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Bio-efficacy of *Beauveria bassiana* (Bals.) Vuillemin against *Helicoverpa armigera* (Hubn.) infesting tomato in field condition

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ABSTRACT

Field experiments were conducted to evaluate the efficiency of two commercial formulations (WP and AS) and one local isolate of Beauveria bassiana (Bals.) Vuillemin against Helicoverpa armigera (Hubn.) on tomato for two consecutive years. Three doses of each of the commercial formulations (750,1000, 1250 g ha^{-1} for WP formulation and 250, 400, 500 ml ha^{-1} for AS formulation) were tested along with one local isolate (10^{8} conidia perml) and endosulfan (0.07% a.i.). The efficiency of the microbial pesticide was evaluated on the basis of the two years pooled data. Result revealed that three days after the spray endosulfan recorded lowest larval population (1.11 larvae per5 plants). Highest dose of both WP (1.83 larvae per5 plants) and AS (1.56 larvae per5 plants) formulation harboured significantly lower larval population than untreated control (3.17 larvae per5 plants). After seven days of spray all the treated plots had significantly lower larval population (1.00 - 2.44 larvae per5 plants) than untreated control (3.28 larvae per 5 plants). B. bassiana AS @ 500 ml perha produced the highest yield (260.22 q ha^{-1}), followed by endosulfan @ 0.07% a.i. (258.99 q ha^{-1}), B. bassiana WP @ 1250 g ha^{-1} (252.65 q ha^{-1}) and these three treatments were at par among themselves and produced significantly higher yield than all other treatments and untreated control (200.44 q per ha).

Keywords: *Helicoverpa armigera, Beauveria bassiana,* management, tomato

Tomato is one of the most important vegetable crops and cultivated all over the world with an estimated production of 120 million tons (FAOSTAT, 2007). India is one of the important tomato producing countries with third rank on the basis of production. This vegetable has multiple utilities as raw salad, cooked food and processed food. Tomato is one of the important ingredients of food processing industry. The food value of tomato is also high as it contains minerals, vitamins, lipids, carotenoids (Stommel, 2007)

This crop suffers from the attack of number of insect pests and diseases. *Helicoverpa armigera* commonly known as gram pod borer is one of the most important pest of the crop causing 20-50% damage of fruits (Singh *et al*. 1990, Karabhantanal, 2012). Several chemical insecticides were found to be effective against this pest (Gundannavar, 2004, Singh, 2005). Bio pesticides can be an alternative to chemical control against this pest (Dass 2006). In this regard experiment was carried out in farmers field for consecutive two years to evaluate the bioefficacy of *B. bassiana* against *H. armigera* on tomato during spring summer season.

MATERIALS AND METHODS

Field experiment was carried out for consecutive two years 2010 and 2011 in farmer's plot to evaluate the bio-efficacy of two commercial formulations (WP and AS) and one local isolate (10^{8} conidia per ml) of *B. bassiana* against *H. armigera* in tomato crop in spring summer season. There were nine treatments including untreated control and three replications for each treatment. Size of plat for each replication was 3X3.5 m^{2}

Treatments:T_1= *B. bassiana* WP @ 750 g ha^{-1}, T_2= *B. bassiana* WP @ 1000 g ha^{-1}, T_3= *B. bassiana* WP @ 1250 g ha^{-1}, T_4= *B. bassiana* AS @ 250 ml ha^{-1}, T_5= *B. bassiana* AS @ 400 ml ha^{-1}, T_6= *B. bassiana* AS @ 500 ml ha^{-1}, T_7= Endosulfan @ 0.07% a.i., T_8= Local isolate of *B. bassiana* @ 10^{8} conidia per ml, T_9= Untreated control.

Control plots were sprayed with water. Three sprays were given to the crop at 10 days interval after initiation of fruit infestation. Population of *H. armigera* larvae per 5 plants was counted before and 3 and 7 days after each spray, whereas, the number of infested and healthy fruits were recorded before and seven days after each spray. The yield of marketable fruits was recorded at harvest. Pre spray data from second spray onwards was considered as the 10 days after spray data of the corresponding previous spray. Two years pooled data were analysed for test of significance following RBD.

