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EFFICACY OF SOME PLANT OILS, PLANT POWDERS, INERT DUSTS AND MALATHION AGAINST *Callosobruchus maculatus*

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ABSTRACT: Current study evaluated the effect of four plant oils, four plant powders, two inert dusts compared to Malation against one of the major stored product insects (cowpea beetle). Based on percent of reduction obtained after five months of *Callosobruchus maculatus* treatment, results showed that plant oils and clove oil were achieved the strongest effect for reducing the number of emerged adults of the tested insect followed by spearmint and orange depending on LC_{50} values. For inert dusts and malathion, malathion showed the highest effect. While the two inert dusts, silica and katelsous had nearly equal action. For plant powders, the results had the same trend with plant oils where the clove powder had the first order for reducing the number of emerged adults followed by spearmint and orange.

Key words: Reduction, LC_{50}, Stored Products, *Callosobruchus maculatus.*

INTRODUCTION

Legume is one of the main sources of protein and carbohydrates. Poor and developing countries may depend on legume especially cowpea seeds as the main source of protein and carbohydrates. Regarding the importance of cowpea seeds, many studies curried out to investigate protection methods to the seeds in the field and during storage and transportation process. Insects may be the most important pest which attack cowpea seeds in the field and store. Synthetic insecticides used as the main method to protect seeds. Using chemical pesticides in control may cause many problems such as environmental pollution and developing insect resistance. Therefor finding natural and safe components can be used as alternatives of synthetic pesticides. The world is moving now to the green pesticides which are considered safe to environment and protect the natural enemies.

Callosobrucus maculatus is the most important insect which attacks cowpea seeds in field and during storage. This insect can fly that is why it is very important to be controlled especially it can cause completely loss of the yield in store in six months (**Abouelatta *et al.*, 2016**). Controlling of this insect using a huge quantity of chemical pesticides and fumigants increase the production cost.

Storage process purpose to equilibrate of fluctuations between two major factors, supply and demand. Improper management of harvested grain causes significant quantitative and qualitative postharvest food losses are estimated to range from 9% in the United States (**Pimentel, 1991**) up to 50% in some parts of the developing nations.

Legume seeds are considered the main source of protein for human and animal nutrition (**Smart, 1985**). *Callosobruchus maculatus* causes substantial losses to the pulses in the storage throughout the world (**Righi-Assia *et al.*, 2010**). It is known to cause up to 100% loss of stored cowpea (**Jacki and Daoust, 1986**).

Heavy reliance on chemical control has led to widespread insecticide resistance and control failures and reduced interspecific completion in many countries.

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Continuous research is needed to replace the conventional pesticides by cheaper and eco-friendly natural plant products with active safe components, among which are use of powdered plant parts, oils and extracts that result from secondary metabolism in plants (**Lale, 2002**). The use of extreme temperatures may provide the most viable alternative to chemical applications. Temperature affects metabolic rates, defines limits of physiological function, determines developmental times, impacts behavior, and ultimately influences survival of the population (**Lee, 1991; Bhargava *et al.*, 2007**).

Inert dusts such as ash, lime, various ground minerals and clays have a long history of use for grain protection (**Ebeling, 1971; Golob and Webley, 1980; Ross, 1981; Quarles 1992 a,b**).

Essential oils have toxicity effect against sored product insects and also have an effect on progeny. It can be used as insecticide alternatives and also can be used in IPM programs (**Abouelatta *et al.*, 2020; Abo Arab *et al.*, 2022; Arab *et al.*, 2022; Abu arab *et al.*, 2022; Seada *et al.*, 2024; Seada and Abouelatta 2024**).

Therefore the present study was conducted to evaluate the efficacy of some plant oils, powders, dusts and Malathion on *Callosobrucus maculatus* during storage process.

MATERIALS AND METHODS

Materials

Insect Tested

Cowpea beetle *(Callosobruchus maculatus* (L.) Coleoptera, Bruchuidae)

Samples of cowpea seeds were obtained from local markets sieved and cleaned from dusts and inert materials. The cowpea seeds were placed in glass jar and sterilized by heating at 70°C for one hour. The seeds were distributed into other jars (500 ml). Each jar was provided with 300-500 adults of *C. maculatus* (0-2 days old) for laying eggs and covered with muslin and rubber band to prevent insect escape. The jars containing insects and seeds were incubated at 28±2°C and 70 ± 5 R.H. After one week parent adults were sieved out and discarded and newly adult insects (1-2 days old) were used for experimental work according to Zayed (2015).

