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Khorasiya SG
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Raghvani KL
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Bharadiya AM
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Jethva DM
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Bhut JB
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
Khorasiya SG
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Efficacy of bio-pesticides, insecticides alone and their combination against pod damage caused by *Helicoverpa armigera* in chickpea

Khorasiya SG, Raghvani KL, Bharadiya AM, Jethva DM and Bhut JB

Abstract
A field experiment was conducted during Rabi season of 2011-12 and 2012-13 at instructional farm, Junagadh Agricultural University, Junagadh to find out efficacy of bio-pesticides, insecticides alone and their combination against pod damage caused by *Helicoverpa armigera* in chickpea. Among the bio-pesticides *Ha*NPV@ 250 LE ha^{-1} was found most effective against *H. armigera* which recorded significantly lowest per cent pod damage at harvest (15.25 %) and registered the highest grain yield (1264 kg ha^{-1}). *Bacillus thuringiensis* @1.0 kg ha^{-1} was also found equally effective against *H. armigera*. In case of insecticides, chlorantraniliprole 0.006 per cent found most effective, which recorded significantly the least per cent pod damage (13.78 %) with highest grain yield (1383 kg ha^{-1}). In combination of insecticides and bio-pesticides *Ha*NPV 125 LE ha^{-1} with chlorantraniliprole 0.003 per cent found significantly most effective. The highest ICBR *i.e.* 10.19 was observed in *Ha*NPV @ 250 LE/ha which was followed by *Ha*NPV @ 125 LE ha^{-1} + chlorantraniliprole 0.003 per cent (8.06).

Keywords: *Ha*NPV, *B. thuringiensis,* Chlorantraniliprole, *H. armigera*, Chickpea

Introduction

Chickpea (*Cicer arielinum* Linn.) is also known as bengal gram, gram, chana, garbanzo etc. and is one of the important pulse crop of India [5]. India accounts for 68 % of total global output of chickpea and incidentally it is one of the largest consumers. Chickpea is grown in about 8.68 million hectare in India with tentative production of 5.35 million tonnes. In 2010-11, the estimated production was about 8.25 MT, a record in the last 50 year. Four states *viz*, Madhya- Pradesh, Uttar- Pradesh, Maharashtra and Rajasthan together contribute about 87% of production from area. In Gujarat, area under chickpea has been reported 2.39 lakh hectares with total production of 2.73 lakh tones and productivity of 1139 kg/ha during rabi 2011-12 [8]. The productivity of chickpea crop has not witnessed any significant jump as compared to the cereal crops, because of several biotic and abiotic constraints. Among the many biotic factors responsible for low yield, damage due to insect pests is the major limiting factor [4]. Chickpea crop is attacked by nearly 57 species of insect and other arthropods in India [12]. Among them, pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is most important and accounts for about 90 to 95 % of the total damage caused by all the insect pests [16]. This pests is popularly known as "gram pod borer", while in the U.S.A., it is called "bollworm" or "American bollworm" or "Corn worm". Synonyms of gram pod borer *Heliothis armigera* (Hubner) reported by Singh *et.al*. [19] are as *Heliothis obsoleta* Fabricius, *Helicoverpa armigera* (Hubner), *Chloridae armigera* (Hubner) and *Chloridae obsoleta* Fabricius. It has been reported 3.6 - 72.8 per cent pod damage in chickpea [14].

Chickpea is one of the major pulse crops in India and widely grown in Saurashtra region of Gujarat State. This crop is attacked by *H. armigera* which causes the economic damage. Due to the development of resistance toward the commonly used insecticides, this pest has created a serious threat to the agricultural industry in the recent years and has resulted in lack of confidence in insecticides for the control of the pest. It is necessary to develop IPM module which helps to manage the population of *H. armigera* below ETL and conserve the bio-agent and also helps in reducing the environmental pollution. Looking to the present scenario, hence effort was made to know the role of use of bio-pesticides against gram pod borer alone and in combination with newer insecticides, definatly provides some useful information which will help in the reducing insecticidal pollution and conserving bio-control agents.

2. Materials and Methods

2.1. Experimental details

With a view to find out the field efficacy of bio-pesticides alone and in combination with newer insecticides against *H. armigera* on chickpea, a field experiment was conducted in randomized block design (factorial) with three replication at Instructional Farm, Junagadh Agricultural University, Junagadh during two consecutive year *kharif* 2011-12 and *kharif* 2012-13. All the recommended agronomical practices were followed to raise good crop.

