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Field evaluation of some insecticides and bio-pesticide against tur pod bug, *Clavigralla gibbosa* (Spinola) in long duration pigeonpea

Narasimhamurthy G. M. and Ram Keval

Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi – 221 005, India.

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The study was carried out to evaluate some insecticides against tur pod bug, *Clavigralla gibbosa* (Spinola) in long duration pigeonpea during *kharif* 2009-2010 and 2010-2011 at Agriculture Research Farm, Banaras Hindu University, Varanasi. The results revealed that there was a significant difference in percentage population reduction at every observation days. The mean percentage population reduction from spinosad was ranged from 89.85% after first spray (2009-10) to 94.49% after first spray during 2010-2011. The relative performance of various insecticides was found in order of spinosad 45% SC at 73 g a.i./ha > indoxacarb 14.5 SC at 60 g a.i./ha > monocrotophos 36 SL > endosulfan 35 EC > dimethoate 30 EC > NSKE-5%. The highest pod damage by pod bug was recorded in the plot treated with *B. bassiana* at 1.5 kg/ha (14.23%) which is at par with NSKE-5% (14.21%). Highest incremental benefit: cost ratio of 13.23 was recorded in case of spinosad 45% SC followed by NSKE-5% (9.99:1) and indoxacarb 14.5% SC (9.48:1). The lowest benefit cost ratio (4.74:1) was recorded in *Beauveria bassiana* treated plot. It was in the range of 5.24 in dimethoate 30 EC to 8.40 in endosulfon 35 EC. Highest incremental benefit: Cost ratio of 13.23 was recorded in case of spinosad 45% SC followed by NSKE-5% (9.99:1) and indoxacarb 14.5% SC (9.48:1). The lowest benefit cost ratio (4.74:1) was recorded in *Beauveria bassiana* treated plot.

Key words: *Clavigralla gibbosa,* pod damage, *Beauveria bassiana* and insecticides.

INTRODUCTION

Pigeonpea *Cajanus cajan* (L.) Millsp is an important crop in semi-arid tropical and subtropical farming systems, providing high quality vegetable protein, animal feed, and firewood. Insect pests feeding on flowers, pods, and seeds are the most important biotic constraint affecting pigeonpea yields. Sachan and Lal (1988) have reported that about 250 species of insects worldwide belongs to 8 orders and 61 families and few of them causes serious yield loss. The three most important groups of pests: flower- and pod-feeding Lepidoptera, pod-sucking Hemiptera, and seed-feeding Diptera and Hymenoptera. Several species and genera of pod-sucking bugs attack pigeonpea and other legumes in Asia. For pigeonpea, the most dangerous genus is the *Clavigralla,* is found on many legumes and other hosts throughout the tropics and subtropics. Many species of pod-sucking bugs, mainly in the families Alydidae, Coreidae, and Pentatomidae, feed on pigeonpea (Lateef and Reed, 1990). *C. gibbosa* Spinola which is restricted to India and Sri Lanka (Dolling, 1978).

*Corresponding author. E-mail: simhappt@gmail.com.

The tur pod bug, *Clavigralla gibbosa* (Spinola) is one of the important pod damaging insects of pigeonpea. Next to the gram pod borer, *Helicoverpa armigera* and podfly, *Melanagromyza obtusa*, it is the most serious pest causing losses to pigeonpea in Madhya Pradesh (Odak et al., 1976). Feeding by nymphs and adults of this bug causes premature shedding of flower-buds, flowers and pods, deformation of pods, and shriveling of grains, resulting in substantial losses to pigeonpea crops. Besides pod fly and other insects, the damage caused by pod sucking bugs is showing an increasing trend in recent years on pigeonpea. Among pod sucking bugs, *C. gibbosa* (Spinola) is predominant in eastern Uttar Pradesh and the total grain loss due to pod sucking bugs damage has been worked out to the tune of 50,000 tonnes annually for Uttar Pradesh alone. Thus, attempts were made in the present investigation to study the efficacy of certain insecticides against pod bug.