Tested Materials

Plant oils

The three plant oils used in the present study are:

a) Orange (*Citrus sinensis var valencia*) fruit peels.

b) Spearmint (*Mentha virides*) Leaves.

c) Clove (*Eugenia aromatic*) flower buds.

At concentrations of (5.0, 10.0, 15.0, and 20.0) ml/kg. The oils used were obtained from El-Nasr Pharmaceutical Co. Egypt.

Plant powders

Plants used as dusts against stored product insects are:

a) Orange (*Citrus sinensis var valencia*) fruit peels.

b) Spearmint (*Mentha virides*) Leaves.

c) Clove (*Eugenia aromaticum* (L.)) flowers.

The target plant part was dried and finely ground into a fine powder in an electrical blender for five minutes. The powder was thoroughly sieved (300 mech.) for obtaining the dust at the concentrations of (0.5, 1.5, 3.0, and 5.0 %) w/w.

Inert dusts

Katelsous

It consists of (triple phosphate rock 84% and mono Sulphur 16%). Recommended rate: 1.5 kg/150 kg grains (according to Ministry of Agriculture, Egypt).

It was purchased from El-Misria for seed, oils and chemicals (Kormal) CO., Egypt.

Silica dust

Recommended rate:1 g/kg and obtained from El- Nasr CO. Egypt.

Chemical used

Malathion

Chemical name: O,O dimethyl-S-(1,2 dicarboxyethyl) ethyl phosphorodi-thioate

The applied formulation odorless Malathion (dust 1%)

Source: Kafr El-Zayat pesticides and chemicals CO; Egypt.

Grain used

Cowpea seeds (*Vigna sinensis*) were obtained from local markets of Kafr El-Sheikh Governorate, Egypt.

Methods of Application

Insecticidal activity of the tested materials

Effect on the progeny

Twenty grams of cowpea seeds of each treatment were cleaned and tempered to moisture content of 12.5 ± 0.5%. The toxicants tested at the different concentrations of (5.0, 10.0, 15.0, and 20.0 ml/kg) of plant oils, (0.5, 1.5. 3.0 and 5.0% w/w) of plant powders, (0.5, 1.5, 3.0 and 5.0 w/w %) of inert dusts and (0.04, 0.06, 0.08 and 0.1% w/w) of malathion were mixed with cowpea seeds. Twenty adults of *C. maculatus* (0-2 days old) were added to each treatment with three replicates for each. Mortality % of adult number were recorded after three days and one week post-treatment and corrected according to Abbott's formula (**Abbott, 1925**).

The mean number of laid eggs on cowpea seeds and hatchability percentages were recorded and the emerged% of adults was calculated by the following equation:

% adult emerged= mean number of emerged adults / mean number of laid egg × 100.

The reduction % in adult numbers for *C. maculatus* was recorded and calculated according to the equation of **El-Lakwah *et al.* (1992)**.

% Reduction=((mean No. of emerged in control-mean No. of emerged adults in treatment)/ mean No. of emerged adult in control) × 100

Statistical analysis of the Date

The percentage of mortality in the different tests cumulated in time according to the concentrations of essential oil was analyzed using a one-way ANOVA and a subsequent least significant difference (**Duncun, 1955**) test for mean separation at P = 5%, using the SPSS software program version 23. The 50% lethal concentrations (LC_{50}), slope and 95% confidence limits (CL) were calculated based on Finney's analysis (**Finney, 1971**) using the Pc Probit software program, and the differences between LC_{50} values were estimated based on 95% CL overlapping.

RESULTS

Residual Activity

Residual effect of plant oils

Results recorded in Table 1 summarized the effect of cowpea seeds treated with LC_{50} and LC_{90} of orange, spearmint and clove oils on the number of progeny after 1, 2, 3, 4 and 5 months post-treatment.

The results showed that LC_{50} values reduced the insect numbers of progeny to (32.0, 27.0 and 13.0), (41.0, 36.0 and 19.0), (50.0, 47.0 and 24.0), (61.0, 51.0 and 31.0) and (69.0, 59.0 and 41.0) for orange, spearmint and clove oils after 1, 2, 3, 4 and 5 months, respectively post treatment compared to 286.0 for control.

