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Effect of bioinoculants on sucking pests and pod borer complex in urdbean

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ABSTRACT

Pulse crops are damaged by an array of pest complex and yield reduction due to insect pests is one of the major constraints for low productivity. Use of microbial bioinoculants can substitute the conventional pesticide use in short duration crops like urdbean, mungbean and cowpea. In the present study, the bioinoculants such as *Beauveria bassiana* and *Pseudomonas fluorescens* talc formulations (10g/kg seed & 2ml/lit) were tested against whitefly *Bemisia tabaci*, leaf hopper *Empoasca kerri*, legume pod borer *Maruca vitrata* and flea beetle *Madurasia obscurella*. The damage by *M.vitrata*, gram pod borer *Helicoverpa armigera*, blue butterfly *Lampides boeticus* and pod bugs was also recorded. The results of two year experiments revealed that significant effect was observed in the bioinoculants applied plots on the sucking insects and pod borer complex. The *P. fluorescens* seed treated plots had lower whitefly population compared to *B.bassiana* treated plots and untreated check. The foliar application of *B.bassiana* showed good results on the pod borer complex. The damage by *M. vitrata*, *H. armigera*, *L. boeticus* was low in the harvested pods as against the untreated control. The damage by pod bugs was also low in the *B.bassiana* applied plants. The yield in different treatments was recorded and the highest yield was recorded in chemical treated plots followed by bioinoculants treated plots.

Key words: Urdbean, bio inoculants, *Beauveria bassiana, Pseudomonas fluorescens*, pod borer complex

INTRODUCTION

Pulse crops have a unique position in sustainable crop production as they provide highly nutritive food and keep the soil alive and productive. Though India has the distinction of being the world's largest producer of pulses, the average productivity is very low because of the abiotic and biotic stresses. The annual yield loss due to the insect pests has been estimated at about 30 per cent in urdbean and mungbean. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems (Rabindra *et al.*, 2004). The major insect pests during vegetative stage are thrips, whitefly, leafhopper, black aphid, bihar hairy caterpillar, stemfly which cause appreciable damage (Singh and Kumar, 2003). *Maruca vitrata* (Geyer) is one among the pod borers causing serious damage to grain legumes in the tropics apart from *Helicoverpa armigera* (Hubner). Conventional methods of pulse improvement have paid little dividends in development insect pest resistant varieties basically because of unavailability of suitable donor parents and efficient screening technique besides, chemical insecticides causes environmental problems and leads to the development of insecticide resistance (Sharma *et al*., 2002).

Microbial insecticides such as entomopathogenic fungi can provide an alternative, more environmentally friendly option to control this insect pest. The entomopathogenic fungus *B. bassiana* is a promising and extensively researched biological control agent that can suppress a variety of economically important insect pests (Coates *et al*., 2002; McGuire *et al*., 2005; Prasad and Syed, 2010; Hussein *et al*., 2010). Sprays and soil application of pesticides are costly and cumbersome to adopt. So it is imperative to find out an ecofriendly and need based use of chemical pesticides as a component of integrated pest management (IPM). Seed treatment is an easy, economic and feasible method for pest control (Mote and Shah, 1993). It protects against insect pests and is ecofriendlier to bio control agents like coccinellids and chrysopids under field condition (Satpute, 1999; Murugesan and Annakkodi, 2007). In pulses cropping systems minimum attempts have been made to study the effect of bioinoculants on insect pests under field conditions. The present study is aimed at knowing the efficacy of bioinoculants by seed treatment and foliar application on insect pests of urdbean under field conditions.

MATERIALS AND METHODS

The field trials were conducted during *kharif* season in 2008 and 2009 at National Pulses Research Centre, Vamban, Pudukottai district of Tamil Nadu. The lay out was designed in randomized blocks with the plot size of 4X3m and replicated thrice. A total of ten treatments (Table I) were imposed in the two years trial with urdbean variety VBN 3 [T_1- *Beauveria bassiana* Seed treatment (ST) @ 10gm/kg of seed; T_2 -

