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Research Article

Evaluation of Microbial Pathogens for Management of Legume Pod Borer, *Maruca vitrata* F. in Yard Long Bean Ecosystem

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Abstract

Bean pod borer, *Maruca vitrata* is a serious pest of bean which causes serious yield loss of bean and other leguminous crops. To evaluate the field efficacy of two microbial pathogens for the management of legume pod borer, *Maruca vitrata* F an experiment was carried out in the field laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during *kharif* season in 2016 on yard long bean plants. Entomopathogens viz. *Bacillus thuringiensis* and *Beauveria bassiana* were used @ 0.50, 1.00 & 1.50 g/L and 0.25, 0.50 & 0.75 g/L, respectively to conduct the experiment. These two entomopathogens showed significant effect on the management of bean pod borer in comparison to untreated control in the field in decreasing the flower (22.02, 29.72, 33.35% and 16.16, 24.26, 30.05% by Bt & Bb, respectively) and pod infestation (16.45, 25.69, 31.93% and 10.73, 21.57, 28.04% by Bt & Bb, respectively). These two pathogens showed a significant effect on the yield with increasing pod yield 10.65, 20.32, 26.25% and 7.69, 14.58, 21.79% by Bt & Bb, respectively of yard long bean. Besides, these both the two entomopathogens were almost similar to the effect of a widely used chemical insecticide Nitro 505 EC in managing pod borer in the field.

Keywords: Yard long bean; legume pod borer; *Maruca vitrata*; *Bacillus thuringiensis*; *Beauveria bassiana*; management

Introduction

Legumes are important sources of protein, fiber, and micronutrients in the human diet (Messina, 1999) and are considered as the 'poor man's meat' (Heiser, 1990). Legumes are planted in crop rotation to improve soil fertility by fixing atmospheric nitrogen, breaking pest cycles, controlling soil erosion, and producing livestock fodder (Leikam *et al*., 2007). Amongst food legumes, yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*) is one of the most popular vegetables in Bangladesh. It has potentiality to export both fresh and frozen and can be grown all the year round (Rashid, 1999). It is extensively grown in kharif season when there is a shortage of vegetables supply in the market. Insect pest is a great concern of low yield of yard long bean in Bangladesh as well as in the world. Among the insect pests, flower and pod-feeding Lepidopterans cause serious yield losses to edible legumes particularly in tropical and sub-tropical zones (Rouf and Sardar, 2011). *Maruca vitrata* F. (Lepdoptera: Crambidae), a genetically complex species (Margam *et al*., 2011; Periasamy *et al*., 2015), is recognized as one of the most serious legume pests (Abate and Ampofo, 1996; Jackai, 1995; Shanower *et al*., 1999; Sharma, 1998) due to an extensive host range, high damage potentiality and cosmopolitan distribution (Margam *et al*., 2011; Sharma *et al*., 1999; Taylor, 1967). Larvae of *M. vitrata* feed on flowers, stems, peduncles and pods of food legumes, thus damage occurs at all developmental stages from seedling to pod bearing stages (Singh and Taylor, 1978). But the greatest damage occurs at flowering stage (Singh and Jackai, 1988). For example, yield losses on cowpea due to *M. vitrata* ranges from 20–88% (Singh *et al*., 1990). Thus, Yard-long bean growers face serious losses at pod harvest caused by *M. vitrata* infestation. Conventionally farmers of Bangladesh apply different types of chemical insecticides which cause pest resistance, secondary pest outbreaks and adverse effects to the environment and human health, but fail to achieve satisfactory level of control (Srinivasan *et al*., 2012; Yule and Srinivasan, 2013). In this case alternative to chemical insecticides is a great demand for the present time to combat the damage of this pest. Unfortunately, entomologists have given a very less concentration to develop an alternative method to manage *M. vitrata*. Considering the above facts, the present study was conducted to evaluate the efficacy of two widely used entomopathogens viz., *Bacillus thuringiensis* and *Beauveria bassiana* against *M. vitrata* in the yard-long bean field.

