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ORIGINAL ARTICLE

EFFECT OF MIXING OF ORGANIC SOLVENT PLANT EXTRACTS WITH PESTICIDE RUNNER ON ADULT OF LESSER GRAIN BORER RHYZOPERTHA DOMINICA

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Abstract: This study was conducted to find out the effect of mixing organic solvent plants extracts *Conyza dioscoridis*, *Cymbopogon citratus*, and *Moringa oleifera* with Runner insecticide 6% conc. Results showed that organic solvent plant extracts mixed with Runner insecticide increased the percentage of rate of mortality of *R. dominica*. The mortality rates of *M. oleifera* ethanol extracts, using spray method, reached 32.22%, followed by *C. citratus* with 20.74 %, the best conc. of plant extract (4%) mixted with 6ppm of Runner gave the highest rate of mortality (38.15%). The effect of interface between the ethanolic plant extract mixed with Runner and conc. shows that the best plant extract caused the highest mortality was *M. oleifera* and *C. citratus* with 66.67, 31.11%, respectively. Hexane plants extract mixture with the Runner 6ppm showed that the best plant extracts were *C.dioscoridis* and *M. oleifera* with rate of mortality of 25.19, 20%, respectively, the best conc. was 4% caused increase of adult mortality reached 33.43 %. The effect of interface between the hexane plant extracts of 6ppm con. showed that the best plant extract were C. *dioscoridis,* and *C. citratus* that reached mortality of 65.56, 27.87 %, respectively, on the other hand, treating adult insects with Runner insecticide only, gave a percentage of mortality of 18.89% at conc. 6ppm, but in 2ppm conc. mortality was zero %.

***Key words*:** Rhyzopertha dominica, Plant extracts, Runner (IGR), Runner.

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1. Introduction

Cereals and stored products are exposed to attack by many insects, that cause severe damage to both grains and stored products. Al-Iraqi *et al.* (2008) indicated that 20% of crops are destroyed by pests in the post-harvest period, and this percentage increases in third world countries to reach nearly 80%. Marcio *et al.* (2007) mentioned that the percentage of damage may reach 40% in the countries that do not apply modern storage techniques, allow many insects causing damage to cereals and stored products, which leads to losses their quantity and quality, and causing significant economic losses.

Rhyzopertha dominica F. is one of the most important stored product insects in Iraq, particularly during summer, as its density going high.

This insect causes a significant loss of up to 9% in developed countries, and 20% or more in non-developing countries.

In recent periods, insect growth regulators, have been used, due to their high specificity in killing insects, in addition to that are safe compounds for use in the environment, and without any effect on humans, animals and fish, so they are choosing to be one of the best chemicals used in the prevention of insect pests [Stenersen (2004)]. Many researchers give an attention to use those pesticides of plant origin, for having a desirable properties that are not available in most organic pesticides, including non-toxic and rapid decomposition

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due to their exposure to temperature, light and moisture [Abdal-Jabbar (2013)]. Plants also produce an effective secondary compound, that affect the growth and behavior of living organisms, including insects.

The aim of this study is to mix the insect growth regulator (IGR), Runner 24% with the organic solvent's extraction of the plants *Conyza dioscoridis*, *Cymbopogon citratus* and *Moringa oleifera,* to increase the pesticide's effectiveness and control the *R. dominica*.

2. Materials and Methods

2.1 Insects rearing

Insects were collected from local market in Basra Governorate, they were identified by Professor Dr. Kadhim Saleh Al-Hadlag of biology Department, College of Science, University of Basrah. Insects were reared on Sterilized wheat, which was keeping under 18°C for three days to eliminate any existing insect infestation. 1 kg of sterilzed wheat was putting into 2-kg plastic vessels, add a number of insects (male and female) of *Rhyzopertha dominica* to that vessels, then covered with a cloth, fixed with a rubber band, plastic containers were kept in an incubator under 27 ± 2°C and 10 ± 60% relative humidity.

2.2 Plants collection

Plants were collected from various plants fields in Basra Governorate, included *Conyza dioscoridis* (ASteracaece**),** lemon grass *Cymbopogon citratus* (Poacaece) and *Moringa oleifera* (Moringaceae). Plants were identified by Professor Dr. Taha Yassin Mahodar, Department of Plant Protection, College of Agriculture, University of Basrah. Leaves of these plants were washed to get rid of the dust, and dried under natural laboratory conditions, after which leaves of each plant were crushed individually, using an electric mill, type, J-sonic Germany, powder of each plant was kept separately, in a paper bags until they use.