MATERIALS AND METHODS

The present study was carried out during *kharif* 2009-2010 and 2010-2011 at Agriculture Research Farm, Banaras Hindu University, Varanasi. The pigeonpea variety, Bahar was grown following recommended crop growing practices, the crop was raised in 4 × 3.75 m plots with plant to plant spacing of 20 cm and row to row spacing of 75 cm having 5 rows in each plot, the experiment was laid out in Randomized Block Design (RBD) with 8 treatments and each treatment was replicated thrice. The chemicals used during the study are two novel insecticides Indoxocarb 14.5% SC at 60 g a.i./ha and Spinosad 45% sc at 73 g a. i./ha, three conventional insecticides that is, Endosulfan 35 EC at 0.07%, Dimethoate 30 EC at 1.8lt/ha and Monocrotophos 36 SL at 1.2lt/ha, one botanical product that is, NSKE-5% and one mycoinsecticide *Beauveria bassiana* (Bb) at 1.5 kg/ha. The ascomycete fungus *B. bassiana* is a pathogen of hundreds of insect species and is commercially produced as an environmentally friendly mycoinsecticide. Beauveria is one of the best-known genera of entomopathogenic fungi and worldwide numerous registered mycoinsecticide formulations based on *B. bassiana* (Bb) are used for control of insect pests (Xiao et al., 2012). Two sprays were taken, First spray of insecticidal treatments was given after 50% flowering when pest population reaches economic threshold level and subsequent spray was applied 15 days after first spray. The spray mixture of each treatment was prepared by mixing of required quantity of the insecticide formulations in water to make it equivalent to 600 L / ha. The spray mixtures were freshly prepared for each treatment. The spraying was done by ASPEE foot sprayer fitted with cone type nozzle. The sprayer was duly calibrated with water for the application rate of 600 L spray mixture / ha. The population of *C. gibbosa* were recorded on five randomly selected plants in each plot before 24 h of spraying which will be further converted in to per plant population and subsequent observations will be recorded at 3, 5 and 7 days after spraying on same plants. The percent reduction of the bug population was worked out by using the formula.

$$\text{Percent population reduction} = 1 - \frac{\text{Post-treatment population in treatment}}{\text{Pre-treatment population in treatment}} \times \frac{\text{Pre-treatment population in check}}{\text{Post-treatment population in Check}} \times 100$$

Five plants in each plot will be selected randomly and all the pods from 5 plants were pooled together and finally 100 pods were picked up for pod and grain damage assessment and yield was recorded. Benefit cost ratio (BCR) was also assessed by dividing the net monetary return (B) by the total additional cost due to treatments as worked out (C) (Nagrare and More, 1998). The values were duly transformed in to the corresponding angular value and subjected to analysis of variance. Critical difference (CD) was applied for comparing treatment means (Gomez and Gomez, 1984).

RESULTS

Bio efficacy of some insecticides against *C. gibbosa* on long duration pigeonpea

After first spray the results revealed that there was a significant difference in percent population reduction at every observation days. All the treatments were found significantly superior by giving higher reduction of *Clavigralla* population to the control plot. During 2009-2010, the treatment of spinosad 45% SC recorded the highest mean per cent population reduction (89.85%) and it is at par with indoxacarb 14.5 SC (89.26%) and the next best treatment were dimethoate 30 EC (80.26%), endosulfon 35 EC (79.66%) and monocrotophos 36 SL (72.94%), these treatments significantly superior over NSKE-5% and *B. bassiana*. The lowest mean percent larval reduction was found in case of NSKE-5% (59.10%) which is at par with *B. bassiana* (59.24%) (Table 1).

The same trend of result was observed during 2010-2011, where the treatment spinosad 45% SC recorded highest mean percent population reduction (94.49%) and it was at par with indoxacarb 14.5 SC (90.57%). The treatments, dimethoate 30 EC (85.92%), monocrotophos 36 SL (84.44%) and endosulfon 35 EC (79.97%) were found next in order of mean percent population reduction and these treatments were significantly superior among remaining treatments. The lowest mean percent population reduction was found in case of *B. bassiana* at 1.5 kg/ha (59.44%) which was at par with NSKE-5% (64.04%). There is no significant difference among the treatments indoxacarb 14.5 SC, dimethoate 30 EC, monocrotophos 36 SL and endosulfon 35 EC in recording mean percent population reduction (Table 2).

