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RESEARCH ARTICLE :

Evaluation of sequential application of new insecticides against *Helicoverpa armigera* (Hubner) on pigeonpea

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SUMMARY : Field experiments were conducted during *Kharif*, 2016 to evaluate the sequential application of new insecticides against *Helicoverpa armigera* on pigeonpea. Experimental results showed that the least number of *Helicoverpa* larvae per plant , pod damage and highest grain yield were spray sequential application of chlorantraniliprole 18.5%SC @ 30g a. i. /ha >flubendiamide 20 WG@ 73g a.i./ha and dimethoate 30 EC@ 600g a.i./ha which was at par with chlorantraniliprole 18.5%SC @ 30g a. i. /ha >indoxacarb 15.8 EC @ 73g a.i./ha and acetamiprid 20 SP@ 20g a.i. /ha. The treatment application of chlorantraniliprole 18.5%SC@ 30g a. i. /ha >flubendiamide20WG @ 73g a.i./ha and dimethoate 30 EC@ 600g a.i./ha per ha recorded highest increase in yield over control *i.e.* 2506 kg ha as well as higher cost benefit ratio of 1:9.11. The results indicated that chlorantraniliprole 18.5%SC @ 30g a. i. /ha >flubendiamide20WG@ 73g a.i./ha was more effective against *H. armigera*.

KEY WORDS :
Sequential, Pigeonpea, *Helicoverpa armigera*

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BACKGROUND AND OBJECTIVES

Pigeonpea commonly known as arhar, red gram or tur is one of the major grain legumes in the semi-arid tropics. Pulse crop provide protein rich diet to people. They are consumed in the form of split pulse or dal, for livestock it provides not only nutritive fodder but also valuable feed. India is the largest producer and consumer of pulses in the world. At present, it accounts for 33% of the world area and 22% of world production. Pigeonpea is the second largest pulse crop in the country occupying 5.21 million ha with 4.23 million tonnes of production with the productivity of 826 kg/ha In Maharashtra, Area under Pigeonpea was 15.33 lakh ha and production 11.70 lakh tones with the productivity of 764 kg/ha during year 2016-17. When we compare the figure with current year with 2015-16, the area, production and productivity of pigeonpea has been increased by 19.37, 62.05 and 53.01 per cent, respectively. (Anonymous, 2016)

Productivity of pigeonpea has remained static over the past several decades because of many reasons; out of which is heavy damage by insect pests is one of them. More than 200 insects species belonging to 8 orders and 61 families have been found to attack the pigeonpea crop, out of which pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is most devastating pest in the semi-arid tropics (SAT) worldwide (Sharma et al., 2011) and causes significant losses in grain yield, and in severe cases may cause complete crop loss. Over the past decade, three outbreaks of this pest were recorded, 1997 in Gulbarga which is known as the pulses bowl of Karnataka. *Helicoverpa armigera* (Hubner) is reported to cause 50 to 60 per cent grain loss in pigeonpea.

It is attacked by several insect pests from seedling to pod harvesting. Of these, pod borers cause damage to the crop from flowering to maturity stage thereby it accounts to an yield loss of more than 1000 dollars every year (Sharma, 2001), causes complete crop loss. Important pest infecting pigeonpea crop are pod borer, *Helicoverpa armigera* (Hubner), plume moth, *Exelastis atomosa* (Walsingham), pod fly, *Melanogromyza obtusa* (Malloch), spotted pod borer, *Maruca vitrata* (Fabricius), and bruchids. Bruchids which is store grain pest but infection start from field at harvesting stage. Out of these *Helicoverpa armigera, Exelastis atomosa, Melanogromyza obtusa* and *Maruca vitrata* are the key pests. To meet the demand of increasing population the present area and production is in adequate. There is a great scope to increase the production by controlling the key pests. The extent of damage caused by *H. armigera* and *M. obtusa* in pigeonpea during *kharif* 1984 and 1985 in Hissar, Haryana state was observed to be 13.6 and 13.7 per cent to pods and 5.3 and 5.3 per cent to grains damage, respectively (Yadav and Chaudhary, 1993). The early, medium and late maturing cultivars of pigeonpea were reported to be damaged by *M. obtusa* and *H. armigera* to the tune of 29.55 to 55.63, 20.95 to 57.00 and 32.92 to 56.56 per cent, respectively (Shrivastava *et al.*, 1993). Pigeonpea pod damage due to insects varied from 7.6 to 31 per cent. *G. critica* was the most important insect followed by *H. armigera*, *Maruca testulalis* and *E. atomosa* (Lal *et al*., 1997).

