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Field efficacy and economics of different chemicals and biopesticides against pod borer, *Helicoverpa armigera* (Hubner) on chickpea during *rabi* season

Jagtap Pandurang Macchindra and Ashwani Kumar

Abstract

An experiment on chickpea was conducted to determine the "Field efficacy and economics of different chemicals and biopesticides against pod borer, *Helicoverpa armigera* (Hubner) on chickpea during *rabi* season" of 2021-22 at the Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. Efficacy of seven insecticides *viz*., T_1-Flubendiamide 480SC 0.4 ml/lit of water, T_2-Spinosad 45SC 0.5 ml/lit of water, T_3-Profenofos 50EC 4 ml/lit of water, T_4-Lamda Cyhalothrin 5EC 1 ml/lit of water, T_5-*Ha*NPV 2 ml/lit of water, T_6-NSKE 5% 2ml/lit of water and T_7-*Bacillus thuringiensis* @ 2 *gm/lit* of water and treatment of T_8-Untreated control were tested against chickpea pod borer *Helicoverpa armigera* (Hubner). The different insecticides and biopesticides treatments revealed that the pod damage percentage of pod borer, *H. armigera* was recorded in synthetic insecticides, T_2-Spinosad 45SC (6.43%) which found most effective followed by T_1-Flubendiamide 480SC (8.11%), T_4-Lamda Cyhalothrin 5EC (9.17%), T_3-Profenofos 50EC (11.00%). The minimum pod damage percentages (6.43%) were observed in T_2-Spinosad 45SC as compared to the T_8-untreated control (20.60%). The yield among the different treatments were significant. All the treatments were superior over control. Highest yield was recorded in the T_2-Spinosad 45SC @20.20 q/ha then followed by T_1-Flubendiamide 480SC @ 18.50 q/ha, T_4-Lambda cyhalothrin 5EC 16.20 q/ha, T_3-Profenophos 50EC 15.10 q/ha, T_5-*Ha*NPV @ 14.69 q/ha, T_7-*Bacillus thuringiensis* @ 13.50 q/ha, T_8-NSKE 5% @ 12.20 q/ha. The cost benefit ratio was recorded in the T_2-Spinosad 45SC with highest cost benefit ratio of 1:2.70 then followed by T_5-*Ha*NPV with cost benefit ratio of 1:2.60, T_8-NSKE 5% with cost benefit ratio of 1:2.58, T_4-Lambda cyhalothrin 5EC with cost benefit ratio of 1:2.48, T_1-Flubendiamide 480SC with cost benefit ratio of 1:2.47, T_3-Profenophos 50EC with cost benefit ratio of 1:2.00, T_7-*Bacillus thuringiensis* with cost benefit ratio 1:1.86. The synthetic chemicals shows better results in combating to the pest infestation compare to the botanicals.

Keywords: Biopesticides, chickpea, efficacy, *Helicoverpa armigera*, pod borer

1. Introduction

Chickpea *Cicer arietinum* (L.) is an important pulse crop of India, commonly known as Chickpea or Chana, Bengal gram, Gram, belongs to Leguminaceae family. Chickpea originated from south western Asia, which has been considered as 'King of Pulses'. It is generally grown under rainfed or residual soil moisture conditions in *Rabi* season and the plant grows to 20-50 cm height and has small, feathery leaves on either side of the stem. (Spoorthi *et al*., 2017) [19].

Chickpea, *Cicer arietinum* (L.) family Leguminaceae (Fabaceae) is originated in South eastern Turkey and spread to other parts of the world. According to De Candolle, the fact that gram has a Sanskrit name "Chanaka" which indicates that the crop was under cultivation in India longer than in any other country in the world. (Gowda *et al.,* 2007) [10].

India grows a variety of pulse crops under a wide range of agro-climatic conditions and has a pride of being world's largest producer of pulses; share of pulses to total food grain production is only 6-7 per cent. The most commonly grown pulses in India include chickpea, red gram, urd bean, field peas, horse gram, etc. These pulses play an important role in supplying proteins to large masses of the Indian people. In India per capita availability of pulses is 47.2 g per day and contributing share of pulses to total food-grain production in terms of area, production and productivity is 18.92, 6.79 and 35.91 per cent, respectively, during 2014-15. Pigeon pea has a wide range of products, including the dried seed, pods and immature seeds used as green vegetables, leaves and stems used for fodder and the dry stems as fuel. It also improves soil fertility through nitrogen fixation as well as from the leaf fall and recycling of the nutrients.