Results differed from one value to another with LC_{50}, the emerged adults were nearly obviously reduced directly after the treatment, then the effect decreased gradually with the time elapsed and the effect of this concentration (LC_{50}) was still effective till 5 months post treatment where the reduction percentages in the progeny of *C. maculatus* adults were (88.8, 90.6 and 95.0), (85.7, 87.4 and 93.4), (82.5, 83.6 and 91.6), (78.7, 82.2 and 89.2) and (75.8, 79.4 and 85.7) for orange, spearmint and clove oils after 1, 2, 3, 4 and 5 months post-treatment, respectively. While, the LC_{90} for oils (orange, spearmint and clove) achieved nearly 100% reduction in progeny till 3 months especially with the clove oil and also the effect was still clearly high and was closely near to completely reduction in progeny for five months.

Residual effect of plant powders

Results in Table 2 indicated that with LC_{50} value the insect numbers in the progeny were (27.0, 26.0 and 24.0), 38.0, 37.0 and 31.0), (50.0, 48.0 and 40.0), (57.0, 60.0 and 47.0) and (79.0, 70.0 and 58.0) for orange, spearmint and clove powders after 1, 2, 3, 4 and 5 months post-treatment, respectively compared to 286.0 of untreated control. The results differed from one value to another.

The results showed that with LC_{50} the insect numbers in progeny reduced directly after treatment and the effect decreased gradually with the time elapsed, where the insect number increased. For example, the reduction percent decreased from 90.6, 90.9 and 91.6 to 72.4, 75.5 and 79.7 at one and five months, for orange, spearmint and clove, respectively.

Table 1. The efficacy of plant oils on *Callosobruchus maculatus* after 1,2,3,4 and 5 months of treatment

Oil	Conc. ml/kg	Exposure period (months)									
		1		2		3		4		5	
		Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction
Orange	**LC_{50} (7.8)**	32.0 b	88.8 d	41.0 b	85.7 c	50.0 b	82.5 c	61.0 b	78.7 d	69.0 b	75.8 d
	LC_{90} (24.4)	18.0 d	93.0 bc	24.0 d	91.6 b	29.0 c	89.9 b	37.0 d	87.1 b	46.0 d	83.9 b
Spearmint	**LC_{50} (6.5)**	27.0 c	90.6 c	36.0 c	87.4 c	47.0 b	83.6 c	51.0 c	82.2 c	59.0 c	79.4 c
	LC_{90} (18.4)	17.0 d	94.1 b	22.0 cd	92.3 b	28.0 cd	90.0 b	35.0 d	78.8 d	44.0 cd	84.6 b
Clove	**LC_{50} (1.4)**	13.0 e	95.0 b	19.0 e	93.4 b	24.0 d	91.6 b	31.0 e	89.2 b	41.0 d	85.7 b
	LC_{90} (4.9)	0.0	100.0 a	0.00 f	100.0 a	5.0 e	98.3 a	12.0 f	95.8 a	17.0 e	94.1 d
Control	**0**	286.0 a		286.0 a		286.0 a		286.0 a		286.0 a	

Means followed by the same latter in the column are not significantly different (P<0.05)

Table 2. Efficacy of plant powders on *Callosobruchus maculatus* after 1, 2, 3, 4 and 5 month of treatment

Powder	Conc. g/kg	Exposure period (months)									
		1		2		3		4		5	
		Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction
Orange	**LC_{50} (0.9)**	27.0 b	90.6 c	38.0 b	86.7 d	50.0 b	82.5 c	57.0 b	80.1 c	79.0 b	72.4 c
	LC_{90} (6.2)	16.0 c	94.4 b	21.0 d	92.7 bc	26.0 d	90.9 b	38.0 d	86.7 b	51.0 e	82.2 b
Spearmint	**LC_{50} (0.8)**	26.0 c	90.9 c	37.0 b	87.1 d	48.0 b	84.3 cd	60.0 b	79.0 c	70.0 c	75.5 c
	LC_{90} (5.0)	14.0 c	95.1 b	19.0 d	93.4 b	92.3 d	22.0 d	27.0 e	90.6 a	39.0 f	86.4 a
Clove	**LC_{50} (0.8)**	24.0 b	91.6 c	31.0 c	89.2 c	40.0 c	86.0 c	47.0 c	83.6 b	58.0 d	79.7 b
	LC_{90} (4.0)	0.00 a	100.0 a	0.00 e	100.0 a	7.0 e	97.6 a	18.0 f	93.7 a	32.0 g	89.7 a
Control	**0**	286.0 a		286.0 a		286.0 a		286.0 a		286.0 a	

Means followed by the same latter in the column are not significantly different (P<0.05).

