"Comparative efficacy and economics of selected 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 of 2023-24 consists of eight treatments including control *viz,* T_1- *Beauveria bassiana* 1.15 % WP, T_2 Chlorantraniliprole 18.5 SC, T_3-Emamectin benzoate 5 SG, T_4 - *Bacillus thuringiensis* $1x10^9$ CFU/ml, T_5 -Azadirachtin 00.03% WSP , T_6 – NSKE 5% , T_7- Spinosad 45 SC and T_0-untreated control in Randomized Block Design (RBD) with three replications targeting to evaluate the efficacy of selected insecticides on the larval population of *H. armigera* on Chickpea. Data was taken on larval population of chickpea pod borer. The larval population of chickpea pod borer , *Helicoverpa armigera* on third, seven and fourteen days after spray revealed that among all the treatment T_2 Chlorantraniliprole 18.5 SC found superior with larval population of (1.05) and with highest cost benefit ratio (1:3.78), followed by Emamectin benzoate 5 SG with a larval population of (1.17) and cost benefit ratio (1:3.53), Spinosad 45 SC with a larval population of (1.24) and cost benefit ratio (1:3.16), *Beauveria bassiana* 1.15 % WP with a larval population of (1.32) and cost benefit ratio *(*1:3.00 *),* *Bacillus thuringiensis* $1x10^9$ CFU/ml with a larval population(1.35) and cost benefit ratio (1:2.76), Azadirachtin 00.03% WSP with a larval population(1.42) and cost benefit ratio (3.49, 1:2.25), NSKE 5% with a larval population (1.47) and cost benefit ratio (1:1.77), NSKE 5% was least effective among the treatments and control plot T_0 with a larval population (2.07) and cost benefit ratio (1:1.51).

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

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. 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. **(Kumar and Yadav, 2023).**

India ranks first in the production and consumption of chickpea (*Cicer arietinum* L.) in the world. Chickpea is a most important pulse crop of India which is mostly grown under dry land condition with heavy cloudy soil. It is a rich source of nutritional values in the diet of Indian people because of containing 21.5 per cent protein, 64.5 per cent carbohydrates and 4.5 per cent 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. **(Kumar *et al*., 2019).**

Chickpea is attacked by several pests, mainly insects. Sarwar, recorded “57 insect species, namely Lepidoptera as *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), commonly known as gram pod borer is a major polyphagous and noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops”. “In India, the extent of losses due to *H. armigera* in chickpea is up to 27.9 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 per cent 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 28.5per cent in Delhi. **(Bhati *et al*., 2023).**

MATERIALS AND METHODS :-

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology And Sciences, during the *rabi* season of 2023-24. Research field is situated at 25°27 North Latitude 80°50East Longitudes and at an Altitude of 98 meter above sea level. The climate is typically semi-arid andsub-tropical. The maximum temperature reaches up to 47°C in summer and drops down to 2.5°C in winter. The experimental design was Randomized Block Design with 8 treatments, each replicated thrice. The plot size was (2m × 1m) with a spacing of (30×10 cm).The treatments included - *Beauveria bassiana* 1.15 % WP (Bevroz) , Chlorantraniliprole 18.5 SC (Coragen) , Emamectin benzoate 5 SG (Proclaim), *Bacillus thuringiensis* $1x10^9$ CFU/ml (Thuricide), Azardirachtin 00.03% WSP (Neemaura), NSKE 5% (Neemicide) , Spinosad 45 SC (Tracer) and a control.

The numbers of larva were counted on 5 randomly selected plants in each plot. The pre-treatment count was made a day before the spray whereas, the post-treatment counts were made on 3^{rd} , 7^{th} and 14^{th} day after each spray. The larval population over control against gram pod borer was calculated by considering the mean of three observations recorded at 3^{rd} , 7^{th} , and 14^{th} day after spray

RESULT AND DISCUSSION

3.1 Efficacy of *Helicoverpa armigera* after first spray

Third days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over control. Among all the treatments lowest Number of larval populations was recorded inChlorantraniliprole 18.5 SC (1.40) found superior over other treatments followed by Emamectin benzoate (1.53), Spinosad 45 SC (1.60), *Beauveria bassiana* (1.67), *Bacillus thuringiensis* 1×10^9 CFU/ml (1.67), Azardirachtin 00.03% WSP (1.80) and Neem seed kernel extract 5% (1.80) is found to be least effective among all the treatments as compared to control(2.00).

