

INFLUENCE OF SOME SAFE MATERIALS ON MANAGEMENT OF *APHIS CRACCIVORA* KOCH. INFESTING FABA BEAN PLANTS UNDER FIELD CONDITIONS

Abolfadel, M. A.; EL.Solimany, E.A. and Elkholy, Samah Z.
Agricultural Research Centre (ARC), Plant Protection Research Institute (PPRI)

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ABSTRACT: Faba bean *Vicia faba* L. is one of a major grain legume consumed worldwide for its edible seeds and pods. Faba bean is not important cash crop only, but also is considered as a promising crop, which adapts to climate change hence feed future generation due to its high protein content. *Aphis craccivora* (Homoptera : Aphididae) is perennial pest of leguminous crops. The important pest in faba bean is aphid, *Aphis craccivora* in Egypt, which are found to suck sap cells by sucking and piercing mouth parts as well as transmit serious viruses causing great damages. The field experiment was carried out to determine the occurrence of *A. craccivora* attack faba bean, *Vicia faba* L. plants during 2021 & 2022 seasons. All treatments were arranged in randomized complete design. The present study was carried out in the field to evaluate the toxic effects of Faba bean seed treatments by camphor, mint, basil oils and Gaucho (Imidacloprid) on *A. craccivora*, followed by the same treatment after four weeks, as well as on the foliage characters of the plants. Data indicated that the highest reduction percentage in seeds treatments was recorded with Imidacloprid 84.17, 78.54 and 72.75% followed by mint oil with 81.27, 77.35 and 69.57% 2.3 and 4 weeks of planting date, respectively in 2021 and with 89.53, 83.99 and 80.85% in Imidacloprid followed by 83.52, 80.09 and 75.59% in mint oil, respectively in 2022 season. Regarding to the effect of foliar treatments, of Camphor oil, basil oil, mint oil and Imidacloprid on mean numbers of Aphid, it recorded 17.25, 19.95, 17.60 and 12.13 aphids/ 10 leaves, respectively comparing with 222.90 aphids/ 10 leaves in control in 2021 season, and 13.05, 14.43, 13.85 and 10.05, respectively comparing with 192.95 aphids/ 10 leaves in control in 2022 season. Data indicated that both of insecticide and the botanical oils reduced aphid numbers in the field. It could be reported that the tested essential oils can be used as a natural insecticides for the control of the aphid to protect our environment from bad effects of chemical pesticides.

Key words: *Aphis craccivora*, *Vicia faba* L, camphor, mint, basil, Imidacloprid.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the major legume vegetable in different countries all over the world. Faba bean considered one of the most important source of human dietary protein. Damage caused by the insect pests is considered the limit factor of faba bean production, Aphids, leafhoppers, whitefly, thrips and leafminers insects are among of the most important insect attack the most of legume plants including faba bean (El-Solimany, 2008; Abdel Khalek *et al.*, 2018 and El-Sarand *et al.*, 2019). *Aphis craccivora* Koch. (Aphididae: Homoptera) classified by many investigators as the most dangerous and damaged insect pest attacking faba bean in Egypt (El-Dessouki *et al.*, 2014;

Mousa and Metwally, 2014 and Khodeir *et al.*, 2020). Management of aphid on many crops mainly depends on the use of chemical insecticides like imidacloprid as seed treatment (Hassan *et al.*, 2018 and Shehawy and Qari, 2019) or foliar application (Kumar and Bhattacharya, 2019; Moustafa *et al.*, 2022). Because of the negative effects of synthetic chemical insecticides on human health and environment, many researchers have attention to the use of some safe material like essential oils as seed treatment (Sammour *et al.*, 2011; El-Solimany and Abolfadel, 2022) or as spray on the plants (Adly and Bakr, 2016; Mohapatra *et al.*, 2021; Abdel-Aziz *et al.*, 2015 and Bezerra *et al.*, 2023).

Therefore, the objective of this research is to determine the effect of three essential oils and one chemical insecticide on *Aphis craccivora* infested faba bean plants under control program on seeds before planting and on the plants after grown for two successive seasons under field conditions.