It is an important pulse crop that performs well in poor soils and regions where moisture availability is unreliable or inadequate. In the country, the crop is extensively grown in Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Gujarat. Among several insect pests infesting redgram; gram pod borer, *Helicoverpa armigera* (Hubner), spotted pod borer, *Maruca vitrata* (Geyer), pod fly, *Melanagromyza obtusa* (Malloch), plume moth, *Exelastis atomosa* (Walshingham) and blue butterfly, *Lampides boeticus* (Linnaeus) are most serious. The pod sucking bugs also cause considerable damage which constitutes pod bug, Riptortus pedestris (Fabricius), green stink bug, *Nezara viridula* (Linnaeus), green bean bug, *Clavigralla gibbosa* (Spinola), lab lab bug, *Captosoma cribraria* (Fabricius) reported by Bijewar *et al.* (2018) [4]. The damage inflicted by *Helicoverpa armigera* is confined to flowers. (Dadas *et al*., 2019) [6].

2. Materials and Methods

The present investigation was conducted during *rabi* season of 2021-22 at the central research field of Sam Higginbottom University of Agriculture, Technology and Sciences Naini, Prayagraj, Uttar Pradesh. There were eight treatments including an untreated control and each was replicated thrice in the randomized block design. The materials used and methodology adopted for conducting various experiments to fulfill the objectives in the present study is elaborated here under.

The eight treatments consisting T_1-Flubendiamide 480SC, T_2-Spinosad 45SC, T_3-Profenofos 50EC, T_4-Lamda Cyhalothrin 5EC, T_5-*Ha*NPV, T_6-NSKE and T_7-*Bacillus thuringiensis* and treatment of T_8-Untreated control using variety Chirag in a plot size of (2m x 2m) at a spacing of (30 x 10 cm). The observations was recorded visually early from five randomly selected and tagged plants in each plot. The damaged pod was recorded at day before spray, 3, 7 and 14 days after the spray.

2.1 Skeleton of Anova (Analysis of variance)

The analysis of variance (ANOVA) technique was applied for drawing conclusion from data. The calculated values were compared the tabulated values at 5% level of probability for the appropriate degree of freedom.

Source of variation	d.f.	S.S.	M.S.S.	F.(cal)	F.(tab)at5%
Treatment (t)	(t– 1)	T.S.S.	T.S.S./t–1	M.S.S.T./ M.S.S.E.	F(t-1)/(t-1) (r-1)
Replication (r)	(r-1)	R.S.S.	R.S.S./r–1	M.S.S.R./ M.S.S.E.	
Error	(r–1) (t–1)	E.S.S.	E.S.S./(r–1) (t–1)		
Total	(rt–1)				

2.2 Preparation of insecticidal spray solution: The spray solution of a desired concentration was prepared by adopting the following formula – (Spoorthi *et al*., 2017) [19].

$$V=\frac{CXA}{\%a.i}$$

Where,

V = volume/weight of the commercial insecticide

C = concentration required

A = volume of solution to be sprayed

% a.i. = percentages of active ingredient in commercial formulation

2.3 Pod damage percentage: At each picking the total number of pods infested of five selected plants from each treatment replication wise was recorded. Following formulae suggested by (Kumar *et al*., 2019) [14].

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

2.4 Cost benefit ratio of treatments: Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments were deducted from the gross returns, to find out returns and cost benefit of ratio by following formula, Following formulae suggested by (Ojha *et al*., 2019) [18].

$$\text{Cost Benefit Ratio} = \frac{\text{Net returns}}{\text{Cost of treatment}}$$

3. Results and Discussion

In this present investigation, efforts have been made to envolve an economically viable pest management strategy against Pod borer in Chickpea. From this point of view the present investigation conducted.

3.1 Efficacy of certain chemicals and biopesticides on pod borer, *H. armigera* during *rabi* season of 2021-22

In this data T_1-Flubendiamide 480SC (9.05%), T_4-Lambda Cyhalothrin 5EC (10.00%), were found par each other. T_7-*Bacillus thuringiensis* (14.24%), T_5-*Ha*NPV (13.08%), were found par each other. T_6-NSKE 5% (14.56%), T_7-*Bacillus thuringiensis* (14.24%), were found par each other.

