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Research article

BIO-EFFICACY AND ECONOMICS OF CERTAIN NEW INSECTICIDES AGAINST GRAM POD BORER, *HELICOVERPA ARMIGERA* (HUBNER) INFESTING PIGEONPEA (*CAJANUS CAJAN* L.)

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ABSTRACT: Two field experiments were conducted during Kharif, 2010 and 2011 to evaluate the bio-efficacy and economics of certain new insecticides against gram pod borer, *Helicoverpa armigera* (Hubner) on pigeonpea. Experimental results showed that the number of Helicoverpa larvae per plant were lowest in plots treated with chlorantraniliprole 20 SC (0.43), flubendiamide 480 SC (0.59) and spinosad 45 SC (0.85) as against untreated control plot (4.17) with 89.7, 85.9 and 79.6 per cent larval reduction over control, respectively. 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%. Highest grain yield was recorded in 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. The cost effectiveness of chlorantraniliprole and flubendiamide was also high and very favorable with incremental cost-benefit ratios of 1: 4.64 and 1: 4.50 respectively, followed by indoxacarb (1: 3.67), emamectin benzoate (1: 3.13) and spinosad (1: 2.97).
Keywords: *Helicoverpa armigera,* insecticides, *pigeonpea.*

INTRODUCTION

Pigeonpea (*Cajanus cajan* L) is a tropical grain legume mainly grown in India and ranks second in area and production and contributes about 90% in the world's pulse production. In India, pigeonpea is grown in 4.42 million ha with an annual production of 2.89 million tonnes and 655 kg ha^{-1} of productivity. In Andhra Pradesh, it is cultivated in an area of 6.38 lakh ha with 2.65 lakh tonnes of production and with productivity of 415 kg ha^{-1} (Anonymous, 2012). Though the area under redgram is increasing both in Kharif and Rabi seasons, the yields have remained stagnant (500- 700 kg/ha) for the past 3-4 decades, largely due to insect pest damage (Sharma and Pampapathy, 2004). It is attacked by more than 250 species of insects, of which pod borer, *Helicoverpa armigera* Hubner is the most dreaded and polyphagous pest of pigeonpea worldwide (Shanower *et al.* 1999). Its preference for flowering and fruiting parts results in heavy loss up to 60% or more under subsistence agriculture in the tropics. The annual loss due to this was estimated to be US $ 400 million in pigeonpea (Anonymous, 2007a*)*. Management of *Helicoverpa armigera* relies heavily on insecticides, often to the exclusion of other methods of management. A number of insecticides have been found reported to be effective for controlling *H. armigera* on pigeonpea (Ujagir, 2000). Exploring new insecticides with lesser residues and lower environmental threat has become imperative. In recent years, newer compounds with novel modes of action are being evolved to check infestation by this insect pest. The present study is aimed at evaluating the efficacy of certain new insecticides against the pod borer in pigeonpea ecosystem.

MATERIALS AND METHODS

The experiments were conducted during Kharif, 2010 and 2011 at Regional Agricultural Research Station, Lam, Guntur. Emmamectin benzoate 5 SG, spinosad 45 SC, indoxacarb 14.5 SC, chlorantraniliprole 20 SC, flubendiamide 480 SC, novaluron 10 EC, profenofos 50EC along with an untreated control (Table 1) were tried against *H. armigera* on a pigeonpea cv. ICPL 85063 (Lakshmi). There were three replications (4 rows of 5 m long in each replication) in a randomized block design (RBD). The seeds were sown at a depth of 5 cm below the soil surface in black cotton soils with the help "gorru" behind the cattle pair with 180 cm spacing between rows. Immediately after sowing "guntaka" was run over the seeds to cover the seeds with soil.

