Fieldefficacyand economics ofcertainbiopesticidesandchemicalsagainstgrampod borer,*Helicoverpaarmigera*(Hubner)ongreengram[*Vignaradiata*(L.)Wilczek]

ABSTRACT

In the kharif season of 2023–2024, a field experiment was carried out at the in Eight treatments—Spinosad 45SC, Ha NPV 1X109ml/min, Neem seed kernel extract 10% WP, Emamectin Benzoate 5%SG, Azadirachtin (Neem oil) 0.03% WSP, Chlorantraniliprole 18.5SC, Bacillus thuringienssis 4% WSP, and untreated Control—were used in the RBD experiment. Each treatment was replicated three times. After the first and second sprays, data on the Helicoverpa armigera larval population showed that all treatments were much beter than the control. Following Chlorantraniliprole (18.5%SC) (0.323) as the least amount of larvae was recorded among all the treatments, Spinosade (45%SC) (0.456), Emamecttin benzoate (5%SG) (0.578), Azadirachtin (Neem oil) 00.03%EC (0.712), Neem seed kernel extract (10%The highest documented larval population in this case was 1x108CFU (1.112) of Bacillus thuringiensis. However, the treatment that produced the best yield (15.36 q/ha) was chlorantraniliprole 18.5% SC. An intriguing outcome was obtained when the cost-benefit ratio was calculated. The study found that, when compared to a control plot of 1:1.04, the most effective and cost-effective treatment was Chlorantraniliprol 18.5 SC (1:3.65), followed by Spinosade 45% SC (1:3.26), Emamectin benzoate 5% SG (1:2.94), and Azadirachtin (Neem oil) 00.03%EC (1:1.89), Neem seed kernel extract 10% WP (1:1.92), Ha NPV 1X109 POB ml/min (1:1.62), and Bacillus thuringiensis 1x108CFU (1:1.58).0.978, 1X 109 POB/ml/min.

WP) (0.845), and Ha NPV 1X 109 POB/ml/min (0.978) were the next five treatments.

KEYWORDS:Biopesticides,chemicals,greengram,*Helicoverpaarmigera*,podborer.

INTRODUCTION

One of the most crucial pulse crops in India, green gram (Vigna radiata L. Wilczek. 2n=22) is a legume food that is farmed all over the world in tropical and sub-tropical climates and is considered to be commercially significant. This legume's value stems from its beneficial qualities, which include a high protein content (25-28%), lower flatulence than other pulses, broad adaptability, low requirement for agricultural inputs, and the capacity to improve soil fertility. Because they are high in vitamins and minerals, green gram sprouts and green pods are an excellent and costly source of nutritional protein for those in poverty (Mehandi et al., 2019).

Green gram stands out among pulse crops for its impressive adaptability to diverse environmental conditions, making it a resilient choice for farmers in various regions. This adaptability, coupled with its low input requirements, allows for cost-effective cultivation, making it a popular crop in resource-limited settings. Furthermore, green gram plays a pivotal role in sustainable agriculture by its capacity to fix atmospheric nitrogen, thereby improving soil fertility and reducing dependency on synthetic fertilizers.

Mung beans are known for having a lot of nutrients. Mung beans are high in protein, fat, vitamins, and minerals and contain between 55% and 65% carbohydrates. Its protein content ranges from 20% to 50% of the total dry weight, with albumin (25%) and globulin (60%) serving as the main storage proteins. Mung beans are recognized as a major source of dietary protein, with an annual production of 13.45 lakh tonnes and a cultivation area of approximately 30.48 lakh hectares. India is the leading producer of grain legumes or pulses globally, contributing to 70% of the world's greengram production. India achieves an annual production of 1.5 to 2.0 million tonnes of mung beans from approximately 3 to 4 million hectares of land, with an average yield of 798 kg per hectare (Kumar and Sireesha, 2022).

India is the major producer and user of greengrams globally. India's mung bean production spans 3 to 4 million hectares of land annually, yielding between 1.5 to 2.0 million tonnes. The average productivity is approximately 500 kg per hectare. Major mung bean cultivation is concentrated in Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, and Bihar states.Rajasthan (26%), followed by Maharashtra (20%), account for the first two places among these five states, providing more than 46% of the total production. Andhra Pradesh makes up over 10% of the nation's total production, whereas Gujarat and Bihar combined make up approximately 13% (Anonymous 2016).

