SCREENING OF SOME PLANT POWDERS AS BROAD BEAN SEED PROTECTANTS AGAINST SOME STORAGE BRUCHIDS

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Abstract

Broad bean seeds are important main source of dietary proteins and vulnerable to heavy storage infestation by *Callosobruchus maculatus* (F.) and *C. chinensis* (L.). Four botanical seed powders (Black cumin, Datura, Fenugreek and Termes), dusts of Neemazal 10 % as botanical insecticide, Malathion 1% D and Sevin 85 % WP as synthetic pesticides (for comparison) were screened as possible protectants of stored faba bean seeds. Effectiveness was depending on type and concentration of tested powder and insect species, which a reduction of both oviposition and adult emergence increased with increase of the admixture rate. Neemazal and Termes seed powder were the most effective, while fenugreek was the least effective on both insects. *C. maculatus* was more sensitive than *C. chinensis* to the tested powders. Inhibition rate (IR %) as amount of protection increased with increasing of the mixing rate. The tested powders, thus gave satisfactory protection at 8% of faba bean seeds compared with untreated control.

INTRODUCTION

Faba bean seeds are important source of dietary proteins for low-income people and are widely distributed crop in temperate and subtropical regions. The seeds are vulnerable to heavy infestation by *C. maculatus* and *C. chinensis* larvae that make the seeds unsuitable for either human consumption or animal feed. The amount of annual loss reached 24 % of stored pulses from *C. maculatus* infestation (Caswell, 1968). Plant products have been screened as traditional protection methods against infestation by stored grain insects in the tropical and sub-tropical countries (Golob and Webley, 1980, Williams and Mansingh, 1993, Jacob and Sheila, 1993, Patel *et al.*, 1993 and Al-Moajel and Abd-El-Baki, 2000). Such plant materials have many biological effects as ovicidal and larvicidal properties and are so promising for the control of *C. chinensis* (Das, 1987) and *C. maculatus* (Rajapaksa, 1990, Al-Hemyari, 1994 and Fouad, 2000). This work screens the biological properties of some plant seed powders against two seriously damaging storage bruchids, named *C. maculatus* and *C. chinensis* of faba bean seeds.

MATERIALS AND METHODS

1. Test insects

The tested insects, *C. chinensis* and *C. maculatus* were reared at Stored Grain Insect's Laboratory, Plant Protection Research Institute, on cowpea seeds for several generations. Before testing, they were transferred to a commercial variety of faba bean seeds for three generations at 28 ± 1 C and 65 ± 5 % Rh. for its adaptation. Seeds were purchased from the local markets and sterilized by deep freezing for two weeks, to free the seeds from any possible hidden infestation before use (Giga and Smith, 1987). Then, the seeds were placed under test conditions for two weeks for its moisture equilibrium.

2. Tested plants and bioassay method

Tested plant products were dry seeds of the fenugreek, *Trigonella folium*, Neem, *Azadirchta indica*, datura, *Datura alba*, Termes, *Termesa termes* and black cumin, *Nigella sativa*. These seeds were purchased from the local markets and were ground in a home mill and finally sieved to get a very fine powder that were kept in a closed dark glasses until use. A botanical insecticide named Neemazal 10 % (at 0.5 and 1%), Malathion 1 % and Sevin 85% WP as chemical dusts (each at 8 ppm) were included for the comparison. To assay efficacy of the seed powders, the bruchid adults were confined separately in small glass jars containing faba bean seeds, treated with different admixture rates (0.2, 0.4 and 0.8 % w/w). Groups of five replicate of 20 g seeds, each group was treated with one admixture rate and replicated twice for both insects. A similar number of replicates for each insect served as control for comparison.

