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Relative efficacy of newer insecticides against gram pod borer, *Helicoverpa armigera*

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Abstract
The experiment was conducted at Students' Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during Rabi season 2015-16. Studied on Emamectin benzoate 5 SG @ 11 g a.i./ha was found most effective insecticide (94.44%) to reduce the larval population, it was followed by flubendiamide 480 SC @ 30 g a.i./ha that gave 87.78 per cent reduction, which was at par with rynaxypyr 20SC @ 40 g a.i./ha (83.33%). Least effective treatment was Lufenuron 50EC @ 60 g a.i./ha. in which only 64.44 percent reduction in larval population was registered. Reduction in larval population computed from data recorded 14 days after spraying revealed that all the treatments were effective and significantly superior to control. Emamectin benzoate 5 SG @ 11 g a.i.//ha was found most effective that reduced 100.00 per cent larval population.

Emamectin benzoate 5 SG @ 11 g a.i.//ha treated plots gave maximum grain yield (18.00 q/ha), it was at par with flubendiamide 480 SC @ 30 a.i./ha and Rynaxypyr 20SC @ 40 g a.i./ha in which 17.00, 16.50 q/ha grain yield, respectively were recorded. Maximum cost- benefit ratio was obtained in plot treated with flubendiamide 480 SC @ 30 g a.i./ha (1:10.06) followed by emamectin benzoate 5 SG @ 11 g a.i.//ha (1:9.20). Lowest cost -benefit ratio (1:3.10) was found in Lufenuron 50 EC@ 60 g a.i./ha treated plot.

Keywords: Pod borer, management, cost benefit, treatments and insecticides

Introduction
Chickpea, *Cicer arietinum* L. belongs to family Papilionaceate is an important pulse crop grown in many parts of the world. It is an important source of protein in human diet and animal feed (Khoso, 1992) [2]. The split grain of chickpea is called dal which is an excellent source of high quality proteins, essential amino and fatty acids, fibres, minerals and vitamins.

The area under chickpea cultivation in India is about 9.51 m ha with production of 8.83 m tonnes and productivity 929 kg/ ha. The area under U.P. is 0.0604 m ha with production of about 0.0732 m tonnes with an average yield of 1212 kg/ha (Anonymous, 2013-14) [1].

The chickpea pod borer, *Helicoverpa armigera* is polyphagous in nature which causes damage to several crops such as pigeon-pea, groundnut, cotton, vegetables, pearl millets, sorghum, maize, sunflower etc.

The young larvae often feed upon the tender foliage before attacking the pods by causing heavy losses to crop and sometimes whole crop failed due to severe infestation (Lohar and Rahoo, 1993; Nizamani, 1998) [3, 4]. Damage potential of this pest is so great that an average infestation of single larva may destroy 30-40 pods per plant in chickpea. The extent of losses in chickpea by pod borer varies from region to region. On chickpea, the pest appears in late February and reaches its peak by the end of April. Since not much resistance is available in gram genotype against the pest, therefore, farmers are increasingly relying on synthetic insecticides to manage this pest on different crops.

The pest feeds voraciously from seedling stage to maturity and causes about 50 to 60 per cent damage to the chickpea pods (Khare and Ujagir, 1977) [5]. In India, losses caused by pod borer on chickpea and pigeon pea fields exceeded Rs. 12,000 million per year (Anonymous, 1996) [6].

To control this insect pest number of chemical insecticides is used injudiciously which resulted development of resistance in insect, secondary pest outbreaks, threat to their natural enemies and residual effect on environment. In order to develop pest management strategies of *H. armigera*, knowledge on the basic biology of this pest is required. Jadhav and Suryawanshi, (1998) [7] reported that the application of insecticides reduced the larval population of pod borer on chickpea crop to a considerable extent and hence increased the yield. Balasubramanian *et al* (2001) [8] reported that chlorpyrifos 20 EC was the most effective insecticide to control gram pod borer.

