						
10	49 b (87.2)	99 d (74.2)	95 c (75.3)	88 c (77.1)	134.7 c (64.9)	2.7 e (99.3)
50	34 b (91.1)	38 g (90.1)	13.3 fg (96. 5)	28 fg (92.7)	54 d (85.9)	1.3 e (99.7)
100	20 c (94.7)	16.3 hi (95.8)	11fg (97.1)	14 gh (96.4)	25.3 de (93.4)	1 e (99.7)
500	17 c (95.6)	12.3 hi (96.8)	6.7 g (98.3)	6.7 h (98.3)	12 e (96.9)	1 e (99.7)
1000	7 c (98.2)	9.7 i (97.5)	3.3 g (99.1)	4.7 h (98.8)	10.7 e (97.2)	0 e (100)
Untreated	384 a	384 a	384 a	384 a	384 a	384 a
LSD(0.05)	11.3	12.4	12.1	12.8	25.9	11.02

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

It was noticed that, as mixture ratio increased the laid egg decreased in addition, the best results were recorded at the mixtures of linseed oil: malathion (10:90 and 15:85) giving only (1- 6) and (0-2.7) eggs, respectively comparing with 384 egg at control.

All combinations were much effective at 15:85 (oil: insecticide) mixing ratio. it was found that abamectin was more effective than malathion and its component alone when it combined with olive and peanut oil, while malathion was more effective when combined with linseed oil compared with abamectin and its component alone at three mixing ratios 5:95, 10:90 and 15:85. The highest reduction percentages of the numbers of laid eggs were recorded with the mixing ratio of 15:85 of oil and insecticide at 1000 ppm for all treatments.

It could be noticed that no egg was laid at the treatment of linseed oil and malathion of 1000 ppm at 15: 85 ratio.

The obtained results are confirmed with Tembo and Murfitt (1995) who found that significant mortality was produced by groundnut, rape seeds and peanut oils, alone and in combination with pirimiphos-methyl at rates 1/2, 1/3 or 1/4 from recommended rate against *Sitophilus granaries* compared to check.

As for the combined effect of abamectin and malathion at three mixture ratios with olive, peanut and linseed oils on hatchability of C. *maculatus* eggs (Table 5) it was reported that the combinations of abamectin with olive oil and linseed oil gave lower hatchability % than malathion and its component alone. On the other hand, combinations of malathion with peanut oil demonstrated lower hatchability % than that combined with abamectin.

Table 5. Effect of abamectin and malathion at three mixture ratios with olive, peanut and linseed oils on hatchability % of *C. maculatus* eggs

Concentration (ppm)	Hatchability %					
	Olive oil		Peanut oil		Linseed oil	
	abamectin	Malathion	abamectin	malathion	abamectin	Malathion
oil : insecticide 5:95						
10	77.6 b	95.9 a	98.9 a	95.3 ab	95.8 a	100 a
50	77.2 b	95.8 a	97.7 a	93.2 ab	90.3 b	92.5 ab
100	62.1 cd	93.5 a	97.4 a	91.3 ab	88.82 b	91.7 ab
500	52.1 de	90.1 a	97.1 a	88.8 abc	83.6 c	89.1 abc
1000	32.6 f	74.2 b	81.5 ab	75.4 cde	62.3 f	80.8 bcd
oil : insecticide 10:90						
10	76.4 b	95.6 a	98.2 a	94.1 ab	90.8 b	92.9 ab
50	74 b	94.9 a	97.4 a	91.3 ab	89.8 b	91.9 ab
100	57.4 cde	92.9 a	97.4 a	85.4 abcd	84.6 c	89.9 abc
500	50.6 de	89.5 a	97.6 a	83. 6 abcd	77.4 d	80.8 bcd
1000	30.4 f	67.9 b	81.5 ab	71.3 de	41.6 i	75.2 cde
oil : insecticide 15:85						
10	73.1 b	94.1 a	97.6 a	92.8 ab	66.6 2 e	76.8 bcde
50	63.6 c	91.1 a	95.1 a	87.5 abc	57.8 g	67.1 de
100	50.6 de	90.2 a	92.4 ab	82.7 abcd	46.2 h	64.0 e
500	47.5 e	71.7 b	85.4 ab	81.6 bcd	40.3 i	63.9 e
1000	30. 4 f	40.4 c	75.8 b	65.2 e	35.4 j	63.4 e
untreated	99.0 a	99.0 a	99.0 a	99.0 a	99.0 a	99.0 a
LSD (0.05)	8.5	8.9	12.3	9.5	3.23	10.2

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

These results confirmed by (Mohamed *et al*., 2009) who found that hatchability of C. *maculatus* were 69.73, 44.81 % at 0.5, 2.5 ppm of Avermectin, compared with 90.05 % at check.

