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Integrated approaches for the management of gram pod borer *Helicoverpa armigera* (Hubner) in chickpea

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Abstract
A field experiment was carried on chickpea during 2017-18 at Central Research Farm and Department of Entomology SHUATS, Naini, Allahabad (U.P). Different integrated approaches *viz.*, *Bacillus thuringiensis* (2 kg/ha), Ha NPV (500 LE/ha), neem seed kernel extract (2.0 ml/lit), chickpea + coriander, hand picking+ *Bt* (3 times+2 kg/ha), weeding + hand picking + indoxacarb (3 times+3 times + 2 kg/ha) and indoxacarb (350 ml/ha) was evaluated on gram pod borer, *Helicoverpa armigera*. The data on the percentage pod damage of different integrated approaches revealed that the treatment indoxacarb (1.98), followed by weeding + hand picking + indoxacarb (1.76), NSKE (2.89), *Bacillus thuringiensis* (2.63), Ha NPV (2.18), hand picking + Bt (2.11), chickpea + coriander (3.05) found to be more economically viable treatment.

Keywords: *Helicoverpa armigera*, *Bacillus thuringiensis*, Ha NPV, NSKE

1. Introduction
Gram commonly known as a 'chickpea' or chana is a very important pulse crop that grows as a seed of a plant named *Cicer arietinum* in the Leguminosae family. India is the largest chickpea producer as well as consumer in the world. Chickpea is the world's third most important food legume. It contains 25 % proteins, which is the maximum provided by any pulse and 61.1 % carbohydrates. However, high yield is limited by the insect pests attacking chickpea [1].
Chickpea is attacked by 57 insect species among them *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), is a highly polyphagous pest which infests many host plants [2, 3]. The *H. armigera*, commonly known as cotton bollworm or American bollworm, is a major polyphagous noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops [4].
Helicoverpa armigera is the most serious pest of chickpea and other crop plants all over the world [5]. In severe cases, it causes about 75 to 90 % losses in seed yield, and it was pointed out that gram pod borer damage leaves, tender shoots, apical tips, floral buds and pods [6].
Many conventional and modern techniques of pest control have been tested in an attempt to avoid the losses caused by the chickpea pod borer. These include host plant resistance, destruction of larvae manually, removal of weeds, release of *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae), application of Nuclear polyhedrosis viruses, *B. thuringiensis*, and chemical control. Since these approaches have so far been tried only separately, the present studies were designed with an overall objective to develop a low cost technology to control chickpea pod borer to avoid indiscriminate use of insecticides as far as possible [7].

2. Materials and methods
Integrated approaches for the management of gram pod borer in chickpea was carried out during *Rabi* 2017-18 at Agriculture research farm, SHUATS, Allahabad. The experiment was laid out in randomly customized block design with 8 treatments replicated thrice in 2m x 2m = $4m^2$ plot size. The Chickpea variety GNG-1581 was raised as per the recommended package of practices. The following integrated approaches were evaluated against the chickpea pod borer, *Helicoverpa armigera*. The treatments were imposed by using knapsack sprayer @ 400-500 litres of spray solution per hectare depending on stage of the crop.

3. Observation for Pod damage analysis

Pod damage percentage will be calculated using the following formula

$$\% \text{ pod damage} = \frac{\text{No. of affected pods}}{\text{Total no. of pods}} X\ 100$$

4. Application of spray solution

Spray solution was applied with the help of hand compression sprayer. Spraying was done at dawn and desk time and their must not be much during wind currents.

5. Results

Table 1: Effect of integrated approaches in percent pod damage infestation of Gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea after first spray.