Sevan days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over control. Among all the treatments Chlorantraniliprole 18.5 SC (1.07) found superior over other treatments followed by Emamectin benzoate (1.13), Spinosad 45 SC (1.20), *Beauveria bassiana* (1.27), *Bacillus thuringiensis* 1×10^9 CFU/ml (1.27), Azardirachtin 00.03% WSP (1.33) and Neem seed kernel extract 5% (1.40) is found to be least effective among all the treatments as compared to control(2.07).

Fourteen days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over control. Among all the treatments Chlorantraniliprole 18.5 SC (0.67) found superior over other treatments followed by Emamectin benzoate (0.87), Spinosad 45 SC (0.93), *Beauveria bassiana* (1.00), *Bacillus thuringiensis* 1×10^9 CFU/ml (1.07), Azardirachtin 00.03% WSP (1.13) and Neem seed kernel extract 5% (1.20) is found to be least effective among all the treatments as compared to control(2.13).

Overall mean of first spray:

The data on the larval population of gram pod borer on mean (3^{rd}, 7^{th}, 14^{th} DAS) days after spray revealed that all treatments was significantly superior over control. Among all the treatments Chlorantraniliprole 18.5 SC (1.05) found superior over other treatments followed by Emamectin benzoate (1.17), Spinosad 45 SC (1.24), *Beauveria bassiana* (1.32), *Bacillus thuringiensis* 1×10^9 CFU/ml (1.35), Azardirachtin 00.03% WSP (1.42) and Neem seed kernel extract 5% (1.47) is found to be least effective among all the treatments as compared to control (2.07).

Table .1 Effect of certain insecticides and biopesticides on the larval population of *Helicoverpa armigera* on chickpea during *rabi* season 2023-24 :

Treatments		Number of larvae / 5 plants				
		1DBS	After spray			
			3rd Day	7th Day	14th Day	Mean
T_0	Control	1.93	2.00	2.07	2.13	2.07
T_1	*Beauveria bassiana* 1.15 % WP	1.80	1.70	1.27	1.00	1.32
T_2	Chlorantraniliprole 18.5 SC	1.67	1.40	1.07	0.67	1.05
T_3	Emamectin benzoate 5 SG	1.73	1.50	1.13	0.87	1.17
T_4	*Bacillus thuringiensis* $1x10^9$ CFU/ml	1.80	1.70	1.27	1.07	1.35
T_5	Azardirachtin 00.03% WSP	1.73	1.80	1.33	1.13	1.42
T_6	NSKE 5%	1.80	1.80	1.40	1.20	1.47
T_7	Spinosad 45 SC	1.73	1.60	1.20	0.93	1.24
Overall Mean		1.77	1.69	1.34	1.13	1.39
F- test		NS	S	S	S	S
S. Ed. (±)			0.08	0.10	0.10	0.05
C. D. (P = 0.05)			0.185	0.228	0.224	0.255