Thinning was done 20 days after seedling emergence by retaining one seedling per hill at a spacing of 20 cm between the plants Normal agronomic practices were followed for raising the crop (Basal fertilizer N: P: K: 20:50: 0 kg/ha). Intercultural and weeding operations were carried out as needed. Three sprays were applied commencing at 50 per cent flowering, second at pod initiation stage and last at 50 per cent podding stage with hand operated knapsack sprayer with a spray volume of 500 lts per ha. Twenty five inflorescences (30 cm length) were selected at random in each plot from the middle two rows for the observations on larval population of *H. armigera*. At maturity, number of pods showing Helicoverpa damage was recorded and expressed as a percentage of the total number of pods. All the pods were then threshed and grain yield was recorded after discarding the *Helicoverpa armiger* damaged grains. This method was uniformly followed for both the seasons. The monetary returns and incremental cost–benefit ratios of treatments were also worked out for selecting economical treatments against the pest. All the above data were subjected to RBD analysis using AGRES package (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results (Table 1) showed that all the treatments significantly reduced the *H. armigera* larval population and there by pod damage. During 2010, chlorantraniliprole 20 SC, flubendiamide 480 SC and spinosad 45 SC respectively with 0.23, 0.27 and 0.30 larvae / plant were found to be significantly superior over other treatments. The larval population in other treatments ranged from 0.9 to 1.87 larvae / plant as against control (2.67 larvae / plant). During 2011 too, chlorantraniliprole and flubendiamide, followed by spinosad respectively with 0.63, 0.90 and 1.40 larvae / plant were found superior when compared to all other treatments. The untreated check had population abundance of 5.67 larvae/plant. The pooled mean of two seasons (2010 and 2011) showed that chlorantraniliprole, flubendiamide and spinosad respectively with 0.43, 0.59 and 0.85 larvae / plant have recorded 89.7, 85.9 and 79.6 per cent reduction over control and were found to be significantly superior to all other treatments including control (4.17 larvae / plant).

During 2010, there was no significant difference between the treatments with regard to pod damage due to *H. armigera.* whereas, during 2011 the pod damage was significantly reduced in plots treated with flubendiamide (0.33%), chlorantraniliprole (0.64%) and spinosad (2.00%) when compared to control (18.31%) (Table 1). The over all mean showed that pod damage was significantly low 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 in pod damage over control, respectively. The untreated plot has maximum pod damage of 10.22%.

Table 1. Efficacy of insecticides against gram pod borer, *Helicoverpa armigera* in pigeonpea.

Treatment	Dose	Helicoverpa larvae (No./plant) *			Reduction over control (%)	Pod damage (%) **			Reduction over control (%)
		2010	2011	Mean		2010	2011	Mean	
Emmamectin Benzoate 5% SG	0.4 g /lt	1.40 (1.55)	3.37 (2.08)	2.39 (1.84)	42.7	2.43 (8.86)	6.70 (12.13)	4.57 (10.50)	55.3
Spinosad 45% SC	0.3 ml/lt	0.30 (1.14)	1.40 (1.52)	0.85 (1.36)	79.6	1.84 (7.75)	2.00 (6.56)	1.92 (7.16)	81.2
Indoxacarb 14.5% SC	0.4 ml/lt	0.90 (1.38)	1.97 (1.72)	1.44 (1.56)	65.5	2.16 (8.35)	4.47 (11.80)	3.32 (10.08)	67.5
Chlorantraniliprole 20% SC	0.3 ml/lt	0.23 (1.11)	0.63 (1.28)	0.43 (1.20)	89.7	1.87 (7.77)	0.64 (3.74)	1.26 (5.76)	87.7
Flubendiamide 480 SC	0.2 ml/lt	0.27 (1.12)	0.90 (1.38)	0.59 (1.26)	85.9	1.99 (8.02)	0.33 (1.91)	1.16 (4.97)	88.7
Novaluron 10% EC	1.0 ml/lt	1.87 (1.69)	4.43 (2.33)	3.15 (2.04)	24.5	2.64 (9.24)	11.31 (19.66)	6.98 (14.45)	31.7
Profenofos 50%EC	2.0 ml/lt	1.67 (1.63)	3.43 (2.10)	2.55 (1.88)	38.9	2.32 (8.54)	6.74 (15.05)	4.53 (11.80)	55.7
Control	--	2.67 (1.91)	5.67 (2.58)	4.17 (2.27)	--	2.12 (6.44)	18.31 (25.35)	10.22 (15.90)	--
C.D at 5%	--	0.19	0.16	0.18	--	NS	7.16	3.06	--
C.V (%)	--	7.4	4.8	6.1	--	22.3	28.4	25.35	--

