

Effect of growing seasons, plant extracts with various rates on Black Bean Aphid, *Aphis Fabae* (Aphididae: Homoptera)

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Abstract: Four plant extracts: *Eucalyptus* (*Eucalyptus* sp), *Onion* (*Allium cepa* Linn), *Garlic* (*Allium sativum*) and *Cinnamon* (*Cinnamomum* sp) with three extraction rates (0, 1 and 3) % in 2016 and 2017 seasons were used against aphid population in broad bean (*Vicia faba*). Some plants characteristic; Plant Height (cm), Fresh Weight.Plant⁻¹ (g), Dry Weight.Plant⁻¹ (g), Number of Pods.Plant⁻¹, and aphid's dead number after 6 hours and 24 hours were taken. *Eucalyptus* affected significantly on Number of Pods.Plant⁻¹ compared with the other extraction (7.416). As the extraction rate increased, all parameters increased. Pearson's correlation test for traits in 2017 season indicated that there were a significant strong correlate and better than 2016 season among Number of Pods .Plant⁻¹, Fresh Weight.Plant⁻¹ ($r = 0.770^{**}$), Dry Weight .Plant⁻¹ ($r = 0.816^{**}$), and M24 ($r = 871^{**}$). Based on Number of Pods.Plant⁻¹, the best interaction between the season, extraction types, and extraction rates, was a combination of the 2017 season × *Eucalyptus* extraction × 1% Extraction rate.

Keywords: Plant Extracts, *Aphis Fabae*, Broad Bean, Biological control, Bioactivity

1. INTRODUCTION

Broad bean is commonly known as broad bean or field bean which is grown in winter. Total cultivated area in the world about 25.2 million hectares with 19.7 million tones total production per year. Many countries such as Mediterranean, Middle Easter, Chinese, Indian, African and South American use bean as a standard source of their diet, in addition, it has an impressive importance as inexpensive and protein and carbohydrates rich substance [1, 2]. Broad bean can be consumed as vegetable as fresh, but if dry seeds and pods was needed the plants will be leaved in the field until the maturity of the pods when it became dry. They contain fibers, carbohydrates, vitamins, proteins and minerals) in addition to (phytic acid alkaloids, saponins and tannins was previously studied [3, 4]. Several herbivores and pathogens will infect faba bean which consequently absorb nutrient and energy from plants. Aphid is considered one of the world-wide insect pests attacking faba bean and destroying most of the yields. There are about four thousand species were found and about two hundred and fifty species from this pests are harmful to different crops as well as the ornamental plants. One of them is Black bean aphid (*Aphis fabae* Scop.) is a major

polyphagous pest of agricultural crops. The pest can cause to death of plants and causes reductions in the yield quantity and quality. Field losses infested by this pest can reach above 50% [5]. This insect pierce leaves, stems, flowers and young pods during adulthood and nymphs and leads to yellowing plants, withering and dying. Furthermore, it is a vector of more than 30 plant viruses, such as those of tomato and peas, potato, beets, cucurbits, crucifers etc. [6]. *Aphis fabae* is often control by application of the insecticides which are highly expensive and toxic [7]. Results show that insect resistance against pesticides has been increased [8] Pesticides may cause the destruction of useful insects (pollinators, parasitoids and predators), as well as their disadvantages against humans and wildlife ecosystems [9], Therefore, it is necessary to seek for an alternative of managing procedure of the insect. Fertility management practices is the best way for soil amendment as it could change up-take of organic matter and nutrients by plants and also affect soil microorganism and soil-borne pathogens [10]. Moreover, soil O.M and macro-micronutrients encouraged changes in the soil biota [11] and it impact on the aphid in an indirect way which may reform the plant media and create better relationship between soil pathogen and the aphid insect. During previous year's, some new bioactive plant extracts were examined and found that they have insecticidal properties and safe ecologically [12]. It has been found that there are more than 2000 plant species belong to 170 families which possess insecticidal properties [13]. Different parts of the herbaceous plant (dried+ fresh) were used [14, 15]. Few researches concerning this matter in Iraq-Kurdistan Region. In last decades bioactivity of botanical extracts against aphid species investigated by researchers. Among them, *Aphis fabae* [16, 17; 18; 19; 20; 21], *Aphis citricola* [22] *Aphis craccivora* [23], *Aphis gossypii* [24; 16, 17], *Aphis nerii* [16], *Brevicoryne brassicae* [24, 25], *Lipaphis erysimi* [26; 27], *Melanocallis caryaefoliae* [28], *Myzus persicae* [29; 16, 17; 30; 31; 32] and *Schizaphis graminum* [12]. Also, the plant extract repellent property vs. aphids was largely studied, among the aphid species, *Aphis gossypii* [33], *Brevicoryne brassicae* [24], and *Myzus persicae* [29; 30; 16].

