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Bioefficacy and economics of different insecticides against legume pod borer (*Maruca vitrata* Fabricius) infesting cowpea (*Vigna unguiculata* Walpers)

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ABSTRACT

The experiment was carried out in randomized block design (RBD) with ten treatments replicated thice at research farm of Institute of Agricultural Sciences, Banars Hindu University, Varanasi, Uttar Pradesh during *zaid* 2009-10 and 2010-11. The cowpea was grown in experimental plots of 6.0 m^2 by following recommended horticultural practices. The population dynamics of legume pod borer were recorded at weekly interval. The insecticidal treatments were given at economic threshold level of insect. The observations per cent pod damage, yield and benefit: cost ratio revealed that the most effective treatment was *Bacillus thuringiensis* 5WG (0.025%) and fipronil 5SC (0.015%). However, flubendamide 480SC (0.3ml/lit) and azadirachtin 10000ppm (5ml/lit) were observed as least effective treatments. Remianing treatments showed moderate action in management of this insect-pest under cowpea agroecosystem.

Key words: Bioefficacy, Cowpea, Economics, Insecticides, Legume pod borer.

INTRODUCTION

Cowpea (*Vigna unguiculata* Walpers) is known for its versatility and better adaptability to warm and dry conditions because of proven drought tolerance and thereby could prove more appropriate crop in current environmental changing scenario of global warming (Patel *et al*., 2012). The nutritional value of cowpea is very high due to its high protein content of 23%, fats 1.3%, fibre 1.8%, carbohydrate, 67% and water 8–9% (Jefferson, 2009). Cowpea also serves as a cover crop and important in improving the soil fertility by nitrogen fixation (Asiwe *et al*, 2009). Majority of people in the developing countries are engaged in cowpea production. Inspite of all improvement brought in cultivation of cowpea; its productivity is still very low due to insect-pests attack (Singh *et al;* 2000).

Several insect-pests were recorded to attack the crop at its different stages of growth. Out of these, flower bud thrips, *Megalurothrips sjostedti* Trybom, legume pod borer, *Maruca vitrata* Fab and pod sucking bug, *Clavigralla tomentosicollis* Stal act as a major constraints in increasing its production. Among these, legume pod borer is one of the most important insect pests and causes severe yield losses up to 60% (Pandey, *et al.*, 1991). The larvae of legume pod borer attack on vegetative as well as reproductive parts of the plant (Taylor, 1978). The larvae webb the leaves, buds, flowers and pods together and feed inside. This typical feeding habit protects the larvae from natural enemies and other adverse factors and is responsible for retarded growth of the crop.

Therefore, it is important to have a critical look to manage this insect-pest with newer insecticides at a particular crop stage. Recently, the use of synthetic insecticides, biological controls, physical control and resistant/tolerant plant materials have been experimented by many scientists to control this insect-pest (Sharah and Ali, 2008). However, they failed to have cost effective management practices for this insect-pest. Hence, present investigation on bioefficacy and economics of insecticides for managing legume pod borer was carried out under field condition in cowpea agroecosystem.

MATERIALS AND METHODS

Present investigation was carried out under randomized block design (RBD) for two consecutive cropping seasons during *zaid* of 2009-10 and 2010-11 at Agricultural Research Farm, Banaras Hindu University, Varanasi (Uttar Pradesh), India. All ten treatments were replicated thrice with plot size of 3m × 2m. The seeds of cowpea [cultivar: Kashi Kanchan (VRCP-4)] was dibbled on ridges with row spacing of 60cm apart. Plant to plant distance of 20cm was maintained at 15 days after sowing. Crop was raised by following normal recommended horticultural practices.

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TABLE 1: Effect of different insecticides on percent pod damage and yield of cowpea pods and seeds during *zaid*, 2009-10

