The Pharma Innovation Journal 2023; 12(6): 6187-6190

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 6187-6190

www.thepharmajournal.com
Received: 06-03-2023
Accepted: 16-04-2023

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Eco-friendly management of gram pod borer [*Helicoverpa armigera* (Hubner)] in Trans Yamuna region of Allahabad

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Abstract
Commenced from 6th standard week (February second week) with an average population of 0.26 larvae/plant. The pod borer population increased and gradually reached its peak level of 6.32 larvae/plant at 13th standard week (March last week) there after declined trend was observed as temperature increased. It was observed that the temperature between 25-35 ^{0}C favoured the multiplication of gram pod borer. The percent population reduction of gram pod borer *H. armigera* on third, seventh and fouteenth days after spraying revealed that all treatments are superior over control. Among the treatments cypermethrin 10EC found superior over all the treatments followed by Ha-NPV and Bt after first and second sprays, respectively. Among the plant products neem oil found superior over other plant products. Highest reduction in larval population (79.29%) was observed with cypermethrin 10EC @ 0.5 ml/lit. Minimum pod damage of 15.86%. and highest pod yield of 1720 Kg/ha was registered in cypermethrin. Highest cost benefit ratio was recorded in cypermethrin (1:2.70) followed by followed by Ha-NPV (1:1.83), Bt (costar WP) (1:1.46), Nimbicidine (1:1.29), pongamia leaf extract (1:1.27), Tobacco leaf extract (1:1.14) and NSKE (Neem seed kernal extract) (1:1.05).

Keywords: bioagents, botanicals, chickpea, cost benefit ratio, pod borer, pod damage, percent population reduction

Introduction
Chickpea (*Cicer arietinum*) is the largest produced food legume in South Asia and the third largest produced food legume globally. The world's total production of chickpea is around 8.5 million metric tonnes annually and is grown over 11million hectares of land approximately. The Desi type chickpea contribute to around 80% and the Kabuli type around 20% of the total production. Regarding the consumption pattern almost all of the chickpea is consumed in the countries where it is produced (Anonymous, 2010) [5].

Despite being the largest producer in the world, the country is in short supply of pulses. During 2004-2005 the pulses production in the country was 13.38 million tonnes from 22.47 million ha. area which is below the domestic requirements leading to import of pulses to the tune of 1.47 million tonnes (Ali and kumar, 2006) [7]. On an average in 2013, it covers 10.91 million ha. area with an annual production is 9.78 million tones and yield is 896kg per hectare (Faostat, 2013) [8].

Chickpea, *Cicer arietinum* (L.) a member of family Fabaceae, is a self pollinated crop. Pulses are important sources of protein for India's large and growing population. Gram commonly known as Chick pea or Bengal gram is the most important Rabi season pulse crop of India. In India it is also known as 'King of pulses'. It is one of the first cultivated crops and originated in south eastern turkey (Ackcin, 1988) [1]. It is grown usually as a rainfed, cool-weather crop (or) as dry climate crop in semi arid regions, with relative humidity of 21-41% as optimum for seed setting (Muehlbauer and Tullu, 1998) [9]. The pulses are known to improve the physical characteristics of the soil by their tap root system apart from fixing atmospheric nitrogen through biological fixation (Anonymous, 2003) [3]. Chickpea is the third most important grain legume in the world, after dry beans and peas.

Chickpea is a highly nutritious pulse and is placed third in the important list of food legumes that are cultivated throughout the world. It contains 21.1% proteins, which is the maximum provided by any pulse and 61.1% carbohydrates (Singh *et al*., 2003) [10].

Chickpea provide a rich source of soluble fibre which helps in lowering cholesterol. It is also rich in calcium, iron and niacin. The per capita availability of pulses has declined from 64 gms per day during 1950's to 27 gms per day as against the FAO/ WHO's recommendation of 80gm per capita per day (Anonymous, 2007) [4]. Major Chickpea producing states in India are Madhya Pradesh, Uttar Pradesh, Maharastra, Andhra Pradesh, Rajasthan, Gujarat and Karnataka together they contributes 93% of the production from 92% of area (Ali and Kumar, 2005) [6].

A field trial was conducted at farm of Sam Higginbottom Institute of Agriculture Technology and Science, Deemed-to-be-University, Allahabad Uttar Pradesh during Rabi season 2014-2015. Chick pea was raised by all the recommended agronomical practices except plant protection measures which enabled the build up of insect pests in a pesticide free environment. Weekly observation on the appearance and population buildup of larvae was recorded on 15 randomly selected plants. The observation was recorded at seven days interval from the time of planting to harvesting. The data on maximum and minimum temperature, relative humidity, sunshine hours, rainfall and wind velocity were collected from the unit of meteorological observatory, SHIATS-DU, Allahabad located close to the experimental site. The data were correlated with the population of pod borer.