Despite its high productivity, the cultivation of greengram faces significant challenges, particularly from the gram pod borer, Helicoverpa armigera. This pest is recognized for its prolific reproductive capacity, migratory habits, ability to adapt to diverse agroclimatic conditions, and development of resistance to various insecticides, posing a potentially polyphagous threat to numerous crops, including greengram (Kambrekar et al., 2009).

The larvae of Helicoverpa armigera cause substantial damage by consuming the tender leaves and penetrating the pods to feed on developing seeds. Typically, the front portion of the larva remains within the pod, while the rear portion protrudes outside, leading to considerable yield losses (Kumar & Gayathri, 2021). Effective pest management strategies are essential to mitigate the impact of Helicoverpa armigera and ensure the sustained productivity of greengram crops in India.

Materials and methods:

An experiment was carried out during the Kharif season of 2023 at SHUATS, Prayagraj, India, employing a Randomized Block Design (RBD) with eight treatments, replicated three times. The Kamad 60 variety was utilized, grown in plots measuring 2 m x 1 m, spaced at 30 × 10 cm intervals. The agricultural practices followed adhered to recommended standards, with the exception of plant protection measures. The soil type at the experimental site was well-drained and of medium elevation.

Eight treatments were tested against the gram pod borer: Spinosad 45SC (T1), Ha NPV 1x10□ ml/min (T2), Neem seed kernel extract 10% WP (T3), Emamectin Benzoate 5% SG (T4), Azadirachtin (Neem oil) 0.03% WSP (T5), Chlorantraniliprol 18.5% SC (T6), Bacillus thuringienssis 4% WSP (T7), and an untreated control (T8). Pesticides were applied at specified concentrations when the larval population reached the Economic Threshold Level (ETL) of 10% damaged pods. Observations were recorded on the number of larvae per plant at pre-count, and at 3, 7, and 14 days after each application, based on three randomly selected plants per plot. The number of mature pods damaged by Helicoverpa armigera was counted and expressed as the larval population. Grain yield per plot was calculated after threshing all pods from each treatment and reported per hectare.

Cost-effectivenes of each treatment was evaluated based on net returns, which were calculated by subtracting the total cost of treatment (including cultivation and plant protection costs) from the gross returns.

Formulae used:

$$\text{Larval population} = \frac{\text{Number of Larvae}}{\text{Total number of } selected\ plants}$$

Economics :

Cost Benefit ratio

$$\text{C:B ratio} = \frac{Grossreturns}{Totalcostincurred}$$

Gayathri and Kumar (2021)

Results and Discussion:

All treatments showed significantly better results compared to the control when comparing the mean larval population of H. armigera after the first and second sprays. Among the treatments, T6 Chlorantraniliprol 18.5% SC recorded the lowest larval population (0.323), followed by T1 Spinosad 45% SC (0.456), T4 Emamectin benzoate (0.578), T5 Azadirachtin (Neem oil) 0.03% WSP (0.712), T3 Neem seed kernel extract 10% WP (0.845), and T2 Ha NPV 1x10□ POB ml/min (0.978). The highest larval population was observed in T7 Bacillus thuringiensis 1x10□ CFU (1.112).

Data from the first and second sprays indicate that all treatments, except the untreated control, were effective. Chlorantraniliprole 18.5% SC was the most effective in reducing the larval population (0.323). Similar studies by Rahman et al. (2014) and Mahajan et al. (2020) found that Spinosad 45% SC (0.456) was the next best treatment. These findings are consistent with those of Singh et al. (2012), who reported that Spinosad 45% SC was highly effective in reducing the population of greengram pod borer and increasing yield. Emamectin benzoate 5% SG (0.578) was identified as the second-best treatment, as noted by Kale (2008).

The next successful treatment is discovered to be azadirachtin (Neem oil) 00.03%WSP (0.712), which is consistent with the findings of Chandra et al. (2018) and Moraly et al. (2000). The next successful therapy is neem seed kernel extract (0.845), which is consistent with the results of Byrapa et al. (2012) and Moraly et al. (2000). The next successful treatment is determined to be Ha NPV 1X109ml/min (0.978), which is consistent with the findings of Kale (2008), Byrapa et al. (2012), and Rahman et al. 2014.