The aim of this study is to investigate the effect of different plant extracts based on dry matter of *Eucalyptus*, *Onion*, *Garlic* and *Cinnamon* for the control of black bean aphid.

2. METHODS AND MATERIALS

2.1. Experimental Site:

This study was carried out at Bakrajo Technical Institute- Sulaimani Polytechnic University (SPU), Iraqi Kurdistan Region during (2015-2016) and (2016-2017) seasons under the rainfall condition. The location is at (35°32.976"N latitude and 45°21.537" longitude), located at 8 km south Sulaimani. Averages of just four months of rainfall as well as maximum and minimum temperatures, relative humidity and wind rates are shown in table 1.

Table 1: Bakrajo Environmental conditions:

Parameters	2016 (Average 4 month)	2017 (Average 4 month)
Rain (mm)	81.22	85.75
Maximum Temp. (°C)	17.2	16.4
Minimum Temp. (°C)	11.3	4.91
Relative Humidity (%)	23.2	25.9
Wind (km/h)	5.6	6.04

2.2. Preparation of Botanical Extracts:

100 grams of dried materials for each of Eucalyptus (*Eucalyptus sp*) ET1, Onion (*Allium cepa Linn*) ET2, Garlic (*Allium sativum*) ET3 and Cinnamon (*Cinnamomum sp*) ET4, were grinded to fine powder by an electric mixer for 5 minutes separately, then each was soaked in one liter of water. %100 of extracts preserved in well-dark cleaned glass bottles provided with tags at 25 °C which is a room temperature for twenty-four hours. After this period the mixtures were filtered through Whitman filter paper separately and stock of distilled water was also prepared to obtain required concentration (0, 1 and 3%) ER1, ER2, and ER3. Then immediately used to perform the experiments respectively.

2.3. Application of Extracts in Field:

Seeds of local variety of faba bean were sown by hand drill method and successive seedlings were grown in 3X2 m individual field-plots. When the plant height reached 20-25 cm, the field of the experiment were checked once a week for observing signs and symptoms of the aphids and recording any damages happened until it reaches the level of the economic threshold. Number of aphid (both immature and adults) were recorded on the indicated shoots (10 cm apical). The following parameters were taken: number of aphids/plant (before and after botanicals spray), Plant Height (PH) cm, Fresh Weight.*Plant*⁻¹ (FWP) g, Dry Weight.*Plant*⁻¹ (DWP) g,

Number of Pods.*Plant*⁻¹ (NPP). The counting aphid dead numbers individually (Mortality) were also taken after 6 hours (M6^h) and 24 hours (M24^h) spraying.

2.4. Soil Properties:

Physicochemical properties for the soil was determined for each season. Table 2 shows some of these properties defined by [34 and 35]. Physicochemical characteristics were determined following procedures described by [37, 38, 39, 40, and 41].