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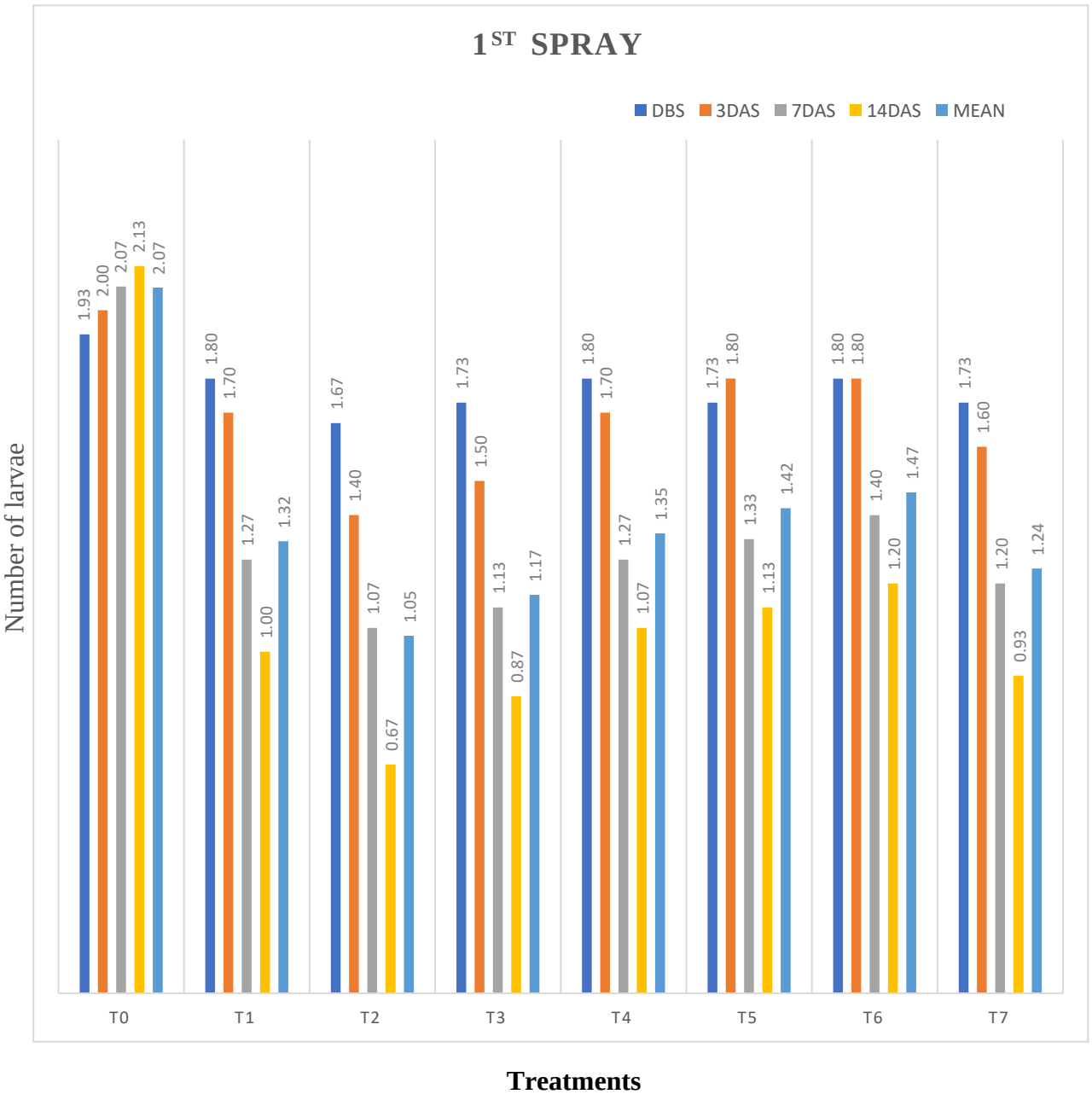

Figure. 1 Efficacy of selected chemicals and biopesticides against larval population of gram pod borer (*H. armigera*) on chickpea after first spray

Table .2 Economics of cultivation

Sr. No:	Treatment	Yield of q/ha	Cost of yield(₹)	Total costof yield (₹) (Gross return)	Common cost (₹)	Treatmentcost (₹)	Net Return (₹)	Total cost (₹)	B:C ratio
T_0	Control	11.00	5500	60500	39940	–	21260	39940	1:1.51
T_1	*Beauveria bassiana* 1.15 % WP	22.50	5500	123750	39940	1300	82510	41240	1:3.00
T_2	Chlorantraniliprole 18.5 SC	29.10	5500	160050	39940	2290	117530	42230	1:3.78
T_3	Emamectin benzoate 5 SG	26.65	5500	146575	39940	1550	105085	41490	1:3.53
T_4	*Bacillus thuringiensis* $1x10^9$ CFU/ml	21.24	5500	116820	39940	2240	74640	42180	1:2.76
T_5	Azardirachtin 00.03% WSP	17.08	5500	93940	39940	1700	52300	41640	1:2.25
T_6	NSKE 5%	13.50	5500	74250	39940	1800	32510	41740	1:1.77
T_7	Spinosad 45 SC	25.8	5500	141900	39940	4830	97130	44770	1:3.16