Each treated replicate was infested with five adult pairs, newly emerged of either *C. chinensis* or *C. maculatus* separately. All the replicates were examined for counting number of hatched and unhatched eggs (oviposition). Hatched eggs were defined by the presence of the larval frass, which causes the egg to turn milky white as neonate larvae bore into the seed, while the unhatched eggs remains transparent and glossy (Giga and Smith, 1987). Thus the total numbers of white and translucent eggs on the seeds indicate bruchid oviposition and numbers of white eggs indicate the number of larvae entering the seed (Dharmasena *et al.,* 2001). The replicates were reincubated again at the previous test conditions for a further week and daily examined for monitoring adult emergence, its separation and counting. Adult emergence (%) was determined from number of emerged adults compared with number of hatched eggs and penetrated larvae, as follows:

$$\text{Adult emergence (\%)} = \frac{\text{Total emerged adults}}{\text{Total hatched and penetrated eggs}} \times 100$$

Also, the reduction of the adult emergence or the inhibition rate (% IR) was also calculated as an indication of the amount of the protection afforded by the tested plant dust as follows:

$$\text{IR (\%)} = \frac{Cn - Tn}{Cn} \times 100$$

Where Cn= number of emerged adults in control and Tn= number of emerged adults in treatment. Weight loss (%) was determined from weight differences before and after adult emergence. Data of each admixture rate were statistically analyzed by analysis of variance (ANOVA) and means separation was done by Duncan multiple range test (Duncan, 1955) at 0.05 % probability level using a computer program. Standard error was also calculated.

