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EFFICIENCY OF CERTAIN PLANT OILS AS GRAIN PROTECTANTS AGAINST THE RICE WEEVIL (*Sitophilus oryzae* L.) (COLEO PTERA: CURCULIONIDAE)

Abdel–Latif, A.M.; A.E. Abdel–Aziz; Sawsan A. Shmes and Salwa M.S. Ahmed

Plant Protection Res. Inst., Agric. Research Center, Dokki, Giza, Egypt.

ABSTRACT

The efficiency of eight plant oils was tested against *Sitophilus oryzae L.* adults using the treated wheat grains technique. The oils were rue, frankincense, juniper, shallot, fenugreek, cabbage, and nactom and marjoram. The high doses caused high mortality (67.8- 97.8%) after 3 days of exposure and a complete mortality (100%) after 7 days. While this effect continued up to five months for some oils as marjoram and cabbage, it lasted two months only with nactom, frankincense and juniper and one month with other oils. The LC50 level of all oils reduced greatly the number of eggs with about (94- 100%) and no offspring was obtained. Treatment of wheat grains with the tested oils had had in some cases a clear adverse effect on the grain germination. This effect, on water absorption was slight with no clear trend comparing with the control.

INTRODUCTION

Wheat (*Trititicum aestivum* L.) is one of the most important cereal crops in the world. In Arab Republic of Egypt, the entire production is not enough for the local consumption, so more quantities of wheat have been imported during the last few decades to meet the gap in human consumption.

After harvest and during storage, wheat grains are subjected to attack and damage by insect infestation. Chemical control of these insects created several problems to the environment, human health and non– target organisms. There is no doubt that, the wide spread of indiscriminate pesticide application has sometimes caused a contamination of the environment and some disastrous ecological damage. Moreover, heavy use of conventional pesticides enhances the potential for the development of pesticides resistance. Also, residues of pesticides in stored products could cause a health hazards to ultimate consumers. So, using of plant products as oils, dusts and extracts is a new trend to preserve the environment from contamination with harmful toxicants. Su, 1985, Ahmed (2000), El – Lakwaih *et al*., (2001), Abdel– Latif (2004) and Abd El- Latif and Al– Moajel (2004), evaluated the efficiency of many plant derivatives against certain insects. All the results obtained by the aforementioned investigators showed good efficiencies. The present work aims to study the efficiency of eight plant oils against *Sitophilus oryzae* L. on wheat grains and in same time, to evaluate their residual effect during storage.

MATERIALS AND METHODS

1- Test insect:

Sitophilus oryzae L. adults, aged 1- 2 weeks old, were taken from a laboratory culture reared on Giza 172 wheat variety at 28±2 °C and 60±5% R.H. Experiments were conducted under the same conditions. Wheat grains were well treated by freezing at -18°C for two weeks before application, to eliminate any possible infestation by species. The moisture content of the grains was about 14%.

2-Tested oils

Oils of eight plants: rue, frankincense, juniper, shallot, fenugreek, cabbage, natocom (containing 20% jojoba, 5% garlic oil and 75% mineral oil) and marjoram were selected for this study. These oils were obtained from the local market.

3-Methods of application

A sample of 20 grams of wheat grains was separately mixed thoroughly with each oil at five concentrations of 4, 6, 8, 10 and 12 ml/ kg. The glass jars (5 cm diameter x 7.9 cm high), contained these samples, were covered with muslin, sealed with rubber bands, and kept for 72 hrs at room temperature for oil adsorption. Thirty adults of *S. oryzae* (1-2 week old) were kindly introduced into each glass jar then covered with muslin fixed with a rubber band. Each concentration was represented with three glass jars (replicates) and all jars were kept at 28±2°C and 65±5% R,H. Similar three jars contained untreated grains were used as a check and also kept under the same conditions. Mortality counts were recorded after 1, 3, 4 and 7 days and corrected by Abbott's formula (1925). Three days after treatment, percentages of mortalities were statistically computed according to Finney (1952) to produce LC50 and LC99 and toxicity slope for each oil. The reduction in Fl- progeny was calculated after 7 weeks of treatment according to the following equation:

% Reduction

$$\frac{No.of\ emerged\ adults\ in\ contrl - No.of\ emerqed\ adult\ in\ treatment x\ 100}{No.of\ emerged\ adults\ in\ control}$$

4- Effect on deposited eggs and progeny

a**- Eggs laid by female:**

Five grams of wheat grains treated with oil at (LC50 or LC99) was infested with ten couples of 2- week old adults were placed in each glass vial (1 X 3 cm) and plugged with muslin cover. After 2 weeks, insects were removed and the number of deposited eggs on the grains was calculated according to Frankenfield (1948) and Howe (1952). Three replicates were made from each concentration in addition to other three replicates of untreated grains as a control.

b- **Percentage of emerging progeny:**

Ten couples of 2-week old adults were placed in a similar glass vial, containing five gm of wheat treated with LC50 or LC99 of tested oil. After 2

weeks, insects were removed and total numbers of emerged adults were recorded after seven weeks in the treatments and the control.

