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Bio-efficacy of *Beauveria bassiana* (Balsamo) Vuillemin and different insecticides against *Lipaphis erysimi* (Kaltenbach) under laboratory condition

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Abstract
Background: A laboratory experiment was conducted to determine the bio-efficacy of *B. bassiana* alone and in combination with different insecticides against *Lipapis erysimi* in mustard under laboratory condition at bio-control laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, and Junagadh during 2016-17. The results indicated that the different treatments evaluated for their laboratory efficacy against *L. erysimi* showed that the treatment o*f* imidacloprid 17.8 SL@ 1 ml/litre recorded the highest (94.81%) mortality after 7th day of its application. Whereas, dimethoate 30 EC @1ml/litre and diafenthiuron 50 WP @ 1g/litre found next better treatments with 85.52 and 85.39% nymphal mortality, respectively.

Keywords: *Beauveria bassiana* (Balsamo) Vuillemin, mustard, *Lipapis erysimi*

Introduction
Oilseed crops are next to cereals in production of agricultural commodities in India. They occupy a place of prime importance in Indian economy. The important oilseed crops grown in India are groundnut, sesamum and niger in *kharif* season and mustard, linseed and safflower in *rabi* season. Mustard, *Brassica juncea* (Linnaeus) Czern and Coss is considered to be high economic importance in national and international trade. It is belongs to family cruciferae. It is major source of edible oil. It serves as a high-energy food and is rightly considered as an essential ingredient of human diet. Annual consumption of about 16 kg of edible oil per capita in India (Mehta, 2015) [5]. From nutritional point of view, it contains edible oil ranging from 38 to 46%, 38 to 57% erucic acid, 4.7 to 13% linolenic acid and 27% oleic acid, which are of high nutritive value required for the human body. Mustard oil is also widely used in cooking, frying and as a raw material for agro-based industries engaged in manufacturing of soaps, varnishes, paints, hair oils, medicines, lubricants *etc.* (Patel, 2005) [7]. The residual cake is valuable by-product used as a feed for animals and rich source of organic manure.
Among such eco-friendly approaches, entomopathogenic fungi form one of the most important components which are being employed to control noxious insect pest of mustard ecosystem *viz*., *L. erysimi.* Looking to the importance of *B. bassiana* as a microbial control agent, and seriousness of *L. erysimi* and hazards of chemical pesticides, it is highly necessity to evaluate the bio-efficacy of *B. bassiana* alone and in combination with different insecticides against this pest infesting mustard.

Materials and Methods
The laboratory experiment on mustard (Gujarat mustard 3) was conducted at bio-control laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, and Junagadh during 2016-2017. Fresh mustard leaves were collected from the unsprayed mustard field were washed properly with clean water and air-dried. The spray of each treatment (Table 1) was applied to leaves of mustard separately with the help of atomizer. Care was taken to obtain uniform coverage of insecticide. Treated leaves were allowed to dry under the ceiling fan for 15 minutes. Then cotton plug soaked in water was attached to the cut end of the leaf petiole to avoid desiccation and then leaves were placed in plastic vialthe one day old nymphs of *L. erysimi* were kept in petri dishes. Treated leaves were provided as food for them. Twenty five nymphs per treatment in each repetition were kept. The nymphs were provided with fresh untreated food after 24 hours of feeding on the treated food.

Mortality counts were recorded 1, 3 and 7 days after the treatment. Data on mortality were converted into corrected per cent mortality of the pest in each treatment by using the modified formula given by Henderson and Tilton (1955) [3]. The data thus, obtain were transformed into Arcsin and analyzed statistically. The zero and cent per cent values were removed by the formulae (Bartlett, 1947 and Gomez and Gomez, 1984) [1, 2].

Results and Discussion

The study on bio-efficacy of *B. bassiana* and different insecticides against *L. erysimi* was tested under laboratory condition. A close perusal of nymphal mortality data (Table 2 and Fig. 1) at one day after the treatment indicated that the highest (58.78%) mortality was obtained in the treatment of flonicamid 50 WP @ 0.4 g/litre and it was at par with imidacloprid 17.8 SL @ 1.0 ml/litre (53.35%). The remaining treatments provided lower results having less than 34.00% mortality. *B. bassiana* 1.15% WP @ 5.0 g/litre and *V. lecanii* 1.15% WP @ 5.0 g/litre were found the poorest among all treatments, as initially slow action of fungus against target pest.

The mortality was increased at third day after treatment. The data showed that the highest (85.39%) mortality was obtained in the treatment of imidacloprid 17.8 SL @ 1ml/litre, which was followed by the treatment of flonicamid 50 WP @ 0.4 g/litre caused 84.59% mortality The remaining all the treatments were found next in order, which recorded 37.19 to 57.35% mortality. The acetamiprid 20 SP @ 0.2 g/litre (37.19%) showed the lowest mortality percentage.