Moreover, results showed significant differences between the effect of the tested three oils and the clove oil had the strongest effect followed by spearmint and orange.

The LC_{90} values of these plant powders achieved reduction in progeny ranged between 82.2 to 100% with the all tested oils at the all periods of experiment.

There was significant variation between the effect of oils may be due to their different compositions.

Residual effect of inert dusts and Malathion

Results in Table 3 revealed that with LC_{50} value, the insect number in the progeny were (31.0, 33.0 and 12.0) and (39.0, 41.0 and 17.0) and (48.0, 44.0 and 21.0) and (59.0, 51.0 and 27.0) and (78.0, 68.0 and 38.0) for silica dust, Katel sous and Malathion dust, respectively after 1, 2, 3, 4 and 5 months post-treatment compared to 286.0 of untreated control.

Also, the effect decreased gradually with the time elapsed. Furthermore, the effect of this concentration (LC_{50}) was still effective till 5 months post-treatment recording reduction percent (72.7, 76.2 and 86.7), for silica, Katel-sous and Malathion after five months of treatment, respectively.

While, the LC_{90} values of (silica dust, Katel-sous and Malathion) achieved reduction in progeny till 5 months, ranged from 83.6 to 97.7 with the all experiment materials at 5 months of experiment.

DISCUSSION

The findings obtained in the current study are in agreement with **Hood (1991)** who reported that the different effects of the same tested toxicant at the different times may be due to the amount of toxicant which introduced to the site of action.

Sharma (1999) recorded that neam oil at 2.0% completely protected maize grain against *S. oryzae*, *R. dominica* and *T. castaneum* for up to 9 months. **Obeng and Reichmuth (1999)** found that plant oils (coconut, sunflower, sesame and mustard) at 10.0 and 15.0 ml/kg grains against *S. granarius* and *S. zeamais* increased adult mortality, reduced progeny and the loss of grains weight was lesser compared to untreated control. **Raja *et al*. (2000)** evaluated volatile oil derived from *Mentha arvensis* against *C. maculatus* for number of eggs laid, adult mortality, adult emergence and subsequent seeds damage. Oils were effective in insect control. **Raghvain and Kapadia (2003)** found that coconut, groundnut, mustard, castor and sunflower oils at 10 ml/kg completely protected cowpea seeds against *C. maculatus* for up to 6 months. In addition that the effect on % weight loss of grain and % germination were studied. These results are in accordance with those of **Abo Arab *et al*. (2004) and Athanassio *et al*. (2004)**, who mentioned that malathion was effective in controlling *S. oryzae, S. zeamais* and *T. castaneum* on maize and wheat. **Hosny *et al*. (2007)** mentioned that plant oils and plant powders were used against *C. maculatus* and *T. granarium* on cowpea seeds and wheat grains, increased adult mortality and reduced progeny and the loss percentage of seeds weight was lesser compared to control. Also, all treatments caused high mortality (97-100%) after 15 days post-treatment. **Shobnam and Nouradin (2010)** found that black pepper powders against *R. dominica* and *S. granarius* produced complete mortality at 5.0% w/w concentration, complete reduction in progeny. **Udo (2011)** reported that groundnut oil inhibited progeny emergence of *C. maculatus* at 20 ml/kg and in general, it reduced the damage caused by *C. maculatus*. **Udo *et al*. (2011)** reported that the effect of root, bark and leaf of *Pracaena arborea* against *S. zeamais* and *C. maculatus* increased adult mortality, reduced progeny and loss of grain weight was lesser compared to control. **Zayed (2012)** reported that plant powders (mustard, turmeric, anise and black pepper) used against *S. oryzae*, *R. dominica* and *T. castaneum* increased adult mortality and reduced progeny. He also found that the loss of grains weight was lower than that of untreated control. **Zayed and Manal (2012)** found that groundnut, parsley, sunflower and nutmeg oils at 1% w/w completely protected cowpea seeds against *C. maculatus* for up to 90 days. Also, the results agree with those reported by **Zayed and Manal (2012)** who found that (red pepper-fennel, cumin and garlic) powders had complete protective for cowpea seeds against *C. maculatus* for up to 90 days. Moreover, the obtained results had the same trend of those. In the current study the all tested

