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Bio-Efficacy of Different Insecticides against Pod Fly, *Melanagromyza obtusa* (Malloch) and Plume Moth, *Exelastis atomosa* (Walsingham) Infesting Pigeonpea

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Keywords

Pigeonpea, Bio-efficacy, Plume moth, *Exelastis atomosa* (Walsingham), Pod fly, *Melanagromyza obtusa* (Malloch), Pod damage, Grain damage

ABSTRACT

Pulses are vital source of plant-based proteins and amino acids for people around the globe. Amongst pulses, pigeonpea is an important pulse-cum-grain legume crop, heavily damaged by plume moth, *Exelastis atomosa* (Walsingham) and pod fly, *Melanagromyza obtusa* (Malloch). Hence, the Central Insecticide Board and Registration Committee have been recommended several insecticides for the control of pigeonpea pod borer complex. However, there is need to revalidate the efficacy status of these insecticides for the effective control of pod borers. Under this background, the present investigation was undertaken to investigate the bio-efficacy and economics of different insecticides against plume moth and pod fly during *Kharif*, 2014. The results revealed that emamectin benzoate 0.0022 per cent was the most effective treatment in minimizing larval population of *E. atomosa* (1.60 and 1.93 per plant) followed by flubendiamide 0.0070 per cent (1.67 and 2.07 per plant) and chlorantraniliprole 0.0055 per cent (1.73 and 2.07 per plant) at 14 days after second and third spray, respectively. Anonymously, maximum reduction in pod and grain damage due to *E. atomosa* was registered in the plots treated with emamectin benzoate 0.0022 per cent to the tune of 2.33 and 1.67 per cent, respectively followed by chlorantraniliprole 0.0055 per cent (3.00 and 2.33 per cent) and flubendiamide 0.0070 per cent (3.67 and 3.00 per cent). Highest reduction in pod and grain damage due to *M. obtusa* was exhibited in the plots treated with emamectin benzoate 0.0022 per cent to the extent of 9.00 and 6.33 per cent, respectively followed by chlorantraniliprole 0.0055 per cent (9.67 and 7.00 per cent) and spinosad 0.0070 per cent (10.33 and 7.67 per cent). The highest grain yield was recorded by the treatment emamectin benzoate 0.0022 per cent (18.83 q/ha) followed by chlorantraniliprole 0.0055 per cent (18.32 q/ha), flubendiamide 0.0070 per cent (17.69 q/ha), while quinalphos 0.0700 per cent (1:3.40) recorded highest incremental cost benefit ratio followed by spinosad (1:2.80) and emamectin benzoate 0.0022 per cent (1:2.30).

Introduction

Pulse crops such as lentils, beans, peas, pigeonpea and chickpea are a critical part of the general food basket. Grain legumes (pulses) are considered as essential source of nutrients and are also recognized as poor man's meat. The year 2016 had been celebrated the International Year of Pulses (IYP) by the Food and Agriculture Organization of the United Nations 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). 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). 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 at its various growth stages (Lal and Singh, 1998). Of these pod borer, *Helicoverpa armigera* (Hubner), plume moth, *Exelastis atomosa* (Walsingham) and pod fly, *Melanagromyza obtusa* (Malloch) are important feeder of pigeonpea which are collectively referred to as the pod borer complex (Lal and Katti, 1998). Among these, plume moth and pod fly are of regular occurrence, causing 10-80 per cent damage (Shanower *et al.,* 1999) and estimated to cause a loss of US$ 256 million annually (Anonymous, 1992). Pod fly is a hidden pest of pigeonpea inflicted 21.00 to 38.50 per cent pod damage, 12.29 to 19.87 per cent grain damage (Khan *et al.*, 2014) and 31.35 per cent mean pod damage (Patra *et al.,* 2016). However, the yield loss of 60 to 80 per cent was recorded due to the pod fly in pigeonpea (Durairaj, 2006). Plume moth lay its eggs on buds and pods, on hatching larvae bores into the developing pods and feed on tender seeds. The pupa which appear like a larva, is often found attached to the pod surface or on the pedicel. The plume moths usually appear at flowering time of the crop or sometimes in pre-flowering stage. Pod fly lay eggs in developing grains and its larvae feed on developing seeds by making tunnel. Larva consumes its starchy portion and embryo, damaged embryo became unable to germinate and grains become shrivel. They excrete a trail of excreta, lead to development of saprophytic fungus, which render the seed inedible. The infested immature pods do not show external evidence of damage until the fully grown larvae make exit hole in the pod walls, it make complicacy to their management (Sharma *et al.,* 2010). 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 complex. However, recently many reports documented failure of label recommended insecticides to control pod borer complex. Therefore, it is necessary to revalidate the efficacy status of commonly used insecticides for the effective management of plume moth and pod fly infesting pigeonpea. Keeping this in view, the present investigation was carried out to investigate the bio-efficacy of different insecticides against the plume moth, *E. atomosa* and pod fly, *M. obtusa* infesting pigeonpea.

