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## Influence of Two Varieties of Broad Bean and *Beauveria bassiana* (Blas) on *Aphis fabae* scop. Under Field Conditions

### Abstract

Black bean aphid (*Aphis fabae* scop.), belongs to order Hemiptera and family Aphididae, is one of the important pests of the Fabaceae family. *Beauveria bassiana* is an important biocontrol agent to replace chemical insecticides. Therefore, in this research, two different varieties of broad bean with three different concentrations of *B. bassiana* were investigated on adults of fabae aphids under field conditions. After 3, 5, 7, and 14 days, the effect of the *B. bassiana* on the population of aphids was measured. The local variety was found to be more sensitive to the aphids compare with the Spain variety. In the high concentration (108 spores/ml), 80% mortality was obtained with *B. bassiana* in day 3 with local variety; then mortality increased after 5, 7, and 14 days of measuring the population of the adults. Mortality declined with the decrease in concentrations. The Spain variety was found to be resistance because fewer aphids were recorded compared to the local variety. In the highest concentration and day 14, mortality was 100%. The achieved results showed that *B. bassiana* can be used as a potential biocontrol agent for the management of black bean aphid in the fields.

### Keywords

Biocontrol, Entomopathogenic fungi, Mortality, Variety, *Vicia faba*

RESEARCH ARTICLE

# Influence of Two Varieties of Broad Bean and *Beauveria bassiana* (Blas) on *Aphis fabae* scop. Under Field Conditions

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## ABSTRACT

Black bean aphid (*Aphis fabae* scop.), belongs to order Hemiptera and family Aphididae, is one of the important pests of the Fabaceae family. *Beauveria bassiana* is an important biocontrol agent to replace chemical insecticides. Therefore, in this research, two different varieties of broad bean with three different concentrations of *B. bassiana* were investigated on adults of fabae aphids under field conditions. After 3, 5, 7, and 14 days, the effect of the *B. bassiana* on the population of aphids was measured. The local variety was found to be more sensitive to the aphids compare with the Spain variety. In the high concentration ( $10^8$  spores/ml), 80% mortality was obtained with *B. bassiana* in day 3 with local variety; then mortality increased after 5, 7, and 14 days of measuring the population of the adults. Mortality declined with the decrease in concentrations. The Spain variety was found to be resistance because fewer aphids were recorded compared to the local variety. In the highest concentration and day 14, mortality was 100%. The achieved results showed that *B. bassiana* can be used as a potential biocontrol agent for the management of black bean aphid in the fields.

**Keywords:** Biocontrol; Entomopathogenic fungi; Mortality; Variety; *Vicia faba*

## INTRODUCTION

Black bean aphids are the most damaging pests of *Vicia faba*, in many countries. Because severe harm to Fabaceae plants, when an infestation of the crop occurs before flowering, some plants can be killed by direct feeding (Shannag, 2007).

Environmental and health problems have arisen due to using chemical pesticides throughout the world. Entomopathogenic fungi are an environmentally friendly and more approachable alternative to chemical pesticides. They are natural, less toxic with no residual activity, easy to formulate (Korunić, 2013), and less chance to develop resistance (Gould et al., 1991). *Beauveria bassiana* has a wide host range (Maurer et al., 1997), parasitizing insects and killing or disabling them (Butt et al., 2001; Grund and Hirsch, 2011). *B. bassiana* is widely distributed in all regions of the world and can be easily isolated (Akmal et al., 2013). It is also cheap to produce in large quantities and easy to store (Mascarin and Jaronski 2016).

*B. bassiana* has proved effective in controlling aphids, even chemical pesticide-resistant strains (Maina et al., 2018), and some strains are already available commercially for the control of various species of insects (Samish et al., 2004).

Previous studies regarding the efficacy of diverse fungal isolates for the management of aphids have shown greater success (Knudsen et al., 1990; Wang and Knudsen, 1993; James et al., 1995; Thungrabeab, 2007; Sayed et al., 2018).

Resistant faba bean cultivars against aphids have been developed, such as *V. faba* Minor, which are tolerant and resistant to *Aphis fabae* (Fouad and Malik 2016). However, aphids can be infested most develop cultivars; therefore, the studies of resistant mechanisms of other faba bean cultivars are directly needed. In the Kurdistan Region, very little is known on relationship between the broad bean cultivars and the *A. fabae* scop. performance. Due to the increasing threats of aphids and indirect damage by the pesticides, a study was planned to check the possible resistance traits in two selected broad bean cultivars against *A. fabae* scop in combination with different concentrations of *B. bassiana*.

## MATERIALS AND METHODS

The study was carried out in 2016–2017 in Khabat Technical Institute fields. Two cultivars of broad (local and Spain) varieties were selected. The experiment was

arranged in a randomized complete block design (RCBD) with three blocks; each block contains eight treatments (two cultivars with three concentrations of *B. bassiana* and one control). Plots were rectangular (1×1.5 m<sup>2</sup>), contains four lines, each line with ten plants, the distance between blocks was 1 m. The planting was started in November, and the treatments were applied on the March 1 and repeated once again on the March 15.