Pseudomonas fluorescens Seed treatment @ 10gm/kg of seed; T_3 - *Beauveria bassiana* + *Pseudomonas fluorescens* each 5 gm/kg of seed ST; T_4 – Imidacloprid 5 gm/kg of seed ST; T_5 - *Beauveria bassiana* (ST) 10gm/kg of seed + *Beauveria bassiana* Foliar spray (FS) 5gm/liter; T_6 - *Pseudomonas fluorescens* 10gm/kg of seed (ST) + *Beauveria bassiana* 5gm/ liter (FS); T_7 - *Beauveria bassiana* 10gm/kg of seed (ST) + Profenophos 2 ml/lit (FS) ; T_8 - *Pseudomonas fluorescens* 10gm/kg of seed (ST) + Profenophos 2 ml/lit (FS) ; T_9 - Imidacloprid 5 gm/kg of seed (ST) + Profenophos 2 ml/lit (FS) ; T_{10} – untreated control

The talc based formulations of bioinoculants *B.bassiana* (2.8 x 10^6 CFU/gm) and *P. fluorescens* (2.5 x 10^8 CFU/gm) were obtained from the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore. The foliar spraying of the chemicals and bio inoculants were imposed two times during flowering stage of the crop (35-45 Days after sowing-DAS).

Observations on insect pest

The incidence of insect pests *viz*., flea beetle *M. obscurella,* whitefly *B. tabaci* and leaf hopper *E. kerri* were recorded during vegetative stage of the crops. The flea beetle incidence was recorded at 15 DAS, whereas whitefly and leafhopper incidence was recorded at weekly intervals from 15 DAS to 50% flowering. During flowering and reproductive stage of the crop, the incidence of legume pod borer, *M. vitrata* was taken based on the number of web larva per plant at 40 DAS. The damage on the pods by different pod borers was recorded in the harvested pods. The pod borers like *H. armigera*, *L. boeticus* and *M.vitrata* were recorded based on the damage hole on the pods. The pod bugs *R. pedestris* and *C. gibbosa* are species occurred in urdbean during two year study period. The damage hole caused by *H.armigera* is bigger in size and irregular in shape whereas *L.boeticus* larval damage in smaller in size. In case of *Maruca* the pods are with silken tunnel and two or three pods attached with each other and hole is small in size. There was no difference in the damage by two species of pod bugs and the symptoms are pin hole on the pod wall and shriveled seeds inside.

The flea beetle incidence was recorded based on the damage on the young leaves. Observation was made randomly on 5 plants in three replication during 15 DAS and number of leaves damaged by *M.obscurella* was expressed in percentage. The sucking pest *B.tabaci* and *E.kerri* population were recorded by following standard procedure i.e. in randomly selected five plants, 3 leaves per plant and at weekly intervals the observations were recorded. The pod borer complex in the harvested pods were recorded in about 500 pods collected in each replication and sorted out based on the damage hole by different borers and pod bugs. The data were expressed in per cent and cumulative damage was worked out. The plot yield in each treatment was recorded and expressed in yield/ ha.

Statistical analysis

The data collected were transformed into angular or square-root values as per the standard requisites (Gomez and Gomez, 1984). The experiments were subjected to statistical scrutiny following the method of Panse and Sukhatme (1989) and the means were compared with Least Significant Difference (L.S.D.).

RESULTS AND DISCUSSION

Sucking pest population

The sucking pests incidence in the field trials conducted during 2008 and 2009 revealed that there was significant difference among treatments (df = 9,29; F = 118.5; P<0.005) (Table 1). The flea beetle damage in urdbean during 2008 trials was 64.6 per cent in control plots. The seed treatment by chemical imidacloprid recorded the lowest leaf damage (T_4 and T_9) than bioinoculants seed treated plants. *B.bassiana* seed treatment significantly reduced flea beetle damage (df= 9,29; F = 82.5; P<0.005). The entomopathogen seed treated plots had the damage of 43.7, 45.7, 48.0 and 45.3 per cent for T_1, T_5, T_7 and T_6 respectively and on a par with each other. The *P.fluorescens* seed treated plots T2 and T8 had the damage of 48.7 and 58.7 per cent respectively. During 2009, the highest flea beetle damage was 68.70 per cent in control and the lowest damage recorded in chemical imidacloprid seed treated plots while bioinoculant *B.bassiana* seed treated plots showed 54.75, 57.05, 53.18 (T_1,T_5, T_7) per cent leaf damage. The *P. fluorescens* seed treated plants had more than 60 per cent leaf damage whereas in untreated check the damage was 98.77 %.