Materials and Methods
An experiment was laid out in Randomized Block Design replicated thrice at Students' Instructional Farm of NDUAT, Kumarganj, Faizabad. Udai variety of chickpea was sown in (43 standard week) October, 2015.

$$\text{Amount of insecticide} = \frac{\text{Recommended rate (kg a. i. /ha) x Area covered}}{\text{Concentration of formulation}} \text{x100}$$

The population of *Helcoverpa armigera* larvae on chickpea was observed by counting ten randomly selected plants at three places at weekly intervals in each treatment. The mean larval population was worked out and the transform value was taken to analyzed the data as per standard statistically methods. The yield data at harvest was also recorded plot wise in gm/plot and converted into q/ha.
The percent reduction in larval population was worked out to know the magnitude of infestation in respect to treatment in compared to control.

$$\text{Percent Reduction in larval population} = \frac{\text{Untreated control} - \text{Treated}}{\text{Untreated}} \times 100$$

The data of mean per cent reduction in infestation were transformed into square root value (n+0.5). All the data were analyzed statistically as per standard method.
Benefit cost ratio was calculated on the basis of net income obtained from additional yield over control.
Value of yield saved due to control (Rs/ha).

$$\text{Benefit cost ratio} = \frac{\text{Value of yield saved due to insecticide}\left(\frac{\text{Rs.}}{\text{ha}}\right)}{\text{Cost of control}\left(\frac{\text{Rs.}}{\text{ha}}\right)}$$

Result and Discussion
The data on the effect of various treatments on the larval population of *H. armigera* represented in Table-1 indicate the larval population was homogenously distributed throughout experimental plots before the application of treatments. All treatments were significantly superior over the control when observations were made at 7 day after spraying. Emamectin benzoate 5 SG @ 11 g a.i./ha was found most effective insecticide (94.44%) to reduce the larval population, it was followed by flubendiamide 480 SC @ 30 g a.i./ha that gave 87.78 per cent reduction, which was at par with rynaxypyr 20SC @ 40 g a.i./ha (83.33%). Least effective treatment was Lufenuron 50EC @ 60 g a.i./ha. in which only 64.44 percent reduction in larval population was registered.
Reduction in larval population computed from data recorded 14 days after spraying revealed that all the treatments were effective and significantly superior to control. Emamectin benzoate 5 SG @ 11 g a.i.//ha was found most effective that reduced 100.00 per cent larval population, however, it was differ significantly with flubendiamide 480 SC @ 30 a.i./ha in which 95.83 per cent reduction in larval population was obtained. Rynaxypyr 20SC @ 40 g a.i./ha also found effective to reduce 93.33 per cent infestation but did not differ significantly with spinosad 45SC @ 73 g a.i. /ha (89.17% reduction). Indoxacarb 14.5 SC, @ 60 g a.i./ha and lufenuron 50 EC @ 60 g a.i./ha reduced 87.50 and 80.83 per cent larval population, respectively.
The effectiveness of treatments determined on the basis of chickpea grain yield obtained in different treatments during *Rabi*, 2015-16 is presented below (Table 2).
All the treatments were found effective over control that gave significantly higher grain yield of chickpea. Emamectin benzoate 5 SG @ 11 g a.i.//ha treated plots gave maximum grain yield (18.00 q/ha), it was at par with flubendiamide 480 SC @ 30 a.i./ha and Rynaxypyr 20SC @ 40 g a.i./ha in which 17.00, 16.50 q/ha grain yield, respectively were recorded. Spinosad 45SC @ 73 g a.i. /ha, indoxacarb 14.5 SC, @ 60 g a.i./ha and lufenuron 50 EC @ 60 g a.i./ha treated plots gave 1650, 15.00 and 14.16 q/ha, respectively and it was higher than control (13.16 q/ha).
The economics of treatments were determined to find out the cost effectiveness of treatment in the term of cost -benefit ratio. The maximum cost -benefit ratio was obtained in plot treated with flubendiamide 480 SC @ 30 g a.i./ha (1:10.06) followed by emamectin benzoate 5 SG @ 11 g a.i.//ha (1:9.20). Lowest cost -benefit ratio (1:3.10) was found in Lufenuron 50 EC@ 60 g a.i./ha treated plot.
All the insecticides tested against pod borer (*H. armigera*) were found significantly effective over the control. Out of six insecticides evaluated against the pest, emamectin benzoate 5 SG@ 11g a.i./ha was found most effective insecticide which caused 97.22 per cent reduction over control followed by flubendiamide 480 SC @ 30.g a.i./ha (91. 8% reduction). Saeed *et al*. (2006) [9], Sahito *et al*. (2012) [10] also reported that indoxacarb, proclaim, chlorantraniliprole, spinosad and flubendiamide were most effective in reduction of larval population H. armigera**:**
The effectiveness of treatments determined on the basis of grain yield obtained in different treatments revealed that all the treatments were found significantly superior over the control. Emamectin benzoate 5 SG @ 11 g a.i./ha treated plots gave maximum grain yield (18.00 q/ha), which was significantly superior then the other treatments, but it was at par with flubendiamide 480 SC @ 30 a.i./ha and Rynaxypyr 20SC @ 40 g a.i./ha in which 17.00, 16.50 q/ha grain yield, respectively were recorded. The grain yield, treated plots with spinosad 45SC @ 73 g a.i. /ha, indoxacarb 14.5 SC, @ 60 g a.i./ha and lufenuron 50 EC @ 60 g a.i./ha were 1650, 15.00 and 14.16 q/ha, respectively and it was higher than control (13.16 q/ha).
The economics of treatments were determined to find out the cost effectiveness of treatment in the term of cost -benefit ratio. The maximum cost -benefit ratio was obtained in plot treated with flubendiamide 480 SC @ 30 g a.i./ha (1:10.06) followed by emamectin benzoate 5 SG @ 11 g a.i.//ha (1:9.20). Lowest cost -benefit ratio (1:3.10) was found in Lufenuron 50 EC@ 60 g a.i./ha treated plot. The findings of the present studies are in conformity of the results of Sahito *et al.* (2012) [10], also reported Proclaim, Spinosad & Indoxacarb able to gave higher yield in the experiments.