After second spray the results revealed that there was a significant difference in percent population reduction at every observation days. All the treatments were found significantly superior by giving higher reduction of *Clavigralla* population to the control. During 2009-2010, the treatment of spinosad 45% SC recorded the highest mean per cent population reduction (93.68%) and it is at par with indoxacarb 14.5 SC (89.36%) and dimethoate 30 EC (89.75%) (Table 1). The next best treatments were monocrotophos 36 SL (82.01%) and endosulfon 35 EC (77.18%) these treatments were significantly superior over NSKE-5% and *B. bassiana*. The lowest mean percent population reduction was found in case of NSKE-5% (55.50%) which is at par with *B. bassiana* (56.82%).

Table 1. Bio efficacy of some insecticides against *Clavigrella gibbosa* on long duration pigeonpea during 2009-2010.

S/N	Treatments	% Reduction of bug population over control after first spray					% reduction of bug population over control after second spray				
		Pre count/pt	3 DAS	7 DAS	10 DAS	Mean	Pre count/pt	3 DAS	7 DAS	10 DAS	Mean
1	Indoxocarb 14.5% SC at 60 g a.i./ha	12.20	90.65 (72.19)	89.93 (71.50)	87.20 (69.03)	89.26 (70.86)	11.20	93.58 (75.81)	88.74 (70.39)	85.76 (67.83)	89.36 (71.34)
2	Spinosad 45% sc at 73 g a. i./ha	13.80	90.40 (72.02)	90.40 (72.02)	88.76 (70.45)	89.85 (71.42)	12.60	98.16 (82.20)	92.33 (73.98)	90.56 (72.53)	93.68 (75.43)
3	Endosulfan 35 EC at 0.07 %	12.40	85.32 (67.75)	82.25 (65.10)	71.42 (57.72)	79.66 (63.19)	10.40	82.95 (65.61)	77.34 (61.57)	71.26 (57.58)	77.18 (61.58)
4	Dimethoate 30 EC at 1.8 lt/ha	13.60	84.20 (66.69)	83.25 (66.04)	73.34 (58.98)	80.26 (63.62)	11.70	94.30 (76.71)	88.45 (71.08)	86.51 (68.59)	89.75 (71.32)
5	NSKE-5%	14.90	58.66 (49.98)	66.98 (54.99)	51.66 (45.95)	59.10 (50.24)	11.20	50.34 (45.19)	63.67 (52.94)	52.50 (46.43)	55.50 (48.15)
6	Monocrotophos 36 SL at 1.2lt/ha	12.50	76.55 (61.03)	73.73 (59.21)	68.55 (55.89)	72.94 (58.71)	10.00	87.12 (69.26)	80.38 (63.71)	78.54 (62.61)	82.01 (65.19)
7	*Beauveria bassiana* (Bb) at 1.5 kg/ha	13.20	68.80 (54.86)	52.50 (46.43)	56.42 (48.72)	59.24(50.32)	12.80	65.62 (54.14)	58.52 (49.97)	46.34 (42.88)	56.82 (48.91)
8	Control	14.40	0.00	0.00	0.00	0.00	12.80	0.00	0.00	0.00	0.00
SEm±			3.07	2.92	2.60	2.86		3.75	3.20	3.96	3.63
C D at 5%			8.43	8.43	7.52	8.12		8.05	7.87	9.35	8.42

Figures in the parenthesis are transformed Arc-sine values, NS- Non Significant, NSKE- Neem Seed Kernel Extract, DAS = Days After Spraying.

Table 2. Bio efficacy of some insecticides and biopesticides against *Clavigrella gibbosa* on long duration pigeonpea during 2010-2011.