. In view of the importance of this crop and immense damage potential by *H. armigera*, which has developed resistance to insecticides have the eco-friendly management of this pest the present investigations have been carried out with the objectives *i.e.* evaluate the sequential application of insecticides against pod borer complex of pigeon pea and to work out the yield and incremental cost benefit ratio.

RESOURCES AND METHODS

The field experiment was conducted at Entomology Research Farm, Agricultural Research Station, Badnapur, VNMKV, Parbhani during *Kharif* season of 2016. The experiment was carried out in randomized block design (RBD) using pigeonpea variety BSMR-736, with eight treatments and three replications in a plot size of 7.20 m x 4.50 m. Row to row and plant to plant spacing was maintained at 90 cm x 30 cm. The treatments T_1- acephate 75SP @ 750g a.i./ha, T_2- acetamiprid 20SP@ 20g a.i. /ha, T_3- chlorantraniliprole 18.5%SC @ 30g a.i./ ha >acephate 75SP @ 750g a.i./ha, T_4- chlorantraniliprole 18.5%SC @ 30g a.i./ha >acetamiprid 20SP@ 20g a.i. /ha, T_5- chlorantraniliprole 18.5%SC @ 30g a.i./ha >indoxacarb 15.8 EC @ 73g a.i./ha >acetamiprid 20 SP@ 20g a.i./ha, T_6- chlorantraniliprole 18.5%SC @ 30g a.i./ha >flubendiamide20WG@ 73g a.i./ ha >dimethoate 30 EC @ 600g a.i./ha, T_7- Dimethoate 30 EC@ 600g a.i./ha and T_8- untreated control etc. were evaluated for their bio-efficacy against *H. armigera* on pigeonpea. Crop was raised with recommended agronomic practices. The first spray was applied at 50 per cent flowering stage, second spray was administered at pod development stage and third spray at pod maturity stage of the crop through high volume hand operated knapsack sprayer. The sprays were applied at evening hours to minimize the toxicity for relative pollinators and support their conservation. The pre-treatment count was made a day before, while, post treatment counts were made on three, seven and fourteen days after each spray, respectively.(Dhaka,2011 and Patel and Patel,2013) The population count of pigeonpea pod borers *i.e.* , *H. armigera* was taken on randomly selected five plants.

Pod damage due to pigeonpea pod borers was calculated at harvest. About five plants were kept without plucking pods throughout the season for recording of actual yields and converted to q per ha. The data, thus, obtained were subjected to RBD analysis using AGRES package (Gomez and Gomez, 1984) for drawing meaningful conclusion. Cost Benefit Ratio was worked out on the realized net profits, considering cost of plant protection, which exhibits the economic viability through the viewpoint of management of pod borers infesting pigeonpea. Per cent pod damage was calculated by using following formula (Naresh and Singh, 1984) :

$$\text{Per cent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

OBSERVATIONS AND ANALYSIS

The data on larval population of gram pod borer, *H. armigera* on pigeonpea is presented in (Table 1). The data indicates that the larval population of *H. armigera* was non-significant on one day before spray (DBS) in all the treatments indicating uniform distribution of pest larvae. The treatment application of chlorantraniliprole 18.5%SC @ 30g a.i./ha >flubendiamide20WG@ 73g a.i./ ha >dimethoate 30 EC @ 600g a.i./ha found as the best treatment which recorded minimum larval population of *H. armigera* on three, seven and fourteen day after spray (DAS) *i.e.* 0.43, 0.43, 0.53 first spray, 0.43, 0.43,0.50 second spray and 0.30, 0.36, 0.50 third spray larvae per plant, respectively and which was at par with where the spray of chlorantraniliprole 18.5%SC @ 30g a.i./ha >indoxacarb 15.8 EC @ 73g a.i./ha >acetamiprid 20 SP@ 20g a.i./ha larval population as 0.50, 0.53, 0.60 at first spray , 0.46, 0.50, 0.60 at second spray and at third spray 0.36, 0.53, 0.60 larvae per plant. The results in relation to larval population of *H. armigera* are in accordance with the earlier reports of (Patel and Patel, 2013) who reported that chlorantraniliprole @ 30 g a.i./ha was the most effective insecticide against pod borer complex and was followed by chlorantraniliprole + lambda cyhalothrin @ 37.5 g a.i./ha, chlorantraniliprole + lambda cyhalothrin @ 30 g a.i./ha and indoxacarb @ 75 g a.i./ha, respectively. Similarly, (Bhosale *et al*. 2009, Nishantha *et al*. 2009, Chowdary *et al*. 2010 and Satpute and Barkhade, 2012) reported that rynaxypyr 20 SC @ 30 g a.i. /ha as superior molecule in recording less larval population.

