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Eco-friendly management of the pod borers *Maruca vitrata* (Fabricius) and *Lampides boeticus* (L.) of yard long bean under field conditions

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ABSTRACT: Investigations on management of pod borers [*Maruca vitrata* (Fabricius), *Lampides boeticus* (L.)] of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt) under field conditions revealed that Spinosad 45 SC followed by *Bt* formulation 2×10^8 cfu/ml and *Beauveria bassiana* @ 10^7 spores/ml of water were the most effective treatments in preventing pod borer infestation as well as controlling number of pod borer larvae.

KEY WORDS: *Vigna unguiculata* subsp. *Sesquipedalis, Lampides boeticus*, *Maruca vitrata*), pest management, spinosad, *Bt, Beauveria bassiana*

INTRODUCTION

Vegetable cowpea or yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt) is one of the most important vegetables grown in Kerala. It is cultivated in an area of 7150 hectares in Kerala (GOK, 2017). The most important constraint on the production and productivity of cowpea is the infestation by insects. The profuse vegetative growth of yard long bean attracts a number of insects. The infestation that occurs at the most crucial period of growth stage of the crop causes great economic loss.Among the insect pests of vegetable cowpea, the most destructive are the pod borers *viz.,*spotted pod borer, *Maruca vitrata* (Fabricius) (Lepidoptera: Crambidae) and blue butterfly, *Lampides boeticus* (L.) (Lepidoptera: Lycaenidae). The spotted pod borer,*M. vitrata* is considered as the most devastating pest of yard long bean causing nearly 40 per cent yield loss (Yule and Srinivasan, 2013). About 4-6 flowers are consumed by a single larva of *M. vitrata* (Sharma, 1998). It webs flower buds and flowers together and feeds from within. Moreover, it bores inside the pods and feed on the internal contents. The pod borer, *Lampides boeticus* consumes the flower buds and pods by boring and contaminating them, which causes heavy yield loss (Ganapathy and Durairaj, 2000). The present study aimed at studying the efficacy of different microbial agents, neem

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based and bio rational insecticides against pod borers of yard long bean.

MATERIAL AND METHODS

The research work was carried out in the Instructional Farm of College of Agriculture, Padannakkad from May 2016 to August 2016 and September 2016 to December 2016 in RBD with 9 treatments and 3 replications with twelve plants per treatment. The yard long bean variety 'Lola' released by Kerala Agricultural University (KAU) was selected for conducting the study. The crop was raised on trellis at a spacing of 1.5 x 0.45m. All the planting operations were done based on the Package of Practice recommendations: crops of KAU, 2016. The pure culture of entomopathogenic fungi *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii* were brought from National Bureau of Agricultural Insect Resources (NBAIR), Bangalore. The commercial formulation of *Bt* 2 x 10^8 cfu/ml (BT CARE) was purchased from Biopharmacy, Krishibhavan, Nileshwar of Kasargod district. The other treatments *viz.,* azadirachtin 1 per cent (Neemazal-T/S), neem oil, spinosad 45 SC (Tracer 45 SC), malathion (Jaithion 50 EC) were purchased. All the treatments were imposed at fortnightly intervals when borer infestation was first noticed. Observations were recorded at weekly intervals corresponding to standard weeks. There were nine treatments (Table 1). All the treatments except fungal entomopathogens were sprayed by diluting the recommended dose in one litre water and the control plot was treated with water.

Observations included the total number of pod borer larvae per plant and the number of pods damaged out of total number of pods due to infestation. The crop was harvested 60 days after planting. Pooled ANACOVA was carried out to find the treatment mean of pod borers, per cent of infestation during two seasons, kharif and rabi and significance were analysed using DMRT method.

RESULTS AND DISCUSSION

ANOCOVA analysis of pooled mean number of borers between treatments during both seasons (Table 1) showed that on 7DAFS, spinosad and malathion was on par with each other with least number of pod borers and the control, T_9 and *Metarrhizium anisopliae* treated plot recorded the maximum number of pod borers. On 14 DAFS, 7 DASS and 14 DASS, spinosad and malathion was on par with each other and was significantly superior to other treatments including control whereas on 7 DATS, spinosad, malathion, *Bt, Beauveria bassiana* found on par with each other and control plot recorded the maximum number of pod borers. On 14 DATS, spinosad, *Bt, Beauveria bassiana* found on par with each other with minimum number of pod borers. On comparison with kharif and rabi seasons, there was a significant difference between the two seasons in the number of pod borers and was found significantly higher during rabi season.