Regarding to the effect of the oil and insecticide mixtures on the numbers of emerged adults of cowpea weevil, the statistical analysis of the data in Table (6) indicated that the numbers of emerged adults were significantly differences than untreated control and all other treatments.

The results showed that the combinations of abamectin with olive oil and peanut oil was more effective in decreased the number of emerged adult compared with its combinations with malathion and malathion with linseed oil was more effective than abamectin .The abamectin combined with olive oils was the most effective in comparison with other mixtures.

It could be observed that the mixtures of the mixtures of 5:95, 10: 90 and 15:85 of olive oil and abamectin especially at 100, 500, 1000 ppm, (10:90) and (15:85) of abamectin and linseed at concentration of 1000 ppm, at mixing ratios of (10:90) and (15:85) for linseed oil and malathion at 500 and 1000 ppm gave complete protection of cowpea weevil resulting 100 % reduction in adult emergency.

Table 6. Effect of abamectin and malathion at three mixture ratios with olive , peanut and linseed oils on emerged adults of *C. maculatus*

Concentration (ppm)	Mean no. of emerged adults (Reduction %)					
	Olive oil		Peanut oil		Linseed oil	
	abamectin	malathion	abamectin	malathion	abamectin	Malathion
oil : insecticide 5:95						
10	10.7 b (95.3)	86.7 b (61.5)	33.3 bc (85.2)	81.3 b (63.9)	38.7 b (82.8)	33.3 b (85.2)
50	2 b (99.1)	34.3 d (84.8)	17.3 de (92.3)	43.7 d (80.6)	16 c (92.9)	22.7 c (89.9)
100	0. 7 b (99.7)	12.7 e (94.4)	15 def (93.3)	26.3 e (88.3)	7.3 cd (96.8)	5.7 d (97.5)
500	0 b (100)	9 e (96.0)	9 ef (96.0)	14.7 f (93.5)	5 cd (97.8)	2.7 d (98.8)
1000	0 b (100)	6 e (97.3)	2.3 e (98.9)	9 f (96.0)	4.7 cd (97.9)	0.3 d (99.9)
oil : insecticide 10:90						
10	0.7 b (99.7)	86.3 b (61.7)	26.3 cd (88.3)	66.3 c (70.6)	7 cd (96.9)	4 d (98.2)
50	0.7 b (99.7)	34.3 d (84.8)	17 de (92.4)	36 d (84.0)	4.7 cd (97.9)	1 d (99.5)
100	0 b (100)	11.3 e (94.9)	11 ef (95.1)	9.7 f (95.7)	2.3 cd (98.9)	0.3 d (99.9)
500	0 b (100)	9 e (96.0)	5 ef (97.8)	6.7 f (97.0)	0.7 d (99.7)	0 d (100)
1000	0 c (100)	4.7 e (97.7)	1.3 f (99.4)	5.6 f (97.5)	0 d (100)	0 d (100)
oil : insecticide 15:85						
10	0.7 b (99.7)	56.7 c (78.8)	38.5 b (82.9)	38.7 d (82.8)	3.3 cd (98.5)	1 d (99.5)
50	0.7 b (99.7)	15.3 e (93.2)	13 ef (94.2)	15.3 ef (93.2)	2.7 cd (98.8)	0.3 d (99.9)
100	0 b (100)	12 e (94.7)	6.7 ef (97.0)	9.3 f (95.9)	1.7 cd (99.2)	0.3 d (99.9)
500	0 b (100)	8 e (96.4)	3.7 ef (98.4)	5.3 f (97.6)	1. 3 cd (99.4)	0 d (100)
1000	0 b (100)	2.3 e (98.9)	1 f (99.5)	2.3 f (98.9)	0 d (100)	0 d (100)
untreated	225.3 a	225.3 a	225.3 a	225.3 a	225.3 a	225.3 a
LSD (0.05)	8.5	9.8	9.3	9.6	8.7	8.6

