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Research paper

Bio-efficacy of certain new insecticides against pod borer complex in pigeonpea (*Cajanus cajan* L.)

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ABSTRACT

A study on evaluation of certain new insecticides against pod borer complex in pigeonpea was conducted at Regional Agricultural Research Station, Warangal for three consecutive years from *Kharif* 2019-20 to *Kharif* 2021-22 in medium maturity pigeonpea cultivar 'Rudreswara' (WRG-65). Seven treatments including untreated control were evaluated for their relative efficacy towards suppression of pod borer larval population and reduction of percent pod damage. The insecticide treatments along with untreated control were applied two times during the crop season *viz*., 50% flowering and pod formation stage. The results revealed that chlorantraniliprole 18.5 SC @ 0.3 ml/L followed by emamectin benzoate 5 SG proved significantly superior against gram pod borer (*Helicoverpa armigera*) and spotted pod borer (*Maruca vitrata*) with highest mean percent larval reduction and cumulative least percent pod damage (10.8 and 14.7%, respectively) over control. Further, chlorantraniliprole 18.5 SC followed by emamectin benzoate 5 SG @ 0.4 g/l recorded higher grain yields and best ICBR ratio (1:4.6; 1:4.5). Thus, the effective chemicals observed in the study could be used as basis for selection of label recommended insecticides for successful management of pod borers in pigeonpea.

Key words: Bio-efficacy, Insecticide, *Helicoverpa armigera, Maruca vitrata,* Pigeonpea

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is an important grain legume crop grown mainly in tropical and subtropical conditions. In India, it is cultivated in 4.5 m ha with 3.66 mt of annual production (AICRP, 2022). In Telangana, it is grown in an area of 2.28 lakh ha with annual production of 2.06 lakh tonnes and productivity of 904 kg/ha (AICRP, 2022). In Telangana, pigeonpea acreage and production is showing increasing trend but the productivity has always been a concern and remained low mainly due to several biotic and abiotic stresses observed at the reproductive stage of the crop. Among the biotic stresses, losses due to insect pests were quite alarming. Although many insect pests were reported to infest this crop, the pod borer complex comprising gram pod borer (*Helicoverpa armigera* Hubner) and legume pod borer (*Maruca vitrata* Geyer) attacking the crop at flowering and pod formation stage, and pod fly (*Melanagromyza obtuse* Malloch) at pod maturation stage are the major biotic constraints in achieving higher productivity of pigeonpea. Approximately, 2.5 to 3.0 mt of pulses are lost annually due to insect pests (Rabindra *et al*., 2004). Pod borers, spotted pod borer and gram pod borer caused 60 to 90 per cent yield loss in pigeonpea (Lal *et al*., 1992).

In general, for management of pod borer complex in pigeonpea, farmers are opting for conventional insecticides due to their easy availability and high potency. But due to continuous and indiscriminate use of conventional insecticides, there is a chance for development of insecticide resistance besides environmental risks. To overcome these issues, the present study was taken to identify new insecticide which is effective against pod borers of pigeonpea.

MATERIALS AND METHODS

The present study on evaluation of bio-efficacy of certain novel insecticides for the management of pod borer complex in pigeonpea was conducted at Regional Agricultural Research Station, Warangal of Professor Jayashankar Telangana Agricultural University for three consecutive years during *Kharif* season of 2019-20, 2020-21 and 2021-22 in a medium maturity pigeonpea cultivar 'Rudreswara (WRG-65)' raised in a planting geometry of 120 cm × 20 cm between rows and plants following all recommended agronomic practices. The experiment was laid out in randomized block design with seven treatments *viz*., lufenuron 5.4% EC @ 1 ml/l, emamectin benzoate 5 SG @ 0.4 g/l, chlorantraniliprole 18.5 SC + lambda cyhalothrin 5% EC @ 0.5 ml/l, chlorantraniliprole 18.5 SC @ 0.3 ml/l, lambda cyhalothrin 5% EC @ 1 ml/l, tolfenpyrad 15% EC @ 2 ml/l, untreated control in three replications. The first spray was done at 50% flowering and second at pod formation stage with hand operated knapsack sprayer using a spray volume of 500 l/ha.