The data on the present Pod damage of *Helicoverpa armigera* of chickpea on 3,7 and 14 days after second spray revealed that all chemical treatments were significantly superior over the untreated control at 3,7,14 days after the first spraying. Among all treatments minimum level of Pod damage of *Helicoverpa armigera* was was recorded in Spinosad 45SC (5.75%) which found most effective followed by Flubendiamide 480SC (7.17%), Lambda Cyhalothrin 5EC (8.35%), Profenophos 50EC (10.39%), *Ha*NPV (11.35%), *Bacillus thuringiensis* (12.57%), NSKE 5% (12.80%), is found to be least effective among all the treatments as compared to Control (22.21%).

In this data (T_6) NSKE 5% (14.56%), (T_7) *Bacillus thuringiensis* (14.24%), were found par each other.

From the experimental findings the treatment of T_2-Spinosad 45SC recorded consistently lowest Pod damage of *Helicoverpa armigera* compaired to the T_0-Untreated check, similar findings were also reported by Akkabathula *et al.* (2015) [2] **(**Spinosad maintained its lethal effect with least pod damage of 6.00%**)**. Sreekanth *et al.* (2014) [20] reported that Pod damage due to pod borer, *Helicoverpa* was lowest in plots treated with flubendiamide (1.16%), chlorantraniliprole (1.26%) and spinosad (1.92%) with 88.7, 87.7 and 81.2 per cent reduction over control respectively. The untreated plot has recorded maximum pod damage of 10.22%. Similarly

Dinesh *et al.* (2017) [7] reported that T_1-Flubendamide 480SC was most effective against *Helicoverpa armigera*. Which was recorded overall mean Pod damage of 8.11% followed by T_4-Lamda cyhalothrin 5EC (9.17%). Similar finding Chitralekha *et al.* (2018) [5]. Similar findings also found Agale *et al.* (2019) [1] reported that the treatment of Spinosad 45 SC was found significantly superior, recording lower pod and seed damage by H. armigera (6.82%) the highest yield was (1359 kg/ha) recorded in Spinosad 45 SC. Similarly Iqbal *et al.* (2014) [12] also reported that T_3-Profenofos 50EC were the most efficacious at consistently providing excellent control of *Helicoverpa armigera*. Similarly Khorasiya *et al.* (2018) [13] also reported that among the different concentrations of *Ha*NPV was found to be the most effective in controlling the *Helicoverpa armigera*, and having lowest per cent pod damage at harvest (15.25%) and registered the highest grain yield (1264 kg ha^{-1}). Kumar *et al*. (2019) [14] also reported that the efficacy of various treatments at this stage was in order of Neem Seed Kernel Extract @5% > Bt. 01 kg/ha > Neem oil @ 2%> Nimbecidine @ 2% > Neem leaf extracts @5% > NPV@450LE/ha. Spray of NSKE @ 5% proved significantly lower pod damage of 13.45% and 12.76%. Similarly Meena *et al.* (2018) [16] also reported that NSKE 5% were effective checking the *Helicoverpa armigera* with the pod damage (10.41%) was recorded. Similarly Kumar *et al*. (2019) [14] also reported that the *Bacillus thuringiensis* has long been recognized for its insecticidal properties and having pod damage (12.10%), also reported that treatments *Bacillus thuringinesis* and Neem can be more economically viable as compared single treatment and should be adopted in integrated pest management.

3.2 Cost benefit ratio of the treatments

The yield among the different treatments were significant. All the treatments were superior over control. Highest yield was recorded in the T_2-Spinosad 45SC (20.20 q/ha) then followed by T_1-Flubendiamide 480SC (18.50 q/ha), T_4-Lambda cyhalothrin 5EC (16.20 q/ha), T_3-Profenophos 50EC (15.10 q/ha), T_5-*Ha*NPV (14.69 q/ha), T_7-*Bacillus thuringiensis* (13.50q/ha), T_6-NSKE 5% (12.20 q/ha).

The marketable yield of Among the different treatment the yield in T_2-Spinosad 45SC and T_1-Flubendiamide 480SC were found par with each other and T_7-*Bacillus thuringiensis* and T_6-NSKE 5% were found par with each other. When cost benefits ratio worked out, interesting result was achieved, among the treatment studied,the cost benefit ratio was recorded in the T_2-Spinosad 45SC with highest cost benefits ratio of 1:2.70 then followed by T_5-*Ha*NPV with cost benefits ratio of 1:2.60, T_6-NSKE 5% with cost benefits ratio of 1:2.58, T_4-Lambda cyhalothrin 5EC with benefit cost ratio of 1:2.48, T_1-Flubendiamide 480EC with benefit cost ratio of 1:2.47, T_3-Profenophos 50EC with cost benefits ratio of 1:2.00, T_7-Bacillus thuringiensis with cost benefits ratio of 1:1.86.