Tr. No.	Insecticides	Doses	*Average pod damage (%) at different days after treatment (DAT)					Yield (Q/ha)	
			Pretreatment	2 DAT	5 DAT	9 DAT	14 DAT	Pods	Seeds
T_1	Azadirachtin 10,000 ppm	5ml/lit	9.33 (18.28)	7.33 (16.25)	4.00 (12.25)	1.33 (7.78)	1.00 (7.03)	7.54	0.99
T_2	Novaluron 10EC	0.005%	8.33 (17.29)	6.67 (15.53)	3.00 (10.78)	1.33 (7.78)	0.67 (6.20)	10.47	0.95
T_3	*Bacillus thuringiensis* 5WG	0.0025%	9.00 (17.95)	3.67 (11.78)	1.67 (8.46)	0.33 (5.24)	0.00 (4.05)	12.39	1.20
T_4	Flubendamide 480SC	0.3ml/lit	9.97 (18.88)	9.00 (17.95)	4.67 (13.14)	2.33 (9.69)	1.00 (7.03)	7.77	0.87
T_5	Acetamiprid 20SP	0.02%	8.34 (17.29)	6.00 (14.77)	3.00 (10.78)	1.67 (8.46)	0.67 (6.20)	7.59	1.02
T_6	Thiodicarb 75 WP	0.075%	9.06 (18.01)	8.24 (17.19)	5.00 (13.56)	2.67 (10.25)	1.00 (7.03)	8.47	0.88
T_7	Cartap hydrochloride 50SP	0.05%	10.11 (19.01)	8.00 (16.95)	5.33 (13.98)	3.33 (11.29)	1.67 (8.46)	8.21	0.84
T_8	Fipronil 5 SC	0.015%	8.06 (17.01)	4.00 (12.25)	2.33 (9.69)	0.67 (6.20)	0.33 (5.24)	12.33	1.19
T_9	Endosulfan 35 EC	0.07%	8.67 (17.62)	8.97 (1792)	6.00 (14.77)	3.00 (10.78)	1.67 (8.46)	8.74	1.12
T_{10}	Untreated control	-	10.14 (19.04)	13.67 (22.11)	16.88 (24..64)	13.33 (21.83)	7.67 (16.61)	4.00	0.44
	C.D. $_{(P\leq0.05)}$	-	NA	3.18	2.40	1.54	1.37	8.16	1.36
	SEm±	-	NA	1.07	0.81	0.52	0.46	2.75	0.46
	F-test	-	NS	**	**	**	**	**	**

Figures in parentheses are square root/angular transformed, NA →Not applicable, NS →Nonsignificant, **Significant
*Average of 3replications, 10 plants in each replication

TABLE 2: Effect of different insecticides on percent pod damage and yield of cowpea pods and seeds during *zaid*, 2010-11

Tr. No.	Insecticides	Doses	*Average pod damage (%) at different days after treatment (DAT)					Yield (Q/ha)	
			Pretreatment	2 DAT	5 DAT	9 DAT	14 DAT	Pods	Seeds
T_1	Azadirachtin 10,000 ppm	5ml/lit	9.33 (18.28)	8.00 (16.95)	6.33 (15.15)	5.00 (13.56)	2.33 (9.69)	8.61	1.18
T_2	Novaluron 10EC	0.005%	8.33 (17.29)	5.67 (14.38)	4.00 (12.25)	3.00 (10.78)	1.33 (7.78)	12.23	1.08
T_3	*Bacillus thuringiensis* 5WG	0.0025%	9.33 (18.28)	3.67 (11.78)	2.00 (9.10)	1.00 (7.03)	0.00 (4.05)	14.31	1.33
T_4	Flubendamide 480SC	0.3ml/lit	10.00 (18.91)	8.67 (17.62)	7.33 (16.25)	4.67 (13.14)	2.10 (9.28)	9.00	0.99
T_5	Acetamiprid 20SP	0.02%	9.00 (17.95)	6.00 (14.77)	4.67 (13.14)	3.67 (11.78)	1.51 (8.14)	8.89	0.99
T_6	Thiodicarb 75 WP	0.075%	9.00 (17.95)	7.00 (15.89)	5.00 (13.56)	3.00 (10.78)	1.17 (7.43)	9.92	0.99
T_7	Cartap hydrochloride 50SP	0.05%	10.00 (18.91)	6.33 (15.15)	5.98 (14.74)	4.00 (12.25)	1.68 (8.49)	9.61	0.94
T_8	Fipronil 5 SC	0.015%	9.67 (18.59)	4.00 (12.25)	2.33 (9.69)	1.33 (7.78)	0.21 (4.83)	13.43	1.34
T_9	Endosulfan 35 EC	0.07%	9.00 (17.95)	7.33 (16.25)	5.67 (14.38)	3.33 (11.29)	1.63 (8.39)	10.41	1.07
T_{10}	Untreated control	-	11.00 (19.82)	16.00 (23.97)	19.33 (26.45)	17.00 (24.73)	9.67 (18.59)	4.92	0.54
C.D. $_{(P\leq0.05)}$			NA	3.31	2.96	2.64	1.88	9.28	1.55
SEm±			NA	1.11	1.00	0.89	0.63	3.12	0.52
F-test			NS	**	**	**	**	**	**