DISCUSSION

In the experiment eight different treatments were used *viz*, T_1- *Beauveria bassiana* 1.15 % WP, T_2- Chlorantraniliprole 18.5 SC, T_3 - Emamectin benzoate 5 SG, T_4 - *Bacillus thuringiensis* $1x10^9$ CFU/ml, T_5- Azardirachtin 00.03% WSP, T_6 – NSKE 5%, T_7- Spinosad 45 SC and T_0- untreated control, to tested to compare the efficacy against larval population of gram pod borer *Helicoverpa armigera* and theirinfluences on yield of chickpea.

The data on the mean (3, 7, 14 DAS) of first spray for population of *Helicoverpa armigera*, revealed that all the treatments except untreated control which effective for controlling the larval population. Among all the treatments lowest larval population was recorded in T_2-Chlorantraniliprole 18.5 SC (1.05) followed by T_3- Emamectin benzoate 5SG (1.17), T_7-Spinosad 45 SC (1.24), T_1- *Beauveria bassiana* 1.15 WP (1.32), T_4-*Bacillus thuringiensis* 1×10^9 CFU/ml (1.35), T_5- Azardirachtin 00.03% WSP (1.42), T_6- Neem seed kernel extract 5% (1.47) is found to be least effective among all the treatments as compared to control (2.07).

The data on mean population after spray revealed that all the insecticides were found very effective and significantly superior over untreated control. Among all the treatments minimum number of larvae were found in T_2 Chlorantraniliprole 18.5 SC (1.05) as the similar findings was reported by **Santosh and Kumar (2022), Jayanth and Kumar (2022), Barwa and Kumar (2022) and Bhati *et al*., (2023)** to control *Helicoverpa armigera* larval population. T_3- Emamectin benzoate 5SG (1.17) was found the next effective treatment with larval population (1.17) similar finding was reported by **Abbas *et al*., (2021) and Reddy and Tayde (2023)** were found to be the next best treatment for reducing the larval population of *Helicoverpa armigera*. T_7-Spinosad 45 SC (1.24) was found the next best effective treatments which was similarly found by **Ravicharan and Tayde (2023)** who reported Spinosad 45 SC to be the next best and effective treatment in controlling larval population , T_1- *Beauveria bassiana* 1.15 WP (1.32) was found the next most effective treatment with the same findings was done by **Sai *et al*.,(2021)**, **Sireesha and Kumar (2022**) T_4-*Bacillus thuringiensis* 1×10^9CFU/ml was found the next best effective treatment with a larval population of (1.35) as the same findings was done by **Abbas *et al*., (2021) and Yerrabala *et al*., (2021)**, T_2 Azardirachtin 00.03% WSP was foundthe next effective treatment with a larval population of (1.42) as the same findings was done by **Santosh and Kumar (2022**) and **Gautam *et al*.,(2018)**,T_6 NSKE 5% was found the least effective

treatment with a larval population of (1.47) and the same findings was done by **Machindra and Kumar (2022).**

When the cost benefit ratio worked out, interesting result was achieved. Among all the treatments the higher cost benefit ratio was obtained from T_2 Chlorantraniliprole 18.5 SC (1:3.78), as the similar findings was done by **Sireesha and Kumar (2022), Barwa and Kumar (2022), Bhati *et al*.,(2023),** followed by the T_3 Emamectin benzoate 5SG exhibited a cost benefit ratio of (1:3.53) as the similar finding was done by **Bharti *et al*.,(2015)**, followed by T_7 Spinosad 45 SC with a cost benefit ratio of (1:3.16) as the similar finding was done by **Nitish *et al*.,(2015), Keval *et al*., (2016) Choudhary *et al*.,(2017) and Chandra *et al*., (2017)** , which was followed by T_1 *Beauvria bassiana* which exhibited cost benefit ratio of (1:3.00) which was supported by the finding of by **Golvankar *et al*.,(2015), Adsure *et al*.,(2015)**, followed by T_4 *Bacillus thuringiensis* exhibited cost benefit ratio of(1:2.76) it was supported by **Kumara *et al*., (2016) and Chitralekha *et al*.,(2018)**, which was followed by T_5 Azardirachtin 00.03% WSP with a cost benefit ratio of (1:2.25) as the similar finding was done by **Yerrabala *et al*.,(2021), Santosh and Kumar (2022)**, Followed by T_6 NSKE 5% which obtained a cost benefit ratio of (1:1.77) which was supported by **Meena *et al*.,(2018)** and **Singh *et al*.,(2015).**