Observations on number of live *Maruca* webs per plant and number of *Helicoverpa armigera* larvae per plant were recorded before spraying, and 7th and 10th day after spraying (DAS) from five randomly selected tagged plants in each replication of the treatment. However, pod damage by *H. armigera, M. vitrata* and *M. obtuse* were recorded separately at crop maturity where in random samples of 100 pods per replication were collected to observe the number of damaged pods and locule damage. The data were converted into per cent pod damage. The grain yield was recorded from 5 tagged plants separately and also from each replication after harvest of the crop. Per cent pod damage, per cent reduction of pod damage over control and per cent increase in yield over control were arrived by using the following formulae:

$$Percent\ pod\ damage = \frac{Number\ of\ damage\ pods}{Total\ number\ of\ pods} x\ 100$$

The data generated on mean pod borer population in pigeonpea were transformed to square root transformation for normalization and then these values were subjected to statistical analysis using OPSTAT software to test the significance.

RESULTS AND DISCUSSION

Larval population of Helicoverpa armigera

The cumulative mean pertaining to relative incidence of *H. armigera* in different insecticidal treated plots before spraying ranged from 1.51 to 1.82 per plant during study period (*Kharif* 2019-20 to *Kharif* 2021-22). Non-significant difference was observed among all the treatments indicating more or less uniform distribution of the pest in the experimental field during the period. However, post treatment results showed significant differences in mean larval population among various treatment after seven and ten days after both the sprayings. The cumulative data of efficacy of insecticides against *H. armigera* revealed that significant minimum number of *H. armigera* counts and high percent reduction (92%) over control was recorded in chlorantraniliprole 18.5 SC @ 0.3 ml/l treated plot after two sprays followed by emamectin benzoate 5 SG (88%), chlorantraniliprole 18.5 SC + lambda cyhalothrin 5 EC (81%), lambda cyhalothrin 5 EC (69%) and lufenuran 5.4% EC (57%) (Table 1).

Larval population of Maruca vitrata

As far as *M. vitrata* incidence was concerned, the cumulative mean of *Maruca* population per plant in all treated plots before spraying ranged from 2.09 to 2.88 per plant during study period and non-significant difference was observed among all the treatments, indicating more or less uniform distribution of the pest in the experimental field. However, cumulative data of efficacy of insecticides revealed that significant minimum number of *M. vitrata* live webs and high percent reduction (87%) over control was recorded in chlorantraniliprole 18.5 SC @ 0.3 ml/l treated plot after two sprays followed by emamectin benzoate 5 SG (79%)> chlorantraniliprole 18.5 SC + lambda cyhalothrin 5 EC (66%)> lambda cyhalothrin 5 EC (53%) > lufenuran 5.4% EC (53%). The results revealed that all the treatments were found to be significantly better over untreated control by recording lower population of *H. armigera* and *M. vitrata* per plant and also highest percent reduction of larval population over control (Table 2).

Pod damage

The cumulative pod damage due to pod borer complex in different treatments has been presented in Figure 1. The results with respect to mean cumulative percent pod damage due to pod borer complex in different insecticidal treatment revealed that all the treatments significantly reduced the pod and grain damage by pod borer complex as compared to control (35.8%). The data revealed that the cumulative mean percent pod damage due to pod borer complex in different treatments ranged from 10.8% to 35.8%. Among all the treatments, chlorantraniliprole 18.5 SC @ 0.3 ml/l was found to be most effective as it recorded lowest pod damage (10.8%). However, other insecticidal treatments comprising emamectin benzoate 5SG @ 0.4 g/l

Table 1. Cumulative data of *Helicoverpa armigera* population (mean of 3 years)

