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Bio-efficacy of some newer insecticides against spotted POD borer *Maruca vitrata* in pigeonpea under field conditions

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Abstract
The present study was conducted at the Research cum Instructional Farm, IGKV, Raipur, Chhattisgarh during Kharif season 2013-2014. The bioefficacy of eight newer insecticidal molecules, acetamiprid 20SP @ 20g a.i/ha, indoxacarb 14.5SC @ 50g a.i/ha, acephate 75SP @ 750g a.i/ha, spinosad 45SC @ 73g a.i/ha, emamectin benzoate 5WSG @ 9.5g a.i/ha, flubendiamide 20WG @ 50g a.i/ha, rynaxipyr 18.5SC @ 30g a.i/ha and thiamethoxam 25WG @ 75g a.i/ha each at two sprays against spotted pod borer *Maruca vitrata* in pigeonpea were evaluated under field conditions including control as check. Management of gram pod borer by newer insecticides, among the treatments, the minimum pod damage of 5.13% was recorded with spinosad which was at par with indoxacarb (5.50%) and emamectin benzoate (5.66%). The maximum pod damage of 8.53% was recorded in flubendiamide. Pod damage by *M.vitrata* recorded in untreated control was 11.10%. Among the treatments, the minimum grain damage (1.00%) was recorded with spinosad. However, the maximum grain damage of 3.20% was recorded with flubendiamide. The grain damage by *M.vitrata* recorded in untreated control was 5.33%.The highest grain yield (1360.54 Kg/ ha) was recorded in spinosad 45SC which was at par with indoxacarb 14.5SC (1207.48 kg/ha) emamectin benzoate 5WSG (1139.44 kg/ha) and acetamiprid 20SP (1122.44 kg/ha), while the lowest grain yield (1037.41 Kg /ha) was recorded in flubendiamide 20WG, and the untreated control resulted least (816.32 kg /ha) grain yield in comparison to newer insecticides treated plots.

Keywords: *Maruca vitrata*, pigeonpea, newer insecticides, bioefficacy, field conditions

Introduction
Our country has the distinction of being the largest producer of legumes with over a dozen of pulse crops, grown on about 25.43 million hectares of land and 18.24 million tonnes of production with the average productivity of 679 kg/ha (Anonymous 2011-12). Among the important pulses grown in India, pigeonpea belongs to family Leguminosae, is a multipurpose grain legume crop. The green pods of pigeonpea are used as vegetables, grains used as split dal and are rich in protein, averaging a protein digestibility of 70% when cooked (Singh, 1991) [14].

Pigeonpea is cultivated in more than 25 countries of the world. As compared to the other pulses produced in the world, pigeonpea holds the sixth rank in production. It covers 6.5 percent of the world’s total pulses area and contributes 5.7 percent to the total pulses production (Rao *et al.*, 2010) [10] and is grown in an area of 4.7 million ha with a production of 3.69 million tonnes in the world with the productivity of 784 kg/ha (FAOSTAT, 2010) [4]. In India, pigeonpea is grown in 3.86 million hectares with an annual production of 2.65 million tonnes and 741 kg $ha^{-1}$of productivity (FAOSTAT, 2012) [5], which is 4/5th share in the world total pigeonpea produced. About 90% of the global pigeonpea area falls in India (Anonymous, 2012). In Chhattisgarh, acreage under pigeonpea is 51.9 thousand hectares with a total production and productivity of 31 thousand tonnes and 597 kg/ha, respectively (Anonymous, 2013) [1].

During recent years due to introduction of short duration pigeonpea cultivars, the incidence of *M. vitrata* has been aggravated as flowering of these varieties occur during periods of high humidity and moderate temperature which is congenial for the development of pest (Sharma 1998) [13]. *M. vitrata* larvae feed on flower buds and pods by webbing them. This typical feeding habit protects the larvae from natural enemies and other adverse factors including insecticides. Larvae move from one flower to another and each may consume 4-6 flowers before larval development is completed. Third instar larvae are capable of boring in to the pods, and occasionally in to peduncles and stems (Taylor, 1967) [18]. In pigeonpea, losses due to *M. vitrata* have been estimated to be $US 30 million annually (ICRISAT 1992) [3]. Vishakantaiah and Jagadeesh Babu (1980) observed the infestation of *Maruca* on pigeonpea varying between 9 and 51% at Banglore, Kamataka. Singh (1999) [15] reported 70 -80% yield loss in pigeonpea due to M. *Vitrata*.