5- Residual efficiency:

A sample of clean wheat grains (500 g) was manually mixed well with the tested oil at the LC99, and then distributed equally in glass vials under the lab.conditions. In the same time, similar vials containing untreated grains were used as control. Biweekly, three vials were taken from treated as well as untreated grains and exposured to *S. oryzae* adults 9 (25 / vial) under 26±2 °C and 65±5% R.H. After three days, mortality percentages were calculated. Number of emerged adults (F1) progeny after seven weeks was counted for each oil treatment.

6- Water Absorption of grains.

Grains of oil treatments and control were weighed then submerged in water for 1, 5 and 24 hr. The seeds were dried with paper towels to measure water absorption as percentage of weight increase according to Yuntaiq and Burkhobler, 1981 method. This technique was applied twice, at the beginning and end of grain storage.

7- Seed germination:

To conduct the germination tests, two samples each of 25 wheat grains was treated with each oil at LC50 and LC99 levels with three replicates for each treatment. The grains were placed in suitable Petri– dishes lined with cotton wool and filter paper soaked in water. Germination was recorded after 7 days (Anonymous, 1966). Another similar quantity quantity of wheat grains treated with the same way with different oils was continually stored to record the germination percent also.

8. Statistical analysis

Differences between means of the different treatments in this work were statistically analyzed using ANOVA.

RESULTS AND DISCUSSION

Effects of the tested oils at different concentrations on *S. oryzae* adults are showed in Tables (la and 1b). Adults were highly affected by the highest dose (12 ml/ kg) after 3 days of exposure. Mortality percentages were 97.8, 95.6, 94.5, 91.1, 87.8, 91.1, 100 and 82.2% for rue, frankincense, juniper, shallot, fenugreek, cabbage, and natcom and marjoram oils, respectively.

Complete mortality (100%) was obtained after 7 days of exposure at 8-12 ml/ kg doses. The same tables indicate that no adults were emerged with all tested oils. These results agree with Abd El- Latif, (2004) when used tooth– pick *(Ammi visnaga* L.*)* seed extracts against *S. granaries L.*

T1a

t1b

Table (2) shows that, rue oil on the basis of LC50 was more effective than the other oils. The slope values show that the adults of *S. oryzae* were more homogenous for the susceptibility to natocom oil than the other oils. Don- pedro (1989) demonstrated that, some mortalities were occurred in *S. oryzae* adults only at rates above 10.5 ml/kg when some vegetable oils were applied to wheat grains.

Table (2): Lethal concentration (LC50 and LC99) and toxicity slope of some plant oils after 3 days from treatment for *S. oryzae (*L.*)* adults.

Oils	LC50 (ml/ kg)	LC99 (ml/ kg)	Slope
Rue	4.9	18.3	4.06
Frankincense	5.0	22.3	3.59
Juniper	5.1	22.2	3.64
Shallot	5.3	22.7	3.68
Fenugreek	6.3	24.9	3.90
Cabbage	7.0	17.6	5.85
Nactom	7.2	17.0	6.27
Marjoram	7.8	24.5	4.68

Data in Table (3) shows that exposing adults to wheat treated with the LC50 and LC99 of the tested oils resulted in a great reduction in the mean number of eggs/5 pairs (96.9 to 99.5 %). Also these oils caused a complete reduction for emerging new progeny. These results agree with Taheya and Hamood (1993) results, who reported that *N. sataiva* seed powder (8%) and extract (0.16 ppm) gave 100% and 90.16% reduction, respectively in F1 progeny of *Trogoderma granarium* Everts.

Table (3): Influence of different plant oils at LC50 and LC99 of wheat grains on eggs/female and progeny of *S. oryzae (L.)* adults.