The data on pod damage due to pigeonpea pod borers and pigeonpea grain yield is presented in (Table 2). The lowest pod damage due to *H. armigera* treatment application of chlorantraniliprole 18.5% SC @ 30g a.i./ ha >flubendiamide 20 WG@ 73g a.i./ha >dimethoate 30 EC @ 600g a.i./ha found as the best treatment which recorded lowest pod damage *i.e.* 5.00 per cent and this was at par with chlorantraniliprole 18.5%SC @ 30g a.i./ ha >indoxacarb 15.8 EC @ 73g a.i./ha >acetamiprid 20 SP@ 20g a.i./h (6.27 %) followed by chlorantraniliprole 18.5%SC @ 30g a.i./ha >acetamiprid 20SP@ 20g a.i. / ha (8.61 %), respectively.

The lowest grain damage due to *H. armigera* treatment application of chlorantraniliprole 18.5% SC @ 30g a.i./ha >flubendiamide20WG@ 73g a.i./ha >dimethoate 30 EC @ 600g a.i./ha found as the best treatment which recorded lowest pod damage *i.e.* 2.12 per cent and this was at par with chlorantraniliprole 18.5%SC @ 30g a.i./ha > indoxacarb 15.8 EC @ 73g a.i./ha >acetamiprid 20 SP@ 20g a.i./h (2.79 %). The present findings are similar with Sreekanth *et al*. (2013) who reported that Pod damage due to pod borer, *Helicoverpa* was lowest in plots treated with flubendiamide (1.16%), chlorantraniliprole (1.26%) and spinosad (1.92%) with 88.7, 87.7 and 81.2 per cent reduction over control, respectively. The untreated plot has recorded maximum pod damage of 10.22%. similarly Patel and Patel (2013) reported the Chlorantraniliprole 18.5 % SC @ 30 g a.i./ha registered the lowest pod damage due to borer and pod fly and recorded the highest yield of pigeonpea. Sreekanth *et al*. (2014) who reported that the pod damage due to pod fly was lowest in spinosad 45% SC (10.2%), flubendiamide 480 SC (10.4%), profenophos 50% EC (10.9%) and chlorantraniliprole 20% SC (12.5%) with 76.7, 76.3, 75.1 and 71.5 per cent reduction over control (43.8%), respectively.

Highest grain yield realized due to the treatment application of chlorantraniliprole 18.5% SC @ 30g a.i./ ha >flubendiamide20WG@ 73g a.i./ha >dimethoate 30 EC @ 600g a.i./ha (2506 kg/ ha) as against 1450 kg per ha in untreated control. The present findings are similar with Sreekanth *et al*. (2013) who reported that the yield enhancement in pigeonpea with chlorantraniliprole treated plots (686.1 kg/ha) with 127.5 per cent increase over control, followed by flubendiamide (595.8 kg/ha) and spinosad (589.0 kg/ha) with 97.6 and 95.3 per cent increase over control, respectively as against the minimum yield of 301.6 kg/ha in the untreated check. Similarly Deshmukh *et al*. (2010) reported that the yield enhancement in chickpea with treatment of flubendiamide 0.007 per cent (1850 kg/ha) followed by indoxacarb 0.0075per cent (1805 kg/ha), spinosad 0.009 per cent (1760 kg/ha) and emamectin benzoate 0.0015 per cent (1665 kg/ha).

Conclusion:

From present study, it may be concluded that the treatment application of chlorantraniliprole 18.5% SC @ 30g a.i./ha >flubendiamide20WG@ 73g a.i./ha >

dimethoate 30 EC @ 600g a.i./ha was found effective for management of *H. armigera* population and extenuate yield. The safer chemical control methods reduce the pest population, pod and grain damage with higher yield; therefore, chemical management popularizes as an effective, practical alternative and makes lucrative cultivation of pigeonpea.

Table 1: Effect of sequential application of newer insecticides against *H. armigera* on pigeonpea