The differences in yields between the various treatments were noteworthy. Every therapy was better than the control. Chlorantraniliprole18.5SC (15.36 q/ha) had the highest yield, followed by Spinosad 45SC (14.15 q/ha), Emamecttin benzoat (12.21 q/ha), Azadirachttin (neem oil) 00.03%WSP (8.1 q/ha), Neem seed kernel extract 10%WP (7.93 q/ha), HaNPV1X109ml/min (7.09 q/ha), Bacillus thuringienssis 4%WSP (6.5 q/ha). An intriguing outcome was obtained when the cost-benefit ratio was calculated. T1 Spinosad 45%SC (1:3.26), T4 Emamectin benzoate 5%SG (1:2.94), and T5 Azadirachtin (Neem oil) 00.03%WSP (1:1.89) were the most effective and economical of the treatments examined. T3 Neem seed kernel extract 10% WP (1:1.92), T2 Ha NPV 1X109ml/min (1:1.62), and T7 Bacilus thuringienssis 1x108CFU (1:1.58) were the next best and most cost-effective treatments. Cherry (2000), Babariya et al. (2010), Rashid et al. corroborate these findings.

Table 1:Field efficacy of biopesticidesandchemicalsonlarvalpopulationofpodborerongreengram and Yield and C:B ratio

T.No	Treatments	Number of larvalpopulationper5plants									Overall mean	Yield (q/ha)	C:B Ratio
		1st Spray					2ndSpray						
		1DBS	3 DAS	7 DAS	14DAS	Mean	3 DAS	7DAS	14DAS	Mean			
T_1	Spinosad45SC	1.200	0.867	0.533	0.667	0.689	0.333	0.067	0.267	0.222	0.456	14.15	1:3.26
T_2	*Ha*NPV1X10^{9}ml/min	1.133	1.667	1.333	1.400	1.467	0.600	0.333	0.533	0.489	0.978	7.09	1:1.62
T_3	Neemseedkernelextract10% WP	1.933	1.467	1.133	1.200	1.267	0.533	0.267	0.467	0.422	0.845	7.93	1:1.92
T_4	Emamectinbenzoate5%SG	1.400	1.067	0.733	0.800	0.867	0.400	0.133	0.333	0.289	0.578	12.21	1:2.94
T_5	Azadirachtin(Neemoil) 00.03%WSP	0.867	1.267	0.933	1.000	1.067	0.467	0.200	0.400	0.356	0.712	8.1	1:1.89
T_6	Chlorantraniliprole18.5SC	1.333	0.667	0.333	0.467	0.489	0.267	0.000	0.200	0.156	0.323	15.36	1:3.65
T_7	*Bacillusthuringiensis* 4%WSP	1.600	1.867	1.533	1.600	1.667	0.667	0.400	0.600	1.556	1.112	6.5	1:1.58
T_8	Control	2.400	2.600	2.767	2.800	2.722	3.200	3.733	4.067	3.667	3.195	4.3	1:1.14
	F-test	**NS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	S		
	S.Ed.(±)	0.142	0.003	0.111	0.001	0.004	0.006	0.008	0.009	0.015	0.097	-	-
	C.D.(P=0.05)	-	0.143	0.279	0.094	0.173	0.209	0.310	0.252	0.313	1.070	-	-

