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A REVIEW ON COMPREHENSIVE MANAGEMENT STRATEGIES OF BRINJAL SHOOT AND FRUIT BORER

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ABSTRACT

Cultivation of brinjal (*Solanum melongena* L.) is of significant global importance, especially in Bangladesh, where it ranks second after potato. The production of brinjal in Bangladesh was 619000 Mt in 2021-22. However, the annual brinjal production in Bangladesh lags behind to leading brinjal-producing countries like India, China, and Japan due to various challenges encompassing environmental factors, soil conditions, insect pests, and diseases. One of the most formidable challenges is the infestation of brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* (Lepidoptera: Pyralidae), which inflicts substantial yield losses and threatens food security. This review synthesizes existing knowledge and innovations to provide a comprehensive understanding of management strategies to combat this notorious pest. This article states the effectiveness of various approaches, and their ecological and economic impacts, and offers insights and recommendations for sustainable management strategies of BSFB. Integrated pest management (IPM) packages have demonstrated significant success in reducing the infestation of brinjal shoot and fruit borer. Among the tactics of IPM, cultural practices such as mulching and clipping prove to be highly effective in reducing infestation levels. Neem oil and leaf extract have shown to be effective in controlling this pest.

Keywords: *Leucinodes orbonalis*, infestation, damage, management

Introduction

Brinjal (*Solanum melongena* L.) belongs to the family Solanaceae and is one of the important vegetable crops ranked second after potato in Bangladesh. The annual production of brinjal in Bangladesh is 619000 metric tons (BBS 2022). Approximately 15 percent of the nation's vegetable farming space is under brinjal cultivation. Brinjal has therapeutic value and is also abundant in minerals like calcium, magnesium, sodium, potassium, iron, etc. (Alam *et al*. 2022).

The most significant and highly destructive pest of brinjal in Bangladesh and across Asia is the brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* (Lepidoptera: Pyralidae). The insect has been responsible for a staggering role in annual yield losses in Bangladesh. BSFB pose a significant threat to brinjal crops in Bangladesh, leading up to 90% yield losses (Alam *et al*. 2022). According to another research finding, BSFB cause a big chunk of our crops to be lost per year around 67 to 80 percent (Majumdar and Powell 2011). Prevalence and infestation of this insect pest become a concern and need effective management strategies to safeguard brinjal yields in this region. Its capacity to damage both the shoots and fruits of the plant makes it a formidable adversary to growers. To combat this pest effectively, a comprehensive set of management strategies is essential. Farmers are presently using countless insecticides nearly 140 times or more in a cropping duration of 6-7 months and 32% of the total cost is contributed to crop production (Alam *et al*. 2006). According to a report from an insecticide survey, 180 times insecticides were used within a year to protect the brinjal against BSFB in Bangladesh (Islam *et al*. 2019). However, non-toxic microbial insecticides might be a potent alternative to chemical insecticides (Mollah *et al.* 2022a). Some microbial insecticides were found effective against BSFB in Bangladesh (Mollah *et al.* 2022b, Mollah *et al.* 2023). The economic threshold level of brinjal for shoot and fruit borer is 0.5% of shoot, 5% of fruit damage. By synthesizing existing knowledge and innovations, this review aims to provide a holistic understanding of how

farmers, researchers, and policymakers can collectively tackle the persistent challenge posed by the BSFB while maintaining the sustainability of brinjal cultivation. The objective of this review is to figure out the effectiveness of various management strategies employed to combat brinjal shoot and fruit borer infestation.

Production of brinjal in Bangladesh

The soil and climatic conditions of Bangladesh are favorable for brinjal production in Bangladesh. There are adequate varieties for cultivation throughout the year. According to the report of BBS 2022, brinjal production has increased 103 metric tons (from 516000 to 619000 Mt) in the last five years (Figure 1). Area of brinjal cultivation in the summer and winter seasons of the fiscal year 2021-22 in Bangladesh were 19995 ha and 34211 ha, respectively (BBS 2022). Amounts of brinjal production in the summer and winter seasons of the year were 145207 Mt and 409002 Mt, respectively. However, brinjal is native to our region and there have been domesticated large number of fruiting cultivars but the yield is still low because of the infestation of different insect and mite species. Brinjal faces challenges from various insect pests. Seventeen species of insects and six types of diseases in Bangladesh are found in brinjal plants (Roy 2014). Some common insect pests of brinjal are listed in Table 1. Amin *et al.* (2018) reported nine species of insects belonging to seven families under four orders as the pest of brinjal in Bangladesh. In our country, infestation of brinjal shoot and fruit borer is the key factor causing a decline in brinjal production.

