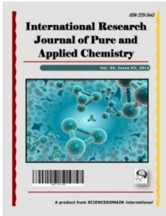

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Field Evaluation of Newer Insecticides against Spotted Pod Borer *[Maruca vitrata* (Geyer)], on Blackgram (*Vigna mungo* L.) in North Coastal Andhra Pradesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author KS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PSR and SD managed the analyses of the study. Author MS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the efficacy of novel insecticides against the spotted pod borer on rice fallow blackgram.
Study Design: Randomised Block Design (RBD) was used in this study.
Place and Duration of Work: The present study was carried out at College farm Agricultural College, Naira during *Rabi* 2017-2018 season.
Methodology: The spotted pod borer, *Maruca vitrata* (Geyer) is a serious pest of blackgram through out the growth period especially in flowering and pod development stages in North Coastal Andhra Pradesh. Management of this pest becomes difficult due to its concealed nature of feeding

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inside flowers and pods. Different newer insecticides were evaluated for the management of *M. vitrata* on blackgram cultivar LBG-752 under rice fallow situations with ten treatments replicated thrice.

Results: The current study indicated that among all the insecticidal treatments chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 ml l^{-1} was found to be very effective by recording 75.91 per cent overall mean reduction in *M. vitrata* larval population with lowest pod damage (7.04%) over control (60.58%) and also recorded highest grain yield (8.31 q ha^{-1}) followed by chlorantraniliprole 18.5 SC @ 0.0037% and flubendiamide @ 39.35 SC 0.00787% with 72.04 and 67.30 per cent overall reduction in mean larval population of *M. vitrata* over untreated control. The cost - benefit (C:B) ratio for all the treatments revealed that chlorantraniliprole 18.5 SC @ 0.0037% was highly economical with a C : B of 1: 17.14 followed by spinosad 45 SC with cost - benefit (C:B) ratio 1: 15.28.

Conclusion: Usage of newer insecticides with novel modes of action are highly effective against spotted pod borer with an additional increase in yield of blackgram.

Keywords: Spotted pod borer; pod damage; management; chlorantraniliprole + λ cyhalothrin; chlorantraniliprole; flubendiamide; cost - benefit ratio; blackgram.

1. INTRODUCTION

Blackgram, *Vigna mungo*(L.) Hepper which is commonly called as urdbean is the fourth important pulse crop in India and the second most important crop in Andhra Pradesh (A.P) in terms of extent of cultivation [1]. It is a short duration, highly remunerative crop. In most parts of the country it is grown traditionally as *kharif* (wet season) crop. However, in A.P, it is being cultivated mostly in *rabi* (dry) season both in uplands and in rice fallow conditions. In Andhra Pradesh, *rabi* blackgram is cultivated in an area of 2 lakh 96 thousand hectares with a production of 244 thousand tonnes and productivity of 936 $kgha^{-1}$ [2]. Spotted pod borer, *Maruca vitrata* has emerged as a major threat in blackgram cultivation during the months of Jan- Feb in coastal region of Andhra Pradesh, India [3]. Spotted pod borer, *M.vitrata* (Geyer) is a major constraint for the production of blackgram at growth stages like flowering and pod formation in the Southern Zone districts of Andhra Pradesh [4]. Larvae feed and webbed mass of leaves, flowers and pods. Its concealed feeding habit, protects the larvae from adverse conditions, natural enemies and even from insecticidal sprays. This typical nature complicates the management strategies of this pest. Chemical insecticides are the only option for effective management of this internal feeder. Several insecticides have been evaluated against *Maruca* on blackgram [5,6,7,8]. The repeated use of older class chemicals results in development of resistance to insecticides. Now, several novel insecticides with novel mode of action with lower doses are effective against target pests and safe to natural enemies [9,10]. The present study was carried out to evaluate newer insecticide formulations against *M. vitrata* in rice fallow blackgram in north coastal Andhra Pradesh.