2.3 Extraction preparing

Plant extract was prepared by using polar and non-polar organic solvents, namely ethanol as a polar solvent, and hexane as a non-polar solvent [Al-Mansur (1995)]. 20 g of leaves powder of each plant was placed separately in the Thumble in the Soxhalt extractor, using 200 ml of organic solvents mentioned above. Extraction was carried out at a temperature of 40°C for 24 hours, samples were dried with a rotary evaporator, then the gel extract was collected, and the concentrations of 1, 2 and 4% were prepared.

1 g of the gel extract was dissolved in 5 ml of the solvent according to the type of extraction, and then completed with 100 ml distilled water, after which, 1 ml of liquid paraffin was added as an adhesive and two drops of tween 80 as a diffuser to become of a concentration of 1%. However, same method followed with the comparison treatment, with excluding the plant extraction.

2.4 The effect of organic solvent extracts (ethanol and hexane) on the destruction of *R. dominica* adults by spraying method

10 insects, 5 males and 5 females, of 1-2 weeks age were taken and placed in a small petri dish, then sprayed with 0.5 ml of different concentration (1,2 and 4%) ethanol and hexane extracts separately, for each of the plant extracts *c. dioscoridis*, *c. citratus* and era *M. oliefera* individually and left for 30 seconds, then remove the insects, put them in a 100 ml plastic container, contain 5 g of sterilized wheat, and cover a piece of millimeter cloth, tie it with a rubber band.

Then incubated under conditions of 27 ± 2°C and of 60% ± 10 R.H. three replicates were carried out for each concentration.

Results were taken after 3,7 and 10 days of treatment, and then calculate percentages of corrected consumption using Abbott equation

$$\% = \frac{\%\ of\ dead\ insect\ in\ treatment - \%\ dead\ of\ insect\ in\ control}{100 - dead\ of\ insect\ in\ control} \times 100$$

2.5 Effect of IGR (Runner) on mortality rate of adult *R. dominica* using spray method

Insect growth regulator (Runner) was prepared by dissolving 1 ml of IGR in a 999 ml of water to get 0.001 concentration of the regulator. To prepare 2 ppm ,4 ppm and 6 ppm of the regulator, 2 ml, 4 ml and 6 ml of the row concentration (0.001) were dissolved in 98,96 and 94 ml of water respectively. Adults were treated with this IGR, using the same methods used with the extract. On the other hand, mixture of runner with the plants extracts (ethanol and hexane) was carried out as follows: 1 ml of runner of 6 ppm concentration was taken and mixed with 1 ml of the three plants extract (ethanol and hexane) separately at the concentration

of 1,2 and 4%. Then 0.5 ml from each mixture was taken for treated adults insects as in the previous method.

2.6 Statistical analysis

Statistical analysis of variance was carried out with the Statistical (GenStat) using a factorial completely randomized design (CRD). Treatment means showing significant difference ($p < 0.05$) were analyzed by using L.S.D.

3. Results and Discussion

3.1 The effect of ethanol plant extracts on the mortality rate of *R. dominica* adults

Table 1 shows the significant differences between the effect of the three plants extracts, *M. oleifera* extract came first in the rate of mortality of *R. dominica* adults with 37.41%, followed by *C. citratus*, with 32.59% mortality rate, while *C. dioscoridis* extract came third with 26.37% rate of mortality. Table 1 also shows the highly significant differences between the effect of time periods, the longest the period of exposure the highest the rate of mortality, in 10 days of treatment, mortality reached 42.70%, while in 3 days after treatment mortality rate reached 20.70%, also differences was clearly significant between the concentrations, the highest the concentration, the highest is the rate of mortality, in the concentration of 4% rate of mortality reached 45.81%. However, in 1 and 2% concentration, mortality rate just reached 26.04 and 25.22%, respectively.

This indicates that there is a direct relationship between concentration and mortality, *i.e.* the highest the concentration, the highest is the mortality rate. In 4% concentration, for example, mortality rate was 55.67 and 44.44 % for the extract of a *C. citratus* and *M. oleifera,* on the other hand, results showed that there was a significant difference for the interaction between the plant extract and the concentration. Relation between the three factors, plant extract, concentration and time period was of a significant differences, as the concentration was 4%, rate of mortality after 10 days of treatment, reached 83.33, 53.33, and 40% for *C. citratus*, *M. oleifera* and *C. dioscoridis*, respectively. However, at 1% concentration for the same period, there were no significant differences between all extracts, and the adult mortality rate was 44.33, 43.33, and 33.33% for *C. dioscoridis*, *C. citratus* and *M. oleifera,* respectively.