S/N	Treatments	% population reduction over control after 1st spray					% population reduction over control after 2nd spray				
		Pre count/pt	3DAS	7DAS	10DAS	Mean	Pre count/pt	3DAS	7DAS	10DAS	Mean
1	Indoxocarb 14.5% SC at 60 g a.i./ha	14.20	92.68 (74.30)	90.83 (72.37)	88.20 (69.90)	90.57 (72.19)	12.30	89.26 (70.86)	90.10 (71.66)	87.66 (69.43)	89.01 (70.65)
2	Spinosad 45% sc at 75 g a. i./ha	14.30	96.40 (79.06)	94.40 (76.31)	92.67 (74.29)	94.49 (76.42)	11.40	93.20 (74.88)	91.43 (72.97)	88.25 (69.95)	90.96 (72.60)
3	Endosulfan 35 EC at 0.07 %	13.90.	80.10 (63.51)	82.47 (65.25)	77.34 (61.57)	79.97 (63.41)	11.80	77.64 (61.78)	80.38 (63.71)	74.10 (59.41)	77.37 (61.59)
4	Dimethoate 30 EC at 1.8lt/ha	31.20	91.25 (72.79)	89.20 (70.81)	77.33 (61.56)	85.92 (67.96)	12.90	85.44 (67.56)	82.71 (65.42)	79.40 (63.10)	82.51 (65.33)
5	NSKE-5%	13.50	68.26 (55.70)	65.20 (58.16)	58.66 (49.98)	64.04 (53.84)	10.20	71.82 (57.93)	61.46 (51.62)	55.25 (48.01)	62.84 (52.52)
6	Monocrotophos 36 SL at 1.2lt/ha	12.80	86.25 (68.23)	85.66 (67.74)	81.42 (64.46)	84.44 (66.76)	10.60	86.45 (68.40)	83.23 (65.82)	74.53 (59.69)	81.40 (64.63)
7	*Beauveria bassiana* (Bb) at 1.5 kg/ha	13.10	50.44 (45.25)	59.28 (50.34)	68.61 (55.92)	59.44 (50.44)	11.00	57.54 (49.33)	60.61 (51.12)	68.33 (55.75)	62.16 (52.03)
8	Control	12.80	0.00	0.00	0.00	0.00	12.80	0.00	0.00	0.00	0.00
SEm±			2.90	3.18	2.78	2.95		3.01	2.90	2.98	2.96
CD at 5%			8.37	9.08	7.67	8.37		8.46	8.22	8.74	8.47

Figures in the parenthesis are transformed Arc-sine values, NS - Non Significant, NSKE- Neem Seed Kernel Extract, DAS = Days After Spraying.

The same trend of result was observed during 2010-2011, where the treatment spinosad 45% SC recorded highest mean percent population reduction (90.96%) and it was at par with indoxacarb 14.5 SC (89.01%) and dimethoate 30 EC (82.51%). The treatments, monocrotophos 36 SL (81.40%) and endosulfon 35 EC (77.37%) were found next in order of mean percent population reduction and these treatments were significantly superior among remaining treatments. The lowest mean percent population reduction was found in case of *B. bassiana* at 1.5 kg/ha (62.16%) which was at par with NSKE-5% (62.84%) (Table 2). There is no significant difference among the treatments dimethoate 30

Table 3. Economics of different insecticides application in the management of pod fly and pod bug in long duration pigeonpea during 2009-2010.

S/N	Treatments	Percent pod damage	Per cent grain damage	Grain yield (kg/ha)	Additional yield over control (kg/ha)	Additional income over control (Rs/ha)	Cost of pest control (Rs/ha)	Net return (Rs /ha)	BC Ratio
1	Indoxocarb 14.5% SC at 60 g a.i./ha	9.00 (17.34)	2.53 (9.08)	1446	680	19720	1880	17840	9.48
2	Spinosad 45% SC at 73 g a. i./ha (0.3 ml/L)	8.66 (17.07)	2.36 (8.79)	1567	801	23229	1632	21597	13.23
3	Endosulfan 35 EC at 0.07%	10.66 (18.94)	3.61 (10.91)	1172	406	11774	1252	10522	8.40
4	Dimethoate 30 EC at 0.03%	12.33 (20.55)	3.30 (10.46)	1044	278	8062	1290	6772	5.24
5	NSKE-5%	15.00 (22.77)	4.01 (11.56)	1022	256	7424	675	6749	9.99
6	Monocrotophos 36 SL at 0.05%	10.00 (18.30)	3.77 (11.18)	1194	428	12412	1378	11034	8.01
7	*Beauveria bassiana* (Bb) at 1.5 kg/ha	14.66 (21.66)	6.41 (14.66)	994	228	6612	1150	5462	4.74
8	Control	18.33 (25.26)	13.73 (21.72)	766	-	-	-	-	-
SEm±		2.24	(1.85)	-	-	-	-	-	-
C D at 5%		5.45	(4.48)	-	-	-	-	-	-