Treatments	Dose	Mean population of *Helicoverpa armigera*							
		1st spray				2nd spray			
		Pre count	7 DAS	10 DAS	Reduction over control (%)	Pre count	7 DAS	10 DAS	Reduction over control (%)
Emamectin benzoate 5 SG	0.4 g/l	1.56 (1.43)	0.52 (1.01)	0.38 (0.94)	72	0.60 (1.05)	0.13 (0.79)	0.07 (0.75)	88
Lufenuron 5.4 % EC	1.0 ml/l	1.66 (1.47)	0.71 (1.10)	0.59 (1.04)	56	0.68 (1.08)	0.39 (0.94)	0.24 (0.86)	57
Chlorantraniliprole 18.5 SC+ Lambda cyhalothrin 5% EC (Ampligo)	0.5 ml/l	1.82 (1.52)	0.80 (1.14)	0.44 (0.97)	67	0.59 (1.04)	0.18 (0.82)	0.11 (0.78)	81
Chlorantraniliprole 18.5 SC	0.3 ml/l	1.61 (1.45)	0.24 (0.86)	0.35 (0.92)	73	0.49 (0.99)	0.11 (0.78)	0.05 (0.74)	92
Lambda cyhalothrin 5% EC	1.0 ml /l	1.51 (1.42)	0.78 (1.13)	0.52 (1.01)	61	0.48 (0.99)	0.35 (0.92)	0.18 (0.82)	69
Tolfenpyrad 15% EC	2 ml/l	1.82 (1.52)	0.84 (1.16)	0.88 (1.17)	34	0.78 (1.13)	0.58 (1.04)	0.33 (0.91)	42
Untreated control	-	1.62 (1.46)	1.50 (1.41)	1.33 (1.35)	-	1.06 (1.25)	0.87 (1.17)	0.57 (1.03)	-
CD (p=0.05)	-	NS	0.19	0.14	-	0.19	0.14	0.12	-
CV (%)	-	7.2	13.8	13.8	-	13.1	12.23	11.6	-

Note: Values in parentheses are square root transformed values

Table 2. Cumulative data of *Maruca vitrata* population (mean of 3 years)

Treatments	Dose	Mean population of *Maruca vitrata* (No. of live webs per plant)							
		1st spray				2nd spray			
		Pre count	7 DAS	10 DAS	Reduction over control (%)	Pre count	7 DAS	10 DAS	Reduction over control (%)
Emamectin benzoate 5 SG	0.4 g/l	2.51 (1.73)	0.86 (1.16)	0.67 (1.08)	63	0.55 (1.02)	0.21 (0.84)	0.11 (0.78)	79
Lufenuron 5.4 % EC	1.0 ml/l	2.49 (1.73)	1.05 (1.24)	0.83 (1.15)	54	0.67 (1.08)	0.47 (0.98)	0.24 (0.86)	53
Chlorantraniliprole 18.5 SC+ Lambda cyhalothrin 5% EC (Ampligo)	0.5 ml/l	2.09 (1.61)	1.02 (1.23)	0.62 (1.06)	65	0.65 (1.07)	0.20 (0.84)	0.18 (0.82)	66
Chlorantraniliprole 18.5 SC	0.3 ml/l	2.22 (1.65)	0.49 (0.99)	0.41 (0.96)	77	0.39 (0.94)	0.09 (0.77)	0.07 (0.75)	87
Lambda cyhalothrin 5% EC	1.0 ml /l	2.40 (1.70)	1.00 (1.22)	0.71 (1.10)	60	0.61 (1.06)	0.42 (0.96)	0.24 (0.86)	53
Tolfenpyrad 15% EC	2 ml/l	2.18 (1.64)	0.91 (1.19)	1.04 (1.24)	42	0.70 (1.10)	0.47 (0.98)	0.31 (0.90)	40
Untreated control	-	2.88 (1.84)	1.80 (1.52)	1.80 (1.52)	-	1.13 (1.28)	0.88 (1.17)	0.52 (1.01)	-
CD (p=0.05)	-	NS	0.18	0.38	-	0.32	0.24	0.12	-
CV (%)	-	9.5	12.8	10.3	-	8.4	11.3	8.8	-

Note: Values in parentheses are square root transformed values

(14.7%) and chlorantraniliprole 18.5 SC + lambda cyhalothrin 5 EC @ 0.5 ml/l (15.1%) were also statistically at par with best treatment in terms of cumulative pod damage (Fig.1).

Seed yield and economics

The results with respect to cumulative grain yields revealed that all the treatments registered significantly higher grain yield as compared to the control. The mean grain yield per hectare in all insecticidal treatments ranged from 1281 kg to 1607 kg as compared to 1125 kg in untreated control, thereby proving that all the chemical treatments were superior over untreated control. Significantly the highest grain yield (1607 kg/ha) was recorded in chlorantraniliprole 18.5 SC @ 0.3 ml/l with 30% increase in yield over untreated control followed by chlorantraniliprole 18.5 SC + lambda cyhalothrin

Table 3. Economics of certain new insecticides against pod borer complex in pigeonpea