It is noted that the difference between plant extracts in terms of the effect on the insect mortality is due to a difference in the quality and quantity of the active compounds present in them, that may affect the work of the enzymes responsible for the important biological processes causing the metabolism to stop and then die [Adedire and Akinneye (2004)].

3.2 The effect of hexane plant extracts on the mortality rate of adults, using spray method

It is clear from Table 2 that plant extract has an effect on the mortality of insects. *C. citratus* extract got the highest mortality rate (30%), followed by *M. oleifera* extract, with 14.81% rate of mortality. In addition, results also showed a significant difference on the effects of extract concentrations on adult mortality. With 4% concentration the average of adult deaths rate reached 39.26%, compared to that of 1% concentration in which mortality rate reached 1.85%. Statistical analysis results also show a highly significant differences among the periods, as the longest is the period, the highest is the mortality rate. In 10 days period, death rate reached 20.37%, while in 7 and 3 days period, mortality rate reached 19.28% and 11.4 respectively.

On the other hand, interactions between the extract and concentration, caused an increase in the decay of adults, *e.g.* at the 4% concentration, extracts of *C. citratus* and *M. oleifera*, got the superiority on the rate of mortality with 77.78 and 24.44%, respectively, *C. dioscoridis* was the lowest with 15.56% rate of mortality. Table 2, also showed there was no significant difference between the plants extract concentration at 1% concentration, where the rate of mortality was zero, 3.33 and 2.22% with the extracts *C. dioscoridis, C. citratus* and *M. oleifera*, respectively. Also, differences were significant with the trible interaction among plant extract, concentration and time period, as the concentration exceeded 4% for the *C. citratus* after 10 days of treatment, the mortality rate going high to reach 90%, while the lowest rate of death was 20% with the plant extract of *C. dioscoridis* for the same concentration and time period.

Thus we conclude that ethanol and hexane extracts of *C. citratus* and *M. oleifera* were more efficient, than that of *C. dioscoridis* extract. This may be due to the different active substances present in plants. Ogendo *et al.* (2008) reported that when *R.dominica* exposed

Table 1: The effect of ethanol plant extracts on the Mortality rate of *R. dominica* adults.

Plant extracts	Conc.	Mortality			Effect rate of plant extract *conc.	Effect rate of plant extract	Effect rate of conc. general
		3 days	7 days	10 days			
C. dioscoridis	1%	6.67	20	44.33	23.67	26.37	26.04
	2%	20	20	20	20		25.22
	4%	26.33	40	40	35.44		45.18
C. citratus	1%	10	26.67	43.33	26.67	32.59	
	2%	13.33	16.67	16.67	15.67		
	4%	26.67	56.67	83.33	55.67		
M. oleifera	1%	16.67	33.33	33.33	27.78	37.41	
	2%	33.33	36.67	50	40		
	4%	33.33	46.67	53.33	44.44		
Control		0	0	0			
Effect rate of time		20.70	35.19	42.70			

L.S.D._0.05 of plant extracts = 6.6 L.S.D._0.05 of conc. *time = 11.4

L.S.D_0.05 of plant extracts* conc. = 11.4 L.S.D_0.05 of plant extracts* conc. *time. = 19.7

L.S.D._0.05 of time = 6.6 L.S.D._0.05 of conc. = 6.6

L.S.D_0.05 of plant extracts* time. = 11.4

Table 2: The effect of hexane plant extracts on the Mortality rate percentage of adults *R. dominica* by spray method.

