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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 1922-1927

www.thepharmajournal.com
Received: 24-04-2023
Accepted: 29-05-2023

Aniket Kumar
Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Usha Yadav
Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Aniket Kumar
Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Efficacy of different plant products against gram pod borer [*Helicoverpa armigera* (Hubner)] on chickpea, *Cicer arietinum* (L.)

Aniket Kumar and Usha Yadav

Abstract
A field investigation was carried out in *Rabi* season of 2022-2023 at Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The experiment was laid in Randomized Block Design with eight treatments each replicated thrice. Result revealed that, among the different treatments the lowest larval population of chickpea pod borer was recorded in Profenofos 40% + Cypermethrin 4% EC @ 0.1 ml/lit (2.36). Neem oil @ 5 ml (2.65) was found as the next best treatment followed by Neem seed kernel extract 5% @ 50 ml/lit, Karanj oil @ 5 ml (2.98), *Calotropis gigantea* 5% @ 50 ml/lit (3.31), *Ageratum conyzoides* 5% @ 50 ml/lit (3.49), whereas *Lantana camera* 5% @ 50 ml/lit recorded (3.81) was found to be least effective against this pest. Among the treatments studied, Profenofos 40% + Cypermethrin 4% EC gave the highest benefit cost ratio (1:3.65) and marketing yield (21.38 q/ha) followed by Neem oil (1:3.35 and 19.27 q/ha), Neem seed kernel extract 5% (1:3.19 and 18.33 q/ha), Karanj oil (1:2.96 and 16.20 q/ha), *Calotropis gigantea* (1:2.47 and 14.16 q/ha), *Ageratum conyzoides* (1:2.41 and 13.16 q/ha), *Lantana camera* (1:2.24 and 12.77 q/ha) and lastly in untreated control (1:1.68 and 9.10 q/ha).

Keywords: Benefit cost ratio, botanicals, chickpea, efficacy, *Helicoverpa armigera*, plant extract

Introduction
Gram commonly known as a 'chickpea' or chana is a self-pollinating diploid (2n=2x=16) plant. It is originated in South-eastern Turkey and spread to other parts of the world. It is a very important pulse crop that grows as a seed of a plant named *Cicer arietinum* (L.) in the Leguminosae family (Sanjayrao, 2013) [18]. According to De Candolle, "Chanaka" which is the Sanskrit name of chickpea gives the indication of being cultivated in India from a very long duration compared to other countries in the world (Guar *et al.*, 2012) [3]. It is adapted to relatively cooler climates. The highest area under chickpea cultivation can be seen mostly in the Indian sub-continent. Chickpea is also regarded as the third most important legume crop in the world. The most important chickpea producing countries are namely India, Ethiopia, Turkey, Iran, Pakistan, Myanmar, Australia, Mexico, and Canada.

Currently, chickpea is being cultivated in about 40 countries in the world and it is a very important part of pulse cultivation in the world, contributing about 58 million tonns produced which is approximately 15 percent of the total pulse harvested all over the world. Nearly 90 percent of the total global area and 88 percent of total production is concentrated in Asia. India with the first rank in production is followed by Turkey (11%), Pakistan (8%), Iran and Syria (Kapoor *et al.*, 2010) [12].

In India it is also known as 'King of pulses' India is the largest producer with 75% of world acreage and production of gram. India produces 5.3 MT of chickpea from 6.67 million ha with an average production of 844 kg per ha. Chickpea is used for human consumption as well as for feeding to animals. Its seeds eaten as green vegetable, fried, roasted, as snack food and ground to obtain flour and dhal (Pachundkar *et al.*, 2013) [14].

It is a rich source of nutritional values in the diet of Indian people because of containing 21.5 percent protein, 64.5 percent carbohydrates and 4.5 percent fat which is comparatively deficient in the cereals and oilseeds. Its green leaves and pods are used as green vegetables and germinated grains for breakfast and other delicious dishes by the people in their daily meals (Parmar *et al.*, 2015) [15]. It contains calcium of about 190 mg/100 g, Iron 90.5 mg/100 g and Phosphorus 280 mg/100 g. Chickpea has medicinal importance as the germinated gram seeds are recommended to cure scurvy, malic and oxalic acids in green leaves are prescribed for

intestinal disorders and blood purification.