Our findings are similar with Nitharwal *et al.* (2017) [17] highest yield of chickpea was recorded among the treatment studied, the best and most economical treatment was Spinosad 45SC. Similar findings also found Agale *et al.* (2019) [1] reported that the treatment of Spinosad 45 SC was found significantly superior and the highest yield was (1359 kg/ha) recorded in Spinosad 45 SC. Similarly Khorasiya *et al.* (2018) [13] also reported that among the different concentrations of *Ha*NPV was found to be the most effective in controlling the *Helicoverpa armigera*, and registered the highest grain yield (1264 kg ha^{-1}). Similarly Altaf Hossain (2017) [11] reported the highest yield (1,856 kg/ha) obtained from *Ha*NPV sprayed plots. Similarly Yerrabala *et al*. (2021) [21] reported that the best and most economical treatment was T6 fipronil 5 SC (1:1.90) followed by T_7 cypermethrin 25EC (1:1.70), T_1 *Bacillus thuringiensis* (1:1.60), T_2 neem seed kernel extract (1:1.54). Similarly Lakshmikanth *et al.* (2018) [15] reported that the best and most economical treatment was Spinosad 45% SC followed by NSKE 5%.

Table 1: Efficacy of certain chemicals and biopesticides on the incidence of pod borer, *H. armigera* on chickpea during *rabi* season of 2021-22. (First and Second spray)

Treatment No.	Treatments	Per cent pod damage (%) 1st spray					Per cent pod damage (%) 2nd spray			
		1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean
T_1	Flubendiamide 480 SC	15.23	9.63	8.40	9.13	9.05	8.15	6.19	7.17	7.17
T_2	Spinosad 45SC	15.40	7.70	6.21	7.47	7.13	6.72	4.79	5.75	5.75
T_3	Profenophos 50EC	15.40	12.44	10.62	11.75	11.60	12.12	8.88	10.17	10.39
T_4	Lamda Cyhalothrin 5EC	15.53	10.68	9.13	10.18	10.00	9.22	7.29	8.55	8.35
T_5	*Ha*NPV	15.52	13.73	12.18	13.33	13.08	12.35	10.43	11.38	11.35
T_6	NSKE 5%	15.84	15.15	13.63	14.92	14.56	13.96	12.06	12.39	12.80
T_7	*Bacillus thuringiensis* $1X10^9$CFU/ml	15.58	14.86	13.28	14.56	14.24	13.57	11.58	12.58	12.57
T_0	Control	16.75	17.66	18.24	21.49	19.13	21.20	21.88	23.56	22.21
	F-test	NS	S	S	S	S	S	S	S	S
	S.Ed. (±)	0.413	0.685	0.702	0.725	0.618	0.631	0.571	0.758	0.523
	C.D.(P = 0.05)	N/A	1.472	1.506	1.557	1.328	1.839	1.228	1.628	1.247