2. MATERIALS AND METHODS

A Field experiment was conducted in Agricultural College farm, Naira, during *Rabi* 2017- 2018 with popularly growing blackgram cultivar LBG- 752 under rice fallow conditions. The experiment was laid out in randomized block design (RBD) with 10 treatments i.e., Thiamethoxam 25WG, Thiacloprid 21.7SC, Flonicamid 50 WG, Spinosad 45 SC, Flubendiamide 39.35 SC, Chlorantraniliprole 18.5 SC, Acetamiprid 4% + Fipronil 4%, Flubendiamide 19.9%+ Thiachloprid 19.9%, Chlorantraniliprole 9.3% + λ Cyhalothrin 4.6% including untreated control in three replications. The inter row spacing of 30 cm and plant to plant intra row spacing of 10 cm was used in a plot of 20 m^2. The treatments (insecticide spray) were applied at 30 and 50 days after sowing. The observations on larval population of *M. vitrata* were recorded on ten plants randomly tagged per replication at one day before treatments application (pre treatment count) and at 1, 3, 5 and 10 days after treatments application (post treatment counts). The pod damage due to *M. vitrata* was identified by presence of small and circular holes [1]. Percentage pod damage in each treatment was computed by counting the total number of damaged pods to the total number of healthy plants. The yield data were also recorded. The percentage population reduction after each treatment with reference to untreated control was calculated by using modified Abbot's formula [11].

Percentage population reduction =

$$= \left[1 - \frac{\text{Post treatment population in treatment}}{\text{Pre treatment population in treatment}} \times \frac{\text{Pre treatment population in untreated control}}{\text{Post treatment population in untreated control}} \right] * 100$$

$$\text{Percentage pod damage} = \frac{\text{No. of damaged pods}}{\text{Total no. of pods}} \times 100$$

Cumulative efficacy of all treatments wereworked out from two sprayings. Percentage pod damage was analysed in each treatment at the time of harvest. The data collected were transformed into angular or square - root values as per the standard requisites for evaluating the relative efficacy of different treatments over control [12]. The statistical used in analysis of the data is OP stat at probability level of 0.05.

3. RESULTS

The pooled data of the two sprays indicated that, all the treatments were significantly superior over untreated control in recording higher percent reduction in mean larval population of *M. vitrata* (Table 1 & Fig. 1). Among the evaluated insecticides applied at one day after spraying, chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mL L^{-1} was found to be very effective by recording 45.26 percentage reduction in mean larval population of *M. vitrata* over untreated control and was significantly (p= 0.05) superior to all other treatments. This was followed by chlorantraniliprole 18.5 SC @ 0.0037% and flubendiamide 39.35 @ 0.00787% which were at par with each other with 37.38 and 33.09 per cent reduction in mean larval population of *M. vitrata* over untreated control, respectively. The lowest percentage reduction over control was recorded by flonicamid 50 WG @ 0.02%(10.66%). Three days after spraying, same trend in the efficacy of insecticides was followed. Chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mL L^{-1} was superior to all other insecticides with 90.68 percentage reduction in mean larval population of *M. vitrata* over untreated control. It is followed by chlorantraniliprole18.5 SC @ 0.0037% with 88.00 percentage reduction in mean larval population of *M. vitrata* over control. low percentage reduction was recorded in flonicamid 50 WG @ 0.02% (23.61%). Five days after spraying, chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mL L^{-1} was significantly superior (93.76%) to rest of the treatments with respect to percent reduction in mean larval population of *M. vitrata* over control, followed by chlorantraniliprole18.5 SC @ 0.0037% with 91.01 per cent reduction in mean larval population of *M. vitrata* over control, whereas the low per cent reduction among all the treatments were recorded in flonicamid 50 WG @ 0.02% (31.43%). At 10 days after spraying, chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mL L^{-1} (73.96%), chlorantraniliprole 18.5 SC @ 0.0037% (71.78%) and flubendiamide @ 39.35 SC 0.00787% (69.95%) were found superior and at par with each other. The minimum percentage reduction of mean larval population of *M. vitrata* over control was recored with thiacloprid 21.7 SC @ 0.0325% (23.86%) and flonicamid 50WG @ 0.02% (20.57%).

The overall efficacy of both the sprays resulted that all the chemical insecticides were effective against the spotted pod borer and the results were statistically significant (p= 0.05). Chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mL L^{-1} was found to be most effective with 75.91 percentage reduction in mean larval population of *M. vitrata* over control, followed by chlorantraniliprole 18.5 SC @ 0.0037% and flubendiamide @ 39.35 SC 0.00787% with 72.04 and 67.30 per cent overall reduction in mean larval population of *M. vitrata* over untreated control. The lowest percentage reduction in mean larval population of *M. vitrata* over control was recorded with thiacloprid 21.7 SC@0.0325% was at par withflonicamid 50WG @ 0.02% with 23.78% and 20.13% over control.