A fungal culture of *B. bassiana* was obtained from the College of Agriculture at Baghdad University. It was maintained by transferring once every 2 weeks on Sabouraud Dextrose Agar supplemented with 2% yeast extract at 25°C. For field tests, conidia were harvested by scraping from culture surfaces in Petri dishes. For suspension treatments, spores were suspended and mixed with 0.1% Tween 80 and vortexed for 2 min.

Suspension at the concentrations zero (only distilled water with 0.1% Tween 80) as control; 1×10<sup>2</sup>; 1×10<sup>4</sup>; and 1×10<sup>8</sup> were prepared and applied by spray method on plants until the plants got wet using pump pressure water sprayers – 2L. The data were collected by taking leaves after 3, 5, 7, and 14 days of spraying the fungal suspension as noted above.

From each treatment, five plants were randomly selected and labeled for recording the aphid observations. The black aphid identified by Dr. Hisamadin Abdulla Mohamed form College of Agriculture, Baghdad University, the population was recorded on each selected plant, and mean number of aphids per plant was worked out. The aphid population was transferred to the mortality using Abbott's formula (Abbott, 1925):

$$\text{Mortality \%} = \frac{X - Y}{100 - Y} \times 100$$

Where X = Percentage mortality in the treated sample and Y = Percentage mortality in the control.

### Data Analysis

The relationship between concentrations and mortality is analyzed using ANOVA and the RCBD. Thus, it means that

it was compared using Duncan's multiple range test and significant differences at 5% probability (Ferreira, 2011).

## RESULTS AND DISCUSSION

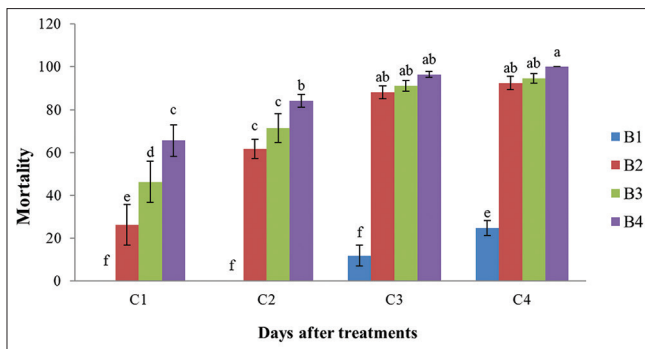
Fungal treatment showed significant mortality of *A. fabae* at 3, 5, 7, and 14 days post-inoculation with 1×10<sup>2</sup>, 1×10<sup>4</sup>, and 1×10<sup>8</sup> conidia/ml suspension of *B. bassiana* recorded [Table 1 and Figure 1]. In local variety, the minimum mortality of the aphides (41.94%) was obtained at 3<sup>rd</sup> day after treatment in concentration 1×10<sup>2</sup>. Then, the mortality was increased at 5, 7, and 14 days (60.14, 85.97, and 92.91%), respectively, with the same concentration, while maximum mortality of 100% was obtained with concentration 1×10<sup>8</sup> at 14 days post-inoculation.

The Spain variety was more resistance to the aphids compare with the local variety because the lowest population of aphids was recorded. The fungal application showed effectiveness after 3 days in concentration (1×10<sup>2</sup> conidia/ml), which gave 10.66% mortality, while maximum mortality of 100% was recorded days post-inoculation at concentration (1×10<sup>8</sup>) conidia/ml. No mortality was recorded after 3 and 5 days inoculation, while in contrast to this, mortality was recorded after 7 and 14 days reached 14.30% and 27.36%, respectively. The cumulative corrected mortality 100% at highest concentration (1×10<sup>8</sup> conidia/ml) on day 14 after treatment (100%) whereas at lowest concentration (1×10<sup>2</sup> conidia/ml), it was 92%. It is evident from the data; mortality decreased with reduced conidial concentration. As the concentration of conidia of *B. bassiana* increased from 1×10<sup>2</sup> to 1×10<sup>8</sup>, the mortality also improved from 0.0% to 79.3% at day 3. Furthermore, the mortality increased from 60.14% to 87.36% at day 5, from 85.97% to 97.22% at day 7, and from 92.91% to 100% at day 14 in the local variety. For the Spain variety, similarly when the concentration of conidia of *B. bassiana* increased from 1×10<sup>2</sup> to 1×10<sup>8</sup>, the mortality also increased from 10.66% to 51.86% at day 3. Moreover, the mortality increased from 63.20% to 80.8% at day 5, from 90.40% to 97.33% at day 7, and from 92% to 100% at day 14.