Materials and Methods

The field trial of two microbial pathogens, *Bacillus thuringiensis* and *Beauveria bassiana*each having three doses along with a standard insecticide and untreated control was conducted against legume pod borer, *M. vitrata* F. in the field of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh in *kharif* season 2016. The yard-long bean variety Long Red Mollika was used as host plant. The seeds were sown on April 01, 2016 in 24 plots. Each plot measuring 2.65m x 1.2m had 20 plants. The distance from plot to plot was 1.0m. Intercultural operations were done as and when needed. Fertilizers were applied as per recommendation (Zaman, 1992). Treatments were as follows: T_1 = *Bacillus thuringiensis* (Bt) @ 0.5g, 1.0g and 1.5 g/L of water, T_2 = *Beauveria bassiana* (Bb) @ 0.25g, 0.5g and 0.75g/L of water, T_3 = Nitro 505EC @ 1.0 ml/L of water and T_4 = Untreated Control. Treatments were assigned in randomized complete block design with three replications. All tested microbial pathogens and insecticide were applied by high volume knapsack sprayer. First spray was done at the time of flowering and was continued 15 days intervals up to harvesting. Only water was sprayed in untreated control plots. Data were collected at 5, 10 and 15 days after spraying (DAS). Number of healthy and infested flowers was counted and recorded from randomly selected 10 inflorescences per plot and calculated percentage of flower infestation at each observation. Similarly, number of healthy and infested pods were recorded and weighed to calculate the percentage of pod infestation and percentage yield increased. The number of legume pod borer larvae were counted and recorded from randomly selected 10 infested pods before spray and at 5, 10, & 15 DAS to calculate percentage of surviving larvae. All data were analyzed statistically after appropriate transformations and the means were separated using DMRT by MSTAT computer software.

Results and Discussion

The tested microbial pathogens viz. *Bacillus thuringiensis* and *Beauveria bassiana* on the infestation of flowers and pods over untreated control indicated that these microbial pathogens had significant effect on *M. vitrata.* In addition to this, microbial pathogens performed similar to the chemical insecticide Nitro 505EC irrespective of reducing the flower and pod infestation, surviving of larvae and increasing of pod yield. The flower and pod damage ranged from 19.25 to 31.28% and 23.83 to 38.53%, respectively. The Nitro 505EC resulted the lowest flower (19.25%) and pod (23.83%) infestation. The reduction of flower and pod infestation over control was 38.45 to 16.16% and 38.15 to 10.73%, respectively (Table 1 & 2). Nitro 505EC offered the maximum reduction of flower (38.45%) and pod (38.15%) damage caused by *M. vitrata* (Table 1 & 2).

The survival of larvae ranged from 64.83 to 95.22% while the minimum of 64.83% surviving larvae was recorded in the plots treated with Nitro 505EC (Table 3). The yield was recorded in the range of 8.77 to 12.29 ton per hectare. The highest yield was 12.29 ton per hectare harvested from the plots applied with Nitro 505EC. The pod yield increased from 7.69 to 28.68% over control in the field treated with microbial pathogens. But the maximum pod yield increased to 28.68%. The highest benefit cost ratio (BCR) of 1.19 was obtained from Nitro 505EC applied plots while the BCR was found 1.0 & 1.03 from the plots treated with *Bacillus thuringiensis* @ 1.0 & 1.50 g/L, respectively (Table 4).

Several researchers confirmed that *Bacillus thuringiensis* formulations (*B. thuringiensis* sub sp. *aizawai* and *B. thuringiensis* sub sp. *kurstaki*) significantly reduced *M. vitrata* damage on yard long bean in field conditions (Sunitha *et al*., 2008; Sreekanth and Seshamahalakshmi 2012; Yule and Srinivasan, 2013; Yule and Srinivasan, 2014; Srinivasan *et al*., 2014). The world Vegetable Centre in Vietnam had confirmed that weekly spraying of *Metarhizium anisopliae* ($2x10^{10}$ conidia ml^{-1}) and *Beauveria bassiana* ($6.5x10^9$ conidia ml^{-1}) formulations on yard long bean could significantly reduce pod damage caused by *M. vitrata*. In contrast, results of this experiment showed that microbial pathogens had comparatively less performed at the field condition in decreasing the flower and pod infestation, increasing pod yield of yard long bean by suppressing the attack of *M. vitrata*. It might be happened due to continuous rain during the experimental period. The present results are in agreement with the following researchers. Sundaram and Sundaram (1996) explained that bioactivity of foliar deposits decreased with increasing cumulative rainfall. The total protein concentrations in *Bacillus thuringiensis* (determined by the BCA method) decreased with increasing amount of rain and with increasing rainfall intensity. The control efficiency afforded by the aqueous conidial suspension in the field experiment without cages was usually 10-20% lower than those of oil dispersions, and significant differences were evident in some sampling dates (Michereff Filho *et al*., 2011). Unformulated preparations are less efficient than oil-formulated conidia under field conditions (Wraight and Ramos, 2002; Batta, 2003). Entomopathogenic fungi sprayed on leaves are sensitive to adverse environmental factors such as sunlight, rain, humidity, leaf surface chemistry, and the phylloplane microbiota (Wraight *et al*., 2001; Steinkraus, 2006; Jaronski, 2010). It is supposed to be noted that in rainy condition *Bacillus thuringiensis* and *Beauveria bassiana* could not play vital role against *M. vitrata* on yard long bean in open field condition.