Table 1. Efficacy of newer insecticides against spotted pod borer (*Marucavitrata*) on Blackgram during *Rabi,* 2017-2018 growing season

Treatments	PTC	Percentage population reduction over control				
		1DAS	**3DAS**	**5 DAS**	**10 DAS**	**Overall mean**
T$_1$: Thiamethoxam 25WG (0.2g L^{-1})	45.83 (42.99)**	19.45 (26.21)^{e}	29.60 (33.52)^{f}	36.24 (37.17)^{f}	31.87 (34.76)^{d}	29.29 (32.27)^{f}
T$_2$: Thiacloprid 21.7SC (1.5 mL L^{-1})	48.50 (44.14)		26.44 (30.98)^{g}	31.43 (34.14)^{g}	23.86 (29.00)^{e}	23.78 (29.67)^{g}
T$_3$: Flonicamid 50 WG (0.4g L^{-1})	49.66 (45.29)	10.66 (19.52)^{g}	23.61 (29.00)^{g}	25.76 (30.98)^{h}	20.57 (26.92)^{e}	20.13 (26.92)^{g}
T$_4$: Spinosad 45 SC (0.3mL L^{-1})	46.49 (43.57)	28.62 (32.27)^{c}	69.16 (56.48)^{d}	81.83 (64.52)^{d}	62.61 (52.24)^{b}	60.55 (51.06$^{)d}$
T$_5$:Flubendiamide 39.35 SC (0.2 mL L^{-1})	48.17 (44.14)	33.09 (35.37)^{b}	79.20 (63.08)^{c}	86.96 (69.30)^{c}	69.95 (56.48)^{a}	67.30 (55.24)^{c}
T$_6$:Chlorantraniliprole 18.5 SC (0.2 mL L^{-1})	46.99 (43.57)	37.38 (37.76)^{b}	88.00 (70.18)^{b}	91.01 (73.05)^{b}	71.78 (58.37)^{a}	72.04 (58.37)^{b}
T$_7$: Acetamiprid 4% + Fipronil 4 % (2 mL L^{-1})	49.49 (44.71)	21.03 (27.63)^{d}	25.09 (30.33)^{g}	29.62 (33.52)^{g}	27.08 (31.63)^{d}	25.77 (30.98$^{)f}$
T$_8$: Flubendiamide19.9 %+ Thiachloprid 19.9 % (1 mL L^{-1})	49.99 (45.29)	26.32 (3.98)^{d}	60.70 (51.08)^{e}	71.84 (58.37)^{e}	53.40 (47.01)^{c}	52.06 (47.01)^{e}
T$_9$:Chlorantraniliprole 9.3% + λ Cyhalothrin 4.6% (0. mL L^{-1})	48.16 (44.14)	45.26 (42.42)^{a}	90.68 (73.05)^{a}	93.76 (76.44)^{a}	73.96 (59.56)^{a}	75.91 (61.00)^{a}
T$_{10}$: Untreated check	50.33 (50.33)	0.00	0.00	0.00	0.00	0.00
F test	NS	Sig.	Sig.	Sig.	Sig.	Sig.
SEm±		1.03	0.81	1.0	1.09	0.98
CD (p= 0.05)		3.07	2.40	2.97	3.24	2.92

*PTC = Pre Treatment count, DAS= Day After Spraying Sign= Significant NS = Non Significant Figures in Parentheses are ** Arc sin transformed Values*

Table 2. Efficacy of newer insecticides against on mean percentage pod damage on Blackgram during *Rabi,* 2017-2018 growing season

