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Compatibility of entomopathogenic fungus *Beauveria bassiana* (Balsamo) Vuillemin with different insecticides

KN Savariya and DM Jethva

Abstract
Compatibility of *B. bassiana* was studied in the laboratory condition with five commonly used insecticides with their three doses by poison food technique. It showed that the carbosulfan 25 EC @ 0.017%, acetamiprid 20 SP @ 0.004%, fipronil 5 SC @ 0.004% and lambda cyhalothrin 5 EC @ 0.001% at lower dose was rated as relatively harmless (Grade 1) and it compatible with *B. bassiana*, while carbosulfan 25 EC @ 0.050% at higher dose and acetamiprid 20 SP @ 0.008% and fipronil 5 SC @ 0.008% at recommended dose were "slightly harmful" (Grade 2) to *B. bassiana*. Imidacloprid 17.8 SL @ 0.009%, acetamiprid 20 SP@ 0.012%, fipronil 5 SC @ 0.012% and lambda cyhalothrin 5 EC @ 0.004% at higher dose were found "moderately harmful" (Grade 3) and lambda cyhalothrin 5 EC @ 0.004% at higher dose showed "harmful" (Grade 4) to growth of *B. bassiana*.

Keywords: Bio-efficacy, *B. bassiana*, compatibility, garlic, *T. tabaci*

Introduction
Beauveria bassiana (Balsamo) Vuillemin (Hypocreales: Clavicipitaceae) is a registered bio-pesticide with a broad host range of approximately 700 insect species used for management of several crop insect pests. It is also very effective and widely used bio-pesticide, which controls various pests of different crops (Ramesh *et al.*, 1999) [12]. It can be developed in laboratory for use as myco-insecticidal agent. Parameswaran and Sankaran (1977) [10] have first time recorded of this fungus occurring naturally in India. Rao (1975) [13] reported the effectiveness of *B. bassiana* on more than 150 insect species. Likewise Dutky (1959) [6] stated that with its wide undefined host range, *B. bassiana* referred as "Magnificant pathogen". The target pests must come into contact with the fungal spores after direct application, movement on treated surface or bodily contact with other target pests already exposed (Horizontal transfer) (Wright and Kennedy, 1996) [14].
Infection by this fungus has generally been regarded to occur as a result of direct penetration into the integument by growing hyphae (Ferron, 1978) [7] and appears to be facilitated by both the mechanical and enzymatic activity. Hyphae penetrate into the skin and reach to the endo and hypodermis, and finally to the alimentary canal in the form of mycelial network. Due to rupturing and irregular growth, the insect may dies. This fungus produces a toxic substance "Beauvericine" which causes the death. Penetration through the alimentary tract (Broome *et al.*, 1976) [3] and respiratory system (Clark *et al.*, 1968) [4] has also been reported.
Though the use of entomopathogenic fungi in Integrated Pest Management (IPM) is increasing now-a-days, its potential is still left untapped. To achieve full potentiality of entomopathogenic fungi in IPM, incorporation of highly virulent, stable and target-specific isolates which have compatibility with the insecticides targeted against such pests is must. Hence an experiment was planned to identify the compatibility of six different strains or isolates of *Beauveria bassiana* with commonly used insecticides targeted against *S. litura*.
Pesticides are undoubtedly effective for averting pest attacks on garlic, but indiscriminate use of chemical insecticides has created many adverse effects resulting into environmental problems, health hazards and poor quality due to chemical residues. To overcome these problems, it is necessary to explore eco-friendly management of this pest without having harmful effects and can be well suited in the Integrated Pest Management programme.

Materials and Methods

1. Location : Bio-control Research Laboratory, Department of Agricultural Entomology, COA, Junagadh Agricultural University, Junagadh
2. Design : CRD
3. Replications : 9
4. Treatments : 16

The insecticides selected for compatibility study were among those commonly used for pest management. The effect of these insecticides on the growth inhibition of *B. bassiana* was evaluated. The insecticides doses were calculated on the basis of lower, recommended and higher for field application rate. Five insecticides with three doses were evaluated by poison food technique described by Dhingra and Sinclair (1986) [5] in Potato Dextrose Agar (PDA) medium. Twenty ml of PDA medium was sterilized in individual boiling tubes and the insecticide emulsions of required concentration (lower, recommended and higher) were incorporated into the melted sterile PDA aseptically, thoroughly mixed, poured into 9 cm diameter sterile petri dishes and allowed to solidify under laminar flow cabinet. An agar disc along with mycelium mat of *B. bassiana* was cored from the periphery of 10 days old colony of *B. bassiana* by 10 mm diameter cork borer and transferred into the center of the PDA plate. Growth medium (PDA) without insecticide but inoculated with mycelial disc served as untreated check.