Figures in parentheses are square root/angular transformed, NA →Not applicable, NS →Nonsignificant, **Significant
*Average of 3replications, 10 plants in each replication

TABLE 3: Economics of different insecticides against legume pod borer infesting cowpea during *zaid*

Tr. No.	Insecticides	Doses	Qty of insecticides (l/kg/ha	Price of insecticides (Rs./ha)	Labour cost (Rs/ha)	Total cost of treatment (Rs/ha)	Yield (Q/ha)		Gross return (Rs/ha)	Net return (Rs/ha)	Net gain over control (Rs/ha)	B:C ratio
							Greenpods	Seeds				
	Economics of different insecticides during *zaid*, 2009-10											
T_1	Azadirachtin 10,000 ppm	5ml/lit	3.000	2538.0	784.0	3372.0	7.54	0.99	14436.2	11064.2	4822.9	1.4:1
T_2	Novaluron 10EC @	0.005%	0.300	1050.0	784.0	1884.0	10.47	0.95	17129.3	15245.3	9003.9	4.8:1
T_3	*Bacillus thuringiensis* 5WG	0.0025%	0.300	720.0	784.0	1554.0	12.39	1.20	20787.0	19233.0	12991.7	8.4:1
T_4	Flubendamide 480SC	0.3ml/lit	0.180	2340.0	784.0	3174.0	7.77	0.87	13863.3	10689.3	4448.0	1.4:1
T_5	Acetamiprid 20SP	0.02%	0.600	1560.0	784.0	2394.0	7.59	1.02	14737.7	12343.7	6102.4	2.5:1
T_6	Thiodicarb 75 WP	0.075%	0.600	600.0	784.0	1434.0	8.47	0.88	14628.3	13194.3	6953.0	4.8:1
T_7	Cartap hydrochloride 50SP	0.05%	0.600	630.0	784.0	1464.0	8.21	0.84	14063.1	12599.1	6357.8	4.3:1
T_8	Fipronil 5 SC	0.015%	1.800	1800.0	784.0	2634.0	12.33	1.19	20664.3	18030.3	11788.9	4.5:1
T_9	Endosulfan 35 EC	0.07%	1.200	600.0	784.0	1434.0	8.74	1.12	16551.1	15117.1	8875.8	6.2:1
T_{10}	Untreated control	-	-	-	784.0	809.0	4.00	0.44	7075.4	6241.4	0.0	0.0
Tr. No.	**Insecticides**					**Economics of different insecticides during *zaid*, 2010-11**						
T_1	Azadirachtin 10,000 ppm	5ml/lit	3.000	2538.0	784.0	3372.0	8.61	1.18	15562.6	12190.6	4350.8	1.3:1
T_2	Novaluron 10EC	0.005%	0.300	1050.0	784.0	1884.0	12.23	1.08	19779.6	17895.6	10055.8	5.3:1
T_3	*Bacillus thuringiensis* 5WG	0.0025%	0.300	720.0	784.0	1554.0	14.31	1.33	23641.3	22087.3	14247.6	9.2:1
T_4	Flubendamide 480SC	0.3ml/lit	0.180	2340.0	784.0	3174.0	9.00	0.99	15925.8	12751.8	4912.0	1.5:1
T_5	Acetamiprid 20SP	0.02%	0.600	1560.0	784.0	2394.0	8.89	0.99	17118.0	14724.0	6884.2	2.9:1
T_6	Thiodicarb 75 WP	0.075%	0.600	600.0	784.0	1434.0	9.92	0.99	16873.9	15439.9	7600.1	5.3:1
T_7	Cartap hydrochloride 50SP	0.05%	0.600	630.0	784.0	1464.0	9.61	0.94	16170.8	14706.8	6867.0	4.7:1
T_8	Fipronil 5 SC	0.015%	1.800	1800.0	784.0	2634.0	13.43	1.34	22803.5	20169.5	12329.7	4.7:1
T_9	Endosulfan 35 EC	0.07%	1.200	600.0	784.0	1434.0	10.41	1.07	17873.3	16439.3	8599.6	6.0:1
T_{10}	Untreated control	-	-	-	784.0	809.0	4.92	0.54	8673.8	7839.8	0.0	0.0