RESULTS AND DISCUSSION

The effects of tested seed powdered on both tested bruchids (*C. chinensis* and *C. maculatus*) are shown on Tables 1 and 2. Results showed that the efficacy was depended on the insect species, plant seed powder and its admixture rate, where the biological efficacy increased with the increase of mixing rate. In respect to effects on *C. chinensis* (Table 1): at 2%, a significant reduction of the adult emergence and the inhibition rate (%) were observed compared to control. Other characters as oviposition, eggs hatch (%) and mean developmental period (MDP, days) were non-significantly differed compared to control. At 4%, oviposition, adult emergence (%), weight loss (%) and the inhibition rate (%) were significantly affected and reduced compared to control. Also, the tested powders did not show significant differences among them. At 8%, a significant variance was observed in oviposition, adult emergence (%), weight loss (%) and IR (%). while eggs hatch (%) and MDP (days) were not affected. Oviposition or the number of laid eggs/ 5 pairs on treated seeds was reduced to 100, 136.7, 152.7 and 167.3 on faba bean seeds treated with Terms, Fenugreek, black Cumin, and Neem seeds compared to control (240.0 eggs). Terms seed powder was the most effective while that of Neem was the least effective. The plant insecticide Neemazal (at 0.5 and 1.0%w/w) was found more effective (even at its low rate, 0.5%) than all the tested plant powders. It reduced oviposition, to about 38 eggs compared to control, affected eggs hatch (%) by reducing it (68%) compared to control (87%), decreased weight loss (%) to 0.3% compared to control (24.3%) and also reduced adult emergence which inhibition of adult emergence reached (96.4%) Malathion dust (8 ppm) largely reduced oviposition, (3.0) and no adults emerged. Sevin induced less reduction of oviposition (89.7) and adult emergence (26.2%). Tested powders could be compared and arranged in ascending order (for its effectiveness on *C. chinensis* oviposition at 8.0%) as follows: Termes (100 eggs)>Fenugreek (136.7 eggs)>black cumin (152.7 eggs)> Neem seed (167.3 eggs). Adult emergence (%) and weight loss (%) and inhibition rate (%) were also reduced with increasing the mixing rate from 2% to 8% w/w. Thus, Termes was the most effective, while Fenugreek seed powder was the least effective. This may be due to repellent effects of the Termes. In *C. maculatus* (Table 2), at 2%, all tested plant powders has non-significant differences on oviposition, eggs hatch (%), MDP (days), but significantly reduced adult emergence (%), weight loss (%) and forced inhibition rate (%) compared to control. At 4% and 8%, tested powders affected significantly oviposition, adult emergence (%), weight loss (%) and increased inhibition rate (%) compared to control. Powders of Neem and Terms have equal effects in reducing oviposition, which reduced oviposition to 78.7 eggs (Terms) compared to control (257.7) and Fenugreek seed dust at 8% reduced oviposition to 146.3 eggs. Seed powders of Neem and Termes were thus, more effective in reducing oviposition and adult development. At 8%, efficacy of the tested seed powders in reducing *C. maculatus* oviposition can be arranged as follows: Termes (78.7 eggs) > black cumin (92.3 eggs) > Neem (124 eggs) > Fenugreek (146.3 eggs) compared to control (257.7 eggs). It was also observed that the highest rate (8%) lengthened the growth duration compared to 2%, i.e. it was 24 days (at 2%) with Fenugreek and increased to 31 days (at 8%) compared to control (23.7 days). *C. maculatus* was more sensitive than *C. chinensis* to the tested powders. Neemazal was more effective on *C. maculatus*, which completely prevented oviposition, larval growth and adult emergence and weight loss (%) as well as the inhibition rate (= reduction of adult emergence). The latter reached 100% and was equal in effectiveness with the Malathion. The tested powders can be arranged on the basis of IR (%) as follows: Neemazal (100%) > Termes (81.7%) > Black cumin (78.7%) > Neem seed (73.6%) > Fenugreek (61.1%). Fenugreek seed powder thus, was also, the least effective on adult emergence, while Termes was the most effective. Malathion resulted no oviposition compared to Sevin (227.7) and control (257.7 eggs). Many farmers in different parts of the World use botanicals to protect their legumes from bruchids attack with varying degrees of success (Dharmasena, *et al.*, 1998, Don-Pedro, 1990). The oviposition-deterrent effects of tested materials are due to its active components (Lale, 1992) and the adult emergence of the cowpea beetle depends initially on the number of eggs present on the seeds. Reduction of oviposition and adult emergence afforded by these tested powders might due to its contact insecticidal effects on both adults and eggs (ovicidal), rendering the adults to lay fewer eggs as well as affected most of the eggs unviable or dead and no adults emerged compared to control. Other explanation was related to or linked with the volatile smells, which make the adults prefer escape from treated seeds especially at higher concentrations. This assumption was ascertained from previous studies pointing out that insects of stored products are capable of receiving and reacting with the volatile compounds of plant origin (Malik and Naqvi, 1984, Sighamony *et al*, 1984, SU, 1985). Fenugreek powder thus, was the least effective on adult emergence of both insects, while Termes was the most effective. The tested seed powders thus, have varying effects on oviposition, larval growth, adult emergence (%), weight loss (%) and inhibition rate (%).The previous powders were more effective on adult emergence than oviposition and could used as protectants of broad bean seeds to reduce bruchid infestation and avoid risks associated with the insecticides use. The tested powders are safe, easily available in Egypt, comparatively cheap and easily obtained by the farmers compared with chemical insecticides. Also, Terms seed powders at 8% was the most effective in reducing oviposition of both bruchids as well as all tested powders affected adult emergence, weight loss, IR (%) compared to untreated control lots. *C. maculatus* was more sensitive than *C. chinensis* to the tested powders.

Table 1. Efficacy of some plant powders, Neemazal, Malathion and Sevin on some biological characters of *Callosobruchus Chinensi*