Treatments		Before spray	Percentage pod damage			
			3DAS	7 DAS	14 DAS	Mean
T_1	*Bacillus thuringiensis*	5.60 (13.67)	4.40 (12.04)	3.33 (10.50)	3.13 (10.17)	3.62 (10.93)
T_2	HaNPV	5.53 (13.57)	3.33 (10.36)	2.86 (9.72)	2.26 (8.63)	2.81 (9.63)
T_3	NSKE	5.66 (13.75)	4.86 (12.74)	3.46 (10.68)	3.20 (10.25)	3.84 (11.25)
T_4	Chickpea+Coriander	6.06 (14.23)	4.86 (12.74)	3.73 (11.10)	3.60 (10.89)	4.06 (11.60)
T_5	Handpicking+*Bt*	5.46 (13.48)	3.33 (10.36)	2.73 (9.49)	2.26 (8.60)	2.77 (9.55)
T_6	Weeding+handpicking+Indoxacarb	4.76 (12.37)	2.80 (9.60)	2.40 (8.89)	2.00 (8.06)	2.40 (8.89)
T_7	I-WANT(Indoxacarb)	5.43 (13.46)	2.86 (9.73)	2.73 (9.43)	2.00 (8.10)	2.53 (9.12)
T_0	Control	3.40 (10.55)	5.33 (13.30)	5.86 (13.98)	6.13 (14.33)	5.77 (13.89)
F- Test		NS	S	S	S	S
S.Ed($\pm$)		_	0.50	0.54	0.54	0.48
C.D.(P=0.05)		_	1.09	1.19	0.97	0.72

Table 2: Effect of different integrated approaches in percent pod damage of gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea after second spray.

Treatments		Before spray	Percentage pod damage			
			3DAS	7 DAS	14 DAS	Mean
T_1	*Bacillus thuringiensis*	5.46 (13.48)	2.00 (8.12)	1.66 (7.32)	1.30 (6.48)	1.65 (7.35)
T_2	HaNPV	5.53 (13.59)	1.86 (7.83)	1.63 (7.30)	1.20 (6.27)	1.56 (7.15)
T_3	NSKE	5.46 (8.25)	2.26 (8.62)	1.83 (7.76)	1.76 (7.61)	1.95 (8.01)
T_4	Chickpea+Coriander	6.73 (15.03)	2.33 (8.78)	1.96 (8.05)	1.86 (7.85)	2.05 (8.22)
T_5	Handpicking+*Bt*	5.46 (13.49)	1.73 (7.54)	1.46 (6.90)	1.20 (6.27)	1.46 (6.92)
T_6	Weeding+handpicking+Indoxacarb	6.06 (14.23)	1.33 (6.60)	1.13 (6.07)	0.93 (5.53)	1.13 (6.08)
T_7	I-WANT(Indoxacarb)	4.76 (12.37)	1.86 (7.83)	1.43 (6.78)	1.00 (5.71)	1.43 (6.81)
T_0	Control	6.33 (14.56)	6.40 (14.8)	6.66 (15.17)	7.13 (15.77)	6.73 (15.03)
F- Test		NS	S	S	S	S
S.Ed($\pm$)		_	0.22	0.39	0.26	0.2
C.D.(P=0.05)		_	0.51	0.84	0.56	0.60

Table 3: Effect of different integrated approaches in percent pod damage of Gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea after first and second spray.

Treatments		Mean (first spray)	Mean (second spray)	Over all mean
T_1	*Bacillus thuringiensis*	3.62	1.65	2.63
T_2	HaNPV	2.81	1.56	2.18
T_3	NSKE	3.84	1.95	2.89
T_4	Chickpea+Coriander	4.06	2.05	3.05
T_5	Handpicking+*Bt*	2.77	1.46	2.11
T_6	Weeding+handpicking+Indoxacarb	2.40	1.13	1.76
T_7	I-WANT(Indoxacarb)	2.53	1.43	1.98
T_0	Control	5.77	6.73	6.25
F- test		S	S	S
S.Ed ($\pm$)		0.34	0.2	0.54
C.D.(P=0.05)		0.72	0.60	1.60

6. Over all mean of the gram pod borer in percent pod damage after first and second spray

The various integrated treatments in Table.3 significantly reduced the pod borer infestation. Among all the treatments evaluated Weeding + Hand picking + Bt found effective which recorded the lowest percent infestation of pod borer (1.76) of 3, 7, 14 days after first and second spraying and then Indoxacarb (1.92). Followed by Hand picking + *Bt*, HaNPV, *Bacillus thuringiensis*, NSKE, Chickpea+ coriander recording (2.11), (2.17), (2.73), (2.79), (3.18) percent infestation. The treatments T6 and T7 at par with each other. Treatments T5, T2, T1, T3 at par with each other.

