"Bioefficacy of certain chemicals and biopesticides against pod borer [*Helicoverpa armigera* (Hubner)] on chickpea (*Cicer arietinum* L.)"

ABSTRACT:-

The research work was undertaken at Central Research Farm (CRF) Sam Higginbottom University of Agriculture Technology and Sciences SHUATS, Naini, Prayagraj during *rabi* season in 2022-23 consists of eight treatments including control *viz*, T_1- NSKE 5% @ , T_2- Neem Oil 5%, T_3-*Bacillus thuringiensis*@ 5mg/ml, T_4-*Beauveria bassiana*@ 1×10^{10} conidia/ml, T_5- Profenofos 40% + Cypermethrin 4% EC, T_6 – Spinosad 45 SC, T_7- Emamectin benzoate 5% SG and T_0- untreated control in Randomized Block Design (RBD) with three replications. The mean larval population of chickpea pod borer *Helicoverpa armigera* after two spraying revealed that ~~the treatment T7~~ Emamectin benzoate 5% SG @1 gm/lit was found ~~superior~~ the most efficient among all treatments with larval population of (2.32 larvae/5plants), highest cost benefit ratio (1:3.87) and marketable yield (29.16q/ha), followed by Spinosad 45 SC @ 0.5 ml/lit with a larval population of (2.60), cost benefit ratio and yield (1:3.27 and 26.66 q/ha), Profenofos 40%+Cypermethrin 4% EC @ 3 ml/lit with a larval population, cost benefit ratio and yield (2.77, 1:3.42 and 25.83 q/ha), *Bacillus thuringiensis* @ 5mg/ml with a larval population, cost benefit ratio and yield (3.01, 1:2.93 and

22.5 q/ha), *Beauveria bassiana* @ 1×10^{10} conidia/ml with a larval population, cost benefit ratio and yield(3.24, 1:2.83 and 21.25 q/ha), Neem oil 5% with a larval population, cost benefit ratio and yield(3.49, 1:2.25), NSKE 5% with a larval population, cost benefit ratio and yield(3.77, 1:1.75 and 13.33 q/ha). NSKE 5% is least effective among the treatments and control plot T_0 with a larval population, cost benefit ratio and yield (5.84, 1:1.54 and 11 q/ha)..........

Keywords: Biopesticides, chemicals, chickpea, efficacy, *Helicoverpa armigera*. Cost benefit ratio.

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INTRODUCTION:-

Gram *(Cicer arietinum)*, commonly known as '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 legume crop ~~. However, the most important chickpea~~ produc~~ed~~ing ~~countries are~~by India, Turkey, Pakistan, Iran, Mexico, Australia, Ethiopia, Myanmar, and Canada (..) with an ~~-~~average annual production of about 9 million tons with 95 % cultivation and consumption occurring in developing countries (…). Currently, chickpea is grown on about 11 million hectares worldwide with 65 % belonging to India and 8 % to Pakistan. In addition to its importance in human food and animal feed, chickpea plays an important role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140kg N per ha from air and meet most of its nitrogen requirement (**Wubneh *et al*., 2016).** ~~Chickpea is currently grown on about 11 million hectares worldwide with 65 and 8 per cent share belonging to India and Pakistan, respectively. Average annual production of chickpea is about 9 million tons with 95 percent of chickpea cultivation and consumption occurring in developing countries.~~

India is the largest chickpea producer as well as consumer in the world (..) with 7.37 million hectares of 5.89 million tons and productivity of 799 kg/ha (..). The chickpea crop area covered mainly in Madhya Pradesh (32.97%), Maharashtra (18.36%), Rajasthan (16.70%), Andhra Pradesh (8.55%), Karnataka (8.21%), Uttar Pradesh (6.85%) and Gujarat (2.92%). In Karnataka, the crop is grown in an area of 6.05 lakh hectares with a productivity of 937 kg/ha**. (Prasanna *et al*., 2020)**. T~~T~~he Desi type chickpea contribute to around 80% and the Kabuli type around 20% of the total production (..). India is the largest producer of this pulse contributing to around 70% of the world's total production (..) and ~~-~~Desi type chickpea~~s~~ largely dominate the ratio of production in India (..). ~~The per cent chickpea crop area covered in major states India is Madhya Pradesh (32.97%), Maharashtra (18.36%), Rajasthan (16.70%), Andhra Pradesh (8.55%), Karnataka (8.21%), Uttar Pradesh (6.85%) and Gujarat (2.92%). In India, the area under chickpea was 7.37 million hectares with a production of 5.89 million tons with productivity of 799 kg/ha. In Karnataka, the crop is grown in an area of 6.05 lakh hectares with a productivity of 937 kg/ha. **(Prasanna *et al*., 2020)**.~~