Oils	Cons. (ml/ kg)	Eggs No./5 females		F1 progeny	
		Mean number	Reduction (%)	Mean number	Reduction (%)
Rue	LC50	2.0	96.6	0.0	100
	LC99	0.3	99.5	0.0	
Frankincense	LC50	1.7	97.4	0.0	100
	LC99	1.0	98.4	0.0	
Juniper	LC50	0.7	98.9	0.0	100
	LC99	0.7	98.9	0.0	
Shallot	LC50	3.6	94.4	0.0	100
	LC99	0.3	99.5	0.0	
Fenugreek	LC50	0.7	98.9	0.0	100
	LC99	0.0	0.0	0.0	
Cabbage	LC50	0.0	0.0	0.0	100
	LC99	0.0	0.0	0.0	
Nactom	LC50	0.3	99.5	0.0	100
	LC99	0.3	98.9	0.0	
Marjoram	LC50	0.0	0.0	0.0	100
	LC99	0.0	0.0	0.0	
Control	**0.0**	64.3	0.0	57.3	

Results in Table (4) indicate that marjoram oil was the most persistent; it gave a complete mortality till the 20th week, followed by cabbage oil when gave satisfactory mortalities, 1005 until the 12th week and 80- 84% till the 20th week.

On the other hand, fenugreek oil had the least stability, followed by rue, then shallot oil. Natocom, frankincense and juniper oils showed a moderate persistence. The deterioration occurred after 8 weeks. These findings are in agreement with Mahgoub and Ahmed (1996); they found that, extracts of *Ricinus communis* seed gave a good protection to wheat grains against *S. oryzae* up to 12 weeks.

Table (4): Residual effect of plant oils (at LC99) as mortality percentages on *S. oryzae* adults after different storage periods.

Weeks after seed treatment	Oils							
	Rue	Frankincense	Juniper	Shallot	Fenugreek	Cabbage	Netcom	Marjoram
Initial	100	100	100	99	100	100	100	100
2	92	100	100	96	52	100	100	100
4	48	97	96	92	46	100	99	100
6	24	96	92	62	32	100	97	100
8	16	84	72	4	24	100	88	100
10	0.0	30	0.0	0.0	0.0	100	35	100
12	0.0	0.0	0.0	0.0	0.0	99	0.0	100
14	0.0	0.0	0.0	0.0	0.0	88	0.0	100
16	0.0	0.0	0.0	0.0	0.0	84	0.0	100
18	0.0	0.0	0.0	0.0	0.0	80	0.0	100
20	0.0	0.0	0.0	0.0	0.0	80	0.0	100
22	0.0	0.0	0.0	0.0	0.0	48	0.0	88
24	0.0	0.0	0.0	0.0	0.0	44	0.0	84
26	0.0	0.0	0.0	0.0	0.0	32	0.0	36

Data presented in Table (5) indicate that, in general, water absorption was increased with elongation of the submerge period. In the same time, it relatively was higher in all treatments than in the control. Also, the absorption values were higher in all treatments than in the control. Also the absorption values were higher at the end than at the beginning of storage (Table, 5). In addition, differences between concentrations as well as between oils were relatively small. These results agree with those reported by Yuntai and Burkholer (1981).

Table (5): Water absorption as weight increase (%) for wheat grains treated with oils (at LC50 and LC99) and submerged in water for1, 5 and 24hrs at the beginning and end of storage.

Oils	Concs. (ml/ kg)	Initial time			End of storage		
		1hr	5hr	24hr	1hr	5hr	24hr
Rue	**LC50**	18.4	31.6	54.0	14.3	32.8	65.7
	LC99	19.6	28.0	60.0	18.3	34.3	59.5
Frankincense	**LC50**	16.0	28.0	44.8	14.7	32.3	57.3
	LC99	18.4	26.4	48.4	17.7	26.8	59.7
Juniper	**LC50**	16.8	30.8	50.4	14.5	33.2	60.5
	LC99	20.0	28.1	48.4	18.0	30.2	58.7
Shallot	**LC50**	15.7	30.3	46.0	11.3	28.3	53.8
	LC99	19.6	28.0	49.4	16.7	32.3	61.8
Fenugreek	**LC50**	16.4	30.2	48.4	17.3	33.7	61.0
	LC99	17.3	28.3	51.2	17.2	32.8	61.5
Cabbage	**LC50**	15.9	27.7	51.5	17.0	34.8	61.2
	LC99	18.8	27.2	49.9	16.7	32.8	62.7
Natcom	**LC50**	17.2	28.3	49.5	17.5	33.7	59.8
	LC99	18.0	27.2	48.5	16.0	30.5	61.0
Marjoram	**LC50**	16.8	27.3	43.2	17.2	33.3	60.7
	LC99	18.5	27.2	46.4	18.5	32.5	61.5
Control	**0.0**	20.0	26.1	45.6	16.7	33.7	57.3

