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BIO-EFFICACY OF DIFFERENT INSECTICIDES AGAINST POD BORER, *HELICOVERPA ARMIGERA* HUBNER INFESTING PIGEONPEA

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ABSTRACT

An experiment was conducted during *Kharif* 2014 to evaluate the efficacy of different insecticides *viz*., quinalphos 0.0700 per cent, indoxacarb 0.0105 per cent, emamectin benzoate 0.0022 per cent, spinosad 0.0070 per cent, flubendiamide 0.0070 per cent, chlorantraniliprole 0.0055 per cent and azadirachtin 0.00015 per cent against pod borer, *Helicoverpa armigera* (Hubner) infesting pigeonpea. The results revealed that emamectin benzoate 0.0022 per cent was the most effective treatment in minimizing larval population (1.80 per plant), pod (2.33 per cent) and grain damage (2.00 per cent) due to pod borer followed by chlorantraniliprole 0.0055 per cent (1.80 per plant, 3.00 and 2.33 per cent), flubendiamide 0.0070 per cent (1.87 per plant, 3.67 and 3.00 per cent) and spinosad 0.0070 per cent (1.73 per plant, 5.00 and 3.67 per cent) at 14 days after third spray. The highest grain yield was achieved by emamectin benzoate 0.0022 per cent (18.83 q per ha) followed by chlorantraniliprole 0.0055 per cent (18.32 q per ha) and flubendiamide 0.0070 per cent (17.69 q per ha), while quinalphos 0.0700 per cent (1:3.40) documented highest incremental cost benefit ratio followed by spinosad 0.0070 per cent (1:2.80) and emamectin benzoate 0.0022 per cent (1:2.30).

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INTRODUCTION

Grain legumes (pulses) are considered as essential source of nutrients and are also recognised as poor man's meat. India grows the large number of varieties of pulses in the world accounting for about 32 per cent of the area and 23 per cent of the world production (Chattopadhyay, 2016). The year 2016 has been designated the International Year of Pulses (IYP) by the Food and Agriculture Organization of the United Nations. The IYP offers an opportunity to focus global attention on this important group of crops, the role they play in human and animal nutrition, their current and potential productivity, and their contribution to sustainable agriculture (FAO, 2016). Pulses are one of the important segments of Indian Agriculture. Pigeonpea is one of the major pulse crops of the tropics and sub-tropics grow in approximately 50 countries in Asia, Africa and America. India accounts for about 75 per cent of world production. Economically it is the second most important pulse crop after chickpea accounting for about 20 per cent of total pulse production (Sharma *et al*., 2010). In India, the area under pigeonpea was 3.88 million hectares and the production was 3.17 million tonnes with average productivity of 817 kg per ha in 2013-14. In Maharashtra, it was cultivated over an area of 1.14 million hectares with production of 1.03 million tonnes and average productivity was 906 kg per ha in 2013-14 (Anonymous, 2015). Major constraint in the production of pigeonpea is the damage caused by insect-pests. In India, nearly three hundred species of insect-pests are known to infest pigeonpea crop at its various growth stages (Lal and Singh, 1998). Of these gram pod borer, *Helicoverpa armigera* (Hubner) is most important feeder of pigeonpea (Lal and Katti, 1998). Pod borer larvae after hatching feed for a short time on the tender leaflets by scrapping green tissue and then shift to flower buds and tender shoots. Slowly it enters and feeds on the seeds inside the pods. The half portion of larvae remains inside pod while feeding on the developing seeds. They can cut hole on one to another locule and feed 20-25 pods in its lifetime. In India, insect-pests of pigeonpea reported up to 78 per cent avoidable losses (Lateef and Reed, 1983) with estimate to cause economic loss of $US 8.48 billion (Sarika *et al*., 2013). *H. armigera* inflicted 60 to 90 per cent loss in the grain yield under favourable conditions (Lal *et al*., 1992). Hence, pest management is an important aspect of pigeonpea production. The Central Insecticide Board and Registration Committee have recommended large number of insecticides for the control of pigeonpea pod borer. However, recently many reports documented failure of label recommended insecticides to control pod borer. Hence, it is necessary to revalidate the efficacy status of commonly used insecticides by the farmers for the effective management of pigeonpea pod borer. Keeping this in view, the present investigation was carried out to investigate the bio-efficacy of different label recommended insecticides against pod borer, *H. armigera* infesting pigeonpea.

MATERIALS AND METHODS

The field experiment on bio-efficacy of different label recommended insecticides against pod borer, *H. armigera* infesting pigeonpea using variety BSMR-853 was conducted in RBD with eight treatments including untreated control replicated three times at Research Farm, Department of Agril. Entomology, College of Agriculture, Latur (Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) (MS)-India during *Kharif* 2014. Pigeonpea was grown with all recommended package of practices recommended by VNMKV, Parbhani for raising the crop except insect-pest management. Five plants were selected randomly from the net plot of each treatment in each replication for recording observations. They were labelled properly. The observations on total number of pod borer larvae on pigeonpea pod and flower were recorded on the observation plants at one day before and 1, 3, 7 and 14 days after first, second and third application of insecticides. The data pertaining to number of pod borer larvae recorded at different intervals were transformed into square root transformation before statistical analysis.