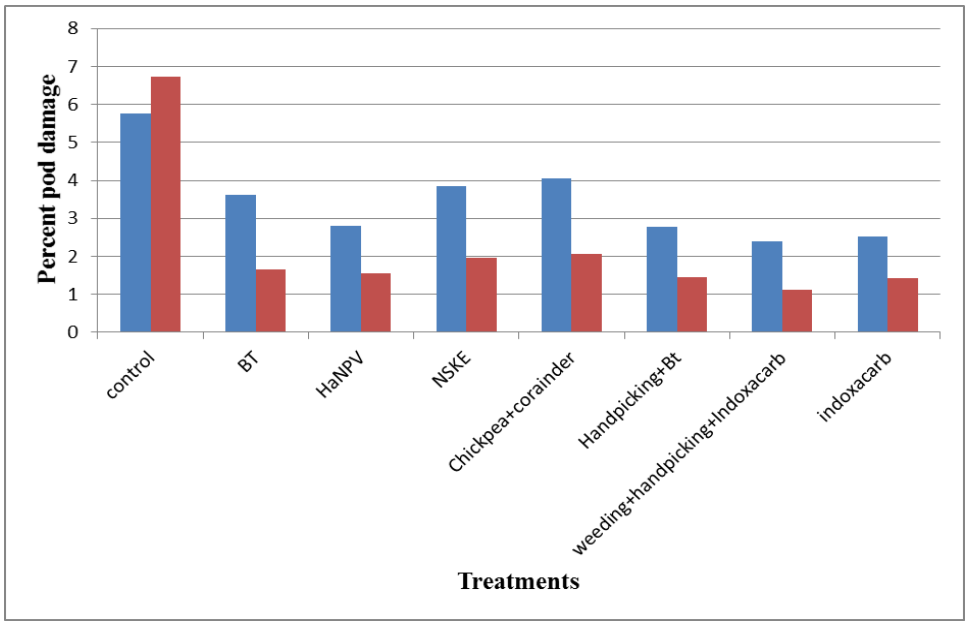

Fig 1: Effect of different integrated approaches in percent pod damage of Gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea after first and second spray**.**

7. Discussion

Hand picking in combination with *Bacillus thuringiensis*, and weeding+hand picking, also controlled the larval population significantly, but was inferior to the above treatments. It was concluded on the basis of the cost-benefit ratio that handpicking was the most cost effective method for the control of *H. armigera*, while the maximum increase in grain yield was obtained in plots with weeding, hand picking, and Indoxacarb [7].

The chemicals, cypermethrin + *Bt* var *kurstaki*, cypermethrin, deltamethrin + *Bt* var *kurstaki* and *Bt* var *kurstaki* were found significantly superior over rest of the treatments and insecticides in combination with *Bt* var *kurstaki* were found highly effective in increase in grain yield and in reducing larval population and pod borer damage [8].

Among the various botanical treatment Neem Seed Kernel Extract (NSKE) and NSKE+BLE (Birbira Leaves Extract) was effective at 2.5% concentration with minimum pod damage [9].

Neem Seed Kernel Extract (NSKE 5 %) was found most effective in reducing the larval population and pod damage [10].

Among various treatments highest benefit cost ratio (1:3:0) was obtained in plots treated with IPM. The effect of various IPM components individually or as package to evolve the best alternate to chemical control of the chickpea pod borer were discussed [11]

8. Conclusion

The treatment weeding + hand picking +Indoxacarb was found most effective in controlling *Helicoverpa armigera* larval population to reduce the pod infestation as it has the low toxicity to non target organisms in environment as compared to the other group of chemicals and also produce the maximum grain yield.

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