Table 1. Percentage of infested flowers of yard long bean genotypes caused by legume pod borer, *M. vitrata* sprayed with microbial pathogens

Treatments	**Dose**	**Infested flower (%)**	**Reduction (%) of flower infestation over control**
Bacillus thuringiensis	0.50 g/L	24.39 (29.57) bc	22.02
	1.00 g/L	21.98 (27.94) bc	29.72
	1.50 g/L	20.84 (27.12) bc	33.35
Beauveria bassiana	0.25 g/L	26.22 (30.79) ab	16.16
	0.50 g/L	23.69 (29.12) bc	24.26
	0.75 g/L	21.88 (27.88) bc	30.05
Nitro 505EC	1.00 ml/L	19.25 (26.01) c	38.45
Untreated control	-	31.28 (34.00) a	-
Level of significance	-	0.01	-
CV (%)	-	4.78	-

Figures in parentheses are the arcsine transformations; Means in each column followed by the same letter(s) are not significantly different by DMRT.

Table 2. Percentage of infested pods of yard long bean genotypes caused by legume pod borer, *M. vitrata* sprayed with microbial pathogens

Treatments	**Dose**	**Infested pod (%)**	**Reduction (%) of pod infestation over control**
Bacillus thuringiensis	0.50 g/L	32.20 (34.56) ac	16.45
	1.00 g/L	28.64 (32.35) bc	25.69
	1.50 g/L	26.23 (30.77) bc	31.93
Beauveria bassiana	0.25 g/L	34.40 (35.89) ab	10.73
	0.50 g/L	30.22 (33.34) ac	21.57
	0.75 g/L	27.73 (31.76) bc	28.04
Nitro 505EC	1.00 ml/L	23.83 (29.20) c	38.15
Untreated control	-	38.53 (38.35) a	-
Level of significance	-	0.01	-
CV (%)	-	6.22	-

Figures in parentheses are the arcsine transformations; Means in each column followed by the same letter(s) are not significantly different by DMRT.

Table 3: Percentage of surviving larvae of legume pod borer, *M. vitrata* inside the pods of yard long bean genotypes sprayed with microbial pathogens

Treatments	Dose	Surviving larva (%)
Bacillus thuringiensis	0.50 g/L	83.77 (66.51) b
	1.00 g/L	74.64 (59.80) bc
	1.50 g/L	72.53 (58.54) bc
Beauveria bassiana	0.25 g/L	82.80 (66.20) a-c
	0.50 g/L	76.42 (61.04) bc
	0.75 g/L	73.88 (59.30) bc
Nitro 505EC	1.00 ml/L	64.83 (53.70) c
Untreated control	-	95.22 (78.09) a
Level of significance	-	0.01
CV (%)	-	7.49

Figures in parentheses are the arcsine transformations; Means in each column followed by the same letter(s) are not significantly different by DMRT.

Table 4: Yield of yard long bean genotypes sprayed with microbial pathogens

Treatments	Dose	Yield (T/ha)	Yield increased (%)	Benefit cost ratio
Bacillus thuringiensis	0.50 g/L	9.81 bd	10.65	0.93
	1.00 g/L	11.00 ac	20.32	1.00
	1.50 g/L	11.89 ab	26.25	1.03
Beauveria bassiana	0.25 g/L	9.50 cd	7.69	0.90
	0.50 g/L	10.26 ad	14.58	0.93
	0.75 g/L	11.21 ac	21.79	0.97
Nitro 505EC	1.00 ml/L	12.29 a	28.68	1.19
Untreated control	-	8.77 d	-	0.87
Level of significance	-	0.05	-	
CV (%)	-	10.78	-	

Means in each column followed by the same letter(s) are not significantly different by DMRT.

Conclusion

Based on above results and discussions, application of Nitro 505 EC and was found the most effective in controlling *Maruca vitrata* among the tested treatments for the management of this pest. But *B. thurigiensis* @ 1.0 & 1.5 g/L of water showed the similar effect to the Nitro 505 EC in reducing borer infestation on bean plants. But both two entomopathogens were significantly effective against the infestation of bean pod borer.

Authors' Contribution

The first author contributed in the conceptualizing, designing and implementing of research, analyzing of data and drafting of manuscript. The other three authors conceptualized and designed the research project, helped the first author to analyze the data and edited the manuscript.

Conflict of Interest

The authors would like to declare that there is no conflict of interest.

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