Table 3. Efficacy of inert dusts and Malathion on *Callosobruchus maculatus* after 1, 2, 3, 4 and 5 months post treatment

Dust	Conc. g/kg	Exposure period (months)									
		1		2		3		4		5	
		Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction	Mean no. of emerged adults	% Reduction
Silica	**LC_{50} (0.7)**	31.0 b	89.2 c	39.0 b	86.4 c	48.0 b	83.2 c	59.0 b	78.7 d	78.0 b	72.7 d
	LC_{90} (4.07)	17.0 c	94.1 b	20.0 c	963.0 b	33.0 c	88.5 b	37.0 d	87.0 b	47.0 e	83.6 b
Katel-sous	**LC_{50} (0.7)**	33.0 b	88.5 c	41.0 c	85.7 c	44.0 b	84.6 c	51.0 c	82.2 c	68.0 c	76.2 c
	LC_{90} (3.9)	11.0 d	96.2 b	15.0 d	94.8 b	20.0 d	93.0 b	29.0 e	98.9 b	38.0 d	86.7 b
Malathion	**LC_{50} (0.04)**	12.0 d	95.8 b	17.0 d	94.1 b	21.0 d	92.7 b	27.0 e	90.0 b	38.0 d	86.7 b
	LC_{90} (0.06)	0.0 e	100.0 a	0.0 e	100.0 a	0.0 e	100.0 a	3.0 f	98.9 a	7.0 e	97.7 a
Control	**0**	286.0 a		286.0 a		286.0 a		286.0 a		286.0 a	

Means followed by the same latter in the column are not significantly different (P<0.05).

materials, plant oils (clove, spearmint and orange), plant powders (clove, spearmint and orange), inert dusts (silica and katel-sous) and Malathion negatively affected on the all tested parameter (% mortality, % hatchability, % emerged adults and % reduction). **Zayed and Manal (2012)** mentioned that plant oils (groundnut, parsley, sunflower and nutmeg) were more effective with greater lower eggs laying, lower number of adults emerged and weight loss of seeds against *C. maculatus*.

Zayed and Manal (2012) found that malathion had the highest effect with greater adult mortality, reduced egg laying, reduced number of adult emerged against *C. maculatus* and lower loss in weight of cowpea seeds. No significant difference of treatment on germination percentage of cowpea seeds compared to untreated control. **Theou *et al*. (2013)** found that *origanum vulgare* essential oil reduced development of *C. maculatus* on cowpea seeds and that the main toxic action of these oils was against eggs. **Zayed and Hassan (2013)** found that plant powders (red pepper, fennel, cumin and garlic) against *S. oryzae* and *C. maculatus* increased adult mortality, reduced progeny and the loss grain weight was lesser compared to untreated control. **Abdelwareth *et al.* (2024)** studied the effect of Malathion against *C. maculatus*.

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دراسة فاعلية بعض الزيوت النباتية والمساحيق النباتية والمساحيق الخاملة والملاثيون على حشرة *Callosobruchus maculatus*

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بناءً على نسبة الخفض في التعداد التي تم الحصول عليه بعد خمسة أشهر من معاملة *Callosobruchus maculatus*، تشير النتائج إلى الجوانب التالية: الزيوت النباتية، حقق زيت القرنفل أقوى تأثير في تقليل عدد الحشرات البالغة الناشئة لحشرة خنفساء اللوبيا التي تم اختبارها بعد النعناع والبرتقال حسب معدل LC_{50}. المساحيق الخاملة والملاثيون، على الدوام كان الملاثيون هو الأول بين المساحيق التي تم اختبارها. في حين كان للمسحوقين الخاملين، السيليكا وقاتل سوس تأثير متساوى تقريبا. المساحيق النباتية، كانت النتائج متماثلة مع الزيوت النباتية حيث كان لمسحوق القرنفل الترتيب الأول في تقليل عدد الحشرات البالغة في الجيل الأول يليه النعناع والبرتقال.

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