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

Sridevi and Dhingra (1996, 2000) evaluated the efficacy of deltamethrim and in mixture with linseed, ,neem and citronella oils as four ratios (1:1, 1:2, 1:4, 1:8) against susceptible and resistant strains of *T. castaneum* adults by direct spray and film residue methods and found that all vegetable oils had additive action.

As for seed weight loss percentages caused by *C. maculatus* infestation, the statistical analysis of the results in Table (7) indicated that the values of loss seed weight were significantly differences compared with untreated control and all other treatments.

The highest loss percentage in seed weight was recorded at the treatment 10 ppm of peanut: malathion at the mixture ratio of 5:95 resulting 22 % comparing with 56 % at untreated control with significant difference. It was observed that the seed weight loss was decreased as the concentration of combinations increased, indicating a negative relation between the concentrations and the weight loss percentage and more seed protection.

Table 7. Effect of abamectin and malathion at three mixture ratios with olive, peanut and linseed oils on weight loss % of cowpea seeds infested by *C. maculatus*

Concentration (ppm)	Weight loss (%)					
	Olive oil		Peanut oil		Linseed oil	
	abamectin	malathion	abamectin	malathion	abamectin	Malathion
oil : insecticide 5:95						
10	5 b	19.7 b	8.5 b	22 b	15.8 b	12 b
50	3 bc	10.7 c	5.6 bc	17 c	13.5 bc	10 bc
100	1.5 bc	6.7 cd	4 bcd	13.3 cd	13.2 bc	4.5 de
500	1.3 bc	4.3 d	1 d	3.3 f	11.4 bcde	2.6 de
1000	0.83 bc	1.3 d	0 d	0.3 f	8.4 cdef	0.8 e
oil : insecticide 10:90						
10	3.8 bc	17.5 b	6.2 bc	15.7 c	13.5 bc	12 b
50	2.5 bc	10.3 c	4.3 bcd	12.3 cd	10.1 bcdef	5 de
100	1.5 bc	5.3 cd	3.9 bcd	9.7 de	7.07 defg	3.7 de
500	0.7 bc	4 d	0 d	0.3 f	6.6 efg	1.3 e
1000	0.7 bc	0.7 d	0 d	0 f	2.4 gh	0.3 e
oil : insecticide 15:85						
10	2.7 bc	10.7 c	6 bc	6 ef	12.7 bcd	7 cd
50	2.5 bc	5 cd	1.7 cd	3.5 f	5 fgh	3.7 de
100	1.3 bc	4.5 d	0.7 d	3.9 f	4.7 fgh	3.3 de
500	0 c	3 d	0 d	0 f	1.3 gh	1 e
1000	0 c	0.4 d	0 d	0 f	0.7 h	0 e
untreated	56.0 a	56.0 a	56.0 a	56.0 a	56.0 a	56.0 a
LSD (0.05)	2.7	3.9	2.99	4.5	4.01	3.2

Means followed by the same letters in a column insignificantly differences at 0.05 % level.

Combinations of abamectin with olive oil and peanut oil demonstrated lower weight loss % than malathion, on the other side combinations of malathion with linseed oil was more effective in decreasing weight loss % than abamectin.

Complete protection of treated seeds form weevil infestation was achieved with abamectin/olive oil (15:85) at the concentrations of 500 and 1000 ppm, and abamectin /peanut oil (5:95) at 1000 ppm, in addition to the treatments of abamectin /peanut oil (10:90 & 15:85) at the concentrations of 500 and 1000 ppm, malathion/peanut oil (10:90) at 1000 ppm and (15:85) at 500 and 1000 ppm and malathion/linseed oil (15:85) at 1000 ppm, resulting 0 % loss in seed weight comparing with 56 % at control.