The observations were also recorded on per cent pod and grain damage caused by *H. armigera* by randomly collecting hundred pods and grains from five randomly selected plants from each treatment at harvest. The oval to round hole on pod and partly eaten grains exhibits the pod and grain damage due to *H. armigera*. Later, these pods were threshed and grains were added to the yield of respective plots. The data on per cent pod damage and grain damage were transformed into angular transformation before statistical analysis to know the significance of difference among different treatments.

After crop attained maturity, it was harvested separated in each treatment. The weight of grain per plot was recorded after drying. Plot wise yield was computed on hectare basis for statistical interpretation. The economics of the treatment was also worked out based on grain yield and cost of protection. Based on cost of protection and gross profit, the incremental cost benefit ratio (ICBR) was worked out. The data in respect of bio-efficacy and economics of different insecticides against gram pod borer, *H. armigera* infesting pigeonpea were statistically analyzed by standard 'analysis of variance'. The null hypothesis was tested by 'F' test of significance at 5 per cent level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of different insecticides on larval population of pod borer, *H. armigera* infesting pigeonpea

Data pertaining to effect of different insecticides on larval population of pod borer, *H. armigera* after first, second and third spray are presented in Table 1. The results revealed that all the insecticides were found to be significantly superior over untreated control in reducing larval population of pod borer at 1, 3, 7 and 14 days after first, second and third application of insecticides. The plots treated with emamectin benzoate 0.0022 per cent recorded significantly lowest larval population of pod borer on pigeonpea (0.73, 0.93, 1.27 and 1.40 per plant after first spray; 0.87, 1.00, 1.20 and 1.47 per plant after second spray and; 0.73, 0.83, 1.13 and 1.80 per plant after third spray) at 1, 3, 7 and 14 days after spraying, respectively over rest of the insecticides followed by chlorantraniliprole 0.0055 per cent (0.87, 1.00, 1.33 and 1.53

Table 1: Effect of different insecticides on larval population of pod borer infesting pigeonpea, pod and grain damage

Treatments	Mean larval population of *H. armigera*													Pod damage (per cent)	Grain damage (per cent)
	One day before spray	Ist spray Days after spraying				IInd spray Days after spraying				IIIrd spray Days after spraying					
		1	3	7	14	1	3	7	14	1	3	7	14		
Quinalphos 0.0700 per cent	2.27(1.67)*	1.33(1.35)	1.47(1.41)	1.73(1.49)	2.00(1.58)	1.27(1.33)	1.40(1.37)	1.60(1.44)	2.13(1.62)	1.13(1.27)	1.27(1.33)	1.67(1.48)	2.00(1.58)	6.67 (14.89)**	5.33(13.29)
Indoxacarb 0.0105 per cent	2.47(1.71)	1.20(1.30)	1.33(1.35)	1.60(1.44)	1.73(1.49)	1.20(1.31)	1.33(1.35)	1.47(1.41)	1.67(1.48)	1.07(1.25)	1.20(1.30)	1.53(1.42)	2.00(1.58)	5.33 (13.34)	4.67(12.46)
Emamectin benzoate 0.0022 per cent	2.53(1.74)	0.73(1.10)	0.93(1.19)	1.27(1.32)	1.40(1.37)	0.87(1.16)	1.00(1.23)	1.20(1.31)	1.47(1.40)	0.73(1.11)	0.80(1.14)	1.13(1.27)	1.80(1.52)	2.33 (8.75)	2.00(8.13)
Spinosad 0.0070 per cent	2.73(1.79)	1.07(1.25)	1.20(1.31)	1.47(1.41)	1.67(1.48)	1.13(1.27)	1.27(1.33)	1.40(1.37)	1.60(1.44)	1.00(1.23)	1.13(1.27)	1.40(1.37)	1.73(1.49)	5.00 (12.93)	3.67(11.01)
Flubendiamide 0.0070 per cent	2.40(1.70)	0.93(1.19)	1.13(1.27)	1.33(1.35)	1.60(1.44)	1.07(1.24)	1.13(1.27)	1.33(1.35)	1.53(1.42)	0.93(1.20)	1.00(1.23)	1.33(1.35)	1.87(1.53)	3.67 (10.87)	3.00(9.97)
Chlorantraniliprole 0.0055 per cent	2.67(1.77)	0.87(1.16)	1.00(1.23)	1.33(1.35)	1.53(1.42)	0.93(1.20)	1.07(1.25)	1.27(1.33)	1.47(1.41)	0.87(1.16)	0.93(1.19)	1.20(1.30)	1.80(1.52)	3.00 (9.88)	2.33(8.75)
Azadirachtin 0.00015 per cent	2.67(1.78)	1.47(1.41)	1.53(1.42)	1.93(1.55)	2.27(1.66)	1.33(1.35)	1.40(1.37)	1.73(1.49)	2.20(1.64)	1.27(1.33)	1.33(1.35)	1.73(1.49)	2.40(1.71)	7.33 (15.67)	6.33(14.39)
Untreated Control	2.47(1.72)	2.53(1.74)	2.66(1.77)	2.80(1.81)	2.90(1.85)	3.27(1.95)	3.40(1.97)	3.53(2.00)	3.67(2.05)	3.87(2.09)	3.93(2.10)	4.07(2.14)	4.27(2.18)	10.0 (18.43)	9.00(17.49)
S.E	0.21	0.04	0.02	0.03	0.04	0.33	0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.93	0.84
C.D. at 5 per cent	N.S.	0.12	0.07	0.08	0.12	0.10	0.09	0.08	0.12	0.11	0.12	0.10	0.12	2.68	2.50
C.V.	-	4.94	3.19	3.35	4.65	4.13	3.82	3.17	4.17	4.74	4.94	3.86	3.90	11.71	11.95