Pooled ANOCOVA analysis data on mean per cent of pod infestation between the treatments during two seasons were tabulated (Table 2). Data showed that on 7 DAFS, spinosad, *Beauveria bassiana, Bt* and malathion was on par with each other and the control, T_9 and *Metarrhizium anisopliae* treated plot recorded the maximum per cent of pod borer infestation. On 14 DAFS, 7 DASS and 14 DASS spinosad recorded the lowest infestation (8.86, 4.77 and 1.71 per cent respectively) and was significantly superior to other treatments. On 7 DATS and 14 DATS minimum per cent of pod infestation was noticed in spinosad (0.54 and 1.74 per cent respectively). *Bt, Beauveria bassiana* and malathion was on par with spinosad and control plot recorded the maximum per cent of pod damage. On comparing the percentage of pod infestation between seasons, the infestation was on par initially (7 DAFS) and thereafter a significant difference was noticed between the seasons. Pod infestation was lower comparatively during rabi season (Table 2).

From the results obtained, it was concluded that Spinosad 45 SC was effective in reducing the number of pod borer larvae during both kharif and rabi seasons after three consecutive application of treatments (Table 1). The findings of Yadav and Singh (2014) that the larval population of *M. vitrata*

Table 1. Pooled univariate analysis of covariance data on mean number of pod borers during kharif and rabi

Treatments	Days after first/ second/ third spray					
	7DAFS	14DAFS	7DASS	14DASS	7DATS	14DATS
T_1 - *Beauveria bassiana* @ 10^7 spores/ml	2.85[cd]	2.53[cd]	2.11[cd]	1.10[de]	0.77[c]	0.44[cd]
T_2 - *Metarhizium anisopliae* @ 10^7 spores/ml	3.44[ab]	3.12[b]	2.94[b]	2.67[b]	2.53[b]	2.80[b]
T_3 – *Lecanicillium lecanii* @ 10^7 spores/ml	3.13[bc]	2.76[c]	2.45[bc]	1.69[cd]	1.92[b]	2.38[b]
T_4 – *Bt* formulation @ 2× 10^8 cfu/ml @ 1 ml/l	2.96[c]	2.65[cd]	2.21[cd]	1.04[de]	0.49[c]	0.20[d]
T_5 – Neem (Azadirachtin 1%) @ 5ml/l	2.91[cd]	3.26[b]	2.84[b]	2.37[bc]	2.25[b]	2.54[b]
T_6 – Neem oil emulsion 5% @ 50ml/l	3.14[bc]	3.22[b]	2.84[b]	2.42[bc]	2.37[b]	2.68[b]
T_7 – Spinosad 45 SC @ 0.4 ml/l	2.50[de]	1.97[e]	1.19[e]	0.06[f]	0.04[c]	0.07[d]
T_8 – Malathion 50 EC @ 2ml/l	2.36[e]	2.31[de]	1.66[de]	0.74[ef]	0.55[c]	0.75[c]
T_9 – Absolute control	3.72[a]	3.99[a]	3.76[a]	4.09[a]	4.41[a]	4.45[a]
Between seasons						
Kharif	1.68[b]	1.75[b]	1.85[b]	0.48[b]	0.86[b]	1.17[b]
Rabi	4.32[a]	3.99[a]	3.04[a]	3.09[a]	2.55[a]	2.46[a]

Figures denote adjusted treatment means (adjusted for the covariates)
DAFS- Days after first spray; DASS- Days after second spray; DATS- Days after third spray.

was found to be very low three days after first spray of Spinosad 45 SC in mung bean was in line with the above results. In the present study, though malathion 50 EC showed good control of pod borer larvae at the initial stage, later Spinosad competes with the efficacy of malathion and thus Spinosad is adjudged as the best treatment in reducing larvae of pod borer over other treatments. Sparks *et al.* (2012) explained that Spinosad 45 SC was allowed to use in organic farming as the level of toxicity was less than the treatment with malathion.

The efficacy of Spinosad in pigeon pea was reported by Rao *et al*. (2007) in which it could bring about more than 70 per cent of reduction in population of *M. vitrata.* The present study is in agreement with Kumar and Muthukrishnan (2017) that Spinosad 45 SC assured 76.4 per cent reduction in number of larvae of pod borer, *L. boeticus* in pigeon pea. *Bacillus thuringiensis* formulation 2 × 10^8 cfu/ml showed effectiveness similar to Spinosad 45 SC in controlling the larval population of pod borers during kharif season in the year 2016 (Table 1). Similar findings were made by Sunitha *et al*. (2008) that Spinosad exhibited higher efficacy in lowering the larval population of *M. vitrata* followed by *Bt.* However, the present finding that Spinosad is highly effective against the larvae of pod borers is consistent with the report of Ipsita *et al.* (2014) that there was a greater reduction in the number of pod borer larvae (2.6 per 10 plants) when Spinosad 45 SC was treated. The report of Adsure and Mohite (2015) revealed that Spinosad 45 SC could bring down the larval population to a great extent even after first spray reconfirmed the present study.