Price of cowpea pod: Rs. 10.0/kg, **Price of cowpea seed:** Rs. 70.0/kg, **Labour charge:** Rs. 196.0/day, **Sprayer charges:** Rs. 25.0

The treatments were applied with recommended doses at economic threshold level (5 to 10 % damage). Before application, stock solution of all the treatments were made. The data on per cent pod damage were recorded by selecting ten plants randomly from each plot at one day before spraying as pre-treatment observation and 2, 5, 9 and 14 days after spraying (DAS) as post treatment observations to find out the comparative efficacy of treatments (Abbott,1925). The yield of green pods at the time of each picking and seed at the time of last picking were recorded in plots treated with insecticides and converted to quintal/hectare. The benefit cost ratios were also worked out for assessing cost effectiveness of the treatments. All observations recorded were subjected to statistical analysis after angular (arc sin) transformation.

RESULTS AND DISCUSSION

On the basis of per cent pod damage, it was found that *B. thuringiensis* 5WG (0.0025%) treated plot produced more healthy pods then others followed by fipronil 5SC (0.015%), which differed significantly from remaining treatments. The minimum healthy pods were obtained from plots treated with flubendamide 480SC (0.3ml/lit) and found at par with the performance of azadirachtin 10000ppm (5ml/lit), cartap hydrochloride 50SP (0.05%) and thiodicarb 75WP (0.075%) during both the years (Table- 1 and 2). The findings of present investigation was in confirmity with the finding of Chandrayudu (2008) who reported that damaged pods were less in plots treated with *B. thuringiensis* and fipronil, whereas the cartap hydrochloride and novaluron were registered less effective with higher pod damage. Azadirachtin 0.03EC (5ml/lit) was found least effective for managing legume pod borer (Meena *et al.*, 2011). This investigation supported the observation of Ambekar *et al*. (2000) who reported that nimbicidine (0.03EC) was least effective against this pest.

The maximum green pod and seed producing treatment was *B. thuringiensis* 5WG (0.025%) and fipronil 5SC (0.015%). However, minimum green pod and seed yield were recorded in plots treated with azadirachtin 10,000ppm (5ml/lit) which had nonsignificant differences from flubendamide 480SC (0.3ml/lit), thiodicarb 75WP (0.075%) and cartap hydrochloride 50SP (0.05%) during both the years (Table- 1 and 2). In the same way, Chandrayudu *et al*. (2008) reported that highest grain yield in the plots treated with *B. thuringiensis* and fipronil. A report from Banaras Hindu University, Varanasi also showed that among the biorationals, *B. thuringiensis* provided higher yield over control in short duration pigeon pea (Mahapatra and Srivastava, 2002).

The benefit cost ratio of insecticides revealed that the most cost effective treatment was *B. thuringiensis* 5WG (0.0025%) followed by endosulfan 35EC (0.07%) and fipronil 5SC (0.015%) while, least cost effective treatment was flubendamide 480SC (0.3ml/lit) followed by azadirachtin 10000ppm (5ml/lit) during both the years (Table- 3). Similarly, Chandrayudu (2008) was also of openion that *B. thuringiensis* and fipronil gave maximum B: C ratio while managing insect-pest. Mahapatra and Srivastava (2008) also reported that amongst the biorationals, *B. thuringiensis* subsp. *kurstaki* gave the highest ICBR in managing legume pod borer. However, Meena *et al*., (2011) reported minimum benefit: cost ratio in plots treated with azadirachtin.

On the basis of above discussion, the present investigation was concluded as the most cost effective treatment was *Bacillus thuringiensis* 5WG @ 0.0025% and fipronil 5SC @ 0.015%. However, least effective insecticide was flubendamide 480SC @ 0.03ml/lit., azadirachtin 10000ppm @ 5ml/lit and endosulfan 35EC (0.07%). The insecticides namely, novaluron 10EC 0.005%, and acetamiprid 20SP @ 0.02% expressed moderate action in managing legume pod borer infesting cowpea.

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