Nevertheless, ~~In addition to its importance in human food and animal feed, chickpea plays an important role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140kg N per ha from air and meet most of its nitrogen requirement (**Wubneh *et al*., 2016).**~~

c~~C~~hickpea is attacked by several pests, mainly insects. **Sarwar, (2012)** recorded 57

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insect species, namely Lepidoptera but as *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), commonly known as cotton bollworm or American bollworm, is a major noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops **(Talekar *et al*., 2006).**

is the most important pest of chickpea (Sarwar, 2012). *H. armigera*, commonly known as cotton bollworm or American bollworm, is a major noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops **(Talekar *et al*., 2006).**

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In India, the extent of losses due to *H. armigera* in chickpea is up to 27.925 per cent% in North west Plain Zone, 13.2 per cent in North East Plain Zone, 24.3 per cent in Central Zone and

36.4 per cent in South Zone. The crops have been noticed to suffer an avoidable loss of 9 to 60 percent% by this insect. In Uttar Pradesh alone 15.3 per cent of the chickpea crop worth Rs. 462.5 million is lost annually due to *H. armigera* attack, 17.2 per cent in Karnataka and 28.5 per cent in Delhi. reported that the yield losses of chickpea grain due to *H. armigera* were 75-90 per centand in some places the losses were up to 100 per cent**. (Singh *et al*., 2015).**

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MATERIALS AND METHODS :-

Study area

The ~~experiment~~ study was conducted at the experimental research plot of the Department of Entomology, Central Research Farm (lat. 25°27 N; long. 80°50 E; alt. 98m), in Sam Higginbottom University of Agriculture Technology and Sciences (India), during the *Rabi* season of 2022-23. ~~Research field is situated at 25°27 North Latitude 80°50 East Longitudes and at an Altitude of 98 meter above sea level.~~ The climate is typically semi-arid and sub-~~-~~tropical. The maximum temperature reaches up to 47°C in summer and drops down to 2.5°C in winter~~.~~….

Experiment

The experiment was conducted in randomized complete block design (RBD) with eight treatments (including control), each with three replications. The plot size taken was ~~2m×1m=~~ $2m^2$ (2m×1m). The crops of chickpea were used for sowing~~.~~ by maintaining 30 cm inter-row and 10 cm intra-row distance with the seed rate of 60 kg/ha. The spray solution was applied with the help of a hand compression sprayer. Spraying was done at dawn and desk time and there must not be much wind currents according to …protocol.

Treatment

The Chemicals and Biopesticides used for spraying are T_1- NSKE 5%~~-~~, T_2- Neem Oil 5%, T_3-*Bacillus thuringiensis* @ 5mg/ml, T_4-*Beauveria bassiana* @ 1×10^{10}, T_5-Profenofos 40% + Cypermethrin 4% EC, T_6 – Spinosad 45 SC, T_7- Emamectin benzoate 5% SG and T_0- untreated control. The insecticidal spray solution of desired concentration as per treatments was freshlyprepared every time at the site of experiment just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased as the crop advanced in age.

In each plot, t~~T~~he number~~s~~ of larva was~~ere~~ counted on 5 randomly selected plants ~~in each plot~~. The pre-treatment count was made a day before the first spray and second spray. W~~w~~hereas, the post-treatment counts were made on 3rd, 7th and 14th day after each spray. The larval population over control against gram pod borer (*H. armigera*) was calculated by considering the mean of three observations recorded at 3rd, 7th, and 14th day after first and second spray.

The cost benefit ratio was calculated…..