Plant extracts	Conc.	Mortality			Effect rate of plant extract *conc.	Effect rate of plant extract	Effect rate of conc. general
		3 days	7 days	10 days			
C. dioscoridis	1%	0	0	0	0	5.93	1.85
	2%	0	3.33	3.33	2.22		9.63
	4%	10	16.67	20	15.56		39.26
C. citratus	1%	3.33	3.33	3.33	3.33	30	
	2%	6.67	10	10	8.89		
	4%	63.33	80	90	77.78		
M. oleifera	1%	0	3.33	3.33	2.22	14.81	
	2%	13.33	20	20	17.78		
	4%	6.67	33.33	33.33	24.44		
Control		0	0	0			
Effect rate of time		11.48	19.28	20.37			

L.S.D._0.05 of plant extracts = 3.8 L.S.D._0.05 of conc. *time = 6.6

L.S.D_0.05 of plant extracts* conc. = 6.6 L.S.D_0.05 of plant extracts* conc. *time. = 11.4

L.S.D._0.05 of time = 3.8 L.S.D._0.05 of conc. = 3.8

L.S.D_0.05 of plant extracts* time. = 6.6

to *Eucalyptus camaldulensis* vaporization at a concentration of 10 ml/air, for 7 days, its mortality rate had been reached 98% and is reported by Sonja *et al.* (2018) that aqueous extract of *Satureja montana* effect in the mortality of adult *R. dominica* in contact and stomach method reached 16.7, 33.33%, respectively after 24 hours of treatment.

3.3 The effect of Runner insecticide on the mortality rate of *R. dominica* adult using spray method

Results of Table 3 show the existence of significant differences between the concentrations, as the concentration reaches 6 ppm, the mortality rate increases to become 18.89%, while the lowest rate of mortality was recorded with the concentration of 2 ppm, which was zero%. Statistical analysis also shows the presence of significant differences between the insecticide, concentration and time period, as the concentration exceeded 6 ppm, mortality rate became 23.33%, after 10 days of exposure, but at 2 ppm mortality rate was the lowest after 3 days of treatment. However, results showed no significant differences between the mortality rate at different periods. It was

Table 3: The of Runner in Mortality rate percentage of adults *R. dominica* by spray treatment.

Insecticide	Conc.	Mortality			Effect rate of conc.	Effect rate of insecticide
		3	7	10		
Runner	2ppm	0	0	0	0	9.99
	4ppm	3.33	6.67	23.33	11.11	
	6ppm	10	23.33	23.33	18.89	
Control		0	0	0	3.33	
Effect rate of time		4.44	10	10		

L.S.D.-0.05 insecticides *con. = 12.4

L.S.D-0.05 con = 11.02

L.S.D.-0.05 insecticides *con. *time = 21.5

L.S.D-0.05 time = 13.9

Table 4: The effect of mixing Runner insecticide with ethanol plants extracts on the mortality rate percentage of adults *R. dominica* by spray method..

Plant extracts	Conc.	Mortality			Effect rate of plant extract +insecticide *conc.	Effect rate of plant extract +insecticide	Effect rate of conc.
		3 days	7 days	10 days			
C. dioscoridis	1% + runner 6ppm	3.33	6.67	6.67	5.56	9.26	10.37
	2% + runner 6ppm	3.33	6.67	6.67	5.56		13.70
	4% + runner 6ppm	3.33	23.33	23.33	16.66		38.15
C. citratus	1% + runner 6ppm	0	16.67	20	12.22	20.74	
	2% + runner 6ppm	16.67	20	20	18.89		
	4% + runner 6ppm	10	33.33	50	31.11		
M. oleifera	1% + runner 6ppm	10	13.33	16.67	13.33	32.22	
	2% + runner 6ppm	3.33	23.33	23.33	16.66		
	4% + runner 6ppm	66.67	66.67	66.67	66.67		
Control		0	0	0			
Effect rate of time		12.96	23.33	25.93			

L.S.D._0.05 of plant extracts + insecticides *conc. *time = 33.42 L.S.D-0.05 conc. 11.1

L.S.D_0.05 time = 11.1 L.S.D_0.05 of plant extract + insecticides *conc. = 19.3

L.S.D._0.05 plant extract + insecticides = 11.1

L.S.D_0.05 of plant extracts + insecticides *time. = 19.3 L.S.D. - 0.05 conc. *time = 19.3

4.44%, 10% and 10% after 3, 7 and 10 days after treatment.

3.4 The effect of mixing Runner insecticide with ethanol plant extracts, on the destruction of *R. dominica* adults by spray method

Results in Table 4 show the significant differences between ethanol extracts mixed with Runner insecticide, once again 6 ppm concentration had more effect in insect mortality rate. Ethanol extract of *M. oleifera* mixed with Runner insecticide came first, with a mortality rate of 32.22%, followed by *C. citratus* extract, with 20.74% mortality rate, the lowest was *C. dioscoridis* extract with 9.26%. However, differences between concentrations was highly significant, the highest mortality rate was recorded with concentrtion of 4% mixed with the Runner pesticide and that was 38.15%, but the lowest was 10.37% at the concentration of 1%. Results of statistical analysis also showed a significant difference between the time periods, mortality rates average were 25.93 and 12.96% after 10 days and 3 of treatment, respectively.