The growth of entomogenous fungus was recorded, when full growth obtained with control (10th day of inoculation). After that the growth observed on the medium was recorded and following grades was given.

Grades	Percent Growth
0	0%
1	1-20%
2	21-40%
3	41-60%
4	61-80%
5	81-100%

The grades given after the observed growth was subjected for the calculation of the growth inhibition percentage of *B. bassiana* by using following formula.

$$X = \frac{Y - Z}{Y} \times 100$$

Where,
X- Percent growth inhibition
Y- Grade obtained to the growth in control plate
Z- Grade obtained to the growth in treated plate

The growth inhibition of the fungus obtained from each treatment and it will be further classified in evaluation categories of following 1- 4 grades in toxicity tests *in vitro* according to Hassan's classification scheme (Hassan, 1989) [8].

Scoring Index	Toxicity
1	Harmless (<50% reduction in beneficial capacity)
2	Slightly harmful (50-79%)
3	Moderately harmful (80-90%)
4	Harmful (>90%)

Results and Discussion

The effects of insecticides on the mycelial growth of *B. bassiana* are shown in Table 3 and depicted in. All the treatments showed significant differences relating to control.

Growth inhibition (%)

The present study on growth inhibition of *B. bassiana* revealed that among the selected insecticides (Table 3 and Fig. 2), lower dose of fipronil 5 SC @ 0.80 ml/litre showed the lowest (7.33%) growth inhibition, which was at par with carbosulfan 25 EC @ 0.68 ml/litre (9.67%). It was followed by imidacloprid 17.8 SL @ 0.16 ml/litre, which recorded 24.33% growth inhibition. Imidacloprid 17.8 SL @ 0.33 ml/litre (32.67%), acetamiprid 20 SP @ 0.20 g/litre (33.67%), lambda cyhalothrin 5 EC @ 0.20 ml/litre (34.00%) and carbosulfan 25 EC @ 1.32 ml/litre (44.67%) showed slightly growth inhibition hence, it categorized as "Harmless", as it inhibited less than 50% growth inhibition. Acetamiprid 20 SP @ 0.40 g/litre (37.67%), fipronil 5 SC @ 1.60 ml/litre (63.33%) and carbosulfan 25 EC @ 2.00 ml/litre (65.33%) showed slight inhibition of growth, hence its categorized as "Slightly harmful" (50-79% growth inhibition). Lambda cyhalothrin 5 EC @ 0.60 ml/litre (82.67%), acetamiprid 20 SP @ 0.60 g/litre (85.33%), imidacloprid 17.8 SL @ 0.50 ml/litre (87.00%) and fipronil 5 SC @ 2.40 ml/litre (87.33%) showed 80-90% growth inhibition hence, it categorized as "moderately harmful". While, Lambda cyhalothrin 5 EC @ 0.80 ml/litre showed significantly the highest (93.67%) growth inhibition hence, it categorized as "Harmful" (>90% growth inhibition). As result revealed by Patel D. S. *et al.* (2020) [11] that carbosulfan 25 EC 0.050% caused the highest growth inhibition with 95.83%, imidacloprid 17.8 SL 0.005% caused 43.33% and Acetamiprid 20 SP 0.009% had the growth inhibition of 83.33%.

Table 1: Effect of insecticides on the growth of *B. bassiana*

Sr. No.	Treatments	Growth inhibition (%)	*Grade	Dose/litre
1	Carbosulfan 25 EC @ 0.017%	18.12 (9.67)	1	0.68 ml
2	Carbosulfan 25 EC @ 0.033%	41.94 (44.67)	1	1.32 ml
3	Carbosulfan 25 EC @ 0.050%	53.93 (65.33)	2	2.00 ml
4	Imidacloprid 17.8 SL @ 0.003%	29.55 (24.33)	1	0.16 ml
5	Imidacloprid 17.8 SL @ 0.006%	34.86 (32.67)	1	0.33 ml
6	Imidacloprid 17.8 SL @ 0.009%	68.87 (87.00)	3	0.50 ml
7	Acetamiprid 20 SP @ 0.004%	35.47 (33.67)	1	0.20 g
8	Acetamiprid 20 SP @ 0.008%	37.86 (37.67)	2	0.40 g
9	Acetamiprid 20 SP @ 0.012%	67.48 (85.33)	3	0.60 g
10	Fipronil 5 SC @ 0.004%	15.71 (7.33)	1	0.80 ml