Chickpea plays an important role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140 kg N per ha from air and meet most of its nitrogen requirement (Wubneh *et al*., 2016) [20].

Various ecological factors, responsible for low yield of chickpea in India, the major insect pests attacking chickpea are pod borer, leaf feeding caterpillar, black cutworm, aphid and semiloopers are most important. (Reed *et al*., 1987) [17] listed 54 species of insect pests on chickpea of these the gram pod borer, *Helicoverpa armigera* (Hub), a pest of national importance in India, is one of the limiting factor in the successful cultivation of chickpea. Pod borer larvae feed on both foliage and pods of chickpea, yield losses are mainly due to pod damage (Lal, 1996) [10]. In India, this pest has been reported to cause 32-100% damage to pods, while yield losses has been estimated to the extent of 4.2 to 77%. A single larva of *Helicoverpa armigera* can damage up to 25-30 pods of chickpea in its life time.

Helicoverpa armigera which is considered as one of the major pests of chickpea. It alone is responsible for losses over Rs 35, 000 million annually in India despite heavy pesticide inputs. The pod borers inflicted great crop losses from seedling to maturity. But the losses reached at its peak when the pods appeared.

(Hossain *et al*., 2010) [6] reported that the seed yield losses due to *Helicoverpa armigera* were 75-90% and in some places the losses were up to 100%. It attacks more than 180 cultivated species from cereals, legumes, vegetables, fruits, forage and wild species. The chickpea crop is attacked by a number of insect- pests from seedling to its maturity. 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) [11, 13].

The insect causes most damage in terms of attacking the economical part of the plant *i.e.* the pod and hence decreases the yield of the crop drastically. The pod borer has been a significant problem with a variety of crops for its polyphagous nature. The attack of pod borer is reported on nearly 182 economically important crop plant species ranging from food to fibre crops, horticulture crops and oil seeds etc. (Gowda, 2007) [5].

Over-dependence of chemicals is one of the important reasons for quick development of resistance. Their indiscriminate use has generated number of well-known problems. However, in the year of epidemic, use of conventional insecticides fails to regulate the damage. Use of chemical pesticides has resulted in immediate high returns to farmers. However, their heavy and extensive use has created various health and environmental problems. Among the several avenues to overcome the insecticidal resistance problem, use of botanicals (plant products) is one of the important considerations for controlling pod borers on chickpea.

Bearing in mind the above facts, the present experiment was carried out to evaluate the efficacy of different plant products against gram pod borer [*Helicoverpa armigera* (Hubner)] on chickpea, *Cicer arietinum* (L.)" with the following objectives.

Objectives

1. To evaluate the efficacy of different plant-based products against gram pod borer *Helicoverpa armigera* (Hubner) larval population on chickpea (*Cicer arietinum*) (L).
2. To calculate the cost benefit ratio of treatments.

Materials and Methods

The experiment was conducted during the *Rabi* season 2022-2023 at Central Research Farm, SHUATS, Prayagraj. The trail was laid out in RBD having eight treatments and three replication. The experiment was carried out on Chickpea variety "Pusa 362" for sowing by maintaining 30 cm ×10 cm with the seed rate of 60 kg/ha in a plot size of 2 m×1 m. spraying was done at dawn. The treatment details were: Neem seed kernel extract 5% @ 50 ml/lit, Neem oil @ 5 ml, Karanj oil @ 5 ml, *Calotropis gigantea* 5% @ 50 ml/lit, *Lantana camera* 5% @ 50 ml/lit, *Ageratum conyzoides* 5% @ 50 ml/lit, Profenofos 40% + Cypermethrin 4% EC @ 0.1 ml/lit and untreated control.