Table 2: physicochemical properties of the soil used in the study:

Parameters	2016	2017
pH	7.65	7.5
Electric Conductivity (mmhos/cm)	2.0	2.12
Calcium Carbonate (%)	2.45	2.49
Organic matter (%)	2.30	2.48
Calcium (mgkg ⁻¹)	4521	4322
Magnesium (mgkg ⁻¹)	223.2	280.78
potassium (mgkg ⁻¹)	203	245
phosphor (mgkg ⁻¹)	4.07	3.47
Zinc (mgkg ⁻¹)	1.43	1.37
Manganic (mgkg ⁻¹)	27.2	35

2.5. Statistical Analysis:

Factorial experiment in Randomized Complete Block Design (RCBD) with four replicates was used in order to test main and interaction effects of Seasons, four plant extractions and three applications rates. Analysis of variance was carried out for the data using JMP statistical discovery and the means were compared according to LSD at 0.05 level. Correlation between mean values was analyzed by (SPSS program version 20.0.0).

3. RESULTS

The results of ANOVA for the seasons, application of dissimilar plant extractions, extractions rate, and their interactions in regard to some measured aphid death and plant features are shown in Table 3. There was a significant effect of the treatments on most of the measured parameters in the broad beans plant except for PH, and NP which were non-significantly affected by seasons. The interaction effect of the S×ET, and S×ET×ER for the M6^h, M24^h, and PH, and the interactions between S × ER for the M24^h, PH, and NP, were also non-significant.

Table 3: The ANOVA results of the treatments and their interactions for the effect plant extracts from different plants against *A. fabae*.

Parameters	Source	Mortality After 6h (%)			Mortality After 24h (%)			Plant Height (cm)		Fresh Weight/Plant (g)		Dry Weight/Plant (g)		No. of Pods/Plant	
		D.F	F-Ratio	P>F	F-Ratio	P>F	F-Ratio	P>F	F-Ratio	P>F	F-Ratio	P>F	F-Ratio	P>F	
Season (S)	1	104.108	0.000	12.3909	0.012	2.7326	0.149	440.9326	0.000	249.9261	0.000	1.7263	0.236		
Extractions Type (ET)	3	308.7971	0.000	314.3005	0.000	7.7259	0.000	38.9103	0.000	63.1768	0.000	14.013	0.000		
Extractions Rate (ER)	2	1382.834	0.000	1437.707	0.000	43.2872	0.000	178.0183	0.000	262.0481	0.000	103.4472	0.000		
S×ET	3	0.9517	0.420	0.5561	0.645	1.5689	0.205	7.703	0.000	7.5872	0.000	4.0822	0.010		
S×ER	2	4.3473	0.016	0.716	0.492	2.8628	0.064	3.5828	0.033	13.0696	0.000	2.4173	0.097		
ET×ER	6	74.4139	0.000	76.8073	0.000	3.0819	0.010	11.1089	0.000	15.6004	0.000	3.5743	0.004		
S×ET×ER	6	0.7151	0.638	0.8193	0.558	1.8824	0.096	2.9858	0.012	2.809	0.017	2.7341	0.019		

Table 4 shows that different plant extracts have significant effects on all parameters. While ET¹ gave maximum mortality after 6h (49.03%), 24h (52.21%), ET⁴ gave the minimum percent of the motility which were 14.96% and 16.17% after 6h and 24h, respectively.

Table 4: Effects of botanical extract on Aphid mortality (%) and yield performance of broad bean plants.

Extractions Type (ET) (%)	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
ET ¹	49.083 ^a	52.208 ^a	55.333 ^a	77.000 ^b	11.300 ^a	7.416 ^a
ET ²	35.791 ^b	38.541 ^b	52.208 ^a	82.250 ^a	11.033 ^a	7.125 ^a
ET ³	31.958 ^c	33.583 ^c	52.708 ^a	78.083 ^b	11.345 ^a	7.416 ^a
ET ⁴	14.958 ^d	16.166 ^d	46.291 ^b	61.125 ^c	7.537 ^b	5.166 ^b
LSD	2.259	2.371	3.877	4.197	0.657	0.818

*Numbers within a column carrying the same letters are not different significantly according to (LSD, p < 0.05)

ET¹ and ET² gave maximum plant height (55.33cm) and fresh weight.plant⁻¹ (82.25g), respectively, while ET⁴ gave minimum dry weight.plant⁻¹ (7.54g) and No. of pods.plant⁻¹(5.17g).