Table 1: Efficacy of different treatments against larval population of gram pod borer (*H. armigera* Hub.) in chickpea during *Rabi*, 2015-16

S. No.	Treatments	Dose (g.a.i./ha)	Pre Treatment	Per cent reduction in larval population After spraying (Days)		
				7 days	14 days	Mean
T_1	Spinosad 45 SC	73	2.00 (1.581)	76.66 (8.774)	89.17 (9.459)	82.91
T_2	Indoxacarb 14.5 SC	60	1.33 (1.353)	71.11 (8.454)	87.50 (9.365)	79.30
T_3	Emamectin benzoate 5 SG	11	2.00 (1.581)	94.44 (9.735)	100.00 (10.025)	97.22
T_4	Flubendiamide 480 SC	30	1.67 (1.473)	87.78 (9.384)	95.83 (9.810)	91.80
T_5	Rynaxypyr 20SC	40	2.00 (1.581)	83.33 (9.125)	93.33 (9.674)	88.33
T_6	Lufenuron 50 EC	60	2.00 (1.581)	64.44 (8.056)	80.83 (9.014)	72.63
T_7	Control (water spray)	-	2.00 (1.581)	0.00 (0.707)	0.00 (0.707)	0.00
SEm±			-	0.313	0.273	-
CD			-	0.965	0.842	-

Table 2: Efficacy of different treatments against *H. armigera* based on seed yield of chickpea during *Rabi*, 2015-16

Treatments	Dose (g a.i./ha)	R_1	R_2	R_3	Mean
T_1 -Spinosad 45 SC	73	16.00	17.50	16.00	16.50
T_2- Indoxacarb 14.5 EC	60	14.90	15.00	15.10	15.00
T_3 -Emamectin benzoate 5 SG	11	18.00	17.80	18.20	18.00
T_4 -Flubendiamide 480 EC	30	17.10	17.00	16.90	17.00
T_5 -Rynaxypyr 20SC	40	16.00	16.90	16.60	16.50
T_6- Lufenuron50 EC	60	14.00	14.48	14.00	14.16
T_7-Control (water spray)	-	13.30	13.00	13.18	13.16
SEm±	-	-	-	-	0.22
C.D.	-	-	-	-	0.69

Table 3: Cost -benefit ratio of different treatments used for the management of gram pod borer (*H. armigera* Hub.) in chickpea during *Rabi*, 2015-16

Treatments	Dose (g a.i./ha)	Cost of treatment (Rs/ha)	Yield (q/ha)	Saved yield over control (q/ha)	Benefit due to treatment (Rs/ha)	Cost - benefit ratio
T_1- Spinosad 45 SC	73	3894.44	16.50	3.34	16700.00	1:4.28
T_2-Indoxacarb 14.5 EC	60	2243.13	15.00	1.84	9200.00	1:4.10
T_3 -Emamectin benzoate 5 SG	11	2630.00	18.00	4.84	24200.00	1:9.20
T_4- Flubendiamide 480 SC	30	1907.94	17.00	3.84	19200.00	1:10.06
T_5- Rynaxypyr 20SC	40	4050.00	16.50	3.34	16700.00	1:4.12
T_6- Lufenuron 50 EC	60	1610.00	14.16	1.00	5000.00	1:3.10
T_7-Control (water spray)	-	-	13.16	_	_	-

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