Statistical analysis

~~The insecticidal spray solution of desired concentration as per treatments was freshly prepared every time at the site of experiment just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased as the crop advanced in age.~~

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RESULTS :AND DISCUSSION:

The data of table no. 1 showed Results showed that three days after spraying, reveled that all the treatments were significantly superior over control after first spray (p…..). T Among the treatments most effective treatment in reducing number of larval population of gram pod borer was found Emamectin benzoate 5SG (2.77 larvae/5 plants) followed by Spinosad 45SC (2.97 larvae/5 plants), Profenofos40%+Cypermethrin4% (3.10 larvae/5 plants), *Bacillus thuringiensis* @ 5mg/ml (3.33 larvae/5 plants), *Beauveria bassiana* @ 1×10^{10} conidia/ml (3.53 larvae/5 plants), Neem oil 5% (3.79 larvae/5 plants), Neem seed kernal extract 5% (4.08 larvae/5 plants) were significantly superior over control (5.31). NSKE 5% was least effective treatment (table 1).

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The data of table no. 1 on lLarval population of *Helicoverpa armigera* on three days after spraying reveled that all the treatments were significantly superior over control after second spray (p…..). Among all the treatments The most effective treatment for controlling the larval population of gram pod borer was found Emamectin benzoate 5SG (1.88 larvae/5 plants) which was followed by Spinosad 45SC (2.24 larvae/5 plants), Profenofos40%+Cypermethrin4% (2.44 larvae/5 plants), *Bacillus thuringiensis*@5mg/ml (2.70 larvae/5 plants), *Beauvaria bassiana* @ 1×10^{10} conidia/ml (2.95 larvae/5 plants), Neem oil 5% (3.20 larvae/5 plants), Neem seed kernal extract5% (3.46 larvae/5 plants) is found to be least effective among all the treatments. Maximum number of larvae population was recorded in untreated control (6.37).

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The larval population of gram pod borer on Chickpea after first and second spray revealed that all the insecticidal treatments were significantly superior over control (p…). Among all the treatment The most effective treatment for controlling larval population of pod borer was found T7 Emamectin benzoate 5SG (2.32 larvae/5 plants). The less effective was followed by T6 Spinosad 45 SC (2.60), T5 Profenofos 40% + Cypermethrin 4%(2.77), T3 Bacillus thuringiensis @ 5mg/ml (3.01), T4 Beauveria bassiana @ 1×1010 conidia/ml (3.24),T2 Neem oil 5% (3.49), T1 Neem seed kernal extract5% (3.77) is found to be least effective among all the treatments. Maximum number of larvae of H. armigera was recorded in control (5.84 larvae/5 plants).

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The cost benefit ratio worked out, interesting result was achieved. , among the treatment studied, shown in table no 1, tThe best and most economical treatment found was T7 Emamectin benzoate 5% with a cost benefit ratio of (1:3.87), followed by T5 Profenofos 40% + Cypermethrin 4% EC (1:3.42), T6 Spinosad45 (1:3.27), T3 *Bacillus thuringiensis* (1:2.93), T4 *Beauveria bassiana* (1:2.83), T2 Neem oil 5% (1:2.25) a-n-d T1 NSKE 5% (1:1.75) was found

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minimum cost benefit ratio among the treatments over untreated control. Control plot T0 cost benefit ratio was (1:1.54).

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Table no -1 Effect of selected chemicals and biopesticides on the larval population of pod borer [*Helicoverpa armigera* (Hubner)] on chickpea after first and second spray.