The whitefly incidence during 2008 varied from 0.53 to 3.89/ leaf in different treatments and untreated check had the maximum adult population. Imidacloprid seed treatment showed lowest *B.tabaci* population followed by *P.fluorescens* seed treatment. In the 2009 trials also the whitefly population was 0.13and 0.20/leaf in the imidacloprid treated plants, whereas *P.fluorescens* seed treated plots has the population of 1.0, 1.30 and 1.10/leaf. However, the *B.bassiana* seed treated urdbean plants harboured 4.20, 3.87 and 3.73 whitefly/leaf which is on a par with untreated control. The combination of *B.bassiana* and *P.fluorescens* treated plots has the *B.tabaci* population of 2.87/leaf. There was no leaf hopper incidence during the period. Wraight *et al*. (2000) demonstrated that multiple application of *B.bassiana* at 4-5 days intervals provided more than 90 per cent control of large nymphs of *Bemisia argentifolii* on cucumber and cantaloupe melons. The efficacy of the fungal application is high against on nymphs. However, in the present study *P.fluorescens* had significant impact on *B.tabaci*. Two different natural isolates of conidia of the entomopathogenic fungi *Beauveria bassiana* [SBT#11and SBT#16 (strains named from place of collection)] were found effective against the pupae of polyphagous pest *Spodoptera litura* (Fab.), under laboratory conditions. Both strains of *B.bassiana* were highly pathogenic causing 100%

Table 1. Effect of bioinoculants on sucking pests and defoliators of urdbean during 2008 and 2009

Treatment	*B.tabaci* (No./leaf)		*E. kerri* (No./leaf)	*M.obscurella* (% leaf damage)	
	2008	2009	2008	2008	2009
T_1	3.62^e	4.20^d	0.85^a	43.7^b	54.75^{b-d}
T_2	1.24^{a-c}	1.0^b	1.60^b	48.7^b	60.78^{c-e}
T_3	1.60^{cd}	2.87^c	2.00^b	57.8^c	58.27^{b-d}
T_4	0.73^{ab}	0.13^a	0.40^a	21.5^a	21.18^a
T_5	2.38$_d$	3.87^{cd}	1.53^b	45.7^b	57.05^{b-d}
T_6	1.44^{b-d}	1.30^b	1.93^b	48.0^b	60.14^b
T_7	2.45^d	3.73^{cd}	1.67^b	45.3^b	53.18^{bc}
T_8	1.40^{bc}	1.10^b	1.53^b	58.7^{cd}	64.91^{de}
T_9	0.53^a	0.20^a	0.67^a	21.6^a	23.54^a
T_{10}	3.89^e	4.27^d	2.20^b	64.6^d	68.77^e

??In a column means followed by the same letters are not significantly different at P = 0.05

mortality in *S. litura* which is conidial concentration dependent. SBT#11 was more virulent with an LT_{50} of 5.1 and 6.0 days in laboratory for SBT#16 and SBT#11 respectively. Fungal sporulation was observed in 87 % of the insect cadaver in the treated group while no sporulation was observed in the control (Vijayarani *et al*., 2009). Though the combination of both bioinoculants had the population of 1.60/leaf, the *B.bassiana* seed treated plants had more whitefly population. However, *B.bassiana* seed treatment had a significant impact on *E.kerri*. The populations of leaf hoppers in *B.bassiana* treated plots were 0.85, 1.53 and 1.67/leaf whereas in chemical treatment the population was 0.40 and 0.67/leaf. *P.fluorescens* also significantly reduced the leaf hopper population and mean population in three treatment was 1.67/leaf. The combination of bio agents had the population of 2.00/leaf whereas in check it was 2.20/leaf. Murugesan and Kavitha (2009) reported that imidacloprid recorded the least mean population of leafhoppers in cotton. The entomopathogenic fungi, *V. lecanii, H. thompsonii* and *B. bassiana* were found to be the promising virulent isolates for cowpea aphids. By testing their field efficacy, they can be used as potential biocontrol agent for the management of cowpea aphid (Saranya *et al.,* 2010).