Treatments	Mean percentage pod damage
T_1 : Thiamethoxam 25WG (0.2g L^{-1})	36.67 (37.17)^{f}
T_2 : Thiacloprid 21.7SC (1.5 mL L^{-1})	41.99 (40.11)^{g}
T_3: Flonicamid 50 WG (0.4g L^{-1})	46.20 (43.05)^{h}
T_4 : Spinosad 45 SC (0.3mL L^{-1})	16.32 (23.97)^{c}
T_5 :Flubendiamide 39.35 SC (0.2 mL L^{-1})	14.52 (22.38)^{c}
T_6 :Chlorantraniliprole 18.5 SC (0.2 mL L^{-1})	11.55 (20.70)^{b}
T_7 : Acetamiprid 4% + Fipronil 4 % (2 mL L^{-1})	33.40 (35.37)^{e}
T_8 : Flubendiamide19.9 %+ Thiachloprid 19.9 % (1 mL L^{-1})	22.82 (29.00)^{d}
T_9 :Chlorantraniliprole 9.3% + λ Cyhalothrin 4.6% (0.mL L^{-1})	7.06 (15.89)^{a}
T_{10} : Untreated check	60.58 (51.06)^{i}
F test	Sig.
SEm$\pm$	1.12
CD (p= 0.05)	3.341

Table 3. Influence of insecticidal sprays on Blackgram yield during *Rabi*, 2017-2018 growing season

Treatments	Yield		
	Kg/Plot	Kg/ha	Percent increase over control
T_1 : Thiamethoxam 25WG (0.2g l^{-1})	0.62	311.67	41.06
T_2 : Thiacloprid 21.7SC (1.5ml l^{-1})	0.55	273.33	23.84
T_3: Flonicamid 50 WG (0.4g l^{-1})	0.57	286.66	30.27
T_4 : Spinosad 45 SC (0.3ml l^{-1})	0.80	401.66	82.40
T_5 :Flubendiamide 39.35 SC (0.2ml l^{-1})	0.91	453.33	104.93
T_6 :Chlorantraniliprole 18.5 SC (0.2 ml l^{-1})	1.45	725.00	228.7
T_7 : Acetamiprid 4% + Fipronil 4 % (2 ml l^{-1})	0.60	300.00	36.01
T_8 : Flubendiamide19.9 %+ Thiachloprid 19.9 % (1 ml l^{-1})	0.69	345.00	56.80
T_9 : Chlorantraniliprole9.3%+λ Cyhalothrin 4.6% (0.5 ml l^{-1})	1.66	831.67	275.18
T_{10} : Untreated check	0.44	221.67	0.00
F test	Sig .	Sig .	Sig.
SEm$\pm$	0.03	18.92	7.24
CD (p= 0.05)	0.11	56.21	21.52

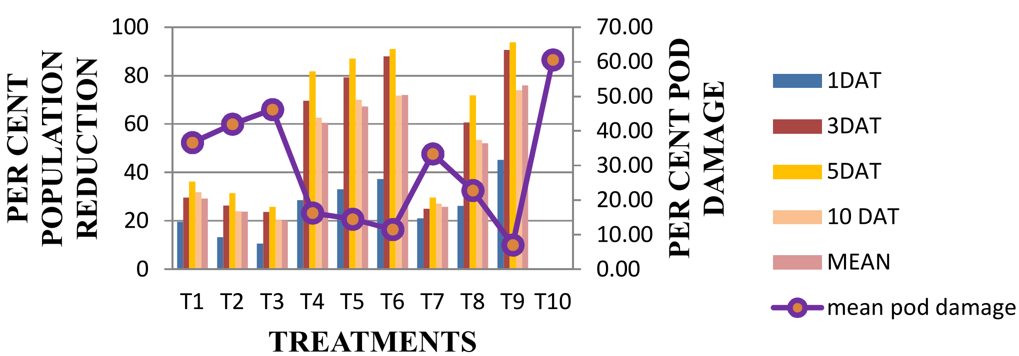

Fig. 1. Cumulative efficacy of two sprays against spotted pod borer (*M. vitrata*) and percentage pod damage on blackgram during *rabi*, 2017-2018 growing season

Table 4. Effect of newer insecticidal sprays on Blackgram yield and their cost benefit ratio during *Rabi*, 2017-2018 growing season