Diagnostic characteristics and life cycle of brinjal shoot and fruit borer

The adult brinjal shoot and fruit borer, with a wingspan of 18-24 mm, features white wings with a distinctive brown patch and black spots. Females are larger, characterized by a swollen, ovate abdomen, while males have a slimmer, cylindrical abdomen with a blunt tip and white hairy structures. Reproductively, elongated, creamy white eggs hatch into larvae that can grow up to 155 mm in length, displaying a reddish color through five larval instars. The fifth instar larvae leave the fruit, cease feeding, and enter a pupation phase, secreting a silk cocoon (Wankhede *et al*. 2009, Maravi *et al*. 2013, Bindu *et al*. 2015). Mating occurs at night or in the early morning, lasting about 43 minutes. (Sharma *et al.* 2017).

Brinjal shoot and fruit borer is a holometabolous insect having four distinct life stages namely egg, larva, pupa, and adult (Figure 1). The larval stage is the longest, followed by the pupa, and the incubation period. The larval stage in the life cycle of this insect is the lengthiest in terms of growth duration, followed by the pupal stage, and finally, the incubation period (Neetam *et al*. 2018). Oviposition or egg-laying occurs over 2-3 days, and the incubation period ranges from 3-8 days depending on temperature. According to Table 2, larvae undergo 5-6 molts, lasting 16.8 ± 4.54 days. The pupal stage usually lasts 12.3±1.76 days. Adult moths have varying lifespans, with males surviving 2.95 ± 0.98 days and females 5.4±1.5 days. The

Table 1. Common insect and mite pests of brinjal plants

Common name	Scientific name	Family	Order
Thrips	*Hercothrips indicus*	Thripidae	Thysanoptera
Aphid	*Aphis gossypii*	Aphididae	Hemiptera
Jassid	*Amrasca biguttula*	Cicadellidae	Hemiptera
Whitefly	*Bemisia tabaci*	Aleyrodidae	Hemiptera
Leaf hopper	*Amrasca devastans*	Cicadellidae	Hemiptera
Epilachna beetle	*Epilachna punctata*	Coccinellidae	Coleoptera
Fruit and shoot borer	*Leucinodes orbonalis*	Crambidae	Lepidoptera
Stem borer	*Euzophera perticella*	Phycitidae	Lepidoptera
Leaf roller	*Eublemma olivacea*	Noctuoidea	Lepidoptera
Mite	*Tetranychus urticae*	Tetranychidae	Acari

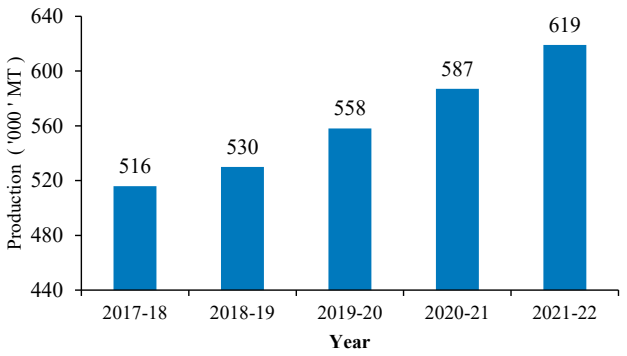


Figure 1. Production of brinjal in Bangladesh during the 2017-18 to 2021-22.



Figure 2. Life cycle of brinjal shoot and fruit borer.

larval stage of *L. orbonalis* lasts for approximately 12-15 days during the summer and extends to 14-22 days during the winter season (Rahman, 2006).

Nature of damage and infestation level of brinjal shoot and fruit borer

The Brinjal shoot and fruit borer primarily target eggplants but can infest other plants in the Solanaceae family, including tomatoes, sweet potatoes, *Solanum indicum*, and African eggplants. Shoot and fruit borer infestation is highly destructive, causing holes in shoots and fruits, reducing yields, and depleting vitamin C content by up to 80%. The larvae of this pest bore into tender shoots, buds, and flowers. Later, they make tunnel inside fruits, creating feeding tunnels and dead heart damage. The entry holes on fruits are often obscured by frass, and circular exit holes become visible. A single fruit can host up to 20 larvae, with each larva capable of damaging 4-7 healthy fruits. This voracious feeding behavior poses a significant threat, necessitating effective pest management strategies for eggplants and related crops (Baral *et al*. 2006, Plazas *et al*. 2014). Yasmin *et al*. (2021) studied the abundance and infestation of brinjal shoot and fruit borer on different germplasms of brinjal. They reported that the abundance of larvae in the tested germplasms ranged from 1.1±0.1 to 2.6±0.2 per fruit and infestation from 14.0±1.2 to 19.3±0.9%, and the results differed with the morphological and biochemical characteristics of the germplasms.