CONCLUSION

From the above discussion it was found that, spraying of insecticides significantly reduced the pod borer population in chickpea. The present findings conclude that the new generation insecticides like T_I *Beauveria bassiana* 1.15 WP , T_2 Chlorantraniliprole 18.5% SC, T_3 Emamectin benzoate 5%SG, T_4 Bacillus thuringiensis 1×10^9 CFU/ml, T_5 Azadirachtin 00.03 WSP, T_6 NSKE 5%, T_7 Spinosad 45 SC. T_2 Chlorantraniliprole was found effective against lepidopteran caterpillar *Helicoverpa armigera* along with an additional yield level in chickpea. Further, it was observed that the cost benefit ratio was also high with Chlorantraniliprole 18.5% SC, Emamectin benzoate 5 SG and Spinosad 45% SC. Hence, it is suggested that the effective insecticides may be alternated in harmony with the existing Integrated pest management programs in order to avoid the problems associated with insecticidal resistance, pest resurgence etc.

REFRENCES

Abbas, A., Wang, Y., Muhammad, U. and Fatima, A. (2021). Efficacy of different insecticides against gram pod borer (*Helicoverpa armigera*) and their safety to the beneficial fauna. *International Journal of Biosciences*, **18**: 82-88.

Adsure, S. P., and Mohite, P. B. (2015). Efficacy of entomopathogenic fungi against grampod borer, *Helicoverpa armigera* (Hub.) on chickpea. *Journal of Global Biosciences*, **4**(8):3154-3157.

Barwa, J. and Kumar, A. (2022). Field efficacy of Chlorantraniliprole with some biopesticides against pod borer [*Helicoverpa armigera* (Hubner)] on chickpea (*Cicer arietinum* L.). *The Pharma Innovation Journal*, **11**(6): 1912-1916.

Bhati, M. S., Rajnikant, T. A., Singh, S. P. and Chandar, A. S. (2023). Effect of Selected Biopesticides and Chemicals against Pod Borer [*Helicoverpa armigera* (L.)] on Chickpea (*Cicer arietinum* L.). *International Journal of Plant and Soil Science*, **35**(18): 423-426.

Bharti, P., Singh, S.P.N. and Kumar, N. (2015). Efficacy of some insecticides, bio-productsand their Phytotonic effect against gram pod borer (*Helicoverpa armigera* Hub.) inchickpea. *Current Biotica* **9**: 247–255.

Chandra, GV., Kumar, A., Lavanya, V., and Sayad, R. (2017). Efficacy of Certain Chemicals and Neem Products against *Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.). *Journal of Entomology and Zoology Studies* **5**(2): 01-05

Chitralekha, G. S., and Verma, T. (2018). Efficacy of insecticides against *Helicoverpa armigera* on chickpea. *Journal of Entomology and Zoology Studies*, **6**(3):1058-1061.

Choudhary, R., Kumar, A., Jat, G. C., Vikram and Deshwal, H. L. (2017). ComparativeEfficacy of Certain Bio-Pesticides against Tomato Fruit Borer, *Helicoverpa armigera* (Hub.). *International Journal of Current Microbiology and Applied Sciences.* **6**(8): 1068-1081.

Gautam, M. P., Chandra, U., Yadav, S. K., Jaiswal, R., Giri, S. K. and Singh, S. N. (2018). Studies on population dynamics of gram pod borer *Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.). *Journal of Entomology and Zoology Studies*, **6**(1): 904-906.