Cost of Chemicals: Neem seeds -Rs. 25/kg, Market Price of pigeonpea- Rs. 29/ kg, Endosulfon 35 EC - Rs. 136/ 500 ml, No. of Labour required/spray- Three Indoxocarb 14.5% SC-Rs. 1325/500 ml, wage of labour per day- Rs. 100, *B bassiana*- Rs. 75/100 g, Total Labour charge –Rs. 600, Monocrtophos 36 SL - Rs. 82/250ml, Dimethoate 30 EC- Rs. 384/lit, Spinosad 45% SC-Rs. 2864/lit.

EC, monocrotophos 36 SL and endosulfon 35 EC in recording mean percent population reduction.

Effect of various treatments on per cent pod damage by pod bug

The treatments applied showed significant differences in the percent pod damage by pod bug and data are given in Table 3. The percent pod damage ranged from 8.66 percent in spinosad 45% SC to 15.00% in NSKE-5%. While in control plot the damage was 18.33% during 2009-2010. All the treatments were found to be superior over control with respect to percent pod damage. The relative performance of various insecticides was found in order of spinosad 45% SC at 73 g a.i./ha > indoxacarb 14.5 SC at 60 g a.i./ha > monocrotophos 36 SL > endosulfan 35 EC > dimethoate 30 EC > *B. bassiana* at 1.5 kg/ha. The highest pod damage by pod bug was recorded in the plot treated with NSKE-5% (15.00%) which is at par with *B. bassiana* at 1.5 kg/ha (14.66%) (Table 3). During 2010-2011, the percent pod damage by pod bug was ranged from 8.30% in spinosad 45% SC to 14.23% in *B. bassiana* at 1.5 kg/ha. While in control plot the damage was 16.92% (Table 4). All the treatments were found to be superior over control with respect to percent pod damage. The relative performance of various insecticides was found in order of spinosad 45% SC at 73 g a.i./ha > indoxacarb 14.5 SC at 60 g a.i./ha > monocrotophos 36 SL > endosulfan 35 EC > dimethoate 30 EC > NSKE-5%. The highest pod damage by pod bug was recorded in the plot treated with *B. bassiana* at 1.5 kg/ha (14.23%) which is at par with NSKE-5% (14.21%). The lowest pod damage was found in case of spinosad 45% SC (8.30%) which is at par with indoxacarb 14.5 SC (8.96%), monocrotophos 36 SL (10.10), endosulfan 35 EC (10.60%) and dimethoate 30 EC (12.14%).

The treatments applied showed significant differences in the percent grain damage by pod bug and data are given in Table 4. The percent grain damage ranged from 2.36% in spinosad 45% SC to 6.41% in *B. bassiana* at 1.5 kg/ha. While in control plot the damage was 13.73% during 2009-2010. All the treatments were found to be superior over control with respect to percent gain damage. The relative performance of various insecticides was found in order of spinosad 45% SC at 73 g a.i./ha > indoxacarb 14.5 SC at 60 g a.i./ha > dimethoate 30 EC > endosulfan 35 EC > monocrotophos 36 SL > NSKE-5%. The highest grain damage by pod bug was recorded in the plot treated with *B. bassiana* at 1.5 kg/ha (6.41%) which is at par with dimethoate 30 EC (3.30%), endosulfan 35 EC (3.61%), monocrotophos 36 SL (3.77%) NSKE-5% (4.01%) (Table 3).