*DAS: Day after spray

*DBS: Day before spray

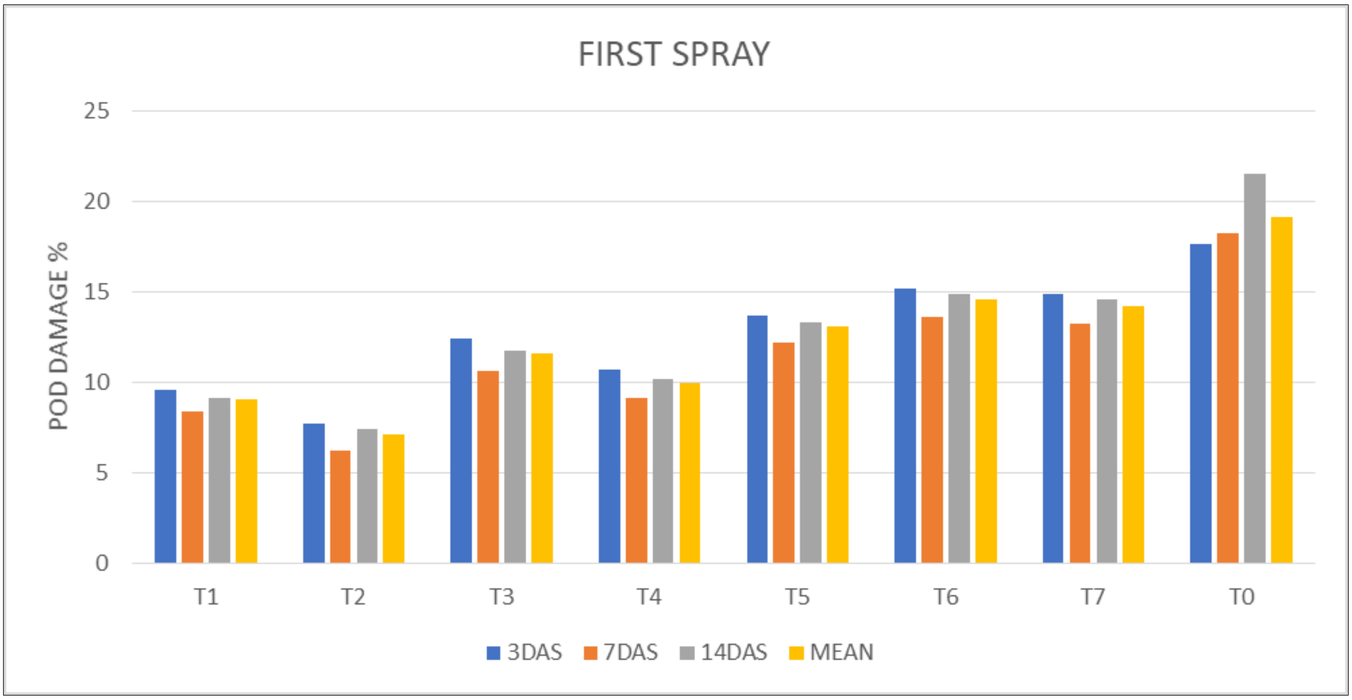

Fig 1: Graphical representation of efficacy of certain chemicals and biopesticides on the incidence of pod borer, *H. armigera* on chickpea during *rabi* season of 2021-22. (First spray)

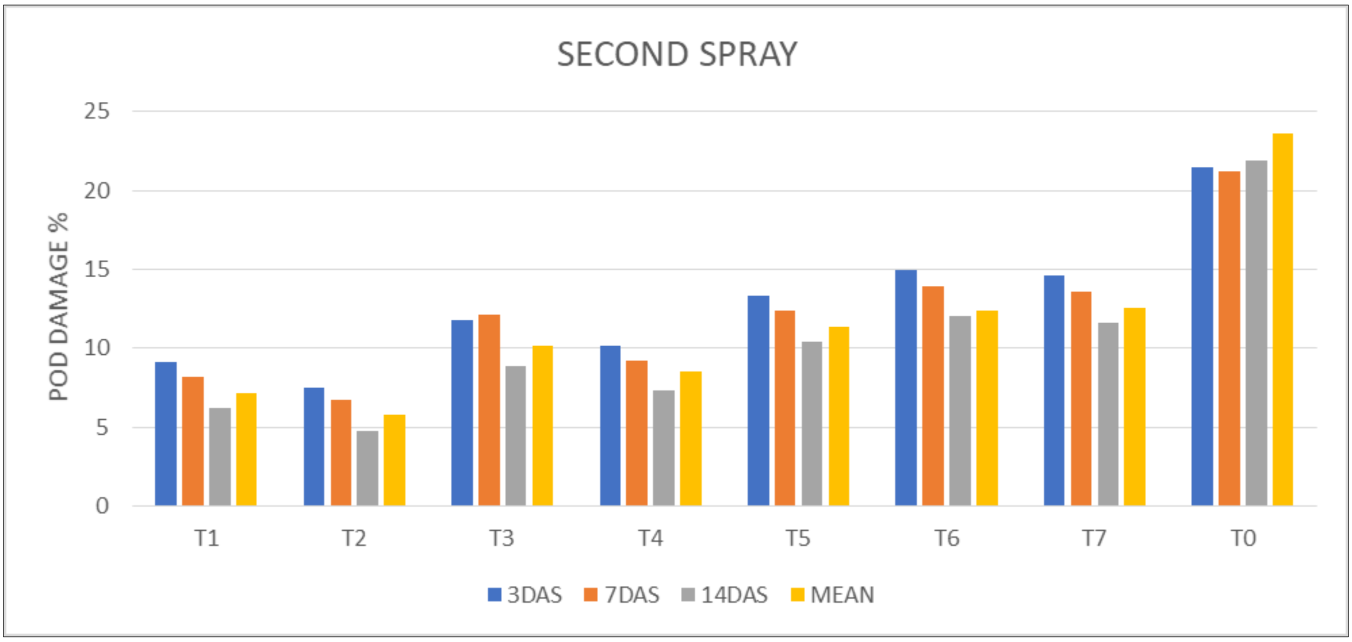

Fig 2: Graphical representation of efficacy of certain chemicals and biopesticides on the incidence of pod borer, *H. armigera* on chickpea during *rabi* season of 2021-22. (Second spray)

Benefit Cost Ratio (BCR)

The data on Cost benefit ratio of the treatments are presented in tables.