Method of Extract Preparation

Collected plants and leaves were washed thoroughly in tap water to remove dust and surface contamination. Washed leaves allowed for drying in shade until the surface moisture dry off. The 100 g of cleaned leaves were ground with little water by using domestic electric grinder to form the chunky paste. To prepare 5 percent of plant extracts 100 g of the ground paste was immersed in 2 litres of water for overnight. In the next day, that solution was filtered and squeezed through the muslin cloth. Around two pinch of detergent powder added to the filtrate to serve as a sticker and wetting agent. The obtained 5 percent formulations were used for spraying on chickpea crop against *Helicoverpa armigera*. (Kumar and Tiwari, 2018) [9].

Recording Observation

Pest population was estimated by observing five plants selected randomly from each treatment for presence of larval population at one day prior to insecticide application and at 3rd, 7th and 14th day after each application. The larval population over control against pod borer (*Helicoverpa armigera*) was calculated by considering the mean of three observations recorded at 3rd, 7th and 14th day after first and second spraying.

$$\text{Larval population} = \frac{\text{No. of larvae}}{\text{Total no. of plants}}$$

Benefit Cost Ratio

Gross returns were calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

The B: C ratio was calculated by formula:

Gross return = Marketable yield × Market price

Net return = Gross return – Total cost

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total cost}}$$

Where,

BCR = Benefit Cost Ratio.

Result and Discussion

Over all mean analysis of 3rd, 7th and 14th day after first spray

application indicated that all the treatments were significantly effective as compared to untreated control. Profenofos 40% + Cypermethrin 4% EC (2.77) was found significantly superior as shown in (Table.1) and it was followed by, Neem oil (3.00**.** The next treatment was Neem seed kernel extract 5% (3.13**)**, Karanj oil (3.21) also found to be effective in controlling the pod borer, the next best treatment were *Calotropis gigantea* (3.60), *Ageratum conyzoides* (3.73) followed by *Lantana camera* recorded (4.09). Which was least effective against gram pod borer.

After 2nd spray over all mean analysis of 3rd, 7th and 14th day after spray application indicated that all the treatments were significantly effective in reducing the larval population of *Helicoverpa armigera* as compared to untreated control. Profenofos 40% + Cypermethrin 4% EC (1.95) was found significantly superior, followed by Neem oil (2.31) and Neem seed kernel extract 5% (2.51). Karanj oil (2.75) also found to be effective in controlling the pod borer, *Ageratum conyzoides* (3.26), followed by *Lantana camera* recorded (3.53). Which was least effective against gram pod borer.

The data on the population of *Helicoverpa armigera* after first spray and second spray revealed that all the treatments were significantly superior over untreated control. Among all the treatments lowest larval population of gram pod borer was recorded in Profenofos 40% + Cypermethrin 4% EC (2.36) was found significantly superior as shown in (Table.1) and supported by Jadhav *et al.,* (2021) [7] and it was followed by Neem oil (2.65) similar findings also reported in chickpea by Santhosh and Kumar (2022) [19]. The next treatment was Neem seed kernel extract 5% (2.82) which was in line with the findings of Kumar *et al.,* (2018) [8]. Karanj oil (2.98) also found to be effective in controlling the pod borer which also reported by Gautam *et al.,* (2018) [4], the next best treatment was *Calotropis gigantea* (3.31) similar findings reported by Prabhu *et al.,* (2018) [16]. *Ageratum conyzoides* (3.49) was the next effective treatment in controlling the population of gram pod borer which was reported by Bhavana and Nagar (2019) [1], followed by *Lantana camera* recorded (3.81) which was least effective against gram pod borer similar results are recorded by Kumara and Tiwari (2018) [9].