Materials and Methods

The field experiment on bio-efficacy of different label recommended insecticides against plume moth, *E. atomosa* and pod fly, *M. obtusa* infesting pigeonpea using variety BSMR-853 was conducted in RBD with eight treatments including untreated control replicated three times at Research Farm, Department of Agriculture 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 plume moth 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 plume moth 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 *E. atomosa* and *M. obtusa* by randomly collecting hundred pods and grains from five randomly selected plants from each treatment at harvest. The irregular hole and pin hole on pod exhibited the damage caused by *E. atomosa* and *M. obtusa*, respectively. Later, these pods were threshed and grains were added to the yield of respective plots. Similarly, the observations were also recorded on per cent grain damage caused by *E. atomosa* and *M. obtusa* by randomly collecting hundred grains at harvest from grains threshed from five randomly selected plants from each treatment. The small round hole on grain and galleries on grain exhibited the damage caused by *E. atomosa* and *M. obtusa*, respectively. Later, these 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 *E. atomosa* and *M. obtusa* 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 plume moth, *Exelastis atomosa* infesting pigeonpea

Data pertaining to effect of different insecticides on larval population of plume moth, *E. atomosa* after 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 *E. atomosa* at 1, 3, 7 and 14 days after second and third application of insecticides. The plots treated with emamectin benzoate 0.0022 per cent recorded significantly lowest larval population of *E. atomosa* on pigeonpea (0.73, 0.93, 1.13 and 1.60 per plant after second spray and; 0.73, 1.00, 1.27

and 1.93 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, 1.20 and 1.73 per plant after second spray and; 0.93, 1.13, 1.33 and 2.07 per plant after third spray, respectively), flubendiamide 0.0070 per cent (0.93, 1.07, 1.20 and 1.67 per plant after second spray and; 1.00, 1.20, 1.47 and 2.07 per plant after third spray, respectively), spinosad 0.0070 per cent (1.13, 1.20, 1.33 and 1.87 per plant after second spray and; 1.13, 1.20, 1.60 and 1.80 per plant after third spray, respectively) and indoxacarb 0.0105 per cent (1.20, 1.27, 1.40 and 2.07 per plant after second spray and; 1.07, 1.27, 1.67 and 2.13 per plant after third spray, respectively). The present findings are in close agreement with the earlier reports of Barad *et al.,* (2013) who revealed that emamectin benzoate 5 % WG was the best treatment against pod borer on red gram.

However, Priyadarshini *et al.,* (2013) noticed maximum reduction in lepidopteran pod borer (*E. atomosa*) with flubendiamide 480 SC at 60 g a.i. per ha. Analogously, Wadaskar *et al.,* (2013) reported that flubendiamide was efficacious against plume moth larvae at 7 and 14 days after application and observed 83.9 and 93.3 per cent reduction over control, respectively. Baviskar (2004) exhibited that spinosad 45 SC at different doses were highly effective against *E. atomosa*. However, Srinivasan and Durairaj (2007) reported that spinosad 45 SC indicated least population of *H. armigera* (2.0 per plant) followed by indoxacarb 14.8 SC (2.4 per plant) on pigeonpea. According to Sreekanth *et al.,* (2014) chlorantraniliprole 20 SC, flubendiamide 480 SC and spinosad 45 SC were significantly superior treatments in reducing pod borer infestation on pigeonpea. Thus the present findings agree with these reports.

Effect of different insecticides on pod and grain damage due to plume moth, *Exelastis atomosa* and pod fly, *Melanagromyza obtusa*

The results revealed that significantly lowest pod damage and grain damage due to *E. atomosa* was observed in the plots treated with emamectin benzoate 0.0022 per cent (2.33 and 1.67 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.

Analogously, the maximum reduction in pod and grain damage due to *M. obtusa* was exhibited in the plots treated with emamectin benzoate 0.0022 per cent to the extent of 9.00 and 6.33 per cent, respectively followed by chlorantraniliprole 0.0055 per cent (9.67 and 7.00 per cent) and spinosad 0.0070 per cent (10.33 and 7.67 per cent).

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 pod borer 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 pod borer 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).