Golvankar, G. M., Desai, V. S., and Dhobe, N. S. (2015). Management of chickpea podborer, *Helicoverpa armigera* Hubner by using microbial pesticides and botanicals. *Trends in Biosciences*, **8**(4):887-890.

Jayanth, T. and Kumar, A. (2022). Field efficacy of selected insecticides with combination of neem oil against gram pod borer [*Helicoverpa armigera* (Hubner)]. *The Pharma Innovation Journal*, **11**(5): 465-469.

Keval, R., Yadav, A., Srivastava, C. P., and Kumar, R. (2016). Evaluation of certain newer insecticides against pod fly (*Melanagromyza obtusa*) and pod borer (*Helicoverpa armigera*) on long duration pigeon pea. *Research on Crops*, **17**(1): 129-133.

Kumar, A. and Yadav, U. (2023). Efficacy of different plant products against gram pod borer [*Helicoverpa armigera* (Hubner)] on chickpea, *Cicer arietinum* (L.) *The Pharma Innovation Journal* 2023; **12**(7): 1922-1927.

Kumar, A., Tripathi, M. K., Chandra, U. and Veer, R. (2019). Efficacy of botanicals and bio-pesticide against *Helicoverpa armigera* in chickpea. *Journal of Entomology and Zoology Studies*, **7**(1): 54-57.

Kumara, G. S., Bhaskarb, L. V., Satishc, Y., and Rehamand, S. J. (2016). Evaluation of liquid formulations of *Bt* against gram pod borer, *Helicoverpa armigera* (Hubner) and spotted pod borer, *Maruca vitrata* (Geyer) in pigeon pea. *Journal of Applied BiologyBiotechnology*, **4**(1):39-42

Machindra, J., P. and Kumar, A. (2022). Field efficacy and economics of different chemicals and biopesticides against pod borer, *Helicoverpa armigera* (Hubner) on chickpea during *rabi* season. *The Pharma Innovation Journal* 2022, SP-**11**(7): 3970-3975.

Meena, R. K., Naqui, A. R., Meena, D. S., and Shibbhagvan, S. (2018). Evaluation of bio-pesticides and indoxacarb against gram pod borer on chickpea. *Journal of Entomologyand Zoology studies*, **6**, 2208-2212.

Nithish, A., Joshi, B., Jayaram, C. S., and Kariyanna, B. (2015). Bio-efficacy of SomeNewer Insecticides against Gram Pod Borer (*Helicoverpa armigera*) in Pigeonpea under Field

Conditions. *Research Journal of Agricultural Sciences*, **6**(3):563-566.

Ravicharan, C., and Tayde, A. R. (2023). Field efficacy of Selected Insecticides against Pod Borer, *Helicoverpa armigera* (H.) in Chick Pea (*Cicer arietinum* Linnaeus). *Biological Forum – An International Journal*, **15(**6): 220-223

Reddy, D. V., and Tayde, A. R. (2023). Comparative efficacy of different insecticides against fruit borer, *Helicoverpa armigera* (Hubner) on tomato, *Solanum Lycopersicon* (L.). *Annals of Plant Protection Sciences*, **31**(2): 122-126.

Sai, K. P., Tayde, A. R., Reddy, R. D. and Srivastava, V. K. (2021). Management of gram pod borer *Helicoverpa armigera* (Hubner) in chickpea with bio-pesticides and combination. *Journal of Entomology and Zoology Studies*, **9**(1): 561-563.

Santhosh, K., and Kumar, A. (2022). Comparative efficacy of selected insecticides and neem products against chickpea pod borer *[Helicoverpa armigera* (Hubner)]. *The Pharma Innovation Journal.* **11**(6): 1558-1562

Sireesha, B. S. and Kumar, A. (2022). Efficacy of selected insecticides against pod borer [*Helicoverpa armigera* (Hubner)] on green gram. *The Pharma Innovation Journal*, SP-**11**(8): 944-948.

Yerrabala, S., Kumar, H. S., and Yadav, U. (2021). Comparative efficacy of *Bacillus thuringiensis* with botanicals and chemicals against gram pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) on cowpea [*Vigna unguiculata* (L.) Walp.]. *The PharmaInnovation Journal*, SP-**10**(5): 709-712.