Among the treatments studied, T_7 Profenofos 40% + Cypermethrin 4% EC gave the highest cost benefit ratio (1:3.65) and marketing yield (21.38 q/ha) supported by Jadhav *et al.,* (2021) [7], followed by T_2 Neem oil (1:3.35 and 19.27 q/ha), T_1 Neem seed kernel extract 5% (1:3.19 and 18.33 q/ha) this result is supported by Yerrabala *et al.,* (2021) [21], the next T_3 Karanj oil (1:2.96 and 16.20 q/ha) supported by Das and Tayde (2022) [2] T_4 *Calotropis gigantea* (1:2.47 and 14.16 q/ha), followed by T_6 *Ageratum conyzoides* (1:2.41 and 13.16 q/ha), after that with least cost benefit T_5 *Lantana camera* (1:2.24 and 12.77 q/ha) supported by Bhavana and Nagar (2019) [1] and lastly in T_0 untreated control (1:1.68 and 9.10 q/ha).

Table 1: Effect of different plant products on the mean population of *Helicoverpa armigera* on Chickpea during *Rabi* season 2022-23 (First spray)

		No. of larvae / 5 plants					
S. No.	**Treatments**	**Dosage**	**1 DBS**	**3 DAS**	**7 DAS**	**14 DAS**	**Mean**
T_1	Neem seed kernel extract 5%	50 ml/lit	5.33	3.33	2.87	3.13	3.13
T_2	Neem oil @ 5 ml	5 ml/lit	5.33	3.27	2.73	3.00	3.00
T_3	Karanj oil @ 5 ml	5 ml/lit	5.33	3.40	3.13	3.33	3.21
T_4	*Calotropis gigantea* 5%	50 ml/lit	5.20	3.80	3.53	3.47	3.60
T_5	*Lantana camera* 5%	50 ml/lit	5.13	4.27	3.87	4.13	4.09
T_6	*Ageratum conyzoides* 5%	50 ml/lit	5.13	3.87	3.60	3.67	3.73
T_7	Profenofos 40% + Cypermethrin 4% EC	0.1 ml/lit	5.47	3.00	2.53	2.80	2.77
T_0	Control		5.00	5.93	5.33	5.40	5.53
SEm (±)				0.092	0.094	0.074	0.054
CD at 5% Level				0.45	0.25	0.22	0.16
F- test				NS	S	S	S

DBS – Day before Spray
DAS – Day after Spray

Table 2: Effect of different plant products on the mean population of *Helicoverpa armigera* on Chickpea during *Rabi* season 2022-23 (Second spray)

		No. of larvae / 5 plants				
S. No.	**Treatments**	**Dosage**	**3 DAS**	**7 DAS**	**14 DAS**	**Mean**
T_1	Neem seed kernel extract 5%	50 ml/lit	2.80	2.47	2.27	2.51
T_2	Neem oil @ 5 ml	5 ml/lit	2.60	2.27	2.07	2.31
T_3	Karanj oil @ 5 ml	5 ml/lit	3.20	2.67	2.40	2.75
T_4	*Calotropis gigantea* 5%	50 ml/lit	3.40	2.93	2.73	3.02
T_5	*Lantana camera* 5%	50 ml/lit	3.87	3.47	3.27	3.53
T_6	*Ageratum conyzoides* 5%	50 ml/lit	3.60	3.20	3.00	3.26
T_7	Profenofos 40% + Cypermethrin 4% EC	0.1 ml/lit	2.40	1.87	1.60	1.95
T_0	Control		5.80	6.21	6.53	6.18
SEm (±)		-	0.058	0.084	0.088	0.145
CD at 5% Level		-	0.17	0.25	0.26	0.44
F- test		NS	S	S	S	S

DBS – Day before Spray
DAS – Day after Spray

Table 3: Effect of different plant products on the mean population of *Helicoverpa armigera* on Chickpea during *Rabi* season 2022-23 (First and Second Spray) (Mean larval population)