Table 2. Developmental time of brinjal shoot and fruit borer

Biological parameter	Duration(days)
1st instar	3.95±0.92
2nd instar	2.3±0.94
3rd instar	3.2±0.67
4th instar	3.55±0.98
5th instar	3.8±1.03
Pupal period	12.3±1.76
Male longevity	2.95±0.98
Female longevity	5.4±1.50

Management strategies of brinjal shoot and fruit borer

Cultural practices: An ecologically based approach to pest management is centered on population regulation through preventive strategies. Instead of relying on chemical control, this approach emphasizes the use of environmentally safe and practical alternatives to manage significant insect pests in fruit and vegetable crops, including brinjal. Various cultural practices are recommended for effectively managing BSFB. These practices offer environmentally friendly alternatives to mitigate pest damage. Some of these strategies include mulching, weed control, irrigation, pruning, stalking, mixed cropping, and removal of alternate hosts. Muhammad *et al*. (2021) reported that mulching, clipping, and mulching along with clipping reduced shoot infestation 39.2%, 47.1% and 61.6%, respectively (Figure 3). They reported that mulching, clipping, and mulching along with clipping reduced fruit infestation 34.8%, 52.8% and 67.9%, respectively (Figure 3).

Mechanical control: Mechanical control methods for managing brinjal shoot and fruit borer involve physical interventions to prevent or remove the pest. Mechanical methods include hand picking, traps, crop rotation,

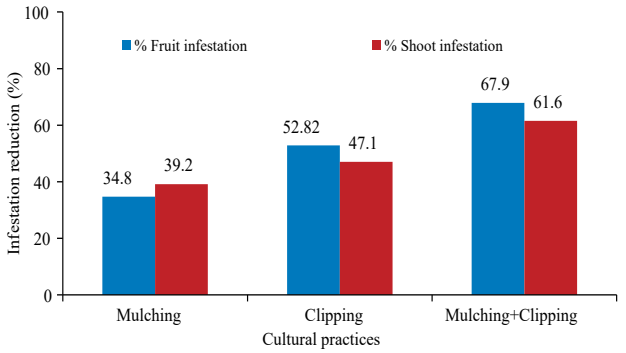


Figure 3. Reduction of brinjal shoot and fruit borer infestation (%) by different cultural practices.

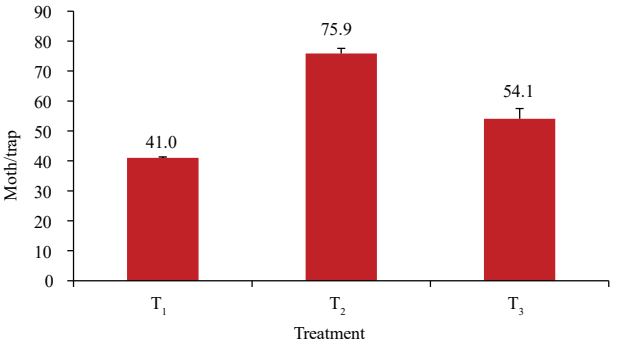


Figure 4. The mean number of adult moths captured in plots using pheromone and sticky traps over a 56-day period.

planting traps, physical barriers, pruning and sanitation, soil drenching etc. These methods help to reduce pest populations and infestations. Combining the use of barriers and prompt removal of damaged shoots, the pest has proven highly effective in reducing shoot damage by an average of 62.7% (Chaukikar *et al*. 2020). Erect barriers made of nylon net at suitable heights affect the flight capabilities of the adult moths. Under such conditions, moths can fly short distances. Net houses or poly-houses are effective protection measures for brinjal shoot and fruit borer (Kaur *et al*. 1998). Faruq *et al*. (2021) applied treatments such as treatment 1(T_1: Voliam flexi 300 SC at the @ 0.5 ml/L water at 10 days intervals + hand collection and destruction of infested fruits and larvae + pheromone trap+ nappy trap), treatment 2 (T_2: Spinosad 45SC @ 0.4 ml/L water at 10 days interval + nappy trap), and treatment 3 (T_3: Ripcord 10EC @ 1.0 ml/L water at 10 days interval + pheromone trap) to control the brinjal shoot and fruit borer, and found that the treatment 2 was best for capturing adult moth.