Tr No.	Treatments	Dosages (g.a.i/ha)	Mean number of *Helicoverpa* larvae per plant											
			First spray				Second spray				Third spray			
			1DBS	3 DAS	7DAS	14 DAS	1DBS	3 DAS	7DAS	14 DAS	1DBS	3 DAS	7DAS	14 DAS
T_1	Acephate 75 SP @ 0.15 %	750	0.60	0.93	0.96	1.16	0.93	0.93	0.96	1.00	0.80	0.73	0.86	0.96
			(1.05)	(1.19)	(1.21)	(1.29)	(1.19)	(1.20)	(1.21)	(1.22)	(1.14)	(1.11)	(1.16)	(1.19)
T_2	Acetamiprid 20 SP @	20	0.86	0.90	0.93	1.00	0.93	0.90	0.90	1.03	0.66	0.76	0.83	0.90
	0.004 %		(1.16)	(1.18)	(1.19)	(1.22)	(1.19)	(1.17)	(1.17)	(1.23)	(1.08)	(1.12)	(1.15)	(1.18)
T_3	Chlorantraniliprole	30	0.73	0.83	0.83	0.83	0.86	0.90	0.93	0.96	0.66	0.80	0.83	0.90
	18.5%SC >Acephate 75SP	750	(1.10)	(1.15)	(1.15)	(1.15)	(1.16)	(1.17)	(1.19)	(1.20)	(1.07)	(1.13)	(1.15)	(1.18)
T_4	Chlorantraniliprole	30	0.46	0.63	0.66	0.73	0.93	0.90	0.90	0.93	0.46	0.70	0.80	0.90
	8.5%SC >Acetamiprid	20	(0.98)	(1.06)	(1.08)	(1.10)	(1.19)	(1.17)	(1.18)	(1.18)	(0.98)	(1.09)	(1.14)	(1.18)
	20SP													
T_5	Chlorantraniliprole 18.5 %	30	0.53	0.50	0.53	0.60	0.93	0.46	0.50	0.60	0.53	0.36	0.53	0.60
	SC >Indoxacarb 15.8 EC	73	(1.01)	(1.00)	(1.02)	(1.05)	(1.19)	(0.98)	(1.00)	(1.05)	(1.02)	(0.93)	(1.01)	(1.04)
	>Acetamiprid 20 SP	20												
T_6	Chlorantraniliprole 18.5%	30	0.60	0.43	0.43	0.53	1.00	0.43	0.43	0.50	0.60	0.30	0.36	0.50
	SC >Flubendiamide20WG	73	(1.05)	(0.96)	(0.97)	(1.02)	(1.22)	(0.96)	(0.96)	(1.00)	(1.05)	(0.89)	(0.93)	(1.00)
	>Dimethoate 30 EC	600												
T_7	Dimethoate 30 EC	600	0.80	0.96	1.06	1.16	0.93	1.03	1.03	1.06	0.66	0.96	1.03	0.96
			(1.14)	(1.21)	(1.25)	(1.28)	(1.19)	(1.23)	(1.23)	(1.25)	(1.08)	(1.21)	(1.23)	(1.21)
T_8	Untreated Control	-	0.53	1.10	1.10	1.20	1.73	1.80	1.66	1.53	1.20	1.30	1.60	1.66
			(1.01)	(1.26)	(1.26)	(1.30)	(1.49)	(1.52)	(1.47)	(1.42)	(1.29)	(1.34)	(1.44)	(1.47)
S.E. ±			0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.07	0.06	0.06	0.06	0.06
C.D. (P=0.05)			NS	0.19	0.20	0.20	NS	0.20	0.20	0.21	NS	0.19	0.20	0.20
CV%			11.80	9.94	10.14	10.22	10.03	10.17	10.03	10.55	10.13	10.27	10.17	10.05

Figures in parentheses are $\sqrt{x+0.50}$ transformed value DBS- Day before spray. DAS - Days after spray.
NS=Non-significant

Table 2: Per cent pod and grain damage by pod borer on Pigeonpea

Sr. No.	Name of treatments	Per cent pod damage	Per cent grain damage	Grain yield (Kg/ha)
1.	Acephate 75 SP @ 0.15 %	14.16 (21.86)	7.38 (15.65)	1720
2.	Acetamiprid 20 SP @ 0.004 %	11.94 (20.21)	5.74 (13.85)	1823
3.	Chlorantraniliprole 18.5%SC >Acephate 75SP	11.66 (19.95)	4.76 (12.58)	2080
4.	Chlorantraniliprole 18.5%SC >Acetamiprid 20SP	8.61 (16.66)	4.36 (11.98)	2310
5.	Chlorantraniliprole 18.5%SC >Indoxacarb 15.8 E C>Acetamiprid 20 SP	6.27 (14.46)	2.79 (9.59)	2410
6.	Chlorantraniliprole 18.5%SC >Flubendiamide 20WG > Dimethoate 30 EC	5.00 (12.92)	2.12 (8.35)	2506
7.	Dimethoate 30 EC	15.28 (22.89)	7.30 (15.64)	1620
8.	Untreated Control	19.72 (26.35)	7.96 (16.39)	1450
S.E. ±		1.69	0.73	
C.D. (P=0.05)		5.12	2.21	
CV %		15.14	9.75	

Figures of percentage in parenthesis are angular transformed values

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