Table 2. Pooled analysis of covariance data on mean per cent of pod infestation during kharif and rabi

Treatments	Days after first/ second/ third spray					
	7DAFS	14DAFS	7DASS	14DASS	7DATS	14DATS
T_1 - *Beauveria bassiana* @ 10^7 spores/ml	28.40 (0.56)^{cd}	23.83 (0.54)^{c}	15.55 (0.40)^{d}	10.38 (0.26)^{de}	6.97 (0.19)^{ef}	2.05 (0.13)^{e}
T_2 - *Metarhizium anisopliae* @ 10^7 spores/ml	71.12 (1.05)^{a}	62.18 (0.87)^{a}	57.45 (0.87)^{b}	45.33 (0.78)^{b}	45.82 (0.78)^{b}	40.39 (0.67)^{b}
T_3 – *Lecanicillium lecanii* @ 10^7 spores/ml	45.10 (0.73)^{bc}	34.85 (0.63)^{bc}	38.55 (0.66)^{c}	28.28 (0.54)^{c}	19.88 (0.45)^{d}	26.94 (0.54)^{c}
T_4 – *Bt* formulation @ 2×10^8 cfu/ml @ 1 ml/l	31.88 (0.60)^{bcd}	24.53 (0.54)^{c}	14.47 (0.39)^{d}	9.23 (0.24)^{e}	5.86 (0.16)^{ef}	0.98 (0.13)^{e}
T_5 – Neem (Azadirachtin 1%) @ 5ml/l	44.82 (0.74)^{bc}	43.49 (0.71)^{b}	37.29 (0.66)^{c}	37.53 (0.66)^{bc}	31.79 (0.61)^{c}	28.08 (0.57)^{c}
T_6 – Neem oil emulsion 5% @ 50ml/l	46.72 (0.75)^{b}	42.31 (0.71)^{b}	38.51 (0.67)^{c}	42.35 (0.72)^{b}	37.43 (0.69)^{bc}	33.52 (0.60)^{bc}
T_7 – Spinosad 45 SC @ 0.4 ml/l	22.24 (0.48)^{d}	8.86 (0.35)^{d}	4.77 (0.19)^{e}	1.71 (0.06)^{f}	0.54 (0.06)^{f}	1.74 (0.15)^{e}
T_8 – Malathion 50 EC @ 2ml/l	35.83 (0.64)^{bcd}	24.36 (0.53)^{c}	20.32 (0.42)^{d}	21.57 (0.37)^{d}	12.38 (0.27)^{e}	9.26 (0.26)^{d}
T_9 – Absolute control	79.31 (1.15)^{a}	75.14 (0.98)^{a}	78.74 (1.14)^{a}	84.03 (1.25)^{a}	83.19 (1.29)^{a}	68.11 (0.95)^{a}
Between seasons						
Kharif	44.07 (0.72)^{a}	40.12 (0.68)^{a}	39.20 (0.66)^{a}	39.89 (0.68)^{a}	31.39 (0.61)^{a}	24.48 (0.49)^{a}
Rabi	46.02 (0.76)^{a}	35.34 (0.62)^{b}	28.72 (0.54)^{b}	22.42 (0.41)^{b}	22.56 (0.39)^{b}	22.43 (0.41)^{b}

Figures in non-parentheses denote adjusted treatment means (adjusted for the covariates)
Figures in parenthesis denotes angular (arc sin) transformed values
DAFS- Days after first spray; DASS- Days after second spray; DATS- Days after third spray.

The mean per cent of pod infestation by pod borer larvae were also found minimum in Spinosad 45 SC treated plot during both seasons, even after two sprays and no damage was seen on pods after third spray (Table 2). The report of Ipsita *et al.* (2014) conveyed that Spinosad 45 SC resulted in only 6.66 per cent of pod infestation compared to control having 27.02 per cent pod damage when sprayed 40 days after sowing endorsed the present study. The effect of the same was again reinforced by the findings of Anitha and Parimala (2014) in which the lowest pod damage of 5.1 per cent was obtained in Spinosad treated plot. The present study and earlier findings ratified the efficacy of Spinosad in reducing the per cent of pod damage in vegetable cowpea.

Bacillus thuringiensis formulation @ 2×10^8 cfu/ml @ 1 ml/l of water was found to be the next effective treatment after Spinosad in reducing the pod damage during both seasons. After three consecutive sprays at fortnightly intervals, the per cent of pod damage decreased far better in *Bt* treated plot. Similar findings were made by Yadav and Singh (2014) in which Spinosad when applied recorded the lowest pod damage of 3.67 per cent followed by *Bt* with 4.33 per cent pod damage. The report of Dhaka *et al.* (2011) that Spinosad @ 500 ml/ha exhibited low percentage of pod infestation three days after second spray followed by *Bt* @ 1500 g/ha also substantiated the present study. The efficiency of biorational insecticide, spinosad in controlling insect pests without harming non-target species and its non-toxicity towards humans found to be the best approach among pest management strategies. Through this it is possible to increase good quality produce. Thus spinosad play a promising tool in pest management and are gaining prior importance in the present scenario.

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