Table 1: Treatment combinations of bio-pesticides and insecticides

Sr. No.	Treatment Combination	Treatment combination details
1	$B_0 + I_0$	Untreated control
2	$B_0 + I_1$	Untreated control + Flubendiamide 480 SC @ 0.007%
3	$B_0 + I_2$	Untreated control + Chlorantraniliprole 20 SC @ 0.006%
4	$B_1 + I_0$	*B. thuringiensis* @ 1.0 kg/ha + Untreated control
5	$B_1 + I_1$	*B. thuringiensis* @ 0.5 kg/ha + Flubendiamide 480 SC @ 0.0035%
6	$B_1 + I_2$	*B. thuringiensis* @ 0.5 kg/ha + Untreated control
7	$B_2 + I_0$	*Ha*NPV @ 250 LE/ha + Untreated control
8	$B_2 + I_1$	*Ha*NPV @ 125 LE/ha + Flubendiamide 480 SC @ 0.0035%
9	$B_2 + I_2$	*Ha*NPV @ 125 LE/ha + Chlorantraniliprole 20 SC @ 0.003%
10	$B_3 + I_0$	*B. bassiana* @ 2.0 kg/ha + Untreated control
11	$B_3 + I_1$	*B. bassiana* @ 1.0 kg/ha + Flubendiamide 480 SC @ 0.0035%
12	$B_3 + I_2$	*B. bassiana* @ 1.0 kg/ha + Chlorantraniliprole 20 SC @ 0.003%

Where,

Bio-pesticides: 1) B_0 Untreated, 2) B_1 *Bacillus thuringiensis* @ 1.0 kg/ha, 3) B_2 *Ha*NPV @ 250 LE/ha, 4) B_3 *Beauveria bassiana* @ 2.0 kg/ha (2 x 10^8)

Insecticides: 1) I_0 Untreated, 2) I_1 Flubendiamide 480 SC @ 0.007%, 3) I_2 Chlorantraniliprole 20 SC @ 0.006

2.2 Application of treatments

All the recommended agronomical practices were followed. Two sprays of bio-pesticides / insecticides at mentioned doses were applied, first at 50 per cent flowering stage and second at 50 per cent pod formation stage. When bio-pesticides and insecticides were used in combination then half dose of bio-pesticides and insecticides was taken. The pesticide was applied by using knapsack sprayer during evening hours. Care was taken to rinse the sprayer thoroughly before and after each spray with soap water to avoid the residue of previous treatment.

2.3 Method of observations

Per cent pod damage

At the time of maturity the pods of five plant were plucked and observations on number of healthy and damaged pods from each treatment was recorded separately and per cent pod damage was work out and then statistical analysis was done.

$$\text{Per cent pod damage} = \frac{\text{number of damage pods}}{\text{Total number of pods}} \times 100$$

2.4 Yield and Economics

The grain yield obtained from each treatment was converted on hectare basis and subjected to statistical analysis. The per cent increase in yield over control was calculated by using following formula:

$$\text{Yield increase over control} = \frac{\text{T - C}}{\text{C}} \text{ X } 100$$

Where,

T = Yield of respective treatment (kg/ha)

C = Yield of control (kg/ha)

The economics of all the treatments was worked out by considering current market price of chickpea grains, cost of insecticides and labourer charges. Incremental Cost benefit ratio (ICBR) was worked out to compare the economics of insecticidal treatments by using following formula.

$$\text{Incremental Cost: benefit ratio (ICBR)} = \frac{\text{Net realization (Rs./ha)}}{\text{Total cost of Insecticides or Bio-pesticides (Rs./ha)}}$$

2.5 Statistical analysis

Data on aspect carried out in experiment was tabulated, analyzed statistically by standard procedure given by Steel and Torrie [21].

3. Results and Discussion

3.1. Per cent pod damage in chickpea

The pool data on per cent pod damage presented in Table 2 showed that all the treatments were found significantly superior in reducing per cent pod damage caused by *H. armigera* than untreated control. In case of different bio-pesticides, *Ha*NPV @ 250 LE/ha registered significantly the lowest pod damage *i.e.* 15.25 per cent which was found at par with *B. thuringeinsis* @ 1.0 kg/ha (17.58%). While the treatment of *B. bassiana* @ 2.0 kg/ha (20.95%) and untreated control (25.18%) were found least effective in reduction in pod damages caused by *H. armigera.*

So far as the pooled results of insecticides are concern, both the insecticides were found significantly superior in reducing pod damage over the untreated control. The treatment of chlorantraniliprole 0.006 per cent and flubendiamide 0.007 per cent found statistically equally effective which registered 13.78 and 15.30 per cent pod damage, respectively.