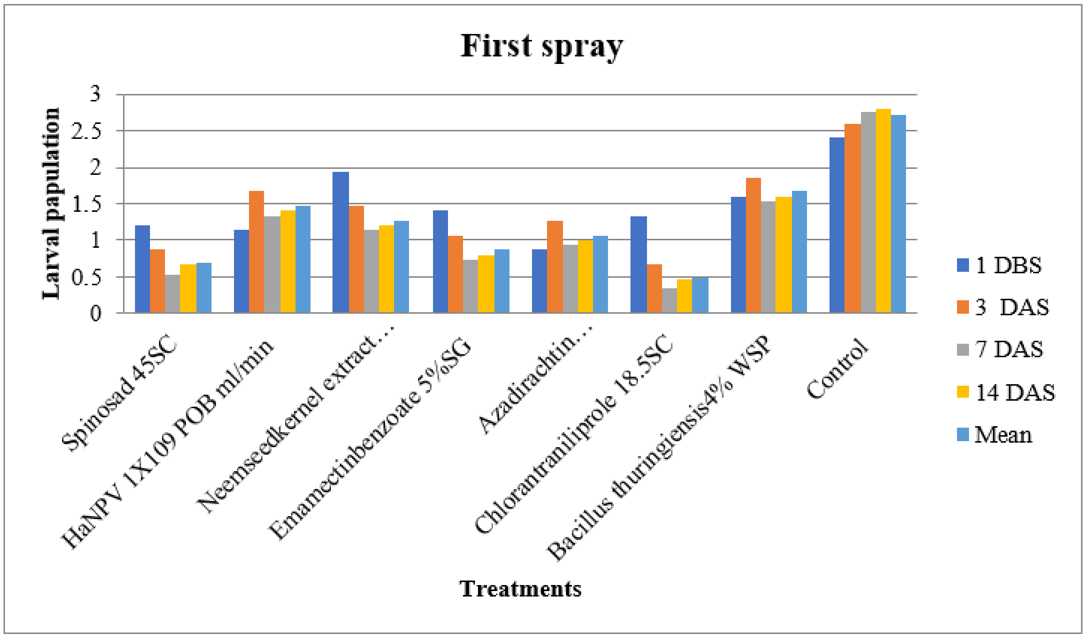

Fig 1 Efficacy of biopesticides and chemicals on the larval population of pod borer on greengram (First spray)

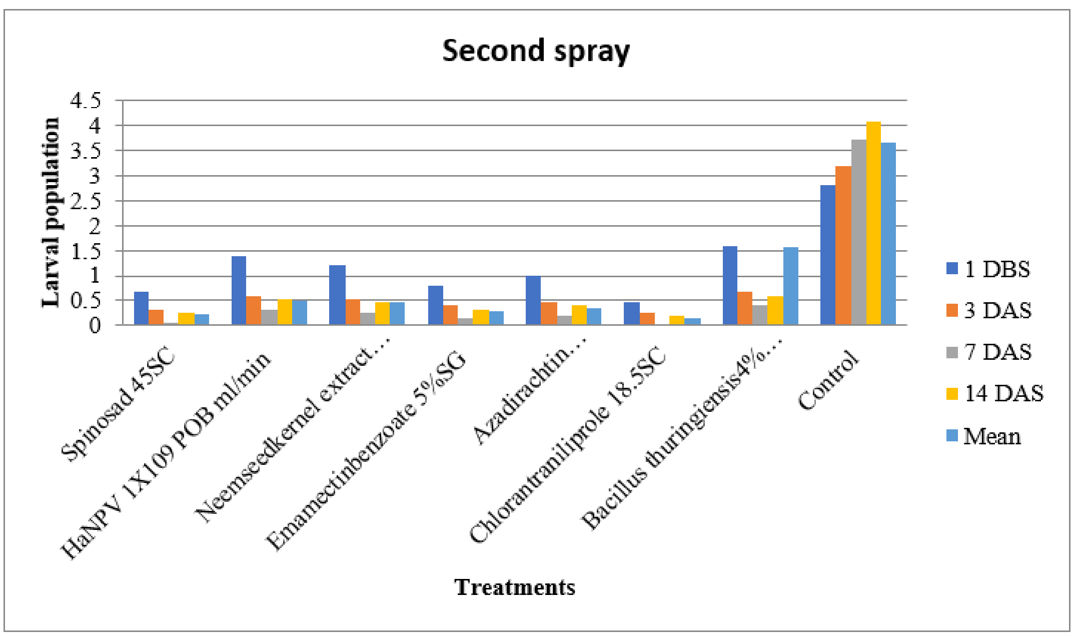

Fig 2 Efficacy of biopesticides and chemicals on the larval population of pod borer on greengram (Second spray)