Material	Con (%) w/w	Hatched eggs No.	Total eggs No.	Eggs Hatch (%)	MDP (Day)	Adult Emerg. (%)	Wt. Loss (%)	IR (%)
Fenugreek	2%	265.7±4.3a	285±0.6a	93.2±2.5a	19.7±0.4ab	64.2±2.9b	26.7±3.4a	26.7±1.6b
Neem seed	2%	238.7±4.4a	256.3±5.7a	93.1±2.1a	20.3±0.3ab	62.9±3.7b	21.7±2.2a	18.6±2.3bc
Terms	2%	256.0±5.3a	261.0±6.5a	98.0±2.0a	20.7±0.2ab	59.9±5.2b	22.3±0.8a	16.3±1.2bc
Black cumin	2%	222.7±4.2a	243.0±4.8a	91.5±1.5a	20.0±0.0ab	55.9±0.6b	21.7±2.2a	32.5±2.9b
Neemazal	0.5	30.7±2.7c	37.7±2.9c	68.4±1.8a	24.7±0.4a	64.7±5.8b	0.29±0.01b	89.5±4.9a
Neemazal	1	4.3±0.03c	5.3±1.2c	73.0±2.1a	25.0±0.9a	40.0±4.9b	0.12±0.0b	96.4±6.1a
Malathion	8ppm	9.0±0.1c	9.0±0.1c	100±0.3a	21.0±0.7ab	0.0d	0.0b	100.0a
Sevin	8ppm	89.7±0.3b	99.0±2.6b	90.8±2.0a	20.7±0.3ab	26.2±3.2c	5.0±0.01b	89.3±8.4a
Control	-----	208.3±3.6a	240.0±4.1a	86.8±1.3a	20.0±0.6ab	89.3±4.1a	24.3±2.7a	0.0c
Fenugreek	4%	116.7±4.8b	140.3±7.5bc	83.2±4.1a	19.7±0.3ab	61.1±3.6b	14.3±3.7b	38.4±3.6b
Neem seed	4%	148.3±6.2b	184.3±3.9b	80.2±1.1a	21.3±0.7ab	64.2±3.8b	14±1.6b	48.6±3.8b
Terms	4%	106.7±5.7b	122.3±6.5bc	87.2±1.2a	19.7±0.7ab	58.1±4.7b	10±1.0b	68.1±3.7b
Black cumin	4%	116.0±8.6b	156.7±9.2bc	73.5±4.3a	19.0±0.7ab	67.4±2.1b	12.3±3.1b	57.9±2.2b
Neemazal	0.5	30.7±2.7c	37.7±2.9d	68.4±1.8a	24.7±0.4a	64.7±5.8b	0.29±0.01d	89.5±4.9a
Neemazal	1	4.3±0.03c	5.3±1.2d	73.0±2.1a	25.0±0.9a	40.0±4.9b	0.12±0.0d	96.4±6.1a
Malathion	8ppm	9.0±0.1c	9.0±0.1d	100±0.3a	21.0±0.7ab	0.0d	0.0d	100.0a
Sevin	8ppm	89.7±0.3b	99.0±2.6c	90.8±2.0a	20.7±0.3ab	26.2±3.2c	5.0±0.01c	89.3±8.4a
Control	-----	208.3±3.6a	240.0±4.1a	86.8±1.3a	20.0±0.6ab	89.3±4.1a	24.3±2.7a	0.0c
Fenugreek	8%	118.7±7.7bc	136.7±6.9bc	85.9±1.0a	19.7±0.3ab	53.2±2.5b	12.3±0.9bc	66.0±2.5b
Neem seed	8%	123.3±4.1b	167.3±3.4b	73.0±4.2a	21.0±1.0a	62.4±3.4b	11.7±2.0c	59.2±5.4c
Terms	8%	86.7±7.1c	100.0±10.9c	87.0±2.5a	19.3±0.3ab	57.9±2.3b	8.0±0.2cd	72.9±6.4b
Black cumin	8%	83.0±5.2c	152.7±7.6bc	54.1±6.2a	21.0±1.0a	59.7±7.03b	11.7±0.4c	72.7±3.7b
Neemazal	0.5	30.7±2.7d	37.7±2.9d	68.4±1.8a	24.7±0.4a	64.7±5.8b	0.29±0.01e	89.5±4.9a
Neemazal	1	4.3±0.03d	5.3±1.2d	73.0±2.1a	22.0±0.9a	40.0±4.9b	0.12±0.0e	96.4±6.1a
Malathion	8ppm	9.0±0.1d	9.0±0.1d	100±0.3a	21.0±0.7a	0.0d	0.0e	100.0a
Sevin	8ppm	89.7±0.3c	99.0±2.6c	90.8±2.0a	20.7±0.3ab	26.2±3.2c	5.0±0.01de	89.3±8.4a
Control	-----	208.3±3.6a	240.0±4.1a	86.8±1.3a	20.0±0.6ab	89.3±4.1a	24.3±2.7a	0.0d