RESULTS AND DISCUSSION

Effect of treatments on *H. armigera* larvae

Pooled data of both the years reflected that there was no significant difference in the larval population of

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H. armigera among the treatments before the commencement of spray. Experimental result of table 1 depicted that after three days of spray endosulfan @ 0.07% a.i. resulted lowest larval population (1.11 larva per 5 plants), and this treatment was superior to all other treatments. Performance of *B. bassiana* AS @ 500 ml ha^{-1} (1.56 larva per 5 plants) and *B. bassiana* WP @ 1250 g ha^{-1} (1.83 larva per 5 plants), were *at par* among themselves and were superior to untreated control (3.17 larva per 5 plants). However *B. bassiana* WP @ 1000 g ha^{-1} (2.11 larva per 5 plants), local isolate of *B. bassiana* @ 10^8 conidia per ml (2.39 larva per 5 plants) and *B. bassiana* AS @ 400 ml ha^{-1} (2.44 larva per 5 plants) also recorded significantly lower larval population of *H. armigera* than untreated control. After seven days of treatment all the treated plots exhibited significantly lower larval population than untreated control (3.28 larva per 5 plants). However, *B. bassiana* AS @ 500 ml ha^{-1} (1.00 larva per 5 plants) recorded lowest larval population which was at par with *B. bassiana* WP @ 1250 g ha^{-1} (1.33 larva per 5 plants) and endosulfan @ 0.07% a.i.(1.39 larva per 5 plants), and was significantly lower than all other treatments except *B. bassiana* WP @ 1000 g ha^{-1} (1.83 larva per 5 plants). Ten days after treatment *B. bassiana* AS @ 500 ml ha^{-1} harboured lowest larval population (1.42 larva per 5 plants) which was at par only with *B. bassiana* WP @ 1250 g per ha (1.83 larva per 5 plants) and was significantly superior to all other treatments.

Effect of treatments on fruit damage

For pooled analysis observation before treatment was considered separately. All the values of 7 days after spray were averaged for analysis. Pre spray data from second spray onwards was considered as the 10 days after spray of the corresponding previous spray. Data depicted in Table 2 showed that there was no significant difference in damaged fruit percentage among the treatments before commencement of spray and damage percentage varied from 8.59 -11.77 %. After seven days of spray all the treated plots recorded significantly lower fruit damage percentage than untreated control (14.00%). However *B. bassiana* AS @ 500 ml ha^{-1} recorded lowest fruit damage percentage (5.65%), followed by endosulfan @ 0.07% a.i. (6.86%), followed by *B. bassiana* WP @ 1250 g ha^{-1} (6.97%).

Data recorded after ten days of spray also showed that damaged fruit percentage was significantly lower in all the treatments than untreated control (13.74%). Again *B. bassiana* AS @ 500 ml ha^{-1} resulted lowest fruit damage percentage (7.32%), which was significantly superior to all other treatments. endosulfan

Table 1: Population of *H. armigera* larvae per 5 plants of tomato (pooled)

Treatments	Population of *H. armigera* larvae per 5 plants of tomato			
	PT	3DAT	7DAT	10 DAT
T_1:*B. bassiana* WP @ 750 g ha^{-1}	2.67 (1.59)	2.89 (1.70)	2.44 (1.55)	2.75 (1.65)
T_2:*B. bassiana* WP @ 1000 g ha^{-1}	3.17 (1.77)	2.11 (1.45)	1.83 (1.35)	2.00 (1.40)
T_3:*B. bassiana* WP @ 1250 g ha^{-1}	3.67 (1.91)	1.83 (1.35)	1.33 (1.15)	1.83 (1.34)
T_4:*B. bassiana* AS @ 250 ml ha^{-1}	3.33 (1.82)	2.61 (1.61)	2.17 (1.46)	2.67 (1.63)
T_5:*B. bassiana* AS @ 400 ml ha^{-1}	3.33 (1.81)	2.44 (1.55)	2.00 (1.41)	2.17 (1.47)
T_6:*B. bassiana* AS @ 500 ml ha^{-1}	3.0 (1.72)	1.56 (1.24)	1.00 (0.99)	1.42 (1.19)
T_7:endosulfan @ 0.07% a.i.	3.0 (1.67)	1.11 (1.04)	1.39 (1.17)	2.42 (1.55)
T_8:Local isolate of *B. bassiana* @ 10^8 conidia per ml	2.67 (1.62)	2.39 (1.54)	2.33 (1.52)	2.75 (1.65)
T_9:Untreated control	2.17 (1.31)	3.17 (1.77)	3.28 (1.81)	3.33 (1.82)
SEm (±)		**0.062**	**0.062**	**0.056**
LSD(0.05)	**NS**	**0.178**	**0.179**	**0.161**
CV (%)		**10.131**	**11.050**	**8.995**

Values within parenthesis are square root transformed values; PT: Pre treatment DAT: Day after treatment

Table 2: Percent fruit damage of tomato caused by *H. armigera* (pooled)