Table (6) shows that, regardless of the treatments, the germination values were greatly lower (51- 95%) than that of the control (95%). In the same time, the percentages were higher (55- 92%) at the beginning of the storage than at its end (51- 87%). Also the germination was affected clearly with LC value, while it ranged 55- 88% and 51- 76% with LC99, it was 79 - 95% and 56- 87% with LC50 at the initial time and end of storage, respectively.

The highest reductions in the germination were 43, 44, 35, 35, and 32%) for fenugreek, cabbage, shallot, marjoram and Rue respectively, at the end of storage with LC99 levels. On the other hand, the lowest reduction percentages were 0.0, 3, 4, and 7%) for juniper, natocom frankincense and Rue oils respectively with LC50 at the initial time. These results agree with Nadra and Abd El– Baki (2000), which wheat grains treated with *Brassica rapa* seed extracts lost its viability.

Table (6): Effect of LC50 and LC99 levels of plant oils on wheat grain germination at the initial and end periods of storage.

Oils	Cons. (ml/ kg)	Initial time		End of storage	
		Germination (%)	Reduction (%)	Germination (%)	Reduction (%)
Rue	**LC50**	88.0	7.0	83.0	12.0
	LC99	72.0	23.0	63.0	32.0
Frankincense	**LC50**	91.0	4.2	87.0	8.0
	LC99	88.0	7.0	76.0	19.0
Juniper	**LC50**	95.0	0.0	87.0	8.0
	LC99	75.0	20.0	73.0	22.0
Shallot	**LC50**	84.0	11.0	87.0	8.0
	LC99	83.0	12.0	60.0	35.0
Fenugreek	**LC50**	83.0	12.0	57.0	38.0
	LC99	69.0	26.0	52.0	43.0
Cabbage	**LC50**	88.0	7.0	56.0	39.0
	LC99	55.0	40.0	51.0	44.0
Nactom	**LC50**	92.0	3.0	84.0	11.0
	LC99	79.0	16.0	68.0	27.0
Marjoram	**LC50**	79.0	16.0	67.0	28.0
	LC99	72.0	23.0	60.0	35.0
Control	95.0				

Finally, it could be concluded, the most persistent oil could be used to gain a reasonable protection for wheat grains against *S. oryzae*, during storage.

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فاعلية بعض الزيوت النباتية كمواد واقية لحبوب القمح ضد حشرة سوسة الأرز

عادل محمد عبد اللطيف،عبد العزيز السيد عبد العزيز، سوسن عبد العزيز شميس و سلوي مصطفي سيد أحمد

معهد بحوث وقاية النباتات- مركز البحوث الزراعية – وزارة الزراعة.

تم اختبار كفاءة بعض الزيوت النباتية ضد حشرة سوسة الأرز علي حبوب القمح، والزيوت المستخدمة هي: السذب / الليان والعرعر والكرات والحلبة والكرنب والناكتوم والبردقوش.

كانت النتائج كالآتي:

- أظهرت كل الزيوت المستخدمة بالتركيزات العالية(٨ مجم/كجم فأكثر) في نسب موت كبيرة(٦٧,٨- ٩٧,٨%) بعد ثلاثة أيام من التعريض و وصلت هذه النسبة إلي موت تام (١٠٠%) بعد سبعة أيام من التعريض. أستمر هذا التأثير لأكثر من ٥ شهور في بعض هذه الزيوت مثل البردقوش والكرنب بينما تدهور بعد شهرين في الناكتوم واللبان والعرعر. وأما باقي الزيوت فتدهورت بعد حوالي شهر واحد فقط.
- أدي إستخدام الزيوت عند مستوي قيم الـ LC50 و LC99 إلي نقص في أعداد البيض مما ادي إلي عدم ظهور أي خلفة في الجيل الأول لهذه الحشرة.
- أظهرت النتائج أن معاملة حبوب القمح بالزيوت المذكورة كان له تأثير بسيط علي الإنبات في بعض الحالات وتأثير واضح في حالات أخري خاصة مع LC99 . أما تأثيرها علي إمتصاص الماء فكان بسيطا ومتفاوتا عن مثيله بالمقارنه سواء بالزيادة أو بالنقص.