Materials and Methods

Studies on the "Eco-friendly management of gram pod borer [*Helicoverpa armigera* (Hubner)] in trans yamuna region of Allahabad" in Allahabad region at field condition was carried out during *rabi* season November 2014 to April 2015 at Agricultural Research Farm, Sam Higginbottom Institute of Agriculture, Technology & Science (Deemed University), Allahabad, Uttar Pradesh, India.

This investigation was carried out on "PUSA-362" a Chickpea variety. All the recommended agronomic practices were followed to raise the crop. Before sowing the field was thoroughly ploughed and pulverized with tractor drawn cultivator to attain desirable tilt. Levelling and formation of plots were done manually. For chickpea, a basal dose of 15 kg N, 50 kg p_2o_5 and 30 kg sulphur should be applied in furrows before sowing. A seed rate of 80 kg/ha was used to raise the crop. Sowing was done with 30cm x 15 cm spacing in a plot size of 2.0 x 2.0 m. First irrigation was given immediately after sowing and subsequent irrigations were given at 15 days interval and three weeding's were done at 30 days interval. The crop was harvested after 120 days and yield per plot was recorded and converted to q/ha. The experiments were laid out in randomized block design (RBD) with three replications. The treatments were randomly allotted in each block. The unit plot size was 2m x 2m with a plot bund/distance of 0.30m between the plots and 0.50m sub-irrigation channel between the replications. The seeds of PUSA 362 of chickpea were sown in rows with the spacing of 30cm. The populations of the plants were maintained constant by keeping plant to plant distance of 15 cm. At maturity, all the pods were collected from 5 randomly selected plants from middle rows of each plot and examined. The Pre-Treatment Population in control and After Treatment Population of pods were counted and the percent Population reduction In over control was determined using the following formula:

$$\% \text{ PR in OC} = \frac{\text{PTP in control} - \text{ATP}}{\text{PTP in control}} X100$$

Where,
PTP = Pre-Treatment Population
ATP = After Treatment Population
PR = Population Reduction
OC = Over Control

The percentage population reduction values were duly transformed in to the corresponding angular value and were subjected to analysis of variance. Critical difference (C.D) was applied for comparing treatment means**.**

The value of C: B of different treatments will be calculated by following formula.

$$\text{C: B} = \frac{\text{Net returns}}{\text{Cost of treatment}}$$

Where,
C: B = Cost Benefit Ratio

Results and Discussion

Efficacy of certain botanicals and chemical insecticides

The results obtained on average percent reduction of *Helicoverpa armigera* (Hubner) on pods for evaluating each treatment for pod borer management have been described thoroughly in earlier under results. The results so obtained have been discussed as under All the treatments were found to be significantly superior over control. Cypermethrin was more effective in percentage damage reduction of pods with 77.53% reduction over control. Singh *et al.,* (2008) reported that cypermethrin gave the highest percentage of reduction of pod and seed damage and its results are supported by Wakil *et al.,* (2008) [12] and Ha-NPV was found to be next effective treatment (64.17%). Ahmad *et al.,* (2004) [2] reported that Ha-NPV proved to be the best after cypermethrin in reducing number of larvae on the basis of pre-spray data and its results are supported by Sidde gowda and Yelshetty (2007) [11]. cypermethrin effective insecticide in preventing the infestation by *H. armigera* on chickpea reported the highest effec-tiveness of cypermethrin against chickpea pod borer.

Percent reduction of larval population

Table 1: 1st spray and 2nd spray Mean

Treatment No.	Treatment	% Reduction over control		
		1st spray Mean	2nd spray Mean	Over all Mean
T_1	*Bacillus thurengiensis*	62.15 (52.04)*	63.97 (53.12)*	63.06 (52.57)*
T_2	Ha-NPV	63.63 (52.92)*	64.72 (53.56)*	64.17 (53.23)*
T_3	Cypermethrin 10EC (control treated)	75.77 (60.52)*	79.29 (62.94)*	77.53 (61.72)*
T_4	Nimbicidine	56.75 (48.88)*	57.09 (49.07)*	56.92 (48.97)*
T_5	Tobacco Leaf Extract	39.53 (38.95)*	54.38 (47.51)*	46.95 (43.23)*
T_6	Pongamia Leaf Extract	48.56 (44.17)*	56.42 (48.68)*	52.49 (46.43)*
T_7	NSKE (Neemseed kernal extract)	38.57 (38.38)*	53.33 (46.90)*	45.95 (42.65)*
T_0	Control (untreated)	0.00	0.00	0.00
	Overall Mean	48.12	53.65	50.88
	F-Test	S	s	S
	SEd. (+)	0.818	1.007	3.602
	C.D.(P= 0.05)	1.753	2.154	10.433