Table 3. List of brinjal varieties resistance to shoot and fruit borer

Country	Tolerant varieties
Bangladesh	BARI begun-6, BARI begun-4, Katabegun, Marich begun, EG075, Jumki-1, Jumki-2, Islampuri-3
India	Long Purple, Katrain-4, Doli-5, Pusa Purple Cluster, Junagarh Long
Pakistan	Shilpa, Nirala and Hybrid 3715

Cultivation of resistant varieties: Studies by Manna *et al*. (2003), Ahmed *et al*. (2008), and Abhishek *et al*. (2021) have documented the presence of brinjal varieties, cultivars, and hybrids that exhibit varying degrees of resistance to pests (Table 3). These resistant strains have shown promise in reducing pest damage and improving crop yields. Several scientific research efforts have developed into a range of host plant resistance mechanisms, including antixenosis, antibiosis, and tolerance (Abhishek *et al*. 2021).

Table 4. List of natural enemies (predators and parasitoids) of insect pests of brinjal

Predators			
Common name	Scientific name	Family	Order
Transverse ladybird	*Coccinella transversalis*	Coccinellidae	Coleoptera
Lady beetle	*Harmonia dimidiata*	Coccinellidae	Coleoptera
two-spotted lady beetle	*Adalia bipunctata*	Coccinellidae	Coleoptera
Striped Lady Beetle	*Cheilomenes propinquq*	Coccinellidae	Coleoptera
Marmalade Hoverfly	*Episyrphus balteatus*	Syrphidae	Diptera
Parasitoids			
Cameron	*Trathala flavoorbitalis*	Ichneumonidae	Hymenopteraa
Wasp	*Trichogramma spp.*	Trichogrammatidae	Hymenoptera
Wasp	*Bracon hebetor*	Braconidae	Hymenoptera

Biological control: Biological control of the brinjal shoot and fruit borer involves the use of natural enemies, such as predators, and parasitoids. Biological control promotes sustainable and environmentally friendly pest management practices, ensuring the quality and yield of agricultural produce. Borkakati *et al*. (2019), Chaukikar *et al*. (2020), Abhishek *et al*. (2021), Das *et al*. (2023), and Maqsood *et al*. (2023) reported different predator and parasitoid species as effective biological control agents of brinjal shoot and fruit borer (Table 4). Srinivasan (2012) reported that the gram-positive and spore-forming bacterium species *Bacillus thuringiensis* (Bt) had effective microbial activity against the larvae of different insects.

Botanical insecticides: Natural plant extracts or oils such as neem oil can be used as organic alternatives for controlling brinjal shoots and fruit borer. Plant oils and extracts are less harmful to beneficial insects, and have fewer residual effects on the environment. Findings of Manzoor *et al*. (2023) showed that the chili and neem leaf extracts reduced shoot infestation of 32.2% and 84.2%, respectively, and the reduction of fruit infestation by tobacco and neem leaf extracts was 10.1% and 18.2%, respectively (Figure 5).

Chemical control: Chemical control of brinjal shoot and fruit borer involves the use of insecticides to manage the pest infestation. Carbamates, pyrethroids, and neonicotinoids are some common chemical insecticides for controlling brinjal shoot and fruit borer. Reddy and Kumar (2022) studied the effect of different insecticides on the fruit infestation of brinjal shoot and fruit borer and

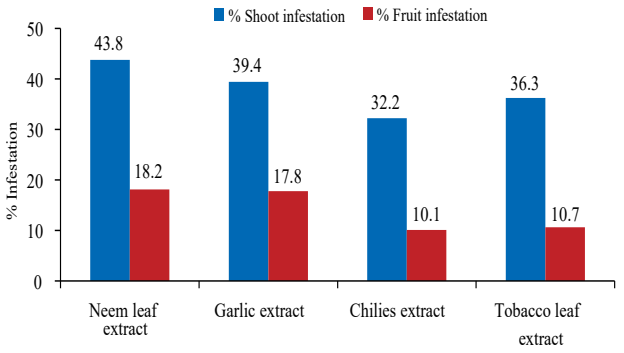


Figure 5. Effect of different botanical extracts on reduction of shoot and fruit infestation (%) of brinjal shoot and fruit borer after 1st spray