Treatments	Dosa-ge L / kg ha $^{-1}$	Cost of the insecticide Rs. /kg	Cost Rs L/kg ha $^{-1}$	Yield		Income Rs.	Labour costs Rs.	Total cost of plant protection Rs. Ha	Net profit Rs.	C:B Ratio
				q/ha	Additional Yield/ha					
T_1 : Thiamethoxam 25WG (0.2g l^{-1})	0.1kg ha $^{-1}$	3000	300.00	3.11	0.80	4320	500	800.00	3520.00	4.06
T_2 : Thiacloprid 21.7SC(1.5ml l^{-1})	0.75 l ha $^{-1}$	2840	21,30.00	2.73	0.52	2808	500	2630.00	178.00	0.06
T_3: Flonicamid 50 WG (0.4g l^{-1})	0.2kg ha $^{-1}$	10200	2040.00	2.86	0.65	3510	500	2540.00	970.00	0.38
T_4 : Spinosad 45 SC (0.3ml l^{-1})	0.15 l ha $^{-1}$	2357	353.55	4.01	1.80	9720	500	853.55	8899.45	15.28
T_5 : Flubendiamide 39.35 SC(0.2ml l^{-1})	0.1l ha $^{-1}$	20000	2200	4.53	2.32	12,528	500	2700	9828	3.64
T_6 : Chlorantraniliprole 18.5 SC (0.2 ml l^{-1})	0.1 l ha $^{-1}$	10000	1000.00	7.25	5.04	27,216	500	1500.00	25716.00	17.14
T_7 : Acetamiprid 4%+ Fipronil 4 % (2 ml l^{-1})	1 lha $^{-1}$	1660	1660.00	3.00	0.79	4266	500	2160.00	2106.00	0.975
T_8 : Flubendiamide19.9 %+ Thiachloprid 19.9 % (1ml l^{-1})	0.5 l ha $^{-1}$	11,590	5795.00	3.45	1.24	6696	500	6295.00	401.00	0.06
T_9 : Chlorantraniliprole9.3%+λ Cyhalothrin 4.6% (0.5ml l^{-1})	0.25 l ha $^{-1}$	10625	2656.25	8.31	6.1	32940	500	3156.25	29783.75	9.43
T_{10} : Untreated check	-	-	-	2.21	-	-	-	-		

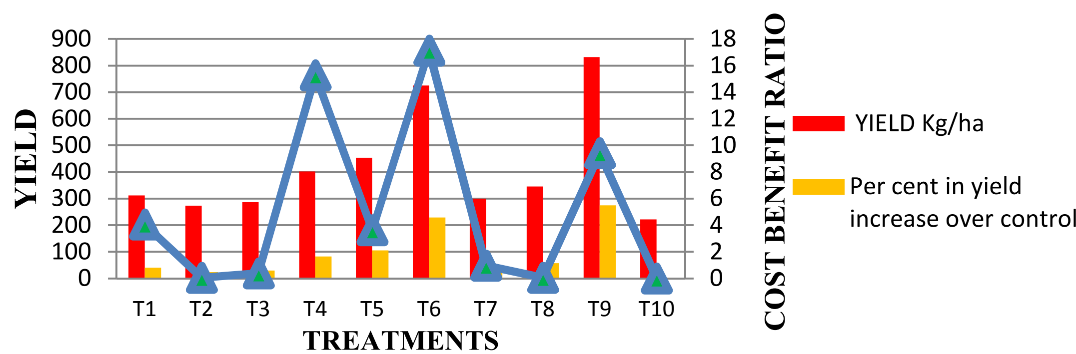

Fig. 2. Effect of different newer insecticides on the yield of blackgram and C: B ratio

4. DISCUSSION

The present results are in agreement with the findings of [13,14] against *M. vitrata* and *Helicoverpa armigera* by recording 90.21 per cent reduction over control. [15,16,17] against *M. vitrata*, [18] against *Thysanoplusia orichalcea* in blackgram and [19,20] against stem borer in paddy. The findings of [6,7,21,22,23,24] against *M.vitrata* and [25] against *Helicoverpa armigera* in tomato conforming the outcome of the present study pertaining the efficacy of flubendiamide.

4.1 Pod Damage

The data on pod damage revealed that lowest pod damage (7.04%) (Table 2) was recorded with chlorantraniliprole 9.3% + λcyhalothrin 4.6% @ 0.5 mL L^{-1}followed by chlorantraniliprole18.5 SC @ 0.0037 % (11.55%). In the untreated control plot, maximum pod damage of 60.58 per cent was recorded.