S. No	Treatments	Mean larval population/ 5 plants		
		1st Spray	2nd Spray	Mean
T_1	Neem seed kernel extract 5%	3.13	2.51	2.82
T_2	Neem oil @ 5 ml	3.00	2.31	2.65
T_3	Karanj oil @ 5 ml	3.21	2.75	2.98
T_4	*Calotropis gigantea* 5%	3.60	3.02	3.31
T_5	*Lantana camera* 5%	4.09	3.53	3.81
T_6	*Ageratum conyzoides* 5%	3.73	3.26	3.49
T_7	Profenofos 40% + Cypermethrin 4% EC	2.77	1.95	2.36
T_0	Control	5.53	6.18	5.85
SEm (±)		0.054	0.145	0.049
CD at 5% Level		0.16	0.44	0.76
F-test		S	S	S

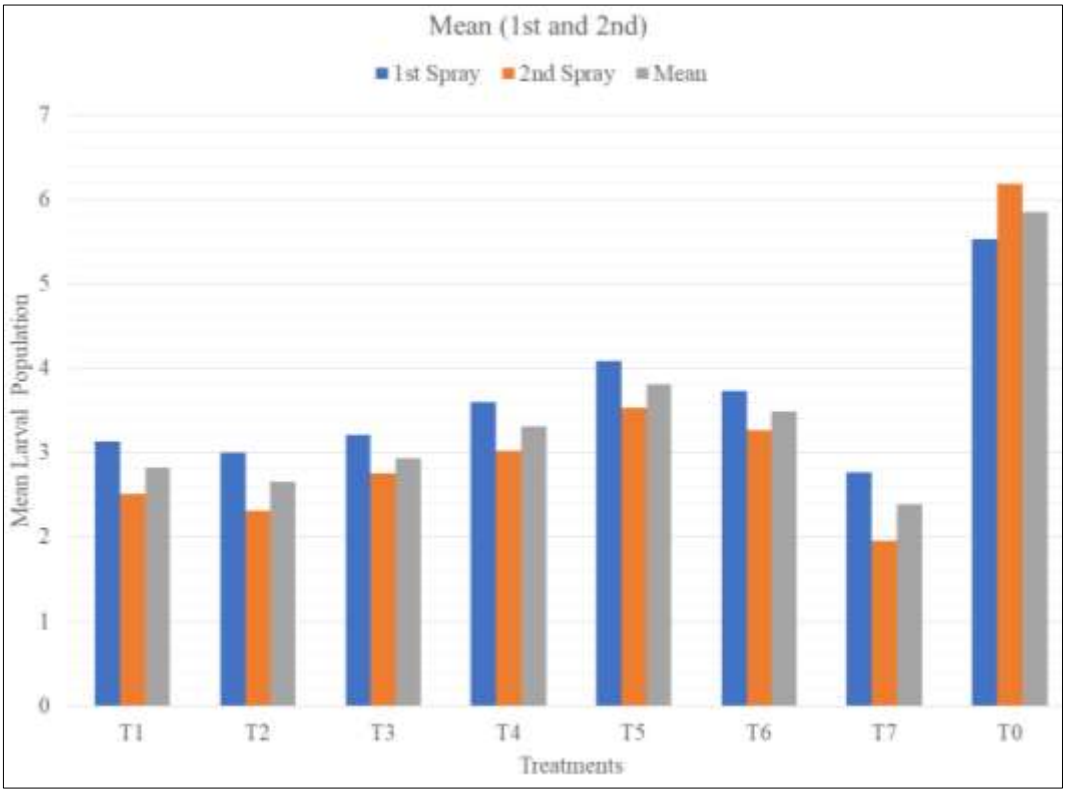

Fig 1: Mean larval population (First and Second Spray)

Table 4: Economics of Cultivation, Benefit Cost Ratio (BCR)

S. No	Treatments	Yield (q/ha)	Cost of yield (₹)	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B: C Ratio
T_1	Neem seed kernel extract 5%	18.33	5500	100815	29650	1950	31600	1:3.19
T_2	Neem oil @ 5 ml	19.27	5500	105985	29650	1925	31575	1:3.35
T_3	Karanj oil @ 5 ml	16.20	5500	89100	29650	1935	31585	1:2.82
T_4	*Calotropis gigantea* 5%	14.16	5500	77880	29650	1800	31450	1:2.47
T_5	*Lantana camera* 5%	12.77	5500	70235	29650	1675	31325	1:2.24
T_6	*Ageratum conyzoides* 5%	13.61	5500	74855	29650	1350	31000	1:2.41
T_7	Profenofos 40% + Cypermethrin 4% EC	21.38	5500	117590	29650	2530	32180	1:3.65
T_0	Control	9.10	5500	50050	29650	-	29650	1:1.68