Perusal of results (Table 2 and Fig. 1) on mortality of *L. erysimi*at 7 days after treatment revealed that imidacloprid 17.8 SL @ 1.0 ml/litre gave the highest (94.81%) mortality, which was followed by the treatments of flonicamid 50 WP @ 0.4 g/litre (91.10%) mortality. The next better treatments were spiromesifen 240 SC @ 1ml/litre, dimethoate 30 EC @ 1ml/litre, acetamiprid 20 SP @ 0.2 g/litre, diafenthiuron 50 WP @ 1g/litre, carbosulfan 25 EC @ 2 ml/litre, dinotefuran 20 SG @ 0.53 g/litre and *B. bassiana* 1.15 WP @ 5 g/litre as it exhibited 85.39%, 85.52%, 82.5%, 82.85%, 82.71%, 82.71% and 82.71% mortality, respectively. The treatment, *V. lecanii* 1.15 WP @ 5 g/litre and azadirachtin 0.15 EC @ 5 ml/litre were found moderately effective with 76.08% and 78.80% mortality, respectively. The remaining treatment, thiamethoxam 25 WG@ 0.24 g/litre was less effective, as it showed 73.36%mortality.

Thus, this study convinced that the treatment of imidacloprid 17.8 SL @ 1ml/litre found to be the most effective insecticide, as it recorded 94.81% mortality of this pest and it was at par with flonicamid 50 WP @ 0.4 g/litre (91.10%) followed by dimethoate 30 EC @1ml/litre, spiromesifen 240 SC @ 1ml/litre and acetamiprid 20 SP @ 0.2 g/litre. The *B. bassiana*1.15%WP @ 5.00 g/litre showed that the toxicity from 1st day of application, increased gradually in subsequent periods, up to maximum toxicity at 7th day of application and found more or less comparable with chemical insecticides.

In present study, imidacloprid caused 94.81% mortality in *L. erysimi*, which in close agreement with the work of Khalequzzaman and Nahar (2008) [4], who stated that imidacloprid proved to be the most toxic having LC_{50} as 0.41 µg cm^{-2} for *A. craccivora*, 0.34 µg cm^{-2} for *A. gossypii* and 0.44 µg cm^{-2} for both *M. persicae* and *L. erysimi*under laboratory conditions. Parmar and Kapadia (2008) [6] conducted laboratory efficacy analysis of V. lecanii and B. bassiana alone and in combination with reduced dose of two insecticides against third nymphal stage of *Lipaphis erysimi* and concluded that insecticides, imidacloprid 0.005% and acephate 0.05% with *B. bassiana* gave 53.7% mortality of *L. erysimi.* Ye *et al.* (2005) [8] conducted laboratory efficacy of low, medium and high concentration of the fungal biocontrol agent, *B. bassiana* alone or supplemented with an increasing sub-lethal rate of imidacloprid were on chrysanthemum aphid *Macrosiphoniella sanborni* and green peach aphid *Myzuspersicae*. They recorded that combined formulation or application of *B. bassiana* and imidacloprid 17.8 SL 0.005% that manage aphid effectively in laboratory. Thus, these results are in conformity with the present findings.

Table 1: Treatment details

Sr. No.	Treatment	Dose/litre
T_1	*Beauveria bassiana*1.15% WP	5.00 g
T_2	*Verticillium lecanii*1.15% WP	5.00 g
T_3	Acetamiprid 20 SP	0.2 g
T_4	Imidacloprid17.8 SL	0.28 ml
T_5	Dimethoate 30 EC	1.00 ml
T_6	Carbosulfan 25 EC	2.00 ml
T_7	Azadirachtin 0.15 EC	5.00 ml
T_8	Thiamethoxam 25 WG	0.24 g
T_9	Dinotefuran 20 SG	0.53 g
T_{10}	Diafenthiuron 50 WP	1.00 g
T_{11}	Spiromesifen 240 SC	1.00 ml
T_{12}	Flonicamid 50 WP	0.4 g
T_{13}	Control	-

Table 2: Bio-efficacy of *B. bassiana* and different insecticides against mustard aphid under laboratory condition