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$); **Figures in parentheses are angular transformed values; N.S.: Non-significant

Table 2. Economics of different insecticides against pod borer, *H. armigera* infesting pigeonpea

Treatments		Healthy grain yield (q per ha)	Increase in yield over control (q per ha)	Cost of insecticide required untreated (Rs. per ha)	Labour charges and rent for 3 sprays (Rs.per ha)	Total cost for3sprays control (Rs.per ha)	Value of additional yield over untreated (Rs. per	Incremental benefit (Rs. per ha)	ICBR	Rank
Quinalphos	0.0700 per cent	15.42	5.46	5392.6	1404	6797.0	30012	23215	1:3.4	1
Indoxacarb	0.0105 per cent	16.90	6.94	10070	1404	11474	38188	26714	1:2.3	4
Emamectin benzoate	0.0022 per cent	18.83	8.87	13526	1404	14930	48785	33855	1:2.3	3
Spinosad	0.0070 per cent	17.36	7.40	9244.4	1404	10648	40700	30052	1:2.8	2
Flubendiamide	0.0070 per cent	17.69	7.73	12356	1404	13760	42533	28774	1:2.1	5
Chlorantraniliprole	0.0055 per cent	18.32	8.36	19037	1404	20441	45962	25521	1:1.2	6
Azadirachtin	0.00015 per cent	15.00	5.04	18667	1404	20071	27720	7649.3	1:0.4	7

Larvae of pod borer **Pod damage** **Grain damage**

Figure 1:

per plant after first spray; 0.93, 1.07, 1.27 and 1.47 per plant after second spray and; 0.87, 0.93, 1.20 and 1.80 per plant after third spray, respectively), flubendiamide 0.0070 per cent (0.93, 1.13, 1.33 and 1.60 per plant after first spray; 1.07, 1.13, 1.33 and 1.53 per plant after second spray and; 0.93, 1.00, 1.33 and 1.87 per plant after third spray, respectively), spinosad 0.0070 per cent (1.07, 1.20, 1.47 and 1.67 per plant after first spray; 1.13, 1.27, 1.40 and 1.60 per plant after second spray and; 1.00, 1.13, 1.40 and 1.73 per plant after third spray, respectively) and indoxacarb 0.0105 per cent (1.20, 1.33, 1.60 and 1.73 per plant after first spray; 1.20, 1.33, 1.47 and 1.67 per plant after second spray and; 1.07, 1.20, 1.53 and 2.00 per plant after third spray, respectively). The trend of results found in the present investigations coincides with Barad *et al.* (2013) who documented that emamectin benzoate 5 per cent WG was the best treatment against *H. armigera* on red gram. However, Priyadarshini *et al.* (2013) reported that flubendiamide 480 SC at 60 g a.i. per ha was the most effective insecticide with a maximum reduction in pod borer (*H. armigera*) on pigeonpea. While, Meena *et al.* (2014) registered that spinosad was effective against tomato fruit borer. Sreekanth *et al.* (2014) showed lowest number of *Helicoverpa* larvae per plant in plots treated with chlorantraniliprole 20 SC (0.43), flubendiamide 480 SC (0.59) and spinosad 45 SC (0.85). However, Singh *et al.* (2015) reported that flubendiamide 480 SC 75 ml/ha was best treatment in minimizing larval population of *H. armigera* on gram. While Sudhir Kumar *et al.* (2015) noted that indoxacarb 14.5 SC @ 500 ml/ha was highly efficacious against *H. armigera* in chickpea.