Table.1 Effect of different insecticides on larval population of plume moth, *Exelastis atomosa*, pod and grain damage due to plume moth, *Exelastis atomosa* and pod fly, *Melanagromyza obtuse*

Sr. No.	Treatment	Mean larval population of *Exelastis atomosa*									*Exelastis atomosa*		*Melanagromyza obtusa*	
		1 Day before Spray	II spray				III spray							
			Days after spraying				Days after spraying				Pod damage (%)	Grain damage (%)	Pod damage (%)	Grain damage (%)
			1	3	7	14	1	3	7	14				
1	Quinalphos 0.0700	2.73 (1.80*	1.33 (1.35)#	1.40 (1.37)	1.60 (1.44)	2.20 (1.64)	1.27 (1.33)#	1.40 (1.37)	1.80 (1.52)	2.20 (1.64)	5.33 (13.26)*	4.00 (11.47)*	11.33 (19.66)*	8.33 (16.75)*
2	Indoxacarb 0.0105	2.87 (1.83)	1.20 (1.30)	1.27 (1.35)	1.40 (1.37)	2.07 (1.61)	1.07 (1.25)	1.27 (1.33)	1.67 (1.48)	2.13 (1.61)	5.00 (12.88)	3.67 (10.95)	12.00 (20.25)	9.00 (17.45)
3	Emamectin benzoate 0.0022	2.60 (1.76)	0.73 (1.10)	0.93 (1.19)	1.13 (1.27)	1.60 (1.44)	0.73 (1.10)	1.00 (1.23)	1.27 (1.33)	1.93 (1.56)	2.33 (8.74)	1.67 (7.33)	9.00 (17.41)	6.33 (14.56)
4	Spinosad 0.0070	2.60 (1.76)	1.13 (1.27)	1.20 (1.31)	1.33 (1.35)	1.87 (1.53)	1.13 (1.27)	1.20 (1.31)	1.60 (1.44)	1.80 (1.52)	4.33 (11.92)	3.33 (10.40)	10.33 (18.74)	7.67 (16.02)
5	Flubendiamide 0.0070	2.73 (1.80)	0.93 (1.19)	1.07 (1.25)	1.20 (1.31)	1.67 (1.46)	1.00 (1.23)	1.20 (1.31)	1.47 (1.41)	2.07 (1.60)	3.67 (10.95)	3.00 (9.88)	10.33 (18.72)	8.00 (16.41)
6	Chlorantraniliprole 0.0055	2.53 (1.74)	0.87 (1.16)	1.00 (1.23)	1.20 (1.30)	1.73 (1.49)	0.93 (1.20)	1.13 (1.27)	1.33 (1.35)	2.07 (1.60)	3.00 (9.97)	2.33 (8.75)	9.67 (18.07)	7.00 (15.32)
7	Azadirachtin 0.00015	2.87 (1.84)	1.40 (1.37)	1.53 (1.42)	1.73 (1.49)	2.33 (1.68)	1.40 (1.37)	1.53 (1.42)	2.00 (1.58)	2.60 (1.76)	8.00 (16.20)	4.67 (12.46)	12.67 (20.83)	9.67 (18.02)
8	Untreated Control	2.67 (1.78)	2.73 (1.80)	2.87 (1.84)	3.00 (1.87)	3.20 (1.92)	3.47 (2.00)	3.67 (2.04)	3.80 (2.07)	4.33 (2.19)	10.67 (19.05)	8.67 (17.00)	17.00 (24.34)	13.33 (21.42)
	S.E ±	0.21	0.0.3	0.03	0.04	0.04	0.02	0.03	0.03	0.04	1.06	0.89	0.75	0.73
	C.D. at 5 %	N.S.	0.10	0.08	0.11	0.12	0.06	0.09	0.08	0.17	2.91	2.67	2.06	1.94
	C.V. (%)	-	4.37	3.64	4.06	3.99	2.69	3.40	2.99	4.23	12.93	13.80	5.96	6.52

#Figures in parentheses are square root transformed values ($\sqrt{x} + 0.5$)

*Figure in parentheses is angular transformed values

Table.2 Effect of different insecticides on grain yield and incremental cost benefit ratio (ICBR) of pigeonpea

Treatments	Healthy grain yield	Increase in yield over untreated control	Cost of insecticide required for 3 sprays	Labour charges and rent for 3 sprays	Total cost	Value of additional yield over untreated control	Increment al benefit	ICBR	Rank
	(q per ha)	(q per ha)	(Rs. per ha)	(Rs. per ha)	(Rs. per ha)	(Rs. per ha)	(Rs. per ha)		
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
Untreated Control	9.96	-	-	-	-	-	-	-	-
S.E. ±	0.39	-	-	-	-	-	-	-	-
C.D. at 5 %	1.22	-	-	-	-	-	-	-	-
C.V. (%)	4.22	-	-	-	-	-	-	-	-

Pod damaged by plume moth

Pod damaged by pod fly

Grain damage by plume moth

Pod damage by pod fly

Healthy grain

Sreekanth *et al.,* (2014) evidenced significantly lowest pod damage due to pod borer 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 centcould 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)

The present study brought out the significant difference among the different label recommended insecticides against pigeonpea plume moth and pod fly. The overall results revealed better response of emamectin benzoate 0.0022 per cent, chlorantraniliprole 0.0055 per cent and flubendiamide 0.0070 per cent with minimum larval population, lowest pod and grain damage by pod borer complex which also reflected with higher grain yield and ICBR. Thus, the results of these studies will be used as a basis for selection of label recommended insecticides for successful control of pod borer infesting pigeonpea.

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