* Values in parentheses are square root n + 1 transformed values

** Values in parentheses are arcsine percentage transformed values

NS: Non Significant.

Continuous heavy rains during August and September, 2010 have resulted in heavy vegetative growth and the rains received during October and December, 2010 have resulted in heavy flower drop (both first and second flesh) which has caused drastic reduction in the yield.

However, maximum yield of 743.1 kg/ha was obtained in plots treated with chlorantraniliprole, followed by flubendiamide (630.5 kg/ha) and spinosad (622.0 kg/ha) as against the lowest yield of 324.1 kg/ha in untreated check during 2010 (Table 2). The erratic rainfall pattern during the crop growth period has resulted in poor yields during 2011-12. However, chlorantraniliprole maintained its superiority during 2011 too, with a maximum yield of 629.1 kg/ha as against 279.0 kg/ha in control. Pooled data revealed that highest grain yield was recorded in 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.

Table 2. Economics of insecticides in the control of gram pod borer, *Helicoverpa armigera* in pigeonpea

Treatment	Dose	Yield (kg/h)			Increase in Yield over control (kg)	Increase in yield over control (%)	Cost of Increased yield (Rs.) [A]	*Plant Protection cost (Rs.) [B]	Net Profit (Rs.) [A-B]	ICBR
		2010	2011	Mean						
Emmamectin Benzoate 5% SG	0.4 g /lt	550.9	529.0	540.0	238.4	79.1	9536.00	2310-00	7226-00	1: 3.13
Spinosad 45% SC	0.3 ml/lt	622.0	556.0	589.0	287.5	95.3	11500.00.	2900-00	8600-00	1: 2.97
Indoxacarb 14.5% SC	0.4 ml/lt	555.5	421.0	488.3	186.7	61.9	7468.00	1600-00	5868-00	1: 3.67
Chlorantraniliprole 20% SC	0.3 ml/lt	743.1	629.1	686.1	384.6	127.5	15384.00	2730-00	12654-00	1: 4.64
Flubendiamide 480 SC	0.2 ml/lt	630.5	561.1	595.8	294.3	97.6	11772.00	2140-00	9632-00	1: 4.50
Novaluron 10% EC	1.0 ml/lt	546.3	398.0	472.2	170.6	56.6	6824.00	2450-00	4374-00	1: 1.79
Profenofos 50% EC	2.0 ml/lt	445.4	376.0	410.7	109.2	36.2	4368.00	1245-00	3123-00	1: 2.51
Control		324.1	279.0	301.6	--	--	--	--	--	--
C.D at 5%		111.62	65.78	88.7	--	--	--	--	--	--
C.V (%)		14.3	10.1	12.20	--	--	--	--	--	--

Market Price of Redgram: Rs. 40/- per kg; Standard spray volume: 500 l/ha; *Labour charges included.