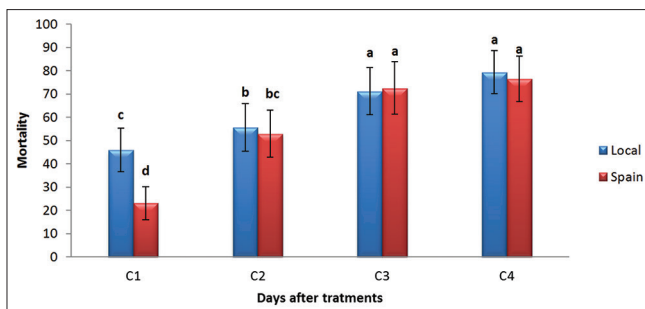
**Table 1: Effects of *Beauveria bassiana* on two different varieties of broad bean aphid mortality**

Variety	Concentration	Day 3	Day 5	Day 7	Day 14
Local	B1	0.0 <sup>l</sup>	0.0 <sup>l</sup>	14.30±4.9 <sup>l</sup>	27.36±0.207 <sup>l-k</sup>
	B2	41.94±10.96 <sup>h,i</sup>	60.14±4.75 <sup>l,g</sup>	85.97±3.88 <sup>a-c</sup>	92.91±5.14 <sup>a-c</sup>
	B3	62.64±5.71 <sup>e-g</sup>	75.00±6.41 <sup>c-f</sup>	89.16±3.44 <sup>a-c</sup>	97.22±1.83 <sup>ab</sup>
	B4	79.30±4.7 <sup>b-f</sup>	87.36±3.04 <sup>a-c</sup>	97.22±1.2 <sup>ab</sup>	100 <sup>a</sup>
Spain	B1	0.0 <sup>l</sup>	0.0 <sup>l</sup>	9.33±9.31 <sup>kl</sup>	22.13±7.21 <sup>jk</sup>
	B2	10.66±9.49 <sup>k,l</sup>	63.20±8.8 <sup>e-g</sup>	90.40±4.99 <sup>a-c</sup>	92±4.61 <sup>a-c</sup>
	B3	29.87±12.81 <sup>l,j</sup>	67.73±13.35 <sup>d-g</sup>	92±4 <sup>a-c</sup>	93.07±3.58 <sup>a-c</sup>
	B4	51.86±7.7 <sup>g,h</sup>	80.8±5.2 <sup>a-e</sup>	97.33±2.66 <sup>ab</sup>	100 <sup>a</sup>

Means in the table followed by different letters are significantly difference. B1=Control; B2=1 × 10<sup>2</sup>; B3=1 × 10<sup>4</sup>; B4=1 × 10<sup>8</sup>



**Figure 1: Aphids mortality on the broad bean leaves treated with different concentrations of *Beauveria bassiana* after 3, 5, 7, and 14 days of treatment**



**Figure 2: Number of aphids mortality on the two varieties of broad bean leaves treated with different concentrations of *B. bassiana***

The obtained results show that the fungus induced high mortality against black bean aphids. These results agree with Feng et al. (1994) who reported that *B. bassiana* has been widely used as antagonistic fungal agents against aphids. Furthermore, Vega (2018) studied the effects of the entomopathogenic fungus, *B. bassiana*, on the adult broad bean aphid declared that the  $LC_{50}$  and  $LC_{90}$  were 35.778 and 361.799 spores/ml, respectively, against the adult aphid. All fungal concentrations ( $1 \times 10^2$ ,  $1 \times 10^4$ , and  $1 \times 10^8$ ) after 4 days of direct treatments, caused significant mortality ranged between 26.67% and 80% (Wafaa et al., 2017).

The field trial results of this study, using *B. bassiana*, are similar to those of McKinnon et al. (2017) in which whole broad bean plants were inoculated with *B. bassiana* as an endophyte through spraying, resulting in negative effects on aphid choice and performance. Pathogenicity of *B. bassiana* strain used against cotton aphids in a survival experiment where 60% and 57% of treated aphids, respectively, died from infection over 7 days versus 10% mortality among control insects (Lopez et al., 2015).

Similarly, Lopez (2015) showed that *A. fabae* feeding on bean plants colonized independently by strains of either *B. bassiana*, *Trichoderma asperellum* or *Gibberella moniliformis* reproduced poorly compared to those on control plants. Aphid's feeding on cotton leaves colonized

by *B. bassiana* slowed aphid reproduction (Gurulingappa et al., 2010).

The 1<sup>st</sup> day of taking data (day 3), the mortality was less compared to days 5, 7, and 14 which increased, respectively. The overall mortality rate was between 20% and 100%. There was statistically significant association of days 3 and 14 with mortality [Figure 1]. The results of this study are similar to Saranya (2009) who studied the biocontrol of cowpea aphid *Aphis craccivora* (koch) using entomopathogenic fungi.

There was strong link between concentrations of *B. bassiana* and aphids mortality [Figure 2]. The lowest concentration ( $1 \times 10^2$ ) showed the lowest mortality and the highest concentration ( $1 \times 10^8$ ) showed the highest mortality, and there was a significant difference between them.

The results were similar to Selvaraj et al. (2012); they reported that when the conidial spore concentration increased, the mortality of aphids also increased. The highest concentration caused maximum cumulative after treatment compared to the lowest concentration.

## CONCLUSION

The results have been obtained with the use of *B. bassiana* for control of broad bean aphid show a promising level of activity. The Spain variety is more resistance compare with the local variety. Mortality of *A. fabae* at day 14 post-inoculation with  $1 \times 10^8$  conidia/ml suspension is the best time and concentration to control aphids. The findings of this study suggest that *B. bassiana* has virulent and highly potential for biological control on *A. fabae*.

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