Treatments	Fruit damage (%)		
	PT	**7DAT**	**10DAT**
T_1:*B. bassiana* WP @ 750 g ha^{-1}	10.35	11.27	11.50
	(18.71)	(19.53)	(19.77)
T_2:*B. bassiana* WP @ 1000 g ha^{-1}	10.50	8.37	10.20
	(18.83)	(16.78)	(18.49)
T_3:*B. bassiana* WP @ 1250 g ha^{-1}	10.83	6.97	9.05
	(19.0)	(15.27)	(17.38)
T_4:*B. bassiana* AS @ 250 ml ha^{-1}	11.45	10.05	11.47
	(19.71)	(18.38)	(19.71)
T_5:*B. bassiana* AS @ 400 ml ha^{-1}	8.59	8.50	11.04
	(16.92)	(16.92)	(19.36)
T_6:*B. bassiana* AS @ 500 ml ha^{-1}	10.10	5.65	7.32
	(18.41)	(13.66)	(15.64)
T_7:Endosulfan @ 0.07% a.i.	11.77	6.86	8.78
	(19.88)	(15.14)	(17.17)
T_8:Local isolate of *B. bassiana* @ 10^8 conidia ml^{-1}	9.26	9.52	11.19
	(17.59)	(17.88)	(19.49)
T_9:Untreated control	8.79	14.00	13.74
	(15.57)	(21.89)	(21.66)
SEm (±)		**0.602**	**0.482**
LSD(0.05)	**NS**	**1.735**	**1.388**
CV (%)		**8.179**	**6.192**

** Values within parenthesis are angular transformed values PT: Pre treatment DAT: Day after treatment*

Table 3: Effect of *B. bassiana* on fruit yield of tomato during 2010 and 2011

Treatments	Fruit yield (q ha^{-1})		
	1st Year	**2nd Year**	**Pooled**
T_1:*B. bassiana* WP @ 750 g ha^{-1}	218.09	217.53	217.81
T_2:*B. bassiana* WP @ 1000 g ha^{-1}	231.75	226.86	229.30
T_3:*B. bassiana* WP @ 1250 g ha^{-1}	258.83	246.48	252.65
T_4:*B. bassiana* AS @ 250 ml ha^{-1}	230.16	217.90	224.03
T_5:*B. bassiana* AS @ 400 ml ha^{-1}	234.41	228.63	231.52
T_6:*B. bassiana* AS @ 500 ml ha^{-1}	263.84	256.60	260.22
T_7:Endosulfan @ 0.07% a.i.	262.73	255.27	258.99
T_8:Local isolate of *B. bassiana* @ 10^8 conidia ml^{-1}	225.21	226.60	225.91
T_9:Untreated control	196.25	204.63	200.44
SEm (±)	**5.044**	**9.430**	**5.347**
CD (P=0.05)	**15.121**	**28.272**	**15.403**
CV (%)	**3.706**	**7.065**	**5.385**

@ 0.07% a.i. (8.78%) and *B. bassiana* WP @ 1250 g ha^{-1} (9.05%) yielded significantly lower percent fruit damage than rest of the treatments except *B. bassiana* WP @ 1000 g ha^{-1} (10.20%).

Effect of *B. bassiana* on fruit yield of tomato:

Pooled data of both the years reflected that *B. bassiana* AS @ 500 ml per ha produced the highest yield (260.22 q per ha) followed by endosulfan @

0.07% a.i. (258.99 q ha^{-1}), *B. bassiana* WP @ 1250 g ha^{-1} (252.65 q ha^{-1}) and these three treatments were at par among themselves and produced significantly higher yield than all other treatments and untreated control (200.44 q ha^{-1}).

B. bassiana has been reported to cause pathogenecity and effective control of *H. armigera* larvae both in laboratory and field though mortality level varied. Gopalakrishnan (1990) reported that *B. bassiana* was pathogenic to all stages of *H. armigera* larvae and caused 60-100% mortality of larvae. The experiment result of Kumar (2004) revealed that *B. bassiana* were pathogenic to *H. armigera* larvae and the mortality ranged from 40.0 to 90.0%. During the present investigation effective control of the pest was obtained by spraying different formulations and doses of *B. bassiana* on tomato. Malik (1993) recorded effective control of *H. armigera* from the 7th day after application of *B. bassiana*. During the present investigation, however, effective control was achieved after 7-10 days after treatment.

Asi *et al.* (2012) reported ovicidal effect *B. bassiana* on egg hatching percentage in *S. litura* and 22 to 62.5 % reduction in hatching was observed, even after hatching larvae also got affected by the fungus. Pandey (2003) also mentioned that *B. bassiana* application caused 44% egg mortality in *H. armigera.* In the present experiment increased efficiency of the entomopathegen after seven days of application may be due to the persistence of the pathogen on the host plant or reduction in the hatchability of the eggs of the insect. Chaudhuri (2001) reported that the biologically originated pesticides were more effective over synthetic pesticides. The author also mentioned that Pesticides from biological origin had no adverse effect on health, environment, and natural enemies of cop pests.

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