Maruca vitrata is the most important polyphagous pests in both tropics and subtropics because of their extensive host range, destructiveness and distribution on cowpea, mungbean, urdbean and field bean (Shanower *et al.*, 1999) [12]. The loss caused due to *Maruca* was estimated to be about 84 percent (Dharmasena *et al.*, 1992) [3] accounting to US $ 30 million (Saxena *et al.*, 2002) [11]. *Maruca* 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 (Sharma, 1998) [13]. It is essential to kill the first instar larvae during the period when they hatch till they enter the flowers and buds. Among the constituents of the pod borer community infesting pigeonpea, the legume pod borer, *Maruca vitrata* (Geyer) (Lepidoptera : Crambidae) is one of the most serious pests occurring during flowering and pod formation stage causing huge losses (Pappu *et al*., 2010) [8]. In India, *Maruca* damage has been found to range from 9 to 51% in pigeonpea (Bhagwat *et al*., 1998) [2].

Management of spotted pod borer in pigeonpea relies heavily on insecticides, often to the exclusion of other methods of control but the studies on the effect of these new molecules on *M. Vitrata* were inconclusive. After the introduction of the new molecules, which were tested and found effective against the key polyphagous pests there is every need to study their effect on *Maruca vitrata*. Hence, the present study was mainly focused on the effective management strategies of *Maruca vitrata* in pigeonpea at Chhattisgarh, and keeping the above points in view, the present study was formulated.

Materials and Methods

The Present study entitled "Bio-Efficacy of Some Newer Insecticides against Spotted Pod Borer, *Maruca vitrata* in Pigeonpea Under Field Conditions" was conducted during July 2013 to February 2014, at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

A field experiment was laid in randomized block design (RBD) with nine treatments including untreated control, replicated three times for the assessment of their comparative performance against spotted pod borer of pigeonpea. The crop was sown in plot size of 19.6 m^2.In this experiment number of caterpillars were cet alounted randomly selected five plants from each plot, 24 hours before spraying of insecticides and the post treatment counts were taken after 3, 5, 7, 10 and 15 days of spraying insecticides. The larval populations were subjected to square root transformation ($\sqrt{x+0.5}$). The spraying was done two times (first spray at pod formation stage and second spray at 15 days after first spray).

Insecticides tested against *Maruca vitrata* in pigeonpea

Treatments	Insecticides	Trade name	Doses(ai/ha)
T_1	Acetamiprid 20SP	Pride	20g
T_2	Indoxacarb 14.5 SC	Avanut	50g
T_3	Acephate 75SP	Lancer	750g
T_4	Spinosad 45SC	Tracer	73g
T_5	Emamectin benzoate 5WSG	Safari	9.5g
T_6	Flubendiamide 20WG	Takumi	50g
T_7	Rynaxipyr 18.5SC	Coragen	30g
T_8	Thiamethoxam 25WG	Actara	75g
T_9	Control		-

The percent pod and grain damage were subjected to angular transformation X=$\sqrt{\sin^{-1}}$ P, where X= transformed value and P= Percent data.

Percent pod and grain damage was recorded with the help of following formula:

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods (healthy + damage)}} \times 100$$

$$\text{Grain damage (\%)} = \frac{\text{Number of damaged grains}}{\text{Total number of grains (healthy + damage)}} \times 100$$

Grain yield

To assess the losses caused by gram pod borer, five random plants from each plot were selected at the time of maturity. There after total number of pods and grains damaged by gram pod borer were counted separately and the percent losses were counted.

The weight of healthy and damaged grains were recorded from each plot and converted in to kg / ha with the help of following formula

$$\text{Grain yield (kg/ha)} = \frac{\text{weight of grains in Kg/plot}}{\text{plot area in m}^2} \times 10000$$

Results and Discussion

Average larval population of *Maruca vitrata* after first spraying

Table-1 shows pre treatment and post-treatment observations. The larval population in the pre treatment observations ranged from 5.00 to 5.36 larvae per plant, which was more or less uniform with non significant differences between them.