MDP=Duration of development (Day), IR (%)=the inhibition rate (amount of afforded protection)

Table 2. Efficacy of some plant seed powders, Neemazal, Malathion and Sevin on some biological characters of *Callosobruchus Maculatus*

Material	Con (%) w/w	Hatched eggs No.	Total eggs No.	Eggs Hatch (%)	MDP (Day)	Adult Emerg. (%)	Wt. Loss (%)	IR (%)
Fenugreek	2%	260.7±7.7a	269.7±8.3a	96.2±2.0a	24.0±0.6a	33.3±1.5b	25.7±2.3a	39.8±3.4b
Neem seed	2%	164.7±3.9a	175.0±3.4a	93.5±2.1ab	24.7±0.9a	36.6±2.5b	15.0±1.3b	58.3±4.0b
Terms	2%	178.0±5.6a	187.3±3.9a	94.8±2.6a	24.0±0.6a	22.2±3.3b	17.7±2.4ab	59.5±8.4b
Black cumin	2%	185.7±4.4a	194.3±4.1a	95.3±2.3a	23.3±0.3a	31.3±5.1b	16.7±2.1b	60.7±6.4b
Neemazal	0.5	0.3±0.0b	0.3±0.0b	0.0d	0.0b	0.0c	0.0c	100±0.0a
Neemazal	1	0.0b	0.0b	0.0d	0.0b	0.0c	0.0c	100±0.0a
Malathion	8ppm	0.0b	0.0b	0.0d	0.0b	0.0c	0.0c	100±0.0a
Sevin	8ppm	197.0±5.6a	227.7±11.1a	86.0±3.1c	24.0±0.6a	24.7±6.1b	11.3±1.2b	65.8±8.6b
Control	----	231.0±8.5a	257.7±4.2a	89.1±2.1ab	23.7±0.7a	61.5±4.7a	17.7±0.8ab	0.0a
Fenugreek	4%	123.0±8.6b	164.0±8.1b	74.4±5.5b	30.7±0.3a	27.9±7.8bc	8.0±0.2b	77.1±4.2bc
Neem seed	4%	126.0±5.9b	145.0±9.9bc	86.5±2.4a	31.3±0.7a	43.3±0.4bc	8.7±0.9b	62.0±6.7bc
Terms	4%	109.7±4.4b	125.7±6.9bc	87.4±2.1a	31.0±0.0a	41.3±2.5b	10.3±0.3b	68.1±7.1bc
Black cumin	4%	74.3±2.3b	102±2.5c	71.2±1.4b	31.3±0.7a	31.8±5.1bc	6.3±0.02b	82.9±7.9b
Neemazal	0.5	0.3±0.0c	0.3±0.0d	0.0c	0.0c	0.0d	0.0c	100±0.0a
Neemazal	1	0.0c	0.0d	0.0c	0.0c	0.0d	0.0c	100±0.0a
Malathion	8 ppm	0.0c	0.0d	0.0c	0.0c	0.0d	0.0c	100±0.0a
Sevin	8 ppm	197.0±5.6a	227.7±11.1a	86.0±3.1a	24.0±0.6b	24.7±6.1c	11.3±1.2b	65.8±8.6b
Control	---	231±8.5a	257.7±4.2a	89.1±2.1a	23.7±0.7b	61.5±4.7a	17.7±0.8a	0.0c
Fenugreek	8%	126.3±7.3b	146.3±7.5b	86.3±3.7a	31.0±1.0a	44.0±3.8b	11.7±2.3b	61.1±2.9d
Neem seed	8%	106.3±5.9b	124.0±3.3b	85.0±1.0a	31.3±0.3a	34.5±5.4bc	7.0±1.0bc	73.6±5.4d
Terms	8%	70.0±6.0c	78.7±7.9c	89.3±2.2a	32.0±0.0a	37.3±2.9bc	6.0±0.01bc	81.7±5.6b
Black cumin	8%	68.0±2.4c	92.3±6.7bc	72.5±2.6b	31.0±0.6a	46.2±11.9b	5.7±0.06bc	78.7±6.1bc
Neemazal	0.5	0.3±0.0d	0.3±0.0d	0.0c	0.0c	0.0d	0.0d	100±0.0a
Neemazal	1	0.0d	0.0d	0.0c	0.0c	0.0d	0.0d	100±0.0a
Malathion	8 ppm	0.0d	0.0d	0.0c	0.0c	0.0d	0.0d	100±0.0a
Sevin	8 ppm	197.0±5.6a	227.7±11.1a	86.0±3.1a	24.0±0.6b	24.7±6.1c	11.3±1.2bc	65.8±8.6cd
Control	----	231±8.5a	257.7±4.2a	89.1±2.1a	23.7±0.7b	61.5±4.7a	17.7±0.8a	0.0e