Effect of different insecticides on pod and grain damage

The results revealed significantly lowest pod damage and grain damage due to *H. armigera* was observed in the plots treated with emamectin benzoate 0.0022 per cent (2.33 and 2.00 per cent, respectively) followed by chlorantraniliprole 0.0055 per cent (3.00 and 2.33 per cent, respectively) and flubendiamide 0.0070 per cent (3.67 and 3.00 per cent, respectively) which were statistically at par with each other. These results are in accordance with the findings of Barad *et al.* (2013) who revealed that emamectin benzoate 5 WG at the rate of 9.4 g a.i. per ha was most effective treatment against *H. armigera* in reducing pod damage (2.86 per cent) on red gram. while, Dodia (2009) noted that flubendiamide 20 WDG 50 g a.i per ha was most effective against *H. armigera* in reducing pod borer damage (5.98 per cent) followed by emamectin benzoate 5 WSG 11 g a.i. per ha (6.53 per cent) and spinosad 45 SC 73 g a.i. per ha (7.35 per cent). Ameta *et al.* (2011) evaluated that flubendiamide 480 SC at 100 ml per ha caused significantly minimum flower, pod damage and grain damage due to pigeonpea pod borer. While, Satpute and Barkhade (2012) revealed significant reduction in pod damage due to pod borer complex with Rynaxypyr 20 SC (Chlorantraniliprole). Sreekanth *et al.* (2014) evidenced significantly lowest pod damage due to pod borer, *H. armigera* in flubendiamide (1.16 per cent), chlorantraniliprole (1.26 per cent) and spinosad (1.92 per cent) with 88.7, 87.7 and 81.2 per cent reduction over control, respectively. Wadaskar *et al.* (2013) revealed that flubendiamide 20 WDG effectively restricted the pod damage due to pod borer (4.4 per cent) to minimal. According to Priyadarshini *et al.* (2013) flubendiamide 480 SC evidenced maximum reduction in grain damage (3.3 per cent) and weight loss of (2.9 per cent) due to pod borer complex.

Effect of different insecticides on grain yield and incremental cost benefit ratio (ICBR)

The data regarding grain yield of pigeonpea (Table 2) revealed that all the treatments were statistically significant in increasing grain yield over untreated control. The grain yield of pigeonpea due to different treatments varied from 15 q to 18.83 q per ha. The significantly highest grain yield (18.83 q per ha) of pigeonpea was recorded in emamectin benzoate 0.0022 per cent which was followed by chlorantraniliprole 0.0055 per cent (18.32 q per ha) and flubendiamide 0.007 per cent (17.69 q per ha). All the treatments were equally effective in recording maximum yield. The subsequently effective treatments were spinosad 0.0070 per cent (17.36 q per ha), indoxacarb 0.0105 per cent (16.90 q per ha), quinalphos 0.0700 per cent (15.42 q per ha) and azadirachtin 0.00015 per cent (15.00 q per ha). However, the lowest pod yield (9.96 q per ha) was registered in untreated control.

Among all the treatments, highest incremental cost benefit ratio (1:3.40) was attained by quinalphos 0.0700 per cent followed by spinosad 0.0070 per cent (1:2.80), emamectin benzoate 0.0022 per cent (1:2.30), indoxacarb 0.0105 per cent (1:2.30), flubendiamide 0.0070 per cent (1:2.10) and chlorantraniliprole 0.0055 per cent (1:1.20). Azadirachtin 0.00015 per cent could not show any conspicuous gain over cost (1:0.40). The present findings are analogous to the findings of Dodia (2009) who revealed that maximum grain yield of pigeonpea was noticed from emamectin benzoate 11 g a.i. per ha (1761 kg per ha) and maximum ICBR from indoxacarb (1: 6.88) followed by flubendiamide 20 WDG 50 g a.i. per ha (1: 4.56), spinosad 73 g a.i. per ha (1: 3.61) and emamectin benzoate 11 g a.i. per ha (1:3.41). Whereas, Singh (2014) noticed that highest grain yield was obtained from chlorantraniliprole followed by emamectin benzoate + acetamiprid, spinosad, emamectin benzoate, flubendiamide and triazophos. However, Sreekanth *et al.* (2014) documented highest grain yield and ICBR in chlorantraniliprole (686.1 kg per ha and 1:4.64), followed by flubendiamide (595.8 kg per ha) and spinosad (589.0 kg per ha and 1:4.50). Similarly, Wadaskar *et al.* (2013) reported that highest yield and ICBR was obtained from flubendiamide 20 WDG (13.30 q per ha and 1:6.8) followed by emamectin benzoate 5 SG at the rate of 0.3 g per l (1:5.0) and spinosad 45 SC at the rate of 0.3 ml per l (1:4.6)

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