Also interaction between plant extracts mixed with the insecticide and the concentration, showed significant differences, as the concentration exceeded 4%, mortality rate was reached 66.67, 31.11 and 16.66% for the extracts *M oleifera* and *C. citratus* and *C. dioscoridis*, respectively compared with the concentration of 1%, in which adult mortality rate was 13.33, 12.22 and 5.65% for *M. oleifera*, *C.* citratus. and *C. dioscoridis extracts,* respectively.

Table 5: The effect of mixing Runner insecticide with hexane plants extracts on the mortality rate percentage of *R. dominica* by spray method..

Plant extracts	Conc.	Mortality			Effect rate of plant extract +insecticide *conc.	Effect rate of plant extract +insecticide	Effect rate of conc.
		3 days	7 days	10 days			
C. dioscoridis	1% + runner 6ppm	3.33	3.33	3.33	3.33	25.19	4.81
	2% + runner 6ppm	6.67	6.67	6.67	6.67		14.45
	4% + runner 6ppm	56.67	70	70	65.56		33.34
C. citratus	1% + runner 6ppm	6.67	6.67	13.33	8.89	20	
	2% + runner 6ppm	16.67	23.33	30	23.33		
	4% + runner 6ppm	16.67	26.67	40	27.78		
M. oleifera	1% + runner 6ppm	0	0	6.67	2.22	5.93	
	2% + runner 6ppm	6.67	10	10	8.89		
	4% + runner 6ppm	0	10	10	6.67		
Control		0	0	0			
Effect rate of time		12.59	17.41	21.11			

L.S.D._0.05 of plant extracts + insecticides *conc. *time = 17.1 L.S.D-0.05 conc. 5.67

L.S.D_0.05 time = 5.67 L.S.D_0.05 of plant extract + insecticides *conc. = 19.3

L.S.D._0.05 plant extract + insecticides = 5.67

L.S.D_0.05 of plant extracts + insecticides *time. = 9.8 L.S.D. - 0.05 conc. *time = 9.8

3.5 The effect of mixing runner insecticide with hexane plants extracts on the mortality rate of *R. dominica* using spray method

Mixing of hexane plants extracts with Runner insecticide (Table 5) caused an increase in the mortality rate of *R. dominica* adults, with a highly significant difference. At 6 ppm, the extracts of *C. dioscoridis* and *C. citratus* got the higher mortality rate with 25.19 and 20%, respectively compared with the extract of *M. oleifera*, which got 15.93%. Results also showed significant differences between time periods, the highest mortality rate (21.11%) recorded after 10 days of treatment, while the lowest (12.59%) was recorded after 3 days of treatment. Table 5 also shows the presence of highly significant differences between the concentrations of hexane extracts mixed with the insecticide Runner of 6 ppm concentration.

4% concentration came first with adult death rate of 33.34%, followed by a concentration of 2%, with death rate of 14.45%. The lowest adult death rate (4.45%) was at a concentration of 1%. Results of the statistical analysis showed that there were significant differences for the interference between the plants extracts mixed with Runner insecticide and concentration. The highest adult mortality at the concentration of 4% was 65.56% recorded with the *C. dioscoridis* extract, followed by the extract *C. citratus*, with death rate of 27.78%, and the lowest adult death rate (6.67%) was recorded with extract of *M. oleifera*. There were also significant differences for the triple overlap between plant extracts mixed with Runner and the concentration and time period, as the time period exceeded 10 days after treatment with the concentration of 4%, adult mortality for *C. dioscoridis* and *C. citratus* extracts were 70% and 40%, respectively

As a conclusion, results showed clearly that the plant extracts mixed with the runner insecticide increased the efficiency in the decimation of the adult's insects. Ali *et al*. (2015) mentioned that mixing of the Spinosad insecticide with the acetone extract of the *Piper nigrum* plant increased the mortality of adult's insects to reached 34.81± 4.5, compared to that of the insecticide alone which recorded 4.83% after 24 hours of treatment.

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