The pooled data of both year on per cent pod damage presented in Table 2 indicated that all the combinations of bio-pesticides with insecticides was found significantly superior over untreated control. The best treatment combinations were (B_0I_2) chlorantraniliprole 0.006 per cent alone was found to be the most effective in reducing per cent pod damages which registered 9.82 per cent. However, it was found at par with (B_0I_1) flubendiamide 0.007 per cent alone (12.13 %) and (B_2I_2) *Ha*NPV @ 125 LE/ha + chlorantraniliprole 0.003 per cent (12.94%). The next best treatment combination were (B_2I_1) *Ha*NPV @ 125 LE/ ha + flubendiamide 0.0035 per cent, (B_1I_2) *B. thuringiensis* @ 0.5 kg/ha+ chlorantraniliprole 0.003 per cent, (B_1I_1) *B.*

thuringiensis @ 0.5 kg/ha + flubendiamide 0.0035 per cent, (B_3I_2) *B. bassiana* @ 1.0 kg/ha + chlorantraniliprole 0.003 per cent which registered 14.16, 15.10, 16.26 and 17.78 per cent pod damage, respectively. Looking to the overall efficacy of various bio pesticides against *H. armigera* in chickpea, *Ha*NPV @ 250 LE/ha followed by *B. thuringeinsis* @1.0 kg/ha were found most effective against *H. armigera*. Similar result was observed by Kumar and Prasad [10], Ujagir and Masood [22], Mandal *et al.* [13], Ahmad and Chandel [1], Siddegowda and Yelshetty [18], Yadav *et al.* [25] and Rijal *et al.* [15].

In case of insecticides, comparatively lower per cent pod damage due to *H. armigera* was noticed in the treatment of chlorantraniliprole 0.006 per cent and flubendiamide 0.007 per cent. Kumar and Shivaraju [11], Deshmukh, *et al*. [6], Babar *et al*. [3], Dey *et al.* [7], Satpute and Barkhade [17]. Sreekanth *et al.* [20] reported same trends of effectiveness of chlorantraniliprole 0.006 per cent and flubendiamide 0.007 per cent against *H. armigera* in chickpea.

3.2 Grain yield

Pooled data of grain yield of both year are presented in Table 3 indicated that all the bio-pesticides and insecticides gave significantly higher yield of chickpea as compared to control. Among the various bio-pesticides, *Ha*NPV @ 250 LE/ha recorded the highest grain yield of chickpea *i.e.* 1264 kg/ha which was found statistically at par with *B. thuringiensis* @ 1.0 kg/ha (1231 kg/ha). So, far as the yield recorded in insecticidal treatments is concerned (Table 3) chlorantraniliprole 0.006 per cent recorded the highest yield *i.e.* 1309 kg/ha which was found statistically at par with flubendiamide 0.007 per cent (1254 kg/ha).

The difference in yield recorded in various combinations of bio-pesticide and insecticide was found statistically significant, However, treatment combination of (B_0I_2) chlorantraniliprole 0.006 per cent alone recorded the highest yield 1383 kg/ha which was statistically at par with (B_2I_2) *Ha*NPV @ 125 LE/ha + chlorantraniliprole 0.003 per cent, (B_1I_2) *B. thuringiensis* @ 0.5 kg/ha + chlorantraniliprole 0.003 per cent, (B_0I_1) flubendiamide 0.007 per cent alone, (B_2I_1) *Ha*NPV @ 125 LE/ha + chlorantraniliprole 0.003 per cent and (B_1I_1) *B. thuringiensis* @ 0.5kg/ha + chlorantraniliprole 0.003 per cent which recorded 1350, 1333, 1300, 1267 and 1250 kg/ha, respectively.

Thus, looking to the yield data recorded in various treatment of bio-pesticides, the highest grain yield was recorded in the treatment of *Ha*NPV @ 250 LE/ha which was at par with the *B. thuringiensis* @ 1.0 kg /ha. Siddegowda and Yelshetty [18] recorded the highest grain yield of chickpea *i.e.* 10.36 q/ha from plots treated with *Ha*NPV followed by *B. thuringiensis* var. kenyae (9.40 q/ha) and Halt (8.70 q/ha). Ahmad *et al.* [2] found that two application of *Ha*NPV either alone or *Ha*NPV followed by insecticidal spray was found effective against *H. armigera* infesting chickpea which also recorded significantly higher grain yield.