MDP=Duration of development (Day), IR (%)=the inhibition rate (amount of afforded protection).

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فاعلية بعض المساحيق النباتية كمواد واقية لبذور الفول البلدي ضد بعض خنافس البقوليات

محروس سليمان غريب

معهد بحوث وقاية النبات – الدقي – جيزة – مصر

يمثل الفول البلدي المصدر الأساسي للبروتين الغذائي النباتي للإنسان وتتعرض بذوره خلال تخزينها للإصابة الشديدة بخنافس البقول *Callosobruchus chinensis (L.)* وحشرة خنفساء اللوبيا *C. maculatus (F.)*، وقد أجريت دراسات معملية تحت ظروف ثابتة من الحرارة (٢٨± ١ درجة مئوية) والرطوبة النسبية(٦٠ ± ٥ %) لدراسة التأثيرات البيولوجية لبعض المساحيق النباتية المتاحة والمتوفرة محليا كمواد واقية لبذور الفول المخزونة ضد الحشرتين السابقتين في مصر.

والمساحيق المختبرة هي مطحون بذور كل من الحلبة والنيم والترمس وحبة البركة عند ثلاث مستويات من التركيز (٢ & ٤& ٨% وزن/وزن) مع مقارنة التأثيرات الناتجة مع مساحيق كل من المبيد النباتي نيمازال ١٠% ، الملاثيون١% والسيفين٨٥% عند تركيز ٨ جزء في المليون، على كل من وضع البيض والنمو اليرقى وخروج الحشرات الكاملة، ونسبة الفاقد في الوزن، وكذلك حساب نسبة الحماية الناتجة.

وجد من النتائج أن فاعلية المساحيق النباتية المختبرة تعتمد علي نوع المسحوق وتركيز الخلط ونوع الحشرة، حيث وجد إنخفاض فى كل من عدد البيض وعدد الحشرات الخارجة مع زيادة تركيز المساحيق. عند تركيز ٢% وجد تأثيرا معنويا منخفضا على نسبة خروج الحشرات الكاملة ، بينما لم يكن هناك أي تأثيرات علي وضع البيض ونسبة الفقس وفترة التكوين. وجد أن المبيد النباتي نيمازال كان الأكثر فاعلية ويليه مسحوق بذور الترمس ضد الحشرتين، بينما كانت الحلبة أقل المساحيق فاعلية ضد حشرتى الاختبار على كل من وضع البيض ونسبة الخروج. ووجد أيضا أن خنفساء البقول *C. Chinensis* كانت أقل حساسية من خنفساء اللوبيا *C. maculatus* ، كما أظهرت قيم نسبة الحماية أن حجم الوقاية والحفظ الناتج من إستخدام المساحيق النباتية يزداد مع زيادة التركيز وكانت أفضلها عند ٨%. كانت كل مساحيق بذور النباتات السابقة تعطي نسبة حماية لبذور الفول البلدى وتقلل من درجات الإصابة الحشرية، مقارنة بالكونترول الغير المعامل.