Table 2: Economics of the cultivation

Sr. No.	Treatments	Yield (q/ha)	Cost of cultivation	Selling price	Gross returns	Net returns	B:C ratio
1)	Flubendiamide 480SC	18.50	34620	6500	120250	85630	1:2.47
2)	Spinosad 45SC	20.20	35420	6500	131300	95880	1:2.70
3)	Profenophos 50EC	15.10	32620	6500	96915	98150	1:2.00
4)	Lamda Cyhalothrin 5EC	16.20	30220	6500	105300	75080	1:2.48
5)	*Ha*NPV 1X 10^9 CFU/ml	14.69	36620	6500	95485	58865	1:2.60
6)	NSKE 5%	12.20	30620	6500	79300	48680	1:2.58
7)	*Bacillus thuringiensis* (1X10^9 CFU/ml)	13.50	30620	6500	87750	57130	1:1.86
8)	Control	9.9	28620	6500	64350	35730	1:1.24

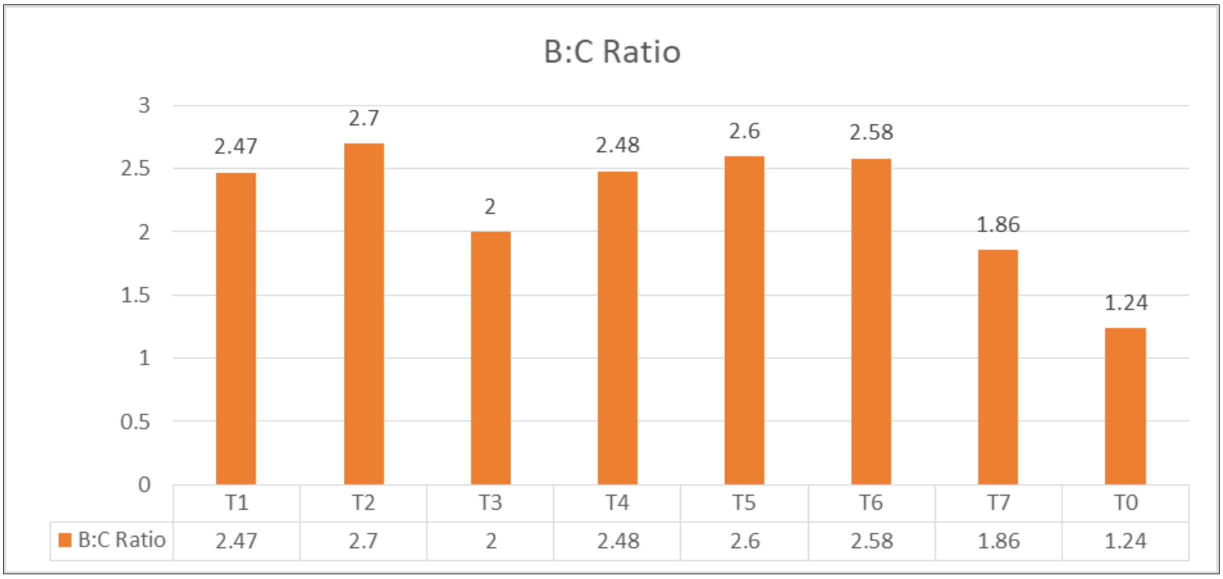

Fig 3: Graphical representation of cost benefit ratio of different treatments against pod borer, *H. armigera* during *rabi* season of 2021-22

4. Conclusion

From the critical analysis of the present findings of "Efficacy of different chemicals and biopesticides against pod borer [*Helicoverp armigera* (Hubner)] on chickpea (*Cicer arietinum* L.)". It can be concluded that, among the treatments T_2-Spinosad 45SC was found to be most superior in managing chickpea pod borer. Whereas the treatment T_6-NSKE 5% found to be the least effective in managing *H. armigera.* Among the treatments studied T_2-Spinosad 45SC gave the highest cost benefit ratio (1:2.70) and marketing yield (20.20 q/ha) under Prayagraj agroclimatic conditions as such more trials are required in future to validate the findings.

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