CONCLUSION

From the critical analysis of the present findings, it can be concluded that Chlorantraniliprole18.5SCismoreeffectiveincontrollinglarvalpopulationofgreengrampodborerf ollowedbySpinosad 45SC, Emamectin benzoate, Azadirachtin (Neem oil) 00.03%WSP, Neem seedkernel extract10%WP in managing green gram pod borer. Among the treatments studied, thebestandmosteconomicaltreatmentwasChlorantraniliprole18.5SCgavethecostbenefitratioof(1 :3.65)andmarketingyieldof(15.36q/ha)followedbySpinosad45SC(1:3.94and14.15q/ha), Emamectin benzoate(1:2.94 and12.21 q/ha), Azadirachtin(Neem oil) 00.03WSP(1:1.89and8.1q/ha),Neemseedkernelextract10%WP(1:1.92and7.93q/ha),*Ha*NPV1X 10^9ml/min (1:1.62 and7.09 q/ha), and *Bacillus thuringiensis* 1x10^8CFU (1:1.58 and 6.5q/ha).Hencethiscanbeapartofintegratedpestmanagementinordertoavoidindiscriminateuse of pesticides for ecofriendly management and to balance flora and fauna from ecosystemwhichcausespollutionintheenvironmentandalsoitwasbelessharmfultobeneficialinsect sand human beings. Respectively as such more trails are required in future to validate thefindings.

ACKNOWLEDGEMENTS

The authors aregreatful to Prof. (Dr.) Rajendra B. Lal, Hon'ble Vice Chancellor, SHUATS, Prof. (Dr.) Alok MiltonLall, Director of Research,Prof.(Dr.) Biswarup mehera, Dean, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, technology and Sciences, Prayagraj for making their keen interest and encouragement to carry out this research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

REFERENCES

1. Anonymous. MinistryofAgriculture&Farmers Welfare, Directorate of PulsesDevelopment,AnnualReport. Curr. Microbiol. App. Sci. International Journal of Plant Protection. 2016-17;9(8):3117-3124; 6, 108-110.

2. **Babariya, P.M., Kabara, S.N., Patel, V. N. and Joshi, M. D. (2010).** Chemological activitiesof control of gram pod borer, *Helicoverpa armigera* pigeonpea. *Legume Research*. **33**(3):224 -226.

3. **Byrappa, A. M., Kumar, N. G. and Divya, M. (2012).** Impact of biopesticides application onpodborercomplexinorganicallygrownfieldbeanecosystem.*JournalofBiopesticides*.**5**(2): 148.

4. **Chandra, U., Gautam, M. P., Singh, S. N., Yadav, S. K. and Giri, S. K. (2018).** Studies onefficacy of botanicals against*Helicoverpa armigera* (Hubner) on chickpea (*Cicerarietinum*L.).*International JournalofCurrentMicrobiologyandAppliedSciences*. **7:**612-618.

5. **Cherry,A.J., Rabindra,R.J.,Parnell,M.A.,Geetha,N.,Kennedy,J.S.andGrzywacz,D.(2000).** Field evaluation of *Helicoverpa armigera* nucleopolyhedrovirus formulationsfor control of the chickpea pod-borer, *Helicoverpa armigera* (Hubner), on chickpea(*Cicerarietinumvar.Shoba*)insouthernIndia. *CropProtection*.**19**(1): 51-60.

6. **Fite, T., Tefera, T., Negeri, M., Damte, T. and Sori, W. (2020).** Evaluation of *Beauveriabassiana*,*Metarhiziumanisopliae*,and*Bacillusthuringiensis*forthemanageme

ntof*Helicoverpaarmigera*(Hubner)(Lepidoptera:Noctuidae)underlaboratoryandfieldconditions.Biocontrol Science andTechnology.**30**(3): 278-295.

7. **Gayathri L, Kumar A.** Field efficacy of certain insecticides against pod borer, *Helicoverpaarmigera* (Hubner) on chick pea in Prayagraj. *Journal of Entomology and ZoologyStudies*.2021;9(3):280-283.

8. **Kale,S.N.andMen,U.B.(2008).**Efficacyofmicrobialinsecticidesandtheircombinations against*Helicoverpaarmigera*(Hubner)onchickpea.*JournalofBiologicalControl*.**22**(1): 205-208.

9. **Kambrekar, D.N., Kulkarni, K.A., Giraddi, R.S., Kulkarni, J.H. and Fakrudin, B.(2009).**Managementofchickpeapodborer,*Helicoverpaarmigera*(Hubner)throughNuclearPolyhedralVirusisolates.*PrecisionAgriculture*.**10:**450–457.