Table 5 shows that ER³ significantly increased mortality after 6h (48.84%) and 24h (52.38%). Minimum PH

(42.63cm), FWP (54.78g), DWP (6.54g) and NP (3.84) obtained from the control (ER¹).

Table 5: Effects of botanical extract rate on Aphid mortality (%) and yield performance of broad bean plants.

Extraction Rate (ER) (%)	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
ER ¹	3.218 ^c	3.312 ^c	42.625 ^b	54.781 ^b	6.537 ^b	3.843 ^b
ER ²	46.781 ^b	49.687 ^b	56.718 ^a	84.781 ^a	12.225 ^a	8.031 ^a
ER ³	48.843 ^a	52.375 ^a	55.562 ^a	84.281 ^a	12.150 ^a	8.468 ^a
LSD	1.956	2.054	3.358	3.635	0.569	0.708

*Numbers within a column carrying the same letters are not different significantly according to (LSD, p < 0.05)

Table 6 shows that all the parameters expect PH and NP significantly affected by growing seasons. Higher mortality% after 6 and 24 h and DWP which were

(35.08%), (36.25%) and (12.74g), respectively obtained from the second season (S²), while higher FWP (85.00g) obtained from the first season (S¹).

Table 6: Effects of different seasons on Aphid mortality (%) and yield performance of broad bean plants.

Season	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
S ¹	30.812 ^b	34.000 ^b	52.500	85.000 ^a	7.782 ^b	6.937
S ²	35.083 ^a	36.250 ^a	50.770	64.229 ^b	12.735 ^a	6.625
LSD	1.024	1.564	2.559	2.420	0.752	0.581

*Numbers within a column carrying the same letters are not different significantly according to (LSD, p < 0.05)

According to the maximum means, the best interactions of M24^h, PH, and NP (78.000 %, 68.250 cm, and 10.750) respectively, were observed in S² × ET¹ × ER², only for M6^h increases with ER³ (75.000). However, the S² × ET³ × ER², and S¹ × ET² × ER² interactions were

mostly affected to DWP, FWP (17.875, 114.500) g respectively. Finally, the minimum value of all parameters was obtained by untreated plants (using distill water) in the experiment (Table 7).

Table 7: The best interaction between the season, extraction types, and extraction rates in the experiment.

Parameters	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
Interactions Maximum Mean	S ² × ET ¹ × ER ³ 75.000	S ² × ET ¹ × ER ² 78.000	S ² × ET ¹ × ER ² 68.250	S ¹ × ET ² × ER ² 114.500	S ² × ET ³ × ER ² 17.875	S ² × ET ¹ × ER ² 10.750
Interactions Minimum Mean	S ¹ × ET ² × ER ¹ 2.250	S ¹ × ET ¹ × ER ¹ 2.000	S ² × ET ¹ × ER ¹ 39.250	S ² × ET ⁴ × ER ¹ 45.750	S ¹ × ET ⁴ × ER ¹ 4.800	S ¹ × ET ⁴ × ER ¹ 3.500
LSD	5.533	5.809	9.497	10.282	1.609	2.004

Base on the Person's correlation coefficient between studied traits illustrated for season S¹ in (Table 8), generally there was a positive significant correlation between all traits. The result showed that NPP has the strongest correlation (r = 0.751**) with FWP. Following this traits DWP and M24^h were showed the most correlation with NPP (r = 0.725**, r = 0.709**) respectively. The stronger positive correlation was

observed between PH and M24^h (r = 0.793**). Also, highly significant and positive relation was observed among DWP with M24^h (r = 0.924**). The broad bean plants were treated with the different types of plant extraction after 24h the death percentage of aphid was increased. Result for correlation indicated that there were a significant positive correlate among NPP with FWP, DWP and M24^h (r = 0.770**, r = 0.816**, r =

0.871**) respectively in S² (Table 9). Later this trait the FWP (r = 0.891**) and M24H (r = 0.892**) showed the strong correlation with DWP, although the same correlation was observed between FWP with M6^h and

M24^h (r = 0.819**). Finally, for both season a very strong positive correlation between M24^h and M6^h were observed.