4.2 Yield

The data on the yield of blackgram in different treatments revealed that maximum yield of 8.31 q ha^{-1} was obtained from chlorantraniliprole 9.3% + λ cyhalothrin 4.6%@ 0.5 mls L^{-1} followed by chloroantraniliprole18.5 SC @ 0.0037% with 7.25 q ha^{-1} (Table 3). In the control plot lowest yield (2.38 qha^{-1}) was recorded. The results are in conformity with [13] who reported that the maximum yield of seed cotton can be obtained with application of chlorantraniliprole+ λ cyhalothrin @ 400 ml ha^{-1}. The highest yield obtained with chlorantraniliprole was also evidenced by [18,26].

4.3 Cost - Benefit Ratio

It is the ratio of the value of yield gain to the cost of treatment. The cost benefit ratios (CBR) among various insecticidal treatments varied between 17.14 and 0.38 (Table 4 & Fig. 2). Maximum CBR (1:17.14) was recorded with chlorantraniliprole 18.5 SC (17.14) followed by spinosad 45 SC (15.28) and least cost - benefit ratio was recorded with flonicamid 50 WG (0.03). The cost effectiveness of chlorantraniliprole might be due to their lower doses against the pod borer coupled with their low market price. These treatments recorded higher cost - benefit ratio which was in accordance with [27].

Hence, it could be concluded that *M. vitrata* can be effectively managed with two sparys of chlorantraniliprole 9.3% + λ cyhalothrin 4.6% @ 0.5 mls L^{-1}or chlorantraniliprole18.5 SC @ 0.0037%. The reduction in larval population is more with these chemicals than with other conventional chemicals, and chances of development of insecticide resistance in this pest might be low against these chemicals and could be recommended for farmers for the effective management of *M. vitrata* and enchanced yield of blackgram. As blackgram is short duration crop and within 65-75 days the crop is harvested, it is worth and best option to use such chemicals to manage the legume pod borer.

5. CONCLUSIONS

The present findings conclude that the new generation insecticides like chlorantraniliprole 9.3% + λ cyhalothrin 4.6%, chlorantraniliprole were effective against spotted pod borer, *M. vitrata* along with an additional yield level in rice fallow blackgram. It was further observed that the cost- benefit ratio was also high with chlorantraniliprole and spinosad. Hence, it is suggested that the reduction in larval population is more with these chemicals and also reduces the risk of increased insecticidal resistance.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Soundararajan RP, Chitra N. Effect of bioinoculants on sucking pests and pod borer complex in urdbean. Journal of Biopesticides. 2011;4:7-11.
2. Ministry of Agriculture, Government of India, 2014-15.
   (Accessed on 16.9.2016)
   Available:http://www.indiastat.com
3. Rangarao GV, Ashwini Kumar PR, Rameswar Rao, Reddy YVR. Evaluation of spinosad and indoxacarb for the management of legume pod borer *Maruca vitrata* (Geyer) in pigeonpea. Journal of Food Legumes. 2007;20:126-12711.