Treatments		Number of larval population/ 5 plants (No.)											Yield (q/ha)	C:B Ratio
		1st spray					2nd spray							
		One day before spray	3rd DAS	7 DAS	14 DAS	Mean	One day before Spray	3 DAS	7 DAS	14 DAS	Mean	Over all mean (1 and 2spray)		
T0	Control	5.00	5.20^{a}	5.33^{a}	5.40^{a}	5.310^{a}	5.40^{a}	5.80^{a}	6.73^{a}	6.60^{a}	6.37^{a}	5.84	11.00	1:1.54
T1	Neem seed kernal extract 5% @ 50ml/lit	5.20	4.26^{b}	3.86^{b}	4.13^{b}	4.083^{b}	4.13^{b}	3.86^{b}	3.06^{b}	3.46^{b}	3.46^{b}	3.77	13.33	1:1.75
T2	Neem oil 5% @ 50ml/lit	5.20	4.13^{b}	3.60^{c}	3.66^{c}	3.797^{c}	3.66^{c}	3.60^{c}	2.80^{c}	3.20^{c}	3.20^{bc}	3.49	17.08	1:2.25
T3	*Bacillus thuringiensis*@ 5 mg/ml @ 2gm/lit	5.33	3.53^{d}	3.13^{e}	3.33^{de}	3.330^{d}	3.33^{de}	3.20^{e}	2.26^{e}	2.66^{e}	2.70^{cde}	3.01	22.5	1:2.93
T4	*Beauveria bassiana*@1×10^10 conidia/ml @ 2gm/lit	5.13	3.80^{c}	3.33^{d}	3.46^{cd}	3.530^{d}	3.46^{cd}	3.40^{d}	2.53^{d}	2.93^{d}	2.95^{bcd}	3.24	21.25	1:2.83
T5	Profenofos40%+Cypermethrin4% EC @ 3ml/lit	5.33	3.33^{de}	2.86^{f}	3.13^{ef}	3.107^{e}	3.13^{ef}	2.80^{f}	2.06^{ef}	2.46^{ef}	2.44^{def}	2.77	25.83	1:3.42
T6	Spinosad 45% SC @ 0.5ml/lit	5.33	3.20^{ef}	2.73^{g}	3.00^{fg}	2.977^{ef}	3.00^{fg}	2.60^{g}	1.86^{f}	2.26^{f}	2.24^{ef}	2.60	26.66	1:3.27
T7	Emamectin benzoate 5% SG @ 1gm/lit	5.46	3.00^{f}	2.53^{h}	2.80^{g}	2.777^{f}	2.80^{g}	2.40^{h}	1.40^{g}	1.86^{g}	1.88^{f}	2.32	29.16	1:3.87
Overall Mean		5.24	3.40	3.42	3.61	3.61	3.61	3.45	2.83	3.17	3.15	3.38		
F- test		**NS**	S	S	S	S	S	S	S	S	S	S		
S. Ed. (±)		**0.13**	0.45	0.488	0.10	0.392	0.10	0.08	0.12	0.10	0.3	0.44		
C. D. (P = 0.05)		-	0.216	0.111	0.224	0.216	0.224	0.177	0.255	0.22	0.569	1.04		

DISCUSSION:

~~The data on mean population after first and second spray revealed that a~~All the insecticides were found very effective and significantly superior over untreated control. Among all seven treatments, minimum l~~L~~arval number of gram pod borer was found ~~in~~ using ~~T_7~~ Emamectin benzoate 5% ~~(2.32)~~ as the similar findings ~~was~~ reported by **Yadav *et al.* (2017), Rani *et al.* (2018), Abbas *et al.* (2021), Bhamare *et al.* (2020)** and **Kambrekar *et al.* (2012)** who reported that Emamectin benzoate 5% SG was the most effective treatment to control *Helicoverpa armigera* larval population. The biopesticide, ~~T_6~~ Spinosad 45 SC was found ~~the next~~ to be effective ~~treatment~~ with ~~larval number (2.60)~~ similar finding ~~was reported by~~of **Lavanya and Kumar (2022), Rashid *et al.* (2012), Gayathri and kumar (2021), Kumar *et al.* (2014)** who reported that Spinosad ~~was found to bethe next best treatment for reducing the larval population of *Helicoverpa armigera*~~………. As well, ~~T_5~~ Profenofos 40% + Cypermethrin 4% EC was found ~~the next best~~to be effective ~~treatments with the~~in the reduction of the ~~larval~~ number of larva as found by ~~(2.77) which was similarly found by~~ **Jadhav *et al.* (2021)** who reported that ……..~~Profenofos 40% + Cypermethrin 4% EC to be the next best and effective treatment in controlling larval population.~~

When the cost benefit ratio worked out, interesting result was achieved. Among all the treatments the higher cost benefit ratio was obtained from T_7 Emamectin benzoate (1:3.87) as the similar findings was done by **Shah *et al.* (2013), Bharti *et al.* (2015), and Kambrekar *et al.*(2012)**, followed by the T_5 Profenofos 40%+Cypermethrin 4% EC exhibited a cost benefit ratio of (1:3.42) as the similar finding was done by **Jadhav *et el.* (2021)** followed by T6 Spinosad 45 SC with a cost benefit ratio of (1:3.27) as the similar finding was done by **Nitish *et al.* (2015)**, **Keval *et al.* (2016) Choudhary *et al.*(2017)** and **Chandra *et al.* (2017)**

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