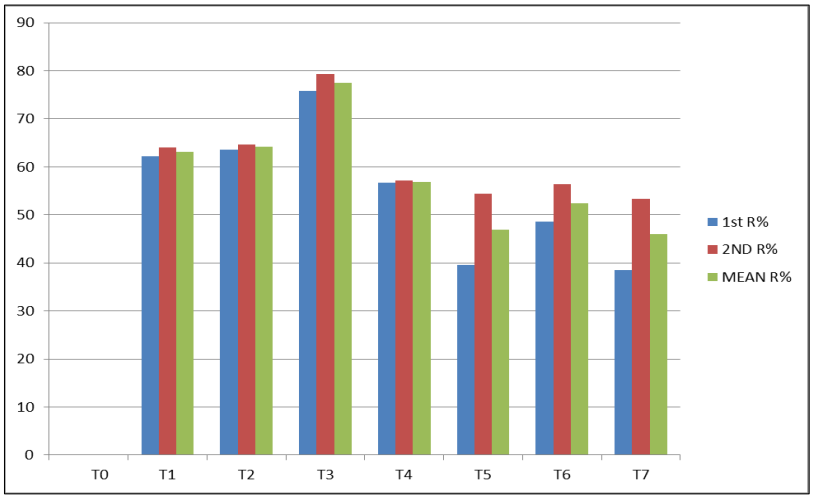

Fig 1: Percent reduction of larval population

Table 2: Efficacy of botanicals & chemical insecticides on Pod damage and Yield of chickpea (*Cicer arietinum* L.)

Treatment No.	Treatment	Pod damage (%)	% Decrease in pod damage over UTC	% Increase in yield over UTC	Yield (Kg/ha)
T_1	Bacillus thurengiensis	26.10	38.37	150.48	1290
T_2	Ha-NPV	25.00	41.31	160.19	1340
T_3	Cypermethrin 10EC (control treated)	15.86	62.76	233.98	1720
T_4	Nimbicidine	29.10	31.69	121.35	1140
T_5	Tobacco leaf extract	30.00	29.57	92.23	990
T_6	Pongamia leaf extract	29.43	30.91	118.44	1125
T_7	NSKE (Neem seed kernal extract)	31.40	26.29	65.04	850
T_0	Control (untreated)	42.60			515
	F-Test	S			
	S.Ed. (+)	0.401			
	C.D.	1.205			

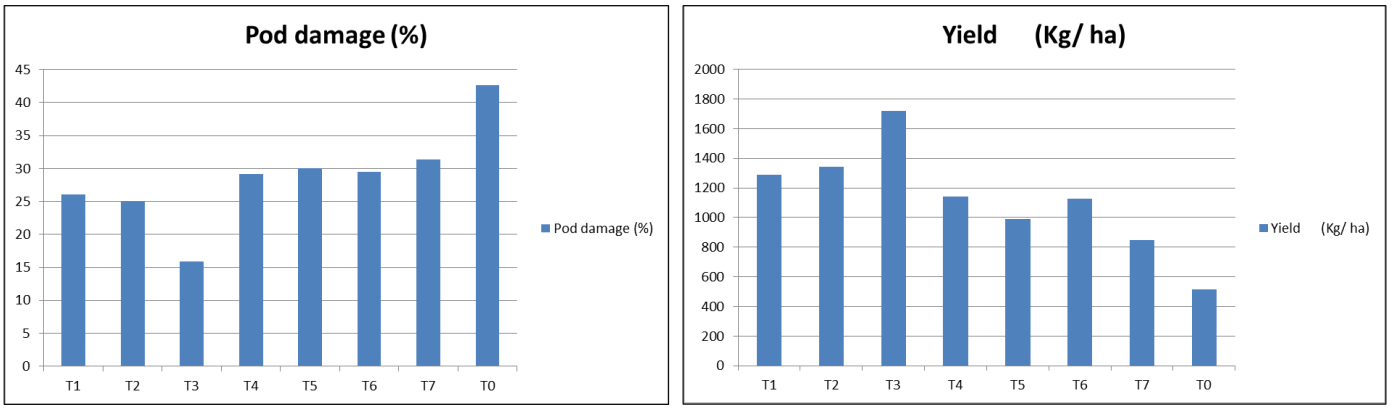

Fig 2: Efficacy of bioagents and botanicals insecticides on pod damage in (%) and Yield (Kg/ ha) of chickpea