In case of insecticides, the highest grain yield was recorded in the treatment of chlorantraniliprole 0.006 per cent and flubendiamide 0.007 per cent. More or less similar trends were noticed by Sreekanth *et al.* [20] showed that the highest grain yield was recorded in chlorantraniliprole treated plots (686 kg/ha) with 127 percent increase over control, followed by flubendiamide (595 kg/ha) in chickpea. Thus, the present findings of investigations are in close agreement with earlier research workers.

3.3 Economics of the treatments

The economics of various treatments was worked out on the basis of current market price of chickpea and management cost which includes price of insecticides and labour charges and finally ICBR value for each treatment was worked out and summarized in Table 4.

It is evident from the data presented in Table 4 that the net realization of different bio-pesticidal treatments varied from 35 to 2882 Rs./ha. The treatment of *Ha*NPV @ 250 LE/ha recorded maximum net realization *i.e.* 2882 Rs./ha, followed by *B. thuringiensis* @ 1.0 kg/ha (2049 Rs./ha) and *B. bassiana* @ 2.0 kg/ha (35 Rs./ha). Among the insecticidal treatments, chlorantraniliprole 0.006 per cent registered maximum realization *i.e.* 6953 Rs./ha followed by Flubendiamide 0.007 per cent (5573 Rs./ha).

The ICBR of different treatments were worked out (Table 4). Among different biopesticidal treatments the highest ICBR *i.e.* 1:4.57 recorded in the treatment of *Ha*NPV @ 250 LE/ha followed by *B. thuringiensis* @ 1.0 kg/ha (1:0.696). In case of insecticidal treatments the highest ICBR was noticed in the treatment of chlorantraniliprole 0.006 per cent (1:2.78) followed by flubendiamide 0.007 per cent (1:1.68). The ICBR of different treatment combinations were worked out (Table 26). Among different treatment combinations the highest ICBR *i.e.* 1:10.19 was observed in (B_2I_0) *Ha*NPV @ 250 LE/ha which was followed by (B_2I_1) *Ha*NPV @ 125 LE/ha + chlorantraniliprole 0.003 per cent (1: 8.06).

Looking to the results of net realization and ICBR values found in different treatments indicated that the treatment of *Ha*NPV @ 250 LE/ha was found to be most economical bio pesticides, which registered maximum net realization of 2882 Rs./ha and highest ICBR *i.e.* 1:4.57. However, remaining bio-pesticidal treatments were found moderately effective. Vaisalakshmi [23] evaluated the effect of various integrated pest management (IPM) components against *H. armigera* and reported that among various IPM components, *Ha*NPV was found as effective as endosulfan in reducing pod damage in chickpea and also recorded the highest cost benefit ratio (1:7.01).

Among different bio-pesticides and insecticides, chlorantraniliprole 0.006 per cent alone recorded the maximum net return *i.e.* 6953 Rs./ha which was followed by flubendiamide 0.007 per cent alone (5572Rs./ha) but the incremental cost benefit ratio of chlorantraniliprole 0.006 per cent (1:2.78) was found low as compare to *Ha*NPV @ 250 LE/ha. *i.e.* 1:4.57, which may be due to high cost of insecticides.

Dodia *et al*., [9] have reported that maximum monitory return was gained in flubendiamide (ICBR=1:4.56), Deshmukh *et al*. [6] revealed that the highest yield was recorded in the treatment of flubendiamide 0.007 per cent (1850 kg/ha) with the highest cost benefit ratio (1:6.10). Wadaskar [24] noticed that flubendiamide 20 WDG @ 0.5 g/l was found most effective in monetary returns (14,657 Rs./ ha) and highest incremental cost benefit ratio (ICBR)1:6.8. Babar *et al*. [3] and Sreekanth *et al.* [20] showed that the cost effectiveness of chlorantraniliprole and flubendiamide was also high and very favorable with incremental cost-benefit ratios. Thus, present finding are collaborate the results reported by the earlier workers.

Table 2: Effect of bio pesticide and insecticides in reducing pod damage caused by *H. armigera* in chickpea.