During 2010-2011, the percent grain damage by pod bug was ranged from 2.58% in indoxacarb 14.5 SC at 60 g a.i./ha to 5.66% in *B. bassiana* at 1.5 kg/ha. While in control plot the damage was 13.73% (Table 4). All the treatments were found

Table 4. Economics of different insecticides application in the management of pod fly and pod bug in long duration pigeonpea during 2010-2011.

S/N	Treatments	Percent pod damage	Per cent grain damage	Grain yield (kg/ha)	Additional yield over control (kg/ha)	Additional income over control (Rs/ha)	Cost of pest control (Rs/ha)	Net return (Rs/ha)	BC Ratio
1	Indoxocarb 14.5% SC at 60 g a.i./ha	8.96 (17.41)	2.58 (9.24)	1304	545	15805	1880	13925	7.40
2	Spinosad 45% SC at 73 g a. i./ha (0.3 ml/L)	8.30 (16.74)	2.92 (9.83)	1625	866	25114	1632	23482	14.38
3	Endosulfan 35 EC at 0.07%	10.60 (19.00)	3.61 (10.95)	1227	468	13572	1252	12320	9.84
4	Dimethoate 30 EC at 0.03%	12.14 (20.39)	3.30 (10.46)	1223	464	13456	1290	12166	9.43
5	NSKE-5%	14.21 (22.14)	4.01 (11.55)	971	212	6148	675	5473	8.10
6	Monocrotophos 36 SL at 0.05%	10.10 (18.53)	3.77 (11.19)	1369	610	17690	1378	16312	11.83
7	*Beauveria bassiana* (Bb) at 1.5 kg/ha	14.23 (22.16)	5.66 (13.76)	962	203	5887	1150	4737	4.11
8	Control	16.92 (24.28)	13.73 (21.74)	759	-	-	-	-	-
SEm±		2.37	1.74	-	-	-	-	-	-
C D at 5%		5.86	5.17	-	-	-	-	-	-

Cost of chemicals: Neem seeds -Rs. 25/kg, Market Price of pigeonpea- Rs. 29/ kg, Endosulfon 35 EC - Rs. 136/ 500 ml, No. of Labour required/spray- Three Indoxocarb 14.5% SC-Rs. 1325/L, wage of labour per day- Rs. 100, *B bassiana*- Rs. 75/100 g, Total Labour charge –Rs. 600, Monocrtophos 36 SL - Rs. 82/250 ml, Dimethoate 30 EC- Rs. 384/L, Spinosad 45% SC- Rs. 2864/L.

to be superior over control with respect to percent grain damage. The relative performance of various insecticides was found in order of indoxacarb 14.5 SC at 60 g a.i./ha > spinosad 45% SC at 73 g a.i./ha > dimethoate 30 EC > endosulfan 35 EC > monocrotophos 36 SL > NSKE-5%. The highest grain damage by pod bug was recorded in the plot treated with *B. bassiana* at 1.5 kg/ha (5.66%) which is at par with NSKE-5% (4.01%), dimethoate 30 EC (3.30%), endosulfan 35 EC (3.61%), monocrotophos 36 SL (3.77%).

The net income was highest in spinosad (Rs 21,597/ha) and it was followed by Indoxocarb 14.5% SC (Rs.17840/ha) and Monocrotophos 36 SL with net returns of Rs 11,034. The lowest net income was recorded from *B. bassiana* and NSKE applied treatment with Rs. 5462/ha and Rs. 6749/ha net income respectively (Table 3). In these treatments BC ratio varied between 4.74 and 13.23 rupees for every one rupee invested for management of pod fly and pod bug. Highest incremental benefit: cost ratio of 13.23 was recorded in case of spinosad 45% SC followed by NSKE-5% (9.99:1) and indoxacarb 14.5% SC (9.48:1). The lowest benefit cost ratio (4.74:1) was recorded in *Beauveria bassiana* treated plot. While, it was in the range of 5.24 in dimethoate 30 EC to 8.40 in endosulfon 35 EC.