Finally, it could be concluded that the use of botanical oils mixed with abamectin and malathion gave complete protection to cowpea seeds from the infestation with Cowpea seed weevil (*Callosobruchus maculatus*), in addition minimized insecticide usage and reduce health hazards to applicators and one of the main advantages is that plant oils are more readily biodegradable; they may be simply and economically produced by farmers as crude or partly refined extracts. Though, application of plant oils to common bean seeds for storage is an inexpensive and effective technique leading to acceptance of this technology by farmers. Also, it could be a components of integrated storage pest management. The neem and linseed oils fully inhibit survival of immature stages of *Callosobruchus chinensis* as well as emerged adults (Ahmed *et al*., 1999). Also, Mohammed *et al*. (2009) indicated that the weight loss in legume seeds produced by C. *maculatus* was small in avermectin treatments resulting 10.28 % compared to the leufenuron treatments (20.38 %).

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التاثيرات التوكسيكولوجية و البيولوجية لمبيدى الاباماكتين والمالاثيون وثلاثة زيوت نباتية منفردة وفى مخاليط على خنفساء اللوبيا

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أجريت هذة الدراسة لتقدير التاثيرات التوكسيكولوجية والبيولوجية لمبيدى الاباماكتين والمالاثيون وثلاثة من الزيوت النباتية (زيت الزيتون – زيت الفول السودانى – زيت الكتان) منفردة وفى مخاليط بثلاثة معدلات خلط (٥:٩٥ ، ١٠:٩٠ ، ١٥:٨٥) (مبيد: زيت) على خنفساء اللوبيا *Callosobruchus maculatus* التى تصيب بذور اللوبيا وذلك بمعامل قسم مبيدات الافات بكلية الزراعة جامعة المنوفية . أظهرت النتائج ان مخاليط الابامكتين مع زيت الزيتون وزيت الفول السودانى اظهرت تنشيطا عند كل نسب الخلط وكان معامل التنشيط (١٢٨.٩ ، ٢٧٦.٠٨ ، ٣٧١.٥٥) و (١١٠.٨٥، ١٣٥.٩٦ ، ٢٠٥.٧٢) على الترتيب و من ناحية اخرى اظهرت مخاليط الملاثيون مع زيت الكتان تنشيطا عند كل نسب الخلط و كان معامل التنشيط١٧٤.٥٦ ،٣٠٧.٤٢ و ٤٧٢.٧٣ و ايضا اظهرت مخاليط الملاثيون و زيت الفول السودانى تنشيطا عند نسبتى خلط ٩٠:١٠ و ٨٥:١٥ و اعطت معامل تنشيط ١١٤.٩٥ و ١٦٣.٨٠ على الترتيب . اظهرت النتائج ان مبيدى الاباماكتين والمالاثيون منفردة او بالخلط مع الزيوت النباتية زادت كفاءتهم مع الزيادة فى التركيز المستخدم. اظهرت معاملة المالاثيون خلطا مع كل من زيت الزيتون وزيت الكتان نقصا معنويا فى عدد البيض للحشرات المعاملة. أعطت معاملة الاباماكتين خلطا مع كل من زيت الزيتون وزيت الكتان نقصا كبيرا فى نسبة فقس البيض مقارنة بمعاملات مبيد المالاثيون. وجد ان مخاليط الاباماكتين مع كل من الزيوت الثلاثة المختبرة اعطت نتائج افضل من مثيلتها فى مخاليط المالاثيون فى عدد الحشرات الكاملة . أعطت معاملات مخاليط الاباماكتين مع زيت الزيتون (١٠:٩٠) ، الاباماكتين مع زيت الفول السودانى (٥:٩٥) ، (١٠:٩٠) فى التركيزين ٥٠٠ ، ١٠٠٠ جزء فى المليون موت كامل للحشرات المعاملة . يوصى البحث بإمكانية استخدام الزيوت النباتية وخاصة زيت الزيتون وزيت الفول السودانى خلطا مع الاباماكتين و زيت الكتان و زيت الفول السودانى خلطا مع الملاثيون لمكافحة خنفساء اللوبيا وذلك لتقليل الكميات المستخدمة من المبيدين للحفاظ على البيئة ولتقليل الاثار الضارة الناجمة عن استخدام المبيدات الكيميائية