Table 8: Correlation coefficients among Aphid mortality (%) and yield performance of broad bean plants in 2015-2016.

Parameters	Correlation with					
	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
Mortality After 6h (%)	1					
Mortality After 24h (%)	0.994**	1				
Plant Height (cm)	0.786**	0.793**	1			
Fresh Weight/Plant (g)	0.854**	0.856**	0.747**	1		
Dry Weight/Plant (g)	0.910**	0.924**	0.762**	0.881**	1	
No. of Pods/Plant	0.698**	0.709**	0.688**	0.751**	0.725**	1

**Correlation is showing significances at 0.01 levels by using (2-tailed) test.

Table 9: Correlation coefficients among Aphid mortality (%) and yield performance of broad bean plants in 2016-2017.

Parameters	Correlation with					
	Mortality After 6h (%)	Mortality After 24h (%)	Plant Height (cm)	Fresh Weight/Plant (g)	Dry Weight/Plant (g)	No. of Pods/Plant
Mortality After 6h (%)	1					
Mortality After 24h (%)	0.996**	1				
Plant Height (cm)	0.692**	0.699**	1			
Fresh Weight/Plant (g)	0.819**	0.819**	0.564**	1		
Dry Weight/Plant (g)	0.888**	0.896**	0.592**	0.891**	1	
No. of Pods/Plant	0.861**	0.871**	0.671**	0.770**	0.816**	1

**Correlation is showing significances at 0.01 levels by using (2-tailed) test.

4. DISCUSSION

Application of materials such as water extract on the plant plays nowadays an important role in reducing aphid number which infests plants. Use of plant natural water extracts for the purpose of aphid control is of special concern in agriculture as they reduce environmental pollution compared to industrial compounds. Researchers have found that plant extracts are of noticeable influence on reducing aphid numbers and increasing yield in broad bean.

All botanical water extracts had effects on reduce of aphid numbers and increase morphological attribute with plant yield. Previous study evaluated water extract of eucalyptus and garlic reduced the number of aphids, also water extracts of tobacco and neem have been tested and showed a great result to control aphids [36].

Repelling activities of natural essential oils is of great importance in showing potential toxic action against aphids. Researchers found some properties of plant natural essential oils which are of special concern in controlling aphids among those are ginger (*Zinigiber* spp.), lavender (*Lavandula officinalis* Chaix), peppermint (*Mentha piperita*), spear-mint (*Mentha spicata*), thyme (*Thymus vulgaris*) and rosemary (*Rosmarinus officinallis*) oils [37, 38]. Among the 13 tested substance compounds contained in rosemary oil a repellent action in relation to *Mentha persicae* is exhibited by such compounds as linalool, d,l-camphor and terpineol.

According to [37] rosemary oil also gives repellent action when related to aphid of the cotton which is known as (*Aphis gossypii* Glover) and as well as the aphid of the potato plant (*Macrosiphum euphorbiae* Thomas), and the extraction of ginger oil.

5. CONCLUSION

Growing season, extraction types and rates influence the black bean aphid and thus resulted in the improving of quantity and quality of the yield. Eucalyptus plant extract gave the best effect in decreasing the number of aphid after 6 and 24 hours compared to the other plant extracts. Both 1% and %3 rates of extracts recorded better results in increasing mortality%, plant height, fresh weight .plant⁻¹, dry weight.plant⁻¹ and number of pods. 2017 season was superior for increasing death number of aphid.

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