Table 1: Average larval population *Maruca vitrata* in pre treatment and post treatment observations

Notation	Treatments and doses (a.i/ha)	Pre -treatment larval population			Post treatment larval population							
					First spray			Second spray				
			3rd day	5th day	7th day	10th day	15th day	3rd day	5th day	7th day	10th day	15th day
T_1	Acetamiprid 20SP @ 20g ai/ha.	5.00 (2.33)	1.30 (1.33)	1.07 (1.25)	1.30 (1.33)	1.27 (1.32)	1.40 (1.36)	1.10 (1.26)	1.01 (1.22)	1.02 (1.22)	1.10 (1.26)	1.23 (1.31)
T_2	Indoxacarb 14.5 SC @ 50g ai/ha.	5.33 (2.40)	0.43 (0.95)	0.36 (0.92)	0.43 (0.96)	0.37 (0.92)	0.56 (1.02)	0.53 (1.00)	0.34 (0.91)	0.36 (0.92)	0.56 (1.01)	0.70 (1.09)
T_3	Acephate 75SP @ 750g ai/ha.	5.36 (2.42)	1.56 (1.42)	1.43 (1.38)	1.40 (1.37)	1.46 (1.39)	1.53 (1.41)	1.33 (1.35)	1.37 (1.36)	1.20 (1.30)	1.50 (1.40)	1.73 (1.49)
T_4	Spinosad 45SC @73g ai/ha.	5.13 (2.37)	0.23 (0.85)	0.23 (0.85)	0.20 (0.83)	0.33 (0.90)	0.46 (0.97)	0.26 (0.87)	0.23 (0.85)	0.24 (0.85)	0.27 (0.87)	0.43 (0.96)
T_5	Emamectin benzoate 5WSG @ 9.5g ai/ha.	5.20 (2.38)	0.96 (1.20)	0.97 (1.21)	0.63 (1.04)	0.56 (1.02)	0.76 (1.12)	0.83 (1.15)	0.48 (0.99)	0.34 (0.90)	0.76 (1.12)	1.00 (1.17)
T_6	Flubendiamide 20WG @	5.33 (2.41)	1.91	1.76	1.70	1.86	1.61	1.50	1.73	1.60	1.77	2.13

	50g ai/ha.		(1.55)	(1.49)	(1.45)	(1.53)	(1.44)	(1.40)	(1.48)	(1.44)	(1.50)	(1.62)
T_7	Rynaxipyr 18.5SC @ 30g ai/ha.	5.03 (2.35)	1.72 (1.48)	1.70 (1.48)	1.43 (1.38)	1.70 (1.48)	1.56 (1.42)	1.47 (1.35)	1.56 (1.43)	1.56 (1.43)	1.63 (1.45)	1.93 (1.56)
T_8	Thiamethoxam 25WG @ 75gai/ha.	5.20 (2.38)	1.66 (1.46)	1.63 (1.43)	1.47 (1.40)	1.66 (1.46)	1.56 (1.43)	1.50 (1.40)	1.43 (1.37)	1.35 (1.35)	1.50 (1.40)	1.80 (1.51)
T_9	Control	5.33 (2.41)	4.66 (2.27)	4.94 (2.32)	5.10 (2.36)	5.04 (2.35)	4.88 (2.31)	4.96 (2.33)	4.94 (2.32)	4.96 (2.33)	4.83 (2.30)	4.97 (2.33)
SE(m)±		NS	0.07	0.08	0.10	0.06	0.08	0.08	0.07	0.06	0.07	0.10
C.D. (5%)			0.21	0.26	0.30	0.20	0.25	0.26	0.23	0.20	0.24	0.30

Figures in Parentheses are square root transformed values

In the post treatment observations after the third day, all the tested doses of insecticides showed significant differences over control. Among the treatments, spinosad was best effective against *Maruca vitrata* larvae with minimum larval population per plant (0.23) which was at par with indoxacarb (0.43). The highest larval population per plant was recorded in plots treated with flubendiamide (1.91) which was least effective treatment. The untreated plot significantly differed over rest of treated plots with 4.66 larvae per plant.

After fifth day, minimum larval population per plant (0.23) was recorded in spinosad which was at par with indoxacarb (0.36).The highest larval population per plant (1.76) was recorded in flubendiamide.

After seventh day, spinosad showed minimum larval population per plant (0.20) which was at par with indoxacarb (0.43) and emamectin benzoate (0.63). The highest larval population per plant (1.70) was recorded in flubendiamide.

After tenth day, plots treated with spinosad depicted least larval population per plant (0.33) which was at par with indoxacarb (0.37) and emamectin benzoate (0.56). The highest larval population per plant (1.86) was recorded in flubendiamide.

After fifteenth day, spinosad showed minimum larval (0.46) population per plant, which was at par with indoxacarb (0.56) and emamectin benzoate (0.76). The highest larval population per plant (1.61) was recorded in flubendiamide. Untreated control showed population of 4.88 larvae per plant.