Insecticides	Dose	Yield (kg/ha)				Additional yield over control (kg/ha)	Income from additional yield (INR)	Cost of plant protection (INR)	Net returns over control (INR)	IBCR*
		2019	2020	2021	Mean yield					
Emamectin benzoate 5 SG	0.4 g/l	1500	1423	1426	1450	325	21,450	3,900	17,550	4.5
Lufenuron 5.4 % EC	1.0 ml/l	1300	1353	1371	1341	216	14,256	4,900	9,356	1.9
Chlorantraniliprole 18.5 SC+ Lambda cyhalothrin 5% EC	0.5 ml/l	1450	1507	1514	1490	365	24,090	10,400	13,690	1.3
Chlorantraniliprole 18.5 SC	0.3 ml/l	1583	1603	1635	1607	482	31,812	5,650	26,162	4.6
Lambda cyhalothrin 5% EC	1.0 ml /l	1267	1353	1226	1282	157	10,362	2,525	7,837	3.1
Tolfenpyrad 15% EC	2 ml/l	1300	1378	1166	1281	156	10,318	5,150	5,168	1.0
Untreated control	-	1150	1115	1109	1125					
CD (p=0.05)					100					
CV (%)					4.1					

*IBCR: Incremental benefit: cost ratio

5% EC @ 0.5 ml/l (1490) and Emamectin benzoate 5 SG @ 0.4 g/l treated plots (1450 kg/ha) (Table 3).

The comparative economics of novel insecticidal treatments evaluated against pod borer complex over a period of 3 years revealed that the incremental benefit: cost ratio (IBCR) ranged from 1.0 to 6.0. The best IBCR of 4.6 and 4.5 recorded in chlorantraniliprole 18.5 SC @ 0.3 ml/l and Emamectin benzoate 5 SG @ 0.4 g/l treated plots, which are at par with each other. Further, with respect to net returns over control of different treatments ranged from INR. 5,168/- to INR. 26,162/- per hectare. The highest net return of INR. 26,162/ha was recorded in chlorantraniliprole 18.5 SC treated plot followed by INR. 17,550/ha in emamectin benzoate 5 SG and INR. 13,690/ha in chlorantraniliprole 18.5 SC + lambda cyhalothrin 5 EC treated plots, respectively.

The cumulative efficacy of these new insecticides against pod borer complex in pigeonpea revealed that chlorantraniliprole 18.5 SC is most effective in controlling *H. armigera* and *M. vitrata* and thus obtaining highest grain yield. The results are in close agreement with the findings of Satpute and Barkhade (2012) who reported chlorantraniliprole (rynaxypyr) 20 SC @ 40 g a.i./ha

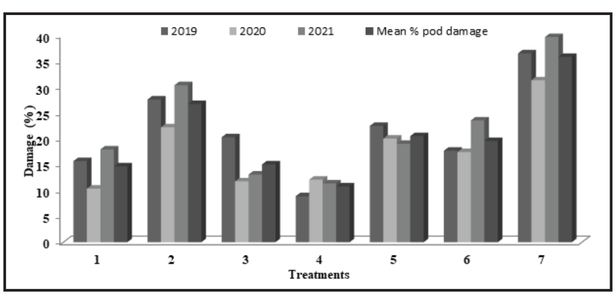

Fig. 1. Cumulative percent pod damage by pod borer complex from 2019-2022

as the most promising insecticide against pod borer complex of pigeonpea and to give highest yield of 1752 kg/ha. Similar studies conducted by Sreekanth *et al.* (2015) revealed that the per cent inflorescence and pod damage due to *M. vitrata* in pigeonpea was lowest in chlorantraniliprole 18.5 SC treated plot over others, with highest grain yield of 686.1 kg/ha, 127.5% more over control. Barad *et al.* (2013) found emamectin benzoate 5 WG at 9.4 g *a.i.* per ha as most effective insecticide against pod borer in reducing pod damage (2.86%) in pigeonpea.

CONCLUSION

The present study brought out the significant differences among different new insecticides against pigeonpea pod borer complex *viz.*, *Helicoverpa armigera* and *Maruca vitrata*. The overall results revealed chlorantraniliprole1 8.5 SC @ 0.3 ml/l, emamectin benzoate 5 SG @ 0.4 g/l and chlorantraniliprole 18.5 SC + lambda cyhalothrin 5% EC @ 0.5 ml/l recorded minimum larval population, lowest pod and grain damage by pod borer complex which reflected in grain yield and benefit: cost ratio. Thus, the potent chemicals observed in this study may be used as alternative in order to check the development of insecticide resistance among pod borers of pigeonpea

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