It was evident from the table that, the net income and marginal benefit cost ratio was varied depending on cost of pesticidal application. The highest net income (Rs. 23482/ha) was recorded from spinosad 45% SC sprayed treatment followed by Monocrotophos 36 SL (Rs. 16312/ha) and indoxacarb 14.5% SC (Rs. 13925/ha). The lowest net income (Rs. 4737/ha) was recorded from *B. bassiana* applied treatment (Table 4). The benefit cost analysis of insecticidal application revealed that the highest benefit cost ratio was recorded from plot treated with spinosad 45% SC (14.38:1) followed by Monocrotophos 36 SL (11.83) and endosulfon 35 EC (9.84:1). While it was in the range of 4.11 to 9.43 in the rest of the treatments. The lowest benefit cost ratio (4.11:1) was recorded in *Beauveria bassiana* treated plot.

DISCUSSION

The bio-efficacy of different insecticides was evaluated under field condition to test the effect on percent population reduction of C. *gibbosa* during 2009-2010 and 2010-2011. All the treatments were found significantly superior by giving higher mortality of pod bug to the control. Spinosad 45% SC recorded the highest percent population reduction in all the observation days during both the years. The mean percent population reduction from spinosad was ranged from 89.85% after first spray (2009-2010) to 94.49% after first spray during 2010-2011. The treatments spinosad and indoxacarb are equally effective in reducing bug population and are significantly superior over remaining treatments.

There is no significant difference among the treatments dimethoate 35 EC, monocrotophos 36 SL and endosulfon 35 EC in reducing bug population during both the years. The lowest percent population reduction was recorded from *B. bassiana* at 1.5 kg/ha treated plots in all the observation days during both the years which is at par with NSKE-5%. The mean percent population reduction in *B. bassiana* at 1.5 kg/ha, treated plot was ranged from 56.42% after first spray in 2009-2010 to 62.16% after second spray in 2010-2011. Nguyen and Chi (2005) were recorded the field mortality of Rice ear head bug, *Leptocorisa acuta* caused by *B. bassiana* isolates ranged from 45.3 to 74.9% at 10 days after treatment.

The treatments applied showed significant difference in the per cent pod and grain damage by pod bug. The plot treated with spinosad 45% SC showed minimum (8.30%) pod damage and 2.36% grain damage by pod bug during 2009-2010, which is at par with indoxacarb 14.5% SC, dimethoate 35% EC and endoslfon 30% EC. Kumar and Nath (2003) recorded endosulfon and monocrotophos as the best insecticides against pod bug. The maximum (15.00%) pod damage and (6.41%) grain damage was recorded in the plot treated with NSKE-5%. while in control plot the pod and grain damage was more. All the treatments were found significantly superior over control plot for controlling pod bug.

Bhuvaneswari and Balagurunathan (2002) showed that 4 round of Endosulfan 35 EC at 35 g a.i./ha recorded less damage compared with untreated control. Spinosad 45% SC at 75 g a. i./ha gave highest net return followed by Indoxocarb 14.5% SC and Monocrotophos 36 SL during both the years. There no significant difference among NSKE-5%, *B. bassiana* (Bb) at 1.5 kg/ha in terms of net return. Same trend of results found by Babariya et al. (2010) and Srivastava et al. (2012). The benefit:cost ratio was high in the plots treated with Spinosad 45% SC followed by Monocrotophos 36 SL. The lowest cost: benefit ratio was found in the treatment *B. bassiana* at 1.5 kg/ha in both the years. The treatments Indoxocarb 14.5% SC, dimethoate 35% EC and *B. bassiana* (Bb) at 1.5 kg/ha could not show any conspicuous gain over cost. Such trend of results has also been reported by Nazrussalam et al. (2007) and Altaf (2007). Both the treatments Spinosad 45% SC and indoxacarb 14.5% SC provided better control and ultimately better yield. Hence, both these chemicals may be considered for recommendation in alternate sprays for managing the pod bug on long duration pigeonpea.

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