11	Fipronil 5 SC @ 0.008%	52.73 (63.33)	2	1.60 ml
12	Fipronil 5 SC @ 0.012%	69.15 (87.33)	3	2.40 ml
13	Lambda cyhalothrin 5 EC @ 0.001%	35.67 (34.00)	1	0.20 ml
14	Lambda cyhalothrin 5 EC @ 0.003%	65.40 (82.67)	3	0.60 ml
15	Lambda cyhalothrin 5 EC @ 0.004%	75.43 (93.67)	4	0.80 ml
16	Untreated control	0.00 (0.00)	1	-
S.Em.±		0.87		
C.D. at 5%		2.43		
C.V.%		5.81		

Data in parenthesis are original values, while outside values are arcsine transformed.
Local strain of *B. bassiana* @ 2×10^6 cfu/g was used.
*Grades: 1 = Harmless (<50% reduction in beneficial capacity), 2 = Slightly harmful (50-79%), 3 = Moderately harmful (80-90%), 4 = Harmful (>90%).

Grading

The present results showed that lower dose of all treatments were harmless and gave less than 50% of growth inhibition (Grade 1). The recommended dose of carbosulfan 25 EC @ 1.32 ml/litre and imidacloprid 17.8 SL @ 0.33 ml/litre showed less than 50% growth inhibition of *B. bassiana* (Grade 1), while acetamiprid 20 SP @ 0.40 g/litre and fipronil 5 SC @ 1.60 ml/litre showed slightly harmful (Grade 2) and lambda cyhalothrin 5 EC @ 0.60 ml/litre showed moderately harmful (Grade 3) as per Joshi *et al.* (2018) [9] revealed that 0.60 ml more compatible with *B. bassiana* and showed 23.18% inhibition and 78% spore germination. The higher dose of carbosulfan 25 EC @ 2.00 ml/litre was slightly harmful (Grade 2), imidacloprid 17.8 SL @ 0.50 ml/litre, acetamiprid 20 SP @ 0.60 g/litre and fipronil5 SC @ 2.40 ml/litre showed moderately harmful (Grade 3) and lambda cyhalothrin 5 EC @ 0.80 ml/litre showed harmful (Grade 4).
Present findings showed that imidacloprid at lower and recommended doses were harmless, which is similar to the results of Ali *et al*. (2007) [1], who stated that imidacloprid had no negative effect on *B. bassiana.* The results observed by Amutha *et al.* (2010) [2] are in contrast with present findings who concluded that imidacloprid was found moderately toxic to *B. bassiana,* which may be due to the difference in the strains of the fungus used in both the studies. During these studies imidacloprid was found slightly harmful to tested fungus at higher concentration. The results of Xu-Shou *et al.* (2002) [15] are more or less similar to this result in which imidacloprid exhibited high compatibility with *B. bassiana* germination rates of 90% was noticed even at higher concentration.

Conclusion

Compatibility of *B. bassiana* was studied in the laboratory condition with five commonly used insecticides with their three doses by poisoned food technique. The results showed that the carbosulfan 25 EC and imidacloprid 17.8 SL at lower (0.68 ml/litre and 0.16 ml/litre, respectively) and recommended dose (1.32 ml/litre and 0.33 ml/litre, respectively), acetamiprid 20 SP (0.20 g/litre), fipronil 5 SC (0.80 ml/litre) and lambda cyhalothrin 5 EC (0.20 ml/litre) at lower dose was rated as relatively harmless (Grade 1), while carbosulfan 25 EC (2.00 ml/litre) at higher dose and acetamiprid 20 SP (0.40 g/litre) and fipronil 5 SC (1.60 ml/litre) at recommended dose were "slightly harmful" (Grade 2) to *B. bassiana*. Imidacloprid 17.8 SL (0.50 ml/litre), acetamiprid 20 SP (0.60 g/litre) and fipronil 5 SC (2.40 ml/litre) at higher dose were found "moderately harmful" (Grade 3) and lambda cyhalothrin 5 EC (0.80 ml/litre) at higher dose showed "harmful" (Grade 4).

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