4. Chandrayadu E, Srinivasan S, Venugopala Rao N. Evaluation of certain new insecticides against spotted podborer, *M. vitrata* (Geyer) on cowpea (*Vigna ungiculata* (L) Walp). Current Biotica. 2008;2(2):240-243.
5. Lakshmi PSR, Sekhar PR, Rao VRS. Bio efficacy of certain insecticides against spotted pod borer on urdbean. Indian Journal of Pulses Research. 2002;15:201-202.
6. Patil SK, Deshmukh GP, Patil JV. Efficacy of flubendiamide 480 SC against pod borers in Blackgram. Pestology. 2008;32(9):20-22.
7. Mahalakshmi MS, Ramarao CV, Koteswararao Y. Efficacy of certain newer insecticides against legume pod borer, *Maruca vitrata* in urdbean. Indian Journal of Plant Protection. 2012;40(2):115-117.
8. Ramu PS, Swathi K, Rao SG. A review on seasonal incidence and insecticidal management of spotted pod borer *Maruca vitrata* (Geyer) with special reference to urdbean in India. Journal of Entomology and Zoology Studies. 2018;6(4):926-931.
9. Mahalakshmi MS, Sreekanth M, Adinarayana M, Koteswararao Y. Evaluation of flubendiamide 20% WG (Takumi 20% WG) against legume pod borer, *Maruca vitrata* (fabricius) in blackgram under field conditions. International Research Journal of Natural and Applied Sciences. 2016;3(6):134-139.
10. Roy D, Chakraborty G, Sarkar PK. Comparitive efficacy, non –target toxicity and economics of seven novel pre- mixed formulations against *Maruca testulalis* G. and *Aphis craccivora* K. infesting cowpea. Journal of Environmental Biology. 2017;38:603-609.
11. Flemming R, Ratnakaran A. Evaluation of single treatment data using Abotts's formula with refrence to insects. Indian Journal of Economic Zoology. 1985;78:1179-1181.
12. Gomez AK, Gomez AA. Statistical procedures for agricultural research. Singapore: John Wiley and Sons, Inc.; 1984.
13. Baskaran MRK, Rajavel DS, Suresh K, Jayaraj J, Palanisamy N. Efficacy of ampligo 150 ZC (chlorantarniliprole 9.6% + lambda cyhalothrin 4.6%) against bollworm complex in cotton. Pestology. 2012;36(6): 55-58.
14. Jose FJG, Andre LFL, Crebio J. Field efficacy of chemical pesticides against *Maruca vitrata* Fabricius (Lepidoptera: Crambide) infesting soybean in Brazil. American Journal of Plant Sciences. 2015;6:537-544.
15. Haritha B. Biology and management of *Maruca vitrata* (Geyer) in pigeonpea. M.Sc. (Ag.) Thseis, Submitted to Acharya N. G. Ranga Agricultural University, Rajendranagar Hyderabad; 2008.
16. Sambathkumar S, Durairaj C, Ganapathy N, Mohan Kumar S. Filed evaluation of newer insecticide molecules and botanicals against pod borers of redgram. Legume Research. 2015;38(2):260-267.
17. Jakhar BL, Kumar S, Ravindrababu Y. Efficacy of different newer insecticides against legume pod borer, *Maruca vitrata* (Geyer) on pigeonpea. Research on Crops. 2016;17(1):134-136.
18. Babu SR, Dudwal GR, Meena PK. Filed efficacy of newer insecticide molecules against green semilooper, *Thysanoplusia orichalcea* in Blackgram. Indian Journal of Plant Protection. 2015;43(3):273-275.
19. Devi RS, Reddy AV. Bio- efficacy of combination formulation of chlorantraniliprole + thiamethoxam (Syn 15645) 40 WG against yellow stem borer in paddy. The Andhra Agricultural Journal. 2012;59(3):440-443.
20. Sachan SK, Kashyap AK, Sharma R, Verma KD, Singh HR. Efficacy of some novel insecticides against yellow stem borer, *Scirpophaga incertulus* (Walker) in Basmati rice. Journal of Pharmacology and Phytochemistry. 2018;SPI:195-197.
21. Ameta OP, Sharma US, Jeengar KL. Efficacy of flubendiamide 480 SC against podborers, *Helicoverpa armigera* (Hubner) and *Maruca testulalis* (Geyer) in pigeonpea. Indain Journal of Entomology. 2011;73(3):191-195.
22. Dey PK, Chakarborty G, Somchoudhry AK. Evaluation of flubendiamide 480 SC against lepidopteran pod borers of pigeonpea (*Cajanus cajan* (L) Millsp.). Journal of Interacademicia. 2012;16:857-862.
23. Priyadarshini G, Narendraredy C, Jadishwar Reddy D. Bio- efficacy of selective insecticides against lepidopteran pod borers in pigeonpea. Indian Journal of Plant Protection. 2013;41(1):6-10.
24. Anusha CH, Balikai RA, Pati IRH. Management of cowpea pests through

newer and conventional insecticides. International Journal of Agricultural and Statistics Sciences. 2014;10(1):157-160.

25. Kumar BV, Kumaran N, Kubendran D, Kuttalam S. Combination of flubendiamide + thiacoprid 480 SC (RM) against bollworms and sucking peats of cotton. Madras Agricultural Journal. 2010;97(4-6): 157-160.

26. Mohanraj A, Bharathi K, Rajavel DS. Evaluation of chlorantraniliprole 20% SC against pests of Blackgram. Pestology. 2012;36(4):39-4327.

27. Kumar GVS, Sarada O. Field efficacy and economics of some new insecticide molecules against lepidopteran caterpillars in chickpea. Current Biotica. 2015;9(2): 153-158.

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