Pod borer

The field incidence of legume pod borer, *M. vitrata* and pod borer complex in harvested pods had shown that there was significant impact by entomopathogen foliar application but only next to chemical insecticide. In 2008 the *M. vitrata* web larva population was 7.50/plant in the untreated plots (Table 2). The insecticide profenophos foliar treated plants had the lowest web larva population. The bio agent *B.bassiana* foliar sprayed plots had the *M.vitrata* larval population of 1.40 and 1.75 in T_6 and T_5 stands next to chemical spray. The results of 2009 trials revealed that the pod borer damage was higher than that in 2008. The blue butterfly damage was more during the period. The legume pod borer population during flowering stage in 2009 trials revealed that profenophos sprayed plants had minimum larval population. The highest larval population of 14.50 was recorded in untreated control. The bio inoculants *B. bassiana* sprayed plots had the incidence of 8.27 and 9.43 per cent (T_5 and T_6).

The damage of different pod borers based on the symptoms in the harvested pods revealed that more *M. vitrata* damage followed by *L. boeticus* in the untreated control. Profenophos sprayed plants had the lowest pod damage of 1.46, 1.56 and 1.76 per cent followed by *B.bassiana* foliar spray. The gram pod borer *H.armigera* damage also showed a similar trend and the damage in the untreated control was 3.79 per cent. In the chemical treated plots the damage ranged between 0.97-1.33 whereas in *B.bassiana* foliar spray had 2.03 and 2.56 per cent pod damage. *B.bassiana* inflict maximum mortality of *H.armigera* at 1 x 10^8 conidia/ml in the laboratory. Gundannavar and Lingappa (2003) reported that mortality caused by the fungus varied from 5-52.5 per cent among various instars on fifth day and reached upto 100 per cent within 10 days. The damage by blue butterfly, *L.boeticus* in different treatments revealed that *B.bassiana* treatment had 4.56 and 4.66 per cent pod damage next to profenophos treated plants. The damage by pod bugs on the urdbean was also significantly reduced by bioinoculants. However, the chemicals showed promising and the damage was 1.00 to 1.56 per cent whereas on check the damage was 3.76 per cent. The *B.bassiana* sprayed plants had 3.13 and 2.96 per cent bug damaged pods. The cumulative pod damage by borers and pod bugs showed a clear picture that bio inoculants occupy a position next to chemicals. The cumulative pod damage of 5.04-7.37 per cent in profenophos sprayed plots whereas it was 16.43 and 16.80 per cent in *B.bassiana* sprayed plots. In the untreated control plants it was 27.15 per cent damage.

The damage in the harvested pods during 2009 field trials showed that the lowest of 2.22 per cent damage was by *M.vitrata* in the chemical treated plots. The bioinoculant *B.bassiana* sprayed plots had the damage of 10.44 per cent and 9.10 per cent (T_5 and T_6). In the untreated check damage by *M.vitrata* was 13.33 per cent. Rachappa *et al*. (2003) reported that the fungus species *M. anisopliae* was found effective against *Maruca testulalis* in cowpea under field conditions. The weather factors are congenial for the pest buildup during *kharif* season and also favourable for the multiplication of fungal species. The conidial survival of *B.bassiana* may be effected by environmental factors or by biopesticide and chemical products used to protect crop plants. The damage by *H.armigera*, *L.boeticus* and pod bugs was low in profenophos treated plots on the harvested pods. The damage by *H.armigera* in *B.bassiana* treated plots was

Table 2. Effect of bioinoculants against pod borers and pod bugs in urdbean (2008 and 2009)