Trat. No.	Treatments	Per cent pod damage		
		2011-12	2012-13	Pooled
B_0	Untreated control	30.80* (26.22)	29.44 (24.16)	30.12 (25.18)
B_1	*B. thuringiensis* @ 1.0 kg/ha	25.09 (17.98)	24.49 (17.18)	24.79 (17.58)
B_2	HaNPV @ 250 LE/ha	23.14 (15.44)	22.84 (15.06)	22.99 (15.25)
B_3	*B. bassiana* @ 2.0 kg/ha	27.18 (20.86)	27.30 (21.03)	27.24 (20.95)
	S.Em.±	1.03	0.90	0.68
	C.D. at 5%	3.02	2.64	1.95
I_0	Untreated control	34.43 (31.97)	33.64 (30.69)	34.04 (31.33)
I_1	Flubendiamide 480 SC @ 0.007%	23.40 (15.78)	22.65 (14.83)	23.03 (15.30)
I_2	C 20 SC @ 0.006 %	21.82 (13.81)	21.76 (13.74)	21.79 (13.78)
	S.Em.±	0.89	0.78	0.59
	C.D. at 5%	2.62	2.28	1.69
BxI	S.Em.±	1.79	1.56	1.18
	C.D. at 5%	5.24	4.57	3.38
	C.V.%	11.65	10.37	11.04
Year	S.Em.±			0.48
	C.D. at 5 %			NS
YxB	S.Em.±			0.97
	C.D. at 5 %			NS
YxI	S.Em.±			0.84
	C.D. at 5 %			NS
YxBxI	S.Em.±			1.68
	C.D. at 5 %			NS
Interaction between bio-pesticides and insecticides				
Sr. No.	**Treatments Combination**	**Per cent pod damage**		
		2011-12	**2012-13**	**Pooled**
1	B_0 I_0	53.20* (64.12)	50.24 (59.09)	51.72 (61.62)
2	B_0 I_1	21.11 (12.97)	19.66 (11.32)	20.38 (12.13)
3	B_0 I_2	18.09 (9.65)	18.42 (9.99)	18.26 (9.82)
4	B_1 I_0	27.93 (21.94)	27.52 (21.35)	27.72 (21.64)
5	B_1 I_1	24.33 (16.98)	23.23 (15.56)	23.78 (16.26)
6	B_1 I_2	23.01 (15.28)	22.72 (14.92)	22.86 (15.10)
7	B_2 I_0	26.04 (19.27)	25.50 (18.54)	25.77 (18.90)
8	B_2 I_1	22.27 (14.36)	21.95 (13.97)	22.11 (14.16)
9	B_2 I_2	21.11 (12.97)	21.06 (12.92)	21.09 (12.94)
10	B_3 I_0	30.56 (25.85)	31.30 (27.00)	30.93 (26.42)
11	B_3 I_1	25.90 (19.09)	25.77 (18.91)	25.84 (19.00)
12	B_3 I_2	25.06 (17.95)	24.82 (17.62)	24.94 (17.78)
*Arcsin transformation. Figures in parentheses are retransformed values.				

Table 3: Grain yield and per cent increase in yield over control in chickpea

Trat. No.	Treatments	Grain yield (kg/ha)			Per cent increase in yield over control (%)
		2011-12	2012-13	Pooled	
B0	Untreated control	1144	1153	1149	--
B1	*B. thuringiensis*@ 1.0 kg /ha	1228	1233	1231	7.13
B2	*Ha*NPV@250 LE/ha	1261	1267	1264	10.04
B3	*B. bassiana*@ 2.0 kg/ha	1145	1156	1150	0.12
	S.Em.±	33.57	32.38	23.32	--
	C.D. at 5%	98.47	94.97	66.47	--
I0	Untreated control	1012	1050	1031	--
I1	Flubendiamide 480 SC 0.007%	1254	1254	1254	21.62
I2	Chlorantraniliprole 20 SC 0.006 %	1317	1302	1309	26.97
	S.Em.±	29.08	28.04	20.20	--
	C.D. at 5%	85.28	82.25	57.57	--
BxI	S.Em.±	58.15	56.08	40.40	--
	C.D. at 5%	170.56	164.49	115.13	--
	C.V.%	8.43	8.08	8.26	--
Year	S.Em.±			16.49	--
	C.D. at 5 %			NS	--
YxB	S.Em.±			32.98	--
	C.D. at 5 %			NS	--
YxI	S.Em.±			28.56	--
	C.D. at 5 %			NS	--
YxBxI	S.Em.±			57.13	--
	C.D. at 5 %			NS	--
Interaction of bio-pesticides and insecticides					