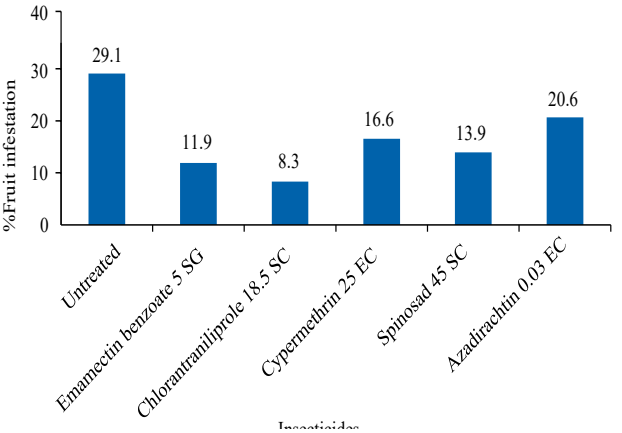


Figure 6. Effect of different insecticides on the fruit infestation rate (%) of brinjal shoot and fruit borer.

reported that the tested insecticides had significantly lower levels of fruit infestation compared to control (Figure 6). In their study, fruit infestation levels of the insecticides ranged from 8.3% to 29.1% and the results were obtained from Azadirachtin 0.03 EC and Chlorantaniliprole 18.5 EC treated plots, respectively.

IPM strategies

In Bangladesh, more than 75% of brinjal is contaminated with pesticides from the growing to marketing stage without consideration of residual toxicity (Islam and Haque, 2018). To overcome this problem, the Integrated Pest Management (IPM) program of brinjal shoot and fruit borer needs to be encouraged. IPM is widely regarded as the most effective approach to managing pests while safeguarding the environment and preserving biodiversity. This holistic strategy combines various management practices like cultural, mechanical, biological, and chemical methods to achieve the goals. However, farmers and researchers must work collaboratively in developing and implementing integrated and environment friendly approaches to manage brinjal shoot and fruit borer effectively. Such efforts will not only protect brinjal crops but also contribute to the overall sustainability of brinjal cultivation, ensuring food security and environmental health. Encouraging the conservation of natural predators, parasitoids, and adopting practices like crop rotation, sanitation, and the timely removal of infested plant material can significantly reduce the infestation of brinjal shoot and fruit borer.

Conclusion

In this article, different management practices of brinjal shoot and fruit borer has been reviewed to figure out their comparative efficacy. Through an in-depth exploration of various control methods, it becomes evident that an integrated approach is the most effective way to manage the infestation. The integration of chemical, biological, and cultural practices offers a multi-pronged strategy to combat the pest while minimizing environmental impacts. Pesticides, when used judiciously, can provide short-term relief, but long-term sustainability requires a shift towards biological control methods and cultural practices. Further research into new techniques and technologies should be encouraged to refine and enhance the effectiveness of brinjal shoot and fruit borer management strategies. Additionally, monitoring the crops regularly to detect early signs of infestation remains critical for prompt intervention.

References

Abhishek T and Dwivedi S. 2021. Review on integrated management of brinjal shoots and fruit borer, *Leucinodes orbonalis* Guenee. Journal of Entomology and Zoology Studies, *9*: 181-189.

Ahmad H, Rahman MH, Haque MA and Ahmed KS. 2008. Screening of brinjal varieties/lines resistance to brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Journal of Agroforestry and Environment, *2*: 131-133.

Alam MJ, Siddika MI, Khan MAM, Kulsum U and Ahmed KS. 2022. Management Of brinjal shoot and fruit borer using exclusion nets. Tropical Agrobiodiversity, *3*: 60-64.

Alam SN, Hossain MI, Rouf FMA, Jhala RC, Patel MG, Rath LK and Talekar NS. 2006. Implementation and promotion of an IPM strategy for control of eggplant fruit and shoot borer in South Asia. AVRDC.

Amin MR, Mia MS, Rahman H, Nancy NP and Bhuiyan MKA. 2018. Functional and group abundance of insects on eggplant. Bangladesh Journal of Agricultural Research, *43*: 647-653.

Bangladesh Bureau of Statistics (BBS). 2022. Agricultural Statistical Year Book Bangladesh 2022, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Baral K, Roy BC, Rahim KMB, Chatterjee H, Mondal P, Mondal D and Talekar NS. 2006. Socio-economic Parameters of Pesticide Use and Assessment of Impact of an IPM Strategy for the Control of Eggplant Fruit and Shoot Borer in West Bengal, India. Tashkent, Uzbekistan: AVRDC.