MATERIALS AND METHODS

Experimental design

Field experiment was carried out in a private farm at Singerg village, Menoufia Governorate, Egypt, during the two successive seasons of 2021 and 2022. An area of 210 m² was divided into 20 equal plots, cultivated with faba bean seeds on 2nd October in both of the two seasons. Three seeds/ hole were planted in 20 cm between holes. After one week of planting seedlings were thinned to two plants/hole. This experiment was set up in a complete randomized block design, replicated four times. The normal agricultural practices were performed and no pesticides were used.

Tested materials

The three selected oils of camphor (*Cinnamomum camphora* L.: Myrtaceae), mint (*Mentha piperita* L.: Labiatae) and basil (*Ocimum basilicum* L.: Lamiaceae) were supplied as ready-made oil from El-Captain Company for Extraction of Natural oils, Plants and Cosmetics, Cairo, Egypt, however, imidacloprid insecticide was obtained as Gaucho (70% WS) for seed treatment and imidastorm (35% SC) imidacloprid as foliar spray, respectively. The seeds of faba bean (Sakiz) were obtained from The Agricultural Research Center at Giza.

Treatments

Faba bean seeds were sprouted after 36 hours, then were treated by three oils at rate of 60 ml/ kg seeds, however, Gaucho (imidacloprid) was used at rate of 7 g/l kg seeds. After that, seeds were taken to the field and grow under natural environmental condition. Four weeks from planting date, the experimental plots were sprayed with the same agents of seed treatments for each one. The three oils were used at rate of 1

cm³/ 1 L water in addition to 0.1% Tween 80 as a surfactant, while the insecticide imidastorm (35% SC) was used at rate of 75 cm³ /100 L. The three tested oils and imidacloprid 35% SC were sprayed three times in 30th October, 13th and 27th November at 2 weeks interval using hydraulic sprayer, while control plots were treated only with water.

Inspection of *Aphis craccivora* infestation

Weekly randomized samples of faba bean leaves (10 leaves/ replicate) were taken after 10 days of sowing until the end of the experiment. Sample were collected, kept in paper bags and transferred to the laboratory of Plant Protection, Giza, Egypt for examination with the aid of a stereomicroscope to count the number of *Aphis craccivora* nymphs and adults. Sampling started from 16th October until the harvesting of green pods at 18th December in both seasons.

For estimating the effect of seed treatment, three samples were taken at 2, 3 and 4 weeks from planting date. Reduction percentages were calculated according to Abbott's formula(1925):

Corrected mortality % =

$$\left(1 - \frac{\text{no in Treatment after treatment}}{\text{no in Control after treatment}}\right) * 100$$

The reduction percentages due to foliar application were calculated by Henderson and Telton formula (Henderson and Telton, 1955).

$$\text{Reduction \%} = \left(1 - \frac{T_a \times C_b}{T_b \times C_a}\right) \times 100$$

Where:

T_a = number in treatment after,

C_b = number in control before,

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C_a = number in control after

Statistical analysis

All obtained data were subjected to ANOVA test using a computer program (Costat, 2008) to determine Duncan's multiple range test and the LSD 5% (least significant difference).

RESULTS AND DISCUSSION

1. Seed treatments

The effect of three oils and imidacloprid as seed treatment on infestation of faba bean plants by *Aphis craccivora* during 2021 and 2022 seasons is shown in Tables (1) and (2). Statistical analysis of the obtained data showed that all seed treatments decreased the mean numbers of aphid found on faba bean leaves compared to control in both seasons of the study.

Depending on the mean numbers of aphid, control gave the highest mean number of aphids/ 10 leaves as 29.75 after 2 weeks from planting date, then it rapidly increased to 158.75 and 247.00 aphids/ 10 leaves after 3 and 4 weeks from planting date, respectively, in 2021 season. The same trend was observed in 2022 season, where control treatment recorded 21.50, 206.00 and 249.50 aphids/ 10 leaves after 2, 3 and 4 weeks from planting date, respectively. However, the three tested oils and imidacloprid recorded low aphid infestation compared to control where it ranged from 4.75 to 6.75 in the first season and from 2.25 to 4.00 aphids/ 10 leaves in 2022 season after 2 weeks from planting date. No significant differences were found among the oils and insecticide after 2 weeks from planting date in both seasons, and after 3 and 4 weeks from planting date in 2021 season. However in 2022 season, the lowest mean numbers were observed in imidacloprid followed by camphor oil after 4 weeks from planting date without significant differences.

Regarding to the reduction percentages in aphid population, the highest one was recorded in plots treated with imidacloprid with 84.17%, 78.54% and 72.75% after 2, 3 and 4 weeks from planting date, respectively, in 2021 season, and with 89.53%, 83.99% and 80.85% after 2, 3 and 4 weeks from planting date, respectively, in 2022 season. No significant differences were found

between imidacloprid and mint oil after 2 weeks in both seasons of the study, and between camphor and mint oils after 3 weeks in the first season. Also, no significant differences were found between imidacloprid and camphor oil after 4 weeks in both seasons of the study. On the other hand, the lowest reduction percentages were observed in basil oil with 77.79%, 74.87% and 68.47% after 2, 3 and 4 weeks from planting date, respectively, in 2021 season, and with 80.69%, 78.37% and 75.44% after 2, 3 and 4 weeks from planting date, respectively, in 2022 season.

From the above data, it is clear that the three oils of camphor, basil and mint can be used as a good and safe seed treatment, because of their effect on the initial infestation of *Aphis craccivora* on faba bean plants especially on seedling stage compared to chemical insecticides.

The obtained results are in agreement with those of El-Defrawi *et al.* (2002) who reported that faba bean seed treated with imidacloprid (70% WSP) at rate of 3 g / kg seeds giving over than 80% reduction in *A. craccivora* population. In the same line, Hassan *et al.* (2018) and Shehawy and Qari (2019) reported that imidacloprid seed treatment can reduce early aphid infestation on wheat. For the effect of essential oils as seed treatment or soil treatment the obtained data are in harmony with Sammour *et al.* (2011) who found that basil and neem oil had an insecticidal effect against *A. craccivora* when the plant was systematically treated, in addition, Abdel-Aziz *et al.* (2015) indicated that rosacide, sagix and cura oils reduced *A. craccivora* when applied systematically (soil treatment). Also, El-Solimany and Abolfadel (2022) demonstrated that sprouted faba bean treatment by camphor, basil or mint oils was effective *A. craccivora*.

Table (1). Effect of three oils and Imidacloprid as seed treatment on infestation of faba bean plants by *Aphis craccivora* during 2021 season.

Treatment	Mean no./ 10 leaves after			Reduction% after		
	2 weeks	3 weeks	4 weeks	2 weeks	3 weeks	4 weeks
Camphor oil	6.00 b	35.50 b	68.25 b	80.57 bc	76.49 ab	72.21 a
Basil oil	6.75 b	38.25 b	77.75 b	77.79 c	74.87 b	68.47 b
Mint oil	5.75 b	34.00 b	74.75 b	81.27 ab	77.35 a	69.57 b
Imidacloprid	4.75 b	32.75 b	67.25 b	84.17 a	78.54 a	72.75 a
Control	29.75 a	158.75 a	247.00 a	-	-	-
F. value	125.01*	20.69*	129.37*	7.63*	4.31*	17.45*

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table (2). Effect of three oils and Imidacloprid as seed treatment on infestation of faba bean plants by *Aphis craccivora* during 2022 season.

Treatment	Mean no./ 10 leaves after			Reduction% after		
	2 weeks	3 weeks	4 weeks	2 weeks	3 weeks	4 weeks
Camphor oil	3.75 b	43.00 b	54.00 bc	82.38 b	79.09 bc	78.23 ab
Basil oil	4.00 b	44.50 b	61.00 b	80.69 b	78.37 c	75.44 b
Mint oil	3.50 b	41.00 b	61.00 b	83.52 ab	80.09 b	75.59 b
Imidacloprid	2.25 b	33.00 c	47.75 c	89.53 a	83.99 a	80.85 a
Control	21.50 a	206.00 a	249.50 a	-----	-----	-----
F. value	88.45*	2020.55*	427.89*	3.97*	26.53*	4.52*

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

2. Foliar treatments

The effect of three oils and imidacloprid as foliar application on infestation of faba bean plants by *Aphis craccivora* during 2021 and 2022 seasons is shown in Tables (3) and (4). Statistical analysis of the obtain data showed that all foliar treatments reduced aphid infestation of faba bean plants by aphid stages in both seasons of the study.

After the first spray (30th October), imidacloprid recorded the highest mean reduction compared to the three tested oils in both seasons of the study, with 95.91% and 88.01% in the two seasons, respectively, after one week from treatment, and 91.02% and

81.26% in the two seasons, respectively, after two weeks from treatment. Basil oil recorded the lowest reduction percentages of 73.54% and 70.19% after 1 and 2 weeks, respectively, from the first spray in 2021 season, while in 2022 season, no significant differences among the three oils were observed in the second season.

After the second spray (13th November) high reduction percentages were obtained from imidacloprid and the three oils without significant differences in both seasons of the study. The same trend was obtained for reduction on aphid infestation after the third spray (27th December).

Table (3). Effect of three oils and Imidacloprid as foliar treatment on infestation of faba bean plants by *Aphis craccivora* during 2021 season.

Treatment	Reduction %						
	1 st spray		2 nd spray		3 rd spray		
	6 th Nov.	13 th Nov.	20 th Nov.	27 th Nov.	4 th Dec.	11 th Dec.	18 th Dec.
Camphor oil	74.53 bc	73.63 b	99.11 a	98.52 b	98.67 a	88.49 a	100.00 a
Basil oil	73.54 c	70.19 c	99.24 a	99.51 a	97.44 a	94.91 a	96.87 a
Mint oil	77.79 b	74.89 b	98.80 a	99.67 a	96.38 a	97.32 a	100.00 a
Imidacloprid	95.91 a	91.02 a	99.37 a	99.62 a	97.10 a	96.87 a	100.00 a
F. value	89.286*	76.662*	1.162 NS	15.076*	0.301 NS	2.024 NS	1.00 NS

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table (4). Effect of three oils and Imidacloprid as foliar treatment on infestation of faba bean plants by *Aphis craccivora* during 2022 season.

Treatment	Reduction %						
	1 st spray		2 nd spray		3 rd spray		
	6 th Nov.	13 th Nov.	20 th Nov.	27 th Nov.	4 th Dec.	11 th Dec.	18 th Dec.
Camphor oil	75.10 b	72.93 b	98.04 a	96.34 a	99.66 a	96.81 a	100.00 a
Basil oil	77.72 b	72.16 b	97.01 a	95.64 a	98.26 a	96.38 a	98.01 a
Mint oil	79.74 b	70.11 b	98.36 a	96.31 a	97.78 a	96.60 a	100.00 a
Imidacloprid	88.01 a	81.26 a	96.93 a	96.65 a	99.54 a	94.85 a	100.00 a
F. value	5.381*	5.840*	0.651 NS	0.212 NS	1.014 NS	0.161 NS	1.00 NS

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

From the previous results, it is clear that the use of 2 to 3 sprays with camphor, basil and mint oils can give a satisfied control of *A. craccivora* in comparing with the chemical insecticide imidacloprid under the experimental conditions.

In previous studies, imidacloprid proved to be one of the most effective insecticides in *A. craccivora* when sprayed on plants in field (Kumar and Bhattacharya, 2019), Moustafa *et al.* (2022) found that imidacloprid was able to keep the reduction percentage of *A. craccivora* above 90% as well as, the use of essential oils in control of aphid was reported by many authors (Adly and Bakr, 2016 and Mohapatra *et al.*, 2021).

3. Mean numbers of *Aphis craccivora*

Data in Tables (5) and (6) show the population density of *Aphis craccivora* during 2021 and 2022 seasons, respectively. Data indicated that the infestation by aphid started with a lower level in all seed treatments compared to control in both seasons. After that the number of aphid slowly increased by time in seed treatments compared to control in both seasons. The three foliar application of the three oils or insecticide clearly suppress *Aphis craccivora* number increase in both seasons. Depending on mean number of aphid counted all over the two seasons, the three oils or insecticide showed a good management of *Aphis craccivora*

with seed treatment plus two or three foliar applications. In the first season imidacloprid recorded the lowest mean number of aphid followed in significantly by camphor and mint oils, however, no significantly differences were found with the three oils in the second season.

Camphor oil, basil oil, mint oil and imidacloprid recorded 17.25, 19.95, 17.60 and 12.13 aphids/ 10 leaves, respectively comparing with 222.90 aphids/ 10 leaves in control in 2021 season, and 13.05, 14.43, 13.85 and 10.05,

respectively comparing with 192.95 aphids/ 10 leaves in control in 2022 season.

In previous studies, Mossa (2016) reported that essential oils have insecticidal, antifeedant, fumigant, repellent and attractive activities against a broad spectrum of insects. Ibrahim *et al.* (2018) found that both of insecticides and oils reduced aphid number in the field. Also, Bezerra *et al.* (2023) suggested that essential oils can use as a natural insecticide for the control of the black aphid.

Table (5). Effect of different management types on mean numbers of *Aphis craccivora* stages infesting faba bean plants during 2021 season.

Treatment	Mean no./ 10 leaves										Mean
	Sampling dates										
	Oct. 2021			Nov. 2021				Dec. 2021			
	16	23	30	6	13	20	27	4	11	18	
Camphor oil	6.00	35.50	68.25	28.50	30.25	0.75	2.00	0.25	1.00	0.00	17.25 ab
Basil oil	6.75	38.25	77.75	34.25	39.75	0.75	0.75	0.25	0.75	0.25	19.95 b
Mint oil	5.75	34.00	74.75	26.75	32.25	1.00	0.50	0.50	0.50	0.00	17.60 ab
Imidacloprid	4.75	32.75	67.25	4.50	10.25	0.50	0.50	0.25	0.50	0.00	12.13 c
Control	29.75	158.8	247.0	408.0	417.3	365.3	492.5	47.50	43.50	19.50	222.90 a
F. value	-	-	-	-	-	-	-	-	-	-	1925.34*

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table (6). Effect of different management types on mean numbers of *Aphis craccivora* stages infesting faba bean plants during 2022 season.

Treatment	Mean no./ 10 leaves										Mean
	Sampling dates										
	Oct. 2022			Nov. 2022				Dec. 2022			
	16	23	30	6	13	20	27	4	11	18	
Camphor oil	3.75	43.00	54.00	13.00	12.75	1.25	2.00	0.25	0.50	0.00	13.05 b
Basil oil	4.00	44.50	61.00	13.75	14.00	2.25	2.75	1.25	0.50	0.25	14.43 b
Mint oil	3.50	41.00	61.00	12.25	15.50	1.25	2.00	1.50	0.50	0.00	13.85 b
Imidacloprid	2.25	33.00	47.75	5.75	7.50	1.75	1.50	0.25	0.75	0.00	10.05 b
Control	21.50	206.0	249.5	255.0	229.0	308.8	250.3	299.5	79.50	30.50	192.95 a
F. value	----	----	----	----	----	----	----	----	----	----	258.73*

Means in each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

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تأثير بعض المواد الآمنة على مكافحة حشرة المن التي تصيب نباتات الفول الرومي تحت الظروف الحقلية

محمد عبد المعطى احمد ابو الفضل^(١)، عصمت احمد السليماني^(١)، سماح زكريا الخولى^(٢)

^(١) قسم افات الخضر والنباتات الطبية والعطرية والزينة، مركز البحوث الزراعية، معهد بحوث وقاية النباتات، دقى، جيزة، مصر

^(٢) قسم اكاروس الخضر، مركز البحوث الزراعية – معهد بحوث وقاية النباتات – دقى - جيزة - مصر

الملخص العربى

يعتبر الفول من اهم المحاصيل البقولية وتعد من أهم مصادر البروتين المعتمد عليه بشكل كبير فى مصر ويصاب بالعديد من الآفات التى من أهمها آفة حشرة المن *Aphis craccivora* ذات التأثير الضار جدا على هذا النبات مباشرة بالتغذية على العصارة وغير مباشر بنقل الامراض الفيروسية وافراز الندوة العسلية والتى تؤدى لحدوث الأمراض الفطرية والبكتيرية ولذلك تم اجراء هذا البحث فى قرية سنجرج مركز منوف محافظة المنوفية على محصول الفول صنف Sakiz خلال موسمى ٢٠٢١ / ٢٠٢٢ لبيان مدى تأثير بعض الزيوت الآمنة على هذه الآفة . وفى هذه الدراسة تمت معاملة بذرة الفول المنبثة بثلاث أنواع من الزيوت وهى زيت الكافور وزيت النعناع وزيت الريحان ومبيد الجاوشو(أميداكلوبرايد) وتم زراعة الفول فى الارض المستديمة وبعد الانبات وظهور الاوراق الحقيقية تم فحص النباتات بشكل دورى لبيان تأثيرها على حشرة المن لمدة اربعة اسابيع وكذلك تم معاملة النباتات بعد اربعة اسابيع من الزراعة بهذه الزيوت السابقة الذكر مع مبيد يحتوى على المادة الفعالة أميداكلوبرايد لبيان اى المواد ذات تأثير الاقوى والافضل فى خفض تعداد حشرة المن على نبات الفول مقارنة بمعاملة الكنترول لبيان انسب الطرق المستخدمة بشكل آمن وذلك خلال موسمى الدراسة ٢٠٢١/٢٠٢٢ وتم اخذ النتائج وتبين الاتى :

الموسم الاول: كانت النتائج واضحة فى أن استخدام هذه المواد المختبرة فى معاملة البذور أدت الى خفض تعداد الآفة بشكل معنوي وكانت النسب متقاربة حيث كان المبيد أعلى تأثيرا بنسبة خفض ٨٤,١٧,٧٨,٥٤,٧٢,٧٥ ٪ على التوالى طوال ايام الفحص يلية زيت النعناع بنسب متقاربة مع المبيد ٨١,٢٧, ٧٧,٣٥, ٦٩,٥ ٪ على التوالى ، يتبعه زيت الكافور واخيرا زيت الريحان. كان متوسط تعداد حشرة المن بعد المعاملة على المجموع الخضرى للمبيد ١٢,١٣ يلية زيت الكافور ١٧,٢٥ يلية زيت النعناع ١٧,٦٠ واخيرا زيت الريحان ١٩,٩ / ١٠ أوراق مقارنة بالكنترول الذى كان متوسط تعداد المن ٢٢٢,٩٥ طور لحشرة المن / ١٠ أوراق.

الموسم الثانى: اوضحت النتائج أن المبيد كان أعلى تأثيرا بنسبة خفض ٨٩,٥٣, ٨٣,٩٩, ٨٠,٨٥ ٪ على التوالى طوال ايام الفحص ، يلية زيت النعناع بنسب متقاربة مع المبيد ٨٣,٥٢, ٨٠,٠٩, ٧٥,٥٩ ٪ على التوالى ، يتبعه زيت الكافور واخيرا زيت الريحان . كما ان متوسط تعداد حشرة المن بعد المعاملة كان للمبيد ١٠,٠٥ ، يلية زيت الكافور ١٣,٠٥ يلية زيت النعناع ١٣,٥٨ واخيرا زيت الريحان ١٤,٤٣ طور من حشرة المن / ١٠ أوراق مقارنة بالكنترول الذى كان متوسط تعداد الآفة به ١٩٢,٩٥ / ١٠ أوراق.

واخيرا توصى الدراسة باستخدام الزيوت المختبرة لمكافحة آفة المن *Aphis craccivora* على نبات الفول لنتائجها الممتازة فى خفض تعداد المن وكذلك تأثيرها الأمن على صحة الانسان .

الكلمات المفتاحية: حشرة المن، نبات الفول الرومى، زيت الريحان، زيت النعناع، زيت الكافور، مبيد اميداكلوبرايد .