The cost effectiveness of chlorantraniliprole and flubendiamide was also high and very favorable with incremental cost-benefit ratios of 1: 4.64 and 1: 4.50, respectively followed by indoxacarb (1: 3.67) (Table 2).
The results are in agreement with the findings of Chowdary *et al.* (2010) who reported that chlorantraniliprole 20 SC was effective against okra fruit borer, *H. armigera* at 30 g a.i. ha^{-1} and 20 g a.i. ha^{-1}. Single foliar application of rynaxypyr (50 g a.i. ha^{-1}) registered 100 per cent mortality of *H. zea* on tomato (Anonymous, 2007b). Ma *et al.* (2000) reported that chlorantraniliprole was found to be the most effective chemical for the control of *H. armigera* in cotton. Similarly, Kuttalam *et al.* (2008) and Vinoth Kumar *et al*. (2010) reported that flubendiamide 480 SC @ 48 g a.i ha^{-1} was effective against *H. armigera* in tomato. Ashok Kumar and Shivaraju (2009) observed that flubendiamide 480 SC @ 48 g a.i. ha^{-1} and 36 g a.i. ha^{-1} was effective against *H. armigera* in black gram with less larval population, low pod damage and higher yields (9.28 q ha^{-1} and 9.07 q ha^{-1} respectively). Dodia *et al*. (2009) revealed that flubendiamide 20 WDG @ 50 g a.i. ha^{-1} has resulted in lowest pod damage (14.16%) due to *H. armigera* on pigeonpea when compared to control (24.40%). Patil *et al.* (2008) reported that flubendiamide 480 SC (@ 48 g a.i. ha^{-1} showed minimum larval population (1.13 and 0.5 larvae per 5 plants) of pod borers in blackgram at 3 and 7 days after spraying, respectively and recorded lowest pod damage (9.98%) and maximum grain yield 793 Kg ha^{-1}. Meena *et al*. (2006) reported that flubendiamide 20 WG @ 50g a.i. ha^{-1} was effective against *H. armigera* and *M. obtusa* with 9.2 and 11.3 per cent pod damage, respectively in pigeonpea. Srinivasan and Durairaj (2007) observed least Helicoverpa larval population (2.0 / plant) with spinosad 45 SC (73 g a.i/ha), followed by indoxacarb 14.8 SC treatment (2.4 / plant) in pigeonpea. Mittal and Ujagir (2005) also recorded lower numbers of *H. armigera* and lower pod damage with different concentrations of spinosad in pigeonpea. Singh *et al.* (2009) reported that indoxacarb was the best treatment for the management of the pod borer and is at par with NPV against *Helicoverpa armigera* in Chickpea.

Superior performance of indoxacarb against *H. armigera* was also reported by Gunning and Devonshire (2002). Chandrakar and Shrivastava (2002) reported that application of 1000 ml profenofos per ha + lufenuron resulted in the lowest pod damage (10%) and grain damage (0.73%) by pod borer with highest yield (1618.3 kg/ha) in pigeonpea. Sharma *et al.* (2011) reported that the effectiveness of emamectin benzoate, which is based on green chemistry, will help in achieving less yield losses through reduction in *H. armigera* incidence in pigeonpea. Prasad and Rao (2009) indicated that novaluron 10 EC @ 1ml l^{-1} was effective against *H. armigera* on cotton by recording low per cent boll damage (1.50%).

The present findings clearly indicated that the new generation insecticides like chlorantraniliprole, flubendiamide and spinosad were found effective against gram pod borer, *Helicoverpa armigera* along with an increased level of yield. Further, the incremental cost benefit ratio was also more with chlorantraniliprole and flubendiamide. Hence, it is suggested that the effective insecticides may be alternated in order to avoid the development of resistance.

REFERENCES

[1] Anonymous 2007a. The medium term plan. ICRISAT, Patancheru 502324, Andhra Pradesh, India. Vol-3. pg no. 1-10

[2] Anonymous 2007b. DuPont-Rynaxypyr insect control technical bulletin. pg no. 1-4

[3] Anonymous 2012. All India Co-ordinated Research Project on Pigeonpea. Project Coordinator's Report. Annual group meet at UAS, Bangalore, 13th-15th May, 2012. Pg. No. 9 & 10.

[4] Ashok Kumar CT and Shivaraju C. 2009. Evaluation of newer insecticide molecules against pod borers of blackgram. Karnataka Journal of Agricultural Sciences 22 (3): 521-523.

[5] Chandrakar HK and Shrivastava SK. 2002. Evaluation of some combinations of match (Lufenuron) against pod damaging pests in pigeonpea. Journal of Applied Zoological Researches 13: 2/3, 206-207

[6] Dodia DA, Prajapathi BG and Asharya S. 2009. Efficacy of insecticides against stem borer, *H. armigera*, infesting Pigeonpea. Journal of Food Legumes 22(2): 144-145.

[7] Gomez KA and Gomez AA.1984. Statistical procedures for agricultural research. Joh Wiley and sons, New York, 207-215 pp

[8] Gunning RV and Devonshire AL. 2002. Negative cross resistance between indoxacarb and pyrethroids in Australian *Helicoverpa armigera*: a tool for resistance management. Resistant Pest Management News letter 11: 52

[9] Singh H, Singh R, Yadav RN, Yadav KG and Adbhut Yadav. 2009. Efficacy and economics of some bio-pesticide in management of *Helicoverpa armigera* (Hub) on chickpea. Pestology 33(7): 36-37

[10] Kuttalam S, Vinoth kumar B, Kumaran N and Boomathi N. 2008. Evaluation of bio-efficacy of Flubendamide 480 SC against fruit borer *Helicoverpa armigera* Hub. in tomato. Pestology 32(3): 13-16.

[1] Ma DL, Gordh G and Zalucki MP. 2000. Toxicity of Biorational insecticides to Helicoverpa spp. (Lepidoptera: Noctuidae) and predators in cotton field. International Journal of Pest Management 46: 237-240.

[12] Meena RS, Srivastava CP and Joshi N. 2006. Bioefficacy of some newer insecticides against the major insect pests of short duration pigeonpea. Pestology 30(9): 13-16.

[13] Mittal V and Ujagir R. 2005. Evaluation of naturalyte spinosad against pod borer complex in early pigeonpea. Indian Journal of Plant Protection 33 (2): 211-215.

[14] Patil SK, Deshmukh and patil JV. 2008. Efficacy of Flubendiamide 480 SC against pod borers in blackgram. Pestology 32(9):20-22.

[15] Prasad NVVSD and Rao NHP. 2009. Field evaluation of Novaluron 10EC against bollworms in cotton. Pestology 33(5): 31-34.

[16] Chowdary Rajesh L, Bheemanna M and Ranjith kumar L. 2010. Bioefficacy of rynaxypyr (Coragen) 20 SC against fruit borer *Helicoverpa armigera* (Hubner) in okra. International Journal of Plant Protection 3(2): 379-381.

[17] Shanower TG, Romeis J and Minja EM. 1999. Insect pests of pigeonpea and their management. Annual Review of Entomology 44: 77-96

[18] Sharma OP, Bhosle BB, Kamble KR, Bhede BV and Seeras NR. 2011. Management of pigeonpea pod borers with special reference to pod fly (*Melanagromyza obtusa*). Indian Journal of Agricultural Sciences 81:6, 539-543.

[19] Sharma HC and Pampapathy G. 2004. Effect of natural plant products, Brassinolide and host plant resistance in combination with insecticides on *Helicoverpa armigera* (Hubner) damages in pigeonpea. Indian Journal of Plant Protection 32 (2) : 40-44

[20] Srinivasan T and Durairaj C. 2007. Newer insecticides against pod borer complex of pigeonpea with special reference to *Helicoverpa armigera* and *Melanagromyza obtusa*. Indian Journal of Plant Protection. 35:1, 47-49.

[21] Ujagir R. 2000. Field efficacy of insecticides against pod borer complex in early pigeonpea (*Cajanus cajan* (L.) Millsp. at Pantnagar, North India. Annals of Plant Protection Sciences 71: 19-25

[22] Vinoth Kumar B, Kumaran N, Kubendran D and Kuttalam S. 2010. Bioefficacy of Flubendiamide+ Thiacloprid 480 SC against insect pests of tomato. Pestology 34(1): 44-47.