Table 3: Economics of chickpea pod borer management using insecticides and plant products

Tr. No:	Treatment	Yield q/ha	Cost of yield	Total cost of yield	Common cost	Treat-ment cost	Total cost	Net retur-Ns	C:B ratio
T_1	Bt (costar WP)	12.90	4100 Rs/q	50345	18435	2000	20435	29910	1:1.46
T_2	Ha-NPV	13.40	4100 Rs/q	57564	18435	1850	20285	37279	1:1.83
T_3	Cypermethrin 10EC	17.20	4100 Rs/q	72580	18435	1160	19595	52985	1:2.70
T_4	Nimbicidine 0.4%	11.40	4100 Rs/q	45435	18435	1328	19763	25672	1:1.29
T_5	Tobacco leaf extract	9.90	4100 Rs/q	41645	18435	1020	19455	22190	1:1.14
T_6	Pongamia leaf extract 5%	11.25	4100 Rs/q	43560	18435	750	19185	24375	1:1.27
T_7	NSKE (Neem seed kernal extract)	8.50	4100 Rs/q	41520	18435	1800	20235	21285	1:1.05
T_0	Control	5.15	4100 Rs/q	21250	18435	.....	18435	2815	.....

Economics of various treatments

The data in respect of agronomical practices were same for all treatments *i.e*., 18435 Rs/ha. Cost benefit ratio is influenced by various treatments. Highest cost benefit ratio of 1:2.70 was recorded in cypermethrin and proved to be effective among all the treatments. However, Ha-NPV recorded second highest C B ratio of 1:1.83 followed by Bt (1:1.46), Nimbicidine 0.4% (1:1.29), pongamia leaf extract (1:1.27), Tobacco leaf extract (1:1.14) and NSKE (Neem seed kernal extract) (1:1.05)

Summary and Conclusion

The present field study on "Eco-friendly management of gram pod borer *Helicoverpa armigera* (Hubner) in trans yamuna region of Allahabad" was carried out during *rabi* eason 2014-2015 at Agricultural Research Farm, Sam Higginbottom Institute of Agriculture, Technology & Sciences (Deemed University), Allahabad, Uttar Pradesh, India. The results are summarized below.

Two sprays revealed that cypermethrin 10EC was found to be more effective than other chemical insecticides. cypermethrin recorded the percent pod damage reduction by 77.53% followed by Ha-NPV, Bt (costar WP), Nimbicidine, pongamia leaf powder, Tobacco leaf extract and NSKE(Neem Seed kernal extract) recorded the percent pod damage reduction by, 64.17, 63.06, 56.92, 52.49, 46.95, and 45.95 percent respectively. recorded least effective among the treatments but significant and superior over control.

Cypermethrin reduce the pod damage by 62.76 followed by Ha-NPV 41.31. The highest pod yield (1720 kg/ha) was noticed in cypermethrin followed by Ha-NPV (1340kg/ha).

Maximum net returns of Rs 52985 was obtained in cypermethrin followed by Ha-NPV Rs 37279. The highest CB ratio was recorded 1:2.70 in cypermethrin followed by Ha-NPV (1:1.83), Bt (costar WP) (1:1.46), Nimbicidine (1:1.29), pongamia leaf extract (1:1.27), Tobacco leaf extract (1:1.14) and NSKE (Neemseed kernal extract) (1:1.05).

Minimum pod damage of 15.86 and higher grain yield of 1720 kg/ha was obtained from cypermethrin treated plots.reported maximum grain yield was recorded in cypermethrin with minimum pod damage and its results are supported by Wakil *et al.* (2008) [12].

From the critical analysis of the present findings it can be concluded that chickpea pod borer population increased with increasing maximum temperature 35 °C, and decreased with increasing maximum temperature above 35 °C, So that time of sowing has to planned in order to escape from peak infestation of pest. Insecticides like Ha-NPV and Bt can be suitably incorporated in integrated pest management schedule against *Helicoverpa armigera* as an effective tool for their management under biopesticide control.

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