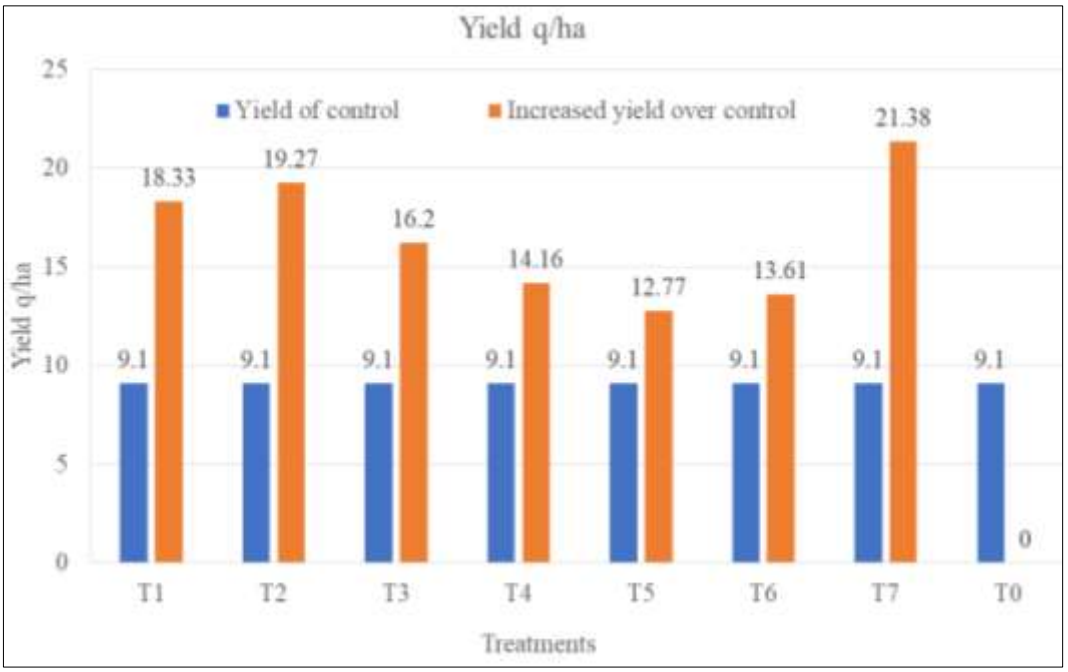

Fig 2: Effect of treatments on yield

Conclusion

From the analysis of present findings it is concluded that among all the treatments Profenofos 40% + Cypermethrin 4% EC was found most effective against gram pod borer followed by Neem oil and Neem seed kernel extract resulted higher yield and better gram pod borer control as compared to untrated control, while Karanj oil, *Calotropis gigantea* ranked middle in order of their efficacy, then *Ageratum conyzoides* and *Lantana camera* found to be least effective in managing *Helicoverpa armigera* and all the botanicals can be a part of Integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not much harmful to beneficial insects. Profenofos 40% + Cypermethrin 4% EC gave the highest cost benefit ratio (1:3.65) and marketable yield (21.38 q/ha), followed by Neem oil ((1:3.35 and 19.27 q/ha), the next Neem seed kernel extract (1:3.19 and 18.33 q/ha) after that Karanj oil (1:2.82 and 16.20 q/ha), *Calotropis gigantea* (14.16q/ha) (1:2.47) followed by *Ageratum conyzoides* (13.16 q/ha) (1:2.41) and after that with least cost benefit *Lantana camera* (1:2.24 and 12.77 q/ha). All botanical treatments and can be used with Integrated pest management.

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