Sr. No.	Treatments (Dose/litre)	Per cent corrected mortality		
		1 DAS	3 DAS	7 DAS
1.	*Beauveriabassiana*1.15 WP @ 5.0 g	20.09 (11.80)	45.38 (50.67)	65.43 (82.71)
2.	*Verticilliumlecanii*1.15 WP @ 5.0 g	20.09 (11.80)	44.59 (49.23)	60.72 (76.08)
3.	Acetamiprid 20 SP@ 0.2 g	25.57 (18.63)	37.58 (37.19)	65.53 (82.85)
4.	Imidacloprid 17.8 SL @ 1.0 ml	46.92 (53.35)	67.53 (85.39)	76.83 (94.81)
5.	Dimethoate 30 EC @ 1.0 ml	31.08 (26.64)	43.09 (46.66)	67.63 (85.52)
6.	Carbosulfan 25 EC @ 2.0 ml	24.47 (17.15)	44.62 (49.33)	65.43 (82.71)
7.	Azadirachtin 0.15 EC @ 5.0 ml	33.59 (30.61)	47.68 (54.67)	62.58 (78.80)
8.	Thiamethoxam 25 WG @ 0.2 g	31.91 (27.94)	49.23 (57.35)	58.92 (73.36)
9.	Dinotefuran20SG @ 0.53 g	25.57 (18.63)	38.41 (38.60)	65.43 (82.71)
10.	Diafenthiuron 50 WP @ 1.0 g	33.62 (30.65)	46.91 (53.34)	65.53 (82.85)
11.	Spiromesifen 240 SC @ 1.0 ml	35.21 (33.24)	49.23 (57.35)	67.53 (85.39)
12.	Flonicamid 50 WP @ 0.4 g	50.06 (58.78)	66.89 (84.59)	72.64 (91.10)
13.	Control	17.71 (9.25)	25.57 (18.63)	37.66 (37.32)
S.Em. ±		1.82	3.62	2.03
C.D. at 5 %		5.30	10.54	5.89
C.V. %		10.36	11.95	4.41

*Data in the parentheses are original values, while outside values are arcsine transformed.

DAT = Days After Treatment *B. bassiana*2x10^6cfu/g, *V. lecanii*2x10^6cfu/g

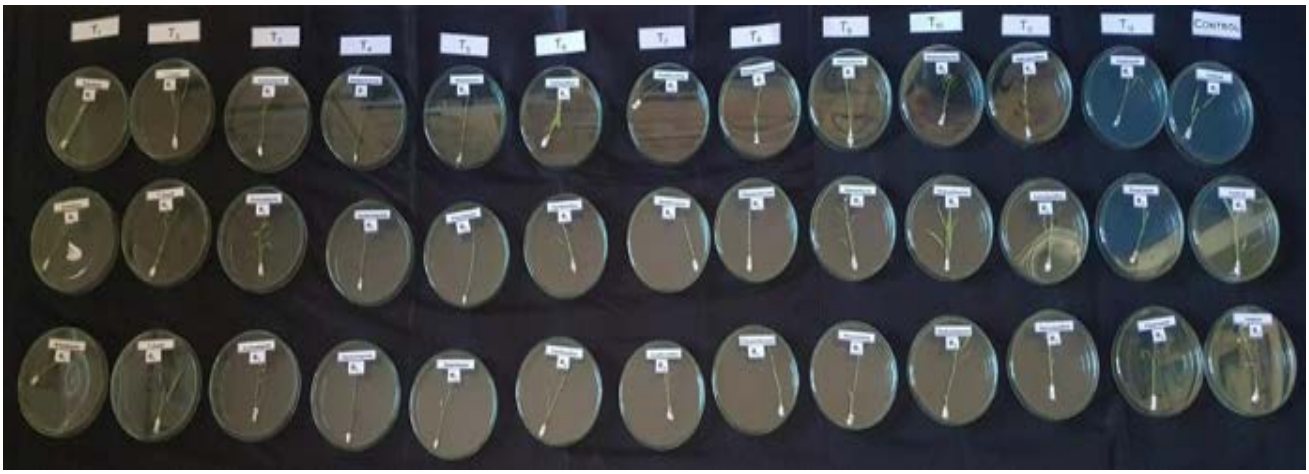

Fig 1: Experimental set up for bio efficacy under laboratory condition

Conclusion

Twelve treatments evaluated for their efficacy against second nymphal instars of *L. erysimi* on mustard under laboratory condition indicated that the highest mortality was achieved in treatment of imidacloprid 17.8 SL @ 1ml/litre and flonicamid 50 WP @0.4g/litre, as they registered 94.81% and 91.10% mortality, respectively at seven days after treatment. Dimethoate30 EC @ 1ml/litre (85.52%), diafenthiuron 50 WP @ 1g/litre(82.85%),*B. bassiana* 1.15% WP @ 2.5 g/litre, carbosulfan 25 EC @ 2 ml/litre and dinotefuran 20 SG @ 0.53 g/litre (82.71%) were found highly effective against aphid.

In chemical insecticides, mortality count at 1 day after treatment was found higher as compared to *B. bassiana* 1.15% WP @ 5 g/litre, but later on mortality per cent in bio-pesticides increased gradually and registered 82.71% mortality at five days after treatment.

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