Sr. No.	Treatments Combination	Grain yield (kg/ha)		
		2011-12	2012-13	Pooled
1	B_0 I_0	750.00	817	783
2	B_0 I_1	1300	1267	1283
3	B_0 I_2	1383	1375	1379
4	B_1 I_0	1100	1133	1117
5	B_1 I_1	1250	1267	1258
6	B_1 I_2	1333	1300	1317
7	B_2 I_0	1166	1183	1175
8	B_2 I_1	1266	1283	1275
9	B_2 I_2	1350	1333	1341
10	B_3 I_0	1033	1067	1050
11	B_3 I_1	1200	1200	1200
12	B_3 I_2	1200	1200	1200

Table 4: Economics of biopesticidal and insecticidal treatments for the control of *H. armigera* infesting chickpea.

Treat. No.	Treatments	No. of spray	Total quantity of insecticides (Lit. or kg. /ha.)	Price of insecticides (Rs./ lit. or kg.)	Cost of insecticides (Rs./ha)	Labour charges (Rs./ha.)	Cost of treatments (Rs./ha.)	Yield (kg/ha)	Gross realization (Rs./ha.)	Net realization (Rs./ha.)	ICBR
B0	Untreated control	-	-	-	-	-	-	1149	28715	-	-
B1	*B. thuringiensis* @ 1 kg/ha	2	2	1320	2640	300	2940	1231	30764	2049	1:0.70
B2	HaNPV @ 250 LE/ha	2	500 LE	165	330	300	630	1264	31597	2882	1:4.57
B3	*B. bassiana* @ 2 kg/ha	2	4	150	600	300	900	1150	28750	35	1:0.04
I0	Untreated control	-	-	-	-	-	-	1031	25781	-	-
I1	Flubendiamide 480 SC @ 0.007%	2	0.2	15000	3000	300	3300	1254	31354	5573	1:1.69
I2	Chlorantraniliprole 20 SC 0.006 %	2	0.2	11000	2200	300	2500	1309	32734	6954	1:2.78

Labour charges Rs. 150 Rs/ day
Current market price of chickpea = Rs. 25/kg
Continue……

Interaction of bio-pesticides and insecticides										
Treat. combination	No. of spray	Total quantity of insecticides (Lit. or kg. /ha.)	Price of insecticides (Rs./ lit. or kg.)	Cost of insecticides (Rs./ha)	Labour charges (Rs./ha.)	Cost of treatments (Rs./ha.)	Yield (kg/ha)	Gross realization (Rs./ha.)	Net realization (Rs./ha.)	ICBR
B_0 I_0	-	-	-	-	-	-	784	19583	-	-
B_0 I_1	2	0.2	15000	3000	300	3300	1283	32083	12500	1:3.78
B_0 I_2	2	0.2	11000	2200	300	2500	1379	34479	14896	1:5.95
B_1 I_0	2	2	1320	2640	300	2940	1117	27916	8333	1:2.83
B_1 I_1	2	1+0.1	2820	2820	300	3120	1258	31458	11875	1:3.80
B_1 I_2	2	1+0.1	2420	2420	300	2720	1317	32916	13333	1:4.90
B_2 I_0	2	500LE	330	660	300	960	1175	29375	9792	1:10.19
B_2 I_1	2	250+0.1	330+15000	1830	300	2130	1275	31875	12292	1:5.77
B_2 I_2	2	250+0.1	330+11000	1430	300	1730	1342	33542	13959	1:8.06
B_3 I_0	2	4	220	880	300	1180	1050	26250	6667	1:5.64
B_3 I_1	2	2+0.1	220+15000	3880	300	4180	1200	30000	10417	1:2.49
B_3 I_2	2	2+0.1	220+11000	3080	300	3380	1200	30000	10417	1:3.08

4. Conclusion
Based on the present study results, it can be concluded that the treatment of *Ha*NPV @ 250 LE/ha was found to be most economical bio pesticides, which registered maximum net realization of 2882 Rs./ha and highest ICBR *i.e.* 1:4.57. Among the insecticides, chlorantraniliprole 0.006 per cent alone proved best to reduce the incidence of H. armigera and in considering the different treatment combinations *Ha*NPV @ 125 LE/ha + chlorantraniliprole 0.003 per cent was found most effective in reducing the incidence of *H. armigera* and obtained higher grain yield.

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