Average larval population of *Maruca vitrata* after second spraying

Among the treatments, spinosad was recorded the best effective treatment with minimum population (0.26) per plant which was at par with indoxacarb (0.53). The highest larval population per plant (1.50) was recorded in plots treated with flubendiamide and thiamethoxam. The untreated plot significantly differed over rest of treated plots with 4.96 larvae per plant.

After fifth day, spinosad showed least larval population per plant (0.23) which was at par with indoxacarb (0.34) and emamectin benzoate (0.48). The highest larval population per plant (1.73) was recorded in flubendiamide.

After seventh day, spinosad again showed least larval population per plant (0.24) which was at par with emamectin benzoate (0.36) and indoxacarb (0.34). The highest larval population per plant (1.60) was recorded in flubendiamide.

After tenth day, spinosad was having least larval population per plant (0.27) which was at par with indoxacarb (0.56). The highest larval population per plant (1.77) was recorded in flubendiamide.

After fifteenth day, spinosad depicted least larval population per plant (0.43) which was at par with indoxacarb (0.70) and emamectin benzoate (1.00). The highest larval population per plant (2.13) was recorded in flubendiamide. Untreated control showed population of 4.97 larvae per plant.

Present findings are in agreement with Sunitha *et al.* (2008) [17] who observed that indoxacarb14.5SC @ 0.5ml/lit and spinosad 48SC @ 0.10 ml/lit were highly effective in reducing the *Maruca vitrata* larval population.

Percent pod damage by *Maruca vitrata*

Among the treatments, the minimum pod damage of 5.13% was recorded in spinosad which was at par with indoxacarb (5.50%) and emamectin benzoate (5.66%). The maximum pod damage of 8.53% was recorded in flubendiamide. Pod damage by *M.vitrata* recorded in untreated control was 11.10%.

Sreekanth and Seshamahalakshmi (2012) [16] also reported that pod damage due to *Maruca* was the lowest in spinosad.

Percent grain damage by *Maruca vitrata*

Among the treatments, the minimum grain damage (1.00%) was recorded in spinosad. However, the maximum grain damage of 3.20% was recorded in flubendiamide. The grain damage by *M. vitrata* recorded in untreated control was 5.33%.

Present findings are also in confirmation with Narasimhamurthy and Ram (2013) [7] as they also recorded significant differences in the percent grain damage in pigeonpea over control plot, and least percent grain damage of 2.36% was observed in spinosad 45SC @ 73g a.i./ha during 2009-2010 while percent grain damage of 2.58% was recorded in indoxacarb 14.5SC @ 60g a.i./ha during 2010-2011.

Grain yield (Kg/ha)

The highest grain yield (1360.54 Kg/ ha) was recorded in spinosad which was at par with indoxacarb (1207.48 kg/ha) emamectin benzoate (1139.44 kg/ha) and acetamiprid (1122.44 kg/ha), while the lowest grain yield (1037.41 Kg /ha) was recorded in flubendiamide, and the untreated control resulted least (816.32 kg /ha) grain yield in comparison to newer insecticides treated plots. Percent pod and grain damage by *Maruca vitrata* and grain yield in different treatments of pigeonpea are given in table No.2

Table 2: Percent pod and grain damage by *Maruca vitrata* and grain yield in different treatments of pigeonpea

Treatments	Percent pod damage	Percent grain damage	Yield (Kg/ha)
Acetamiprid 20SP	6.13 (14.36)	1.53 (7.10)	1122.44
Indoxacarb 14.5 SC	5.50 (14.17)	1.40 (6.78)	1207.482
Acephate 75SP	7.30 (15.13)	1.66 (7.40)	1088.43
Spinosad 45SC	5.13 (12.98)	1.00 (5.65)	1360.54
Emamectin benzoate 5WSG	5.66 (14.18)	1.56 (7.11)	1139.45
Flubendiamide 20WG	8.53 (16.81)	3.20 (10.29)	1037.41
Rynaxipyr 18.5SC	7.39 (15.75)	2.43 (8.95)	1071.42
Thiamethoxam 25WG	7.61 (15.92)	3.06 (10.06)	1062.92
Control	11.10 (19.75)	5.33 (13.34)	816.32
SE (m) ±	0.42	0.36	86.90
C.D (5%)	1.27	0.51	260.53

Figures in Parentheses angular transformed values

The results are in agreement with the findings of Rao *et al.* (2007) [9] who reported that pod damage due to legume pod borer, *M. vitrata* was lowest in plants sprayed with spinosad and also registered lowest seed damage (3.9) and highest grain yield (795 kg/ha).

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