10. **Kumar, A., Tripathi, M. K., Chandra, U. and Veer, R. (2019).** Efficacy of botanicals andbio-pesticideagainst*Helicoverpaarmigera*inchickpea.*JournalofEntomologyandZoologyStudies*. 7(1):54-57.

11. **Kumar, L., Bisht, R.S., Singh, H., Kumar, A., Pandey, N. and Kumar, M. (2018)** Bioefficacyandeconomicsofsomenewerinsecticidesandbio-pesticidesagainst*Helicoverpa armigera* (Hub.) on chickpea (*Cicer arietinum* L.) crop. *Journal ofPharmacognosyand Phytochemistry*.**1**: 1739-1744.

12. **Mahajan, S.S., Kumar, A., Warghat, N.A., Kolhe, P.S. and Jagarlamudi, S.M.R. (2020)2**Comparative Efficacy of Latest Chemical Insecticides and Bio- Pesticides against(*Leucinodes orbonalis* Guenee.) on Brinjal at Trans Yamuna Region of Prayagraj(U.P.). *International Journal of Current Microbiological Applied Sciences.* **9**(7**):**3414-3429.

13. **Meena, L. K. and Raju, S. V. S. (2014).** Bioefficacy of newer insecticides against tomatofruitborer,*Helicoverpaarmigera*(Hubner)ontomato,*Lycopersiconesculentum* mill under fieldconditions. *TheBioscan*.**9**(1): 347-350.

14. **Mehandi S, Quatadah S, Mishra SP, Singh I, Praveen N, Dwivedi N.** Mungbean (*Vigna radiata* L. wilczek): retrospect and prospects. In Legume crops-

characterizationandbreedingforimprovedfood security, 2019, 49-66.

15. **Moraly. R. S., Sornaik, D. N., Satpute, V. S. and Sadwarte, A. K. (2000).** Effect of plantproducts on growth and development of *Helicoverpa armigera* (Hubner) on cotton.*Pestology*.**14**(1): 26-28.

16. **Muhammad,T.C.H.,Muhammad,A.M.andNaveed.(2005).**Studiedonthemanagementof*Helicoverpaarmigera*(Hubner)withdifferentinsecticides,*PakisthanJournalofAgriculture*.**42**(1-2).

17. **Rahman, A. K. M. Z., Haque, M. A., Alam, S. N. and Dutta, N. K. (2014).** Efficacy ofmicrobials as insecticides for the management of tomato (*Lycopersicon esculentum*)Fruitworm,*Helicoverpaarmigera*(Hubner).*TheAgriculturists*. **12**(1):68-74.

18. **Rashid,A.,Habib,A.S.,Lal,H.A.,Sabir,Z.S.andArshad,M.(2003).**Comparativeefficacyofvariousinsecticidestocontrolgrampodborer(*H.armigera*Hub.)onchickpea.*AsianJournalof Plant Sciences*.**2**(4):403-405.

19. **Singh,P.S.,Shukla,R.K.andYadav,N.K.(2012).**Bio-efficacyofsomeinsecticidesagainst*Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.). *Journal of foodlegumes*.***25***(4):291-293.

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

21. **Vikrant,Singh,D.R.,Kumar,S.,Kishor,K.andKewal,R.(2018)**Bio-efficacyofInsecticidesagainst*Helicoverpaarmigera*inChickpea. *LegumeResearch*.

22Mushinamwar DR, Yadav U, Gafar BB, Rajawat S. Efficacy of Selected Biopesticides against Mustard Aphid, Lipaphis erysimi (Kalt.) (Hemiptera: Aphididae). J. Adv. Biol. Biotechnol. [Internet]. 2024 May 25 [cited 2024 May 28];27(6):702-7. Available from: https://journaljabb.com/index.php/JABB/article/view/930

23 Roopwan, Yadav U, Madhu B. Efficacy of Biopesticides for the Management of Rice

Yellow Stem Borer Scirpophaga incertulas (Walker) in Rice at Prayagraj, U.P, India. Int. J. Plant Soil Sci. [Internet]. 2023 Jul. 25 [cited 2024 May 28];35(18):888-93. Available from: https://journalijpss.com/index.php/IJPSS/article/view/3354

24 Malinga LN, Laing MD. Efficacy of three biopesticides against cotton pests under field conditions in South Africa. Crop Protection. 2021 Jul 1;145:105578.