Bindu SP, Pramanik A and Padhi GK. 2015. Studies on biology and physical measurements of shoot and fruit borer (*Leucinodes orbonalis* Guenee) of brinjal in West Bengal, India. Global Journal of Biology, Agriculture and Health Science, *4*: 215-219.

Borkakati RN, Venkatesh MR and Saikia DK. 2019. Insect pests of brinjal and their natural enemies. Journal of Entomology and Zoology Studies, *7*: 932-937.

Chaukikar K, Vaishampayan S and Marabi RS. 2020. The succession of insect pest complex on brinjal at central Narmada valley region (Madhya Pradesh). Journal of Entomology and Zoology Studies, *8*: 1757-1761.

Das B, Choudhury MAR, Dash CK and Al-Habib MJ. 2023. Abundance and fluctuation pattern of insect pests and natural enemies in winter brinjal plant in Sylhet. Bangladesh Journal of Entomology, *31*: 43-55.

Faruq MO, Latif MA, Khan MMH, Das GP and Uddin MR. 2021. Management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) using selected insecticides in farmer's fields at Bandarban hill tracts, Bangladesh. International Journal for Asian Contemporary Research, *1*: 106-112.

Islam MS, Choudhury MAR, Maleque MA, Mondal MF, Hassan K and Khan AU. 2019. Management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) using selected bio-rational insecticides. Fundamental and Applied Agriculture, *4*: 1025-1031.

Majumdar A, Powell M, 2011. Net house vegetable production: pest management successes and challenges. Journal of the NACCA, *4*: 450-454

Mannan MA, Begum A, Rahman MM and Hossain MM. 2003. Screening of local and exotic brinjal varieties/ cultivars for resistance to brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee). Pakistan Journal of Biological Sciences, *6*: 488-492.

Manzoor M, Hamza A, Javaid A, Anees M, Tariq MR, Firdosi MFH and Haider MS. 2023. Bio-efficacy of some botanical extracts against brinjal fruit and shoot borer (*Leucinodes orbonalis* Guenee); Lepidoptera, Pyrallidae. Plant Protection, *7*: 263-272.

Maqsood S, Shafi MU, Javaid A, Khan IH, Ali M and Ferdosi MF. 2023. Control of insect pests and yield improvement in brinjal by plant extracts. International Journal of Biology and Biotechnology, *20*: 329-335.

Matsubara K, Kaneyuki T, Miyake T and Mori M. 2005. Antiangiogenic activity of nasunin, an antioxidant anthocyanin, in eggplant peels. *Journal of agricultural and food chemistry*, *53*: 6272-6275.

Mollah MMI, Hassan N, Khatun S, Rahman MM. 2023. *Bacillus thuringiensis* increases the efficacy of bio-pesticides against eggplant shoot and fruit borer, *Leucinodes orbonalis* Guenee. Journal of Natural Pesticide Research, *6*: 100055.

Mollah MMI, Hassan N, Khatun S, Rahman MM. 2022a. Sequential application of biopesticides suppress eggplant shoot and fruit borer, *Leucinodes orbonalis* G. infestation. Journal of Entomology and Zoology Studies *10*: 140-146.

Mollah MMI, Hassan N, Khatun S. 2022b. Evaluation of Microbial Insecticides for the Management of Eggplant Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee. Entomology and Applied Science Letters, *9*: 9-18.

Muhammad W, Javed H, Ahmad M and Mukhtar T. 2021. Economic impact of some selected cultural practices on population build-up of *Leucinodes orbonalis* in brinjal crop. Fresenius Environ Bull, *30*: 7346-7354.

Netam M, Lakra R, Koshta VK, Sharma D and Deole S. 2018. Screening of Shoot and Fruit Borer (*Leucinodes orbonalis* Guenee), for Resistance in Brinjal *(Solanum melongena* L.) Germplasm Lines. International Journal of Current Microbiology and Applied Sciences, *7*: 3700-3706.

Plazas M, Prohens J, Cunat AN, Vilanova S, Gramazio P, Herraiz FJ and Andujar I. 2014. Reducing capacity, chlorogenic acid content and biological activity in a collection of scarlet (*Solanum aethiopicum*) and Gboma (*S. macrocarpon*) eggplants. International Journal of Molecular Sciences, *15*: 17221-17241.

Rahