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Efficacy and economics of certain new generation novel insecticides against legume pod borer, *Maruca vitrata* (Geyer) on pigeonpea (*Cajanus cajan* L.)

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ABSTRACT

Two field experiments were conducted during Kharif, 2010 and 2011 to find out economical control measures against legume pod borer, *Maruca vitrata* (Geyer) on pigeonpea. Experimental results showed that the per cent inflorescence damage due to Maruca was lowest in chlorantraniliprole 18.5 SC (2.08%) and flubendiamide 39.35 SC (3.64%), followed by spinosad 45 SC (6.21%) as against control (31.18%) with 93.3, 88.3 and 80.1 per cent reduction over control respectively. Similarly, pod damage due to legume pod borer was lowest in chlorantraniliprole (4.30%), flubendiamide (6.03%) and spinosad (8.80%) as against control (47.28%) with 90.9, 87.3 and 81.4 per cent reduction over control respectively. 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 (301.6 kg/ha) respectively. 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).

1. 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} [1]. 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 [2]. More than 300 species of insect species have been reported infesting the crop [3] of which legume pod borer, *Maruca vitrata* is a serious pest of pigeonpea in tropic and sub-tropics, because of its extensive host range, destructiveness and distribution on cowpea, mungbean, urdbean and field bean [4]. The infestation levels range from 9-51% [5], whereas 84 per cent pod borer damage in pigeonpea [6]. The annual loss was estimated to be US $ 30 million [7]. The larvae feed on flowers, buds and pods and the entrance hole is plugged with excreta. It is basically a hidden pest and completes its larval development inside the web formed by rolling and tying together leaves, flowers, buds and pods. This typical concealed feeding protects the larvae from natural enemies, human interventions or other adverse factors including insecticides [8]. Considerable numbers of insecticides have been tested and few of them found effective against legume pod borer in pigeonpea [9]; [10]. Repeated use of these insecticides also resulted in the development of resistance. Insecticides that should leave lesser residues and pose lesser environmental threat has become imperative. The present study is aimed at evaluating the efficacy of certain new insecticides with novel mode of action for effective management of the legume pod borer, *Maruca vitrata* on pigeonpea.

2. 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 legume pod borer, *M. vitrata* on a pigeonpea cv. ICPL 85063 (Lakshmi). There were three replications (4 rows of

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5m 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 per cent inflorescence damage due to *Maruca vitrata*. At maturity, number of pods showing *M. vitrata* damage was recorded and expressed as a percentage of the total number of pods. All the pods were threshed and grain yield was recorded after discarding the *M. vitrata* 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. The data was subjected to RBD analysis using AGRES package [11].

3. RESULTS AND DISCUSSION

During 2010, inflorescence damage due to legume pod borer larvae was significantly reduced in plots treated with chlorantraniliprole (2.3%), flubendiamide (3.1%) and spinosad (5.2%) when compared to control (28.1%) (Table 1). Chlorantraniliprole maintained its superiority during 2011 too, with 1.9 per cent inflorescence damage as against 34.3 per cent in the control.

The mean per cent inflorescence damage after two seasons was also found to be significantly low in plots treated with chlorantraniliprole (2.1%) and flubendiamide (3.6%), followed by spinosad (6.2%), while 31.2% damage was noticed in the untreated control. Similarly, the pod damage due to legume pod borer was significantly reduced in plots treated with chlorantraniliprole (8.3%), flubendiamide (11.6%) and spinosad (14.3%) than the control (68.3%) (Table 1).

Chlorantraniliprole, flubendiamide and spinosad maintained their superiority during 2011 too, with 0.3, 0.4 and 3.3 per cent pod damage respectively as against 26.3 per cent in the control. The mean per cent pod damage after two seasons was also found to be significantly low in plots treated with chlorantraniliprole (4.3%), flubendiamide (6.0%) and spinosad (8.8%), while 47.3% damage was noticed in the untreated control.

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 resulted in 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 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).

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).

Since the insecticides were new, the results available on different crops were presented and discussed here. The results obtained in the present investigation were in agreement with the findings of [12], who reported that chlorantraniliprole (0.009%) recorded least pod damage (1.6 %) due to *M. vitrata* on pigeonpea than control (5.3%). Flubendiamide 24% + thiacloprid 24-48% SC recorded high larval population reduction (84.45%) in *M. testulalis* on blackgram [13]. Pod damage due to legume pod borer, *M. vitrata* was lowest in plants sprayed with spinosad (8.5%) and indoxacarb (11.8%); and also registered lowest seed damage (3.9 and 3.7%, respectively) and highest grain yield (795 and 688 kg/ha) [14]. Lower pod damage due to *M. vitrata* with spinosad 90g, spinosad 73 g, spinosad 56 g and spinosad 45 g a.i/ha, as against other standard insecticides was reported [15]. Novaluron offered moderate suppression of the pest and recorded 30.7% pod damage in cowpea [16]. Studies conducted at Regional Agricultural Research Station, Lam farm during 2002 revealed that novaluron @ 75 g a.i. ha-1 was found to be very effective in reducing the *M. vitrata* pod damage in blackgram and redgram by recording 0.4 and 2.2% respectively [17].

Application of 1000 ml profenofos per ha + lufenuron resulted in the lowest pod damage (10.0%), grain damage by pod borer (0.7%) and the highest yield (1618.3 kg/ha) in pigeonpea [18]. The effectiveness of emamectin benzoate, which was based on green chemistry, will help in achieving less yield losses through reduction in *H. armigera* incidence in pigeonpea [19].

The present findings clearly indicated that the new generation novel insecticides like chlorantraniliprole, flubendiamide and spinosad were found effective against legume pod borer, *Maruca vitrata* along with an increased level of yield. Further, the incremental cost benefit ratio was also more with chlorantraniliprole (1: 4.64) and flubendiamide (1: 4.50). Hence, it is suggested that the effective insecticides may be alternated in order to avoid the development of resistance.

Table 1: Efficacy of insecticides against legume pod borer, *Maruca vitrata* on pigeonpea.

Treatment	Dose	Inflorescence damage (%)			Reduction over control (%)	Pod damage (%)			Reduction over control (%)
		2010	2011	Mean		2010	2011	Mean	
Emmamectin Benzoate 5% SG	0.4 g /lt	8.44 (16.48)	9.23 (17.64)	8.84 (17.06)	71.7	30.11 (33.02)	3.89 (10.99)	17.00 (22.01)	64.0
Spinosad 45% SC	0.3 ml/lt	5.18 (12.7)	7.23 (15.54)	6.21 (14.17)	80.1	14.27 (21.88)	3.33 (8.19)	8.80 (15.04)	81.4
Indoxacarb 14.5% SC	0.4 ml/lt	9.40 (17.56)	10.00 (18.32)	9.70 (17.94)	68.9	28.66 (32.16)	5.00 (12.80)	16.83 (22.48)	64.4
Chlorantraniliprole 20% SC	0.3 ml/lt	2.27 (8.55)	1.89 (7.92)	2.08 (8.24)	93.3	8.26 (16.42)	0.33 (1.91)	4.30 (9.17)	90.9
Flubendiamide 480 SC	0.3 ml/lt	3.09 (9.74)	4.18 (11.56)	3.64 (10.65)	88.3	11.64 (19.90)	0.42 (2.14)	6.03 (11.02)	87.3
Novaluron 10% EC	0.75 ml/lt	10.07 (18.22)	12.17 (20.23)	11.12 (19.23)	64.3	25.45 (30.28)	7.17 (15.50)	16.31 (22.89)	65.5
Profenofos 50%EC	2.0 ml/lt	13.01 (20.84)	20.44 (26.83)	16.73 (23.84)	46.3	47.05 (43.32)	15.38 (23.09)	31.22 (33.21)	34.0
Control		28.09 (31.91)	34.27 (35.82)	31.18 (33.87)	--	68.26 (56.27)	26.30 (30.85)	47.28 (43.56)	--
C.D at 5%		7.39	4.11	5.75	--	9.26	6.17	7.72	--
C.V (%)		21.1	11.4	16.25	--	14.5	23.9	19.2	--

Values in parentheses are arc sine percentage transformed values.

Table 2: Economics of certain new insecticides against legume pod borer, *Maruca vitrata* in pigeonpea.

Treatment	Dose	Yield (kg/h)			Increase in Yield over control (kg/ha)	Increase in yield over control (%)	Cost of Increased yield (Rs.) [A]	Cost of Plant Protection (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	74.1	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

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