Treatment	*M. vitrata* (web larva/plant)		Damage in harvested pods (%)										Yield/ha	
			M.vitrata		*H.armigera*		*L.boeticus*		Pod bugs		Cumulative pod borer damage			
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
T_1	5.88^{de}	9.56^{c}	7.88^{ef}	13.78^{g}	2.33^{bc}	2.11^{a-c}	5.11^{c-e}	10.78^{c}	3.23^{c}	4.78^{h}	18.55^{d}	31.45^{d}	701.0^{f}	702.5^{g}
T_2	6.50^{e}	10.23^{c}	9.11^{fg}	12.78^{ef}	3.00^{cd}	1.89^{ab}	6.56^{c-e}	10.33^{c}	3.06^{c}	3.67^{e}	21.29^{f}	28.67^{c}	645.0^{h}	714.0^{f}
T_3	6.33^{e}	9.33^{b}	10.33^{g}	12.78^{ef}	2.88^{b-d}	2.78^{b-d}	5.03^{cd}	11.11^{c}	3.46^{cd}	5.33^{i}	21.70^{f}	32.0^{d}	631.5^{i}	714.5^{f}
T_4	5.50^{d}	11.57^{d}	9.47^{fg}	13.11^{e}	2.33^{bc}	3.11^{cd}	5.77^{de}	10.56^{c}	3.11^{c}	4.55^{g}	19.68^{e}	31.33^{d}	663.0^{g}	700.0^{h}
T_5	1.75^{bc}	8.27^{b}	6.78^{de}	10.44^{d}	2.03^{b}	1.33^{a}	4.66^{c}	2.33^{b}	2.96^{b}	3.88^{f}	16.43^{c}	17.98^{b}	740.5^{d}	774.0^{d}
T_6	1.40^{b}	9.43^{c}	6.11^{d}	9.10^{c}	2.56^{bc}	3.33^{d}	4.56^{c}	3.00^{b}	3.13^{c}	3.22^{d}	16.80^{c}	18.65^{b}	737.0^{e}	761.0^{e}
T_7	0.73^{a}	1.23^{a}	1.76^{c}	2.89^{b}	1.04^{a}	1.78^{ab}	1.94^{b}	0.44^{a}	1.56^{b}	1.0^{a}	7.30^{b}	6.11^{a}	794.5^{c}	805.5^{c}
T_8	0.87^{a}	1.33^{a}	1.46^{a}	2.22^{a}	1.33^{a}	1.22^{a}	1.14^{a}	0.67^{a}	1.44^{a}	1.56^{b}	7.37^{b}	5.67^{a}	805.5^{b}	712.0^{b}
T_9	0.53^{a}	1.17^{a}	1.56^{b}	2.44^{a}	0.97^{a}	1.56^{a}	1.51^{ab}	0.56^{a}	1.00^{ab}	1.77^{c}	5.04^{a}	6.33^{a}	812.0^{a}	824.0^{a}
T_{10}	7.50^{f}	14.50^{e}	13.50^{h}	13.33^{fg}	3.79^{d}	3.56^{d}	6.10^{e}	11.56^{c}	3.76^{d}	5.88^{j}	27.15^{g}	34.33^{e}	513.0^{j}	525.0^{i}

??In a column means followed by the same letters are not significantly different at P = 0.05

1.33 per cent in the harvested pods which is statistically on a par with chemical treatment. *B.bassiana* @ 1.5g/lit sprayed in the chickpea plots showed less *H.armigera* and was on a par with *Nomurea rileyi* (Farlow) Samson with the same dosage under field condition (Devaraj and Nandihalli, 2003). In the present study, *H.armigera* damage in the check was 3.56 per cent whereas the damage by *L.boeticus* was 11.56 per cent. Significant reduction in the blue butterfly damage was noticed in the chemical as well as bio inoculants applied plots. The profenophos treated plots recorded 0.44-0.67 per cent damage followed by 2.33 and 3.0 per cent pod damage in *B.beauveria* treatment. The pod bug damage was 3.2-3.88 per cent in bio inoculants applied plots whereas it was 1.0-1.77 per cent damage in the chemical treated plots. The cumulative pod damage was 34.33 per cent in the untreated plots whereas it was 5.67-6.33 per cent in profenophos treated plots followed by 17.98 and 18.65 per cent in *B.bassiana* and 18.65 received plants. The yield of urdbean in different treatments have shown significant variation. During 2008 trial, the highest yield of 812kg/ha was recorded in the chemical seed treatment and sprayed plots. The bioinoculants treated plots (T_5 and T_6) have recorded 740.5kg/ha and 737.0kg/ha respectively and the lowest yield recorded in control plot (513.0kg/ha). Similar trend was observed in the 2009 trial. The two years trials revealed that the bio inoculants had a significant influence on the sucking pests as well as different pod borer complex in urdbean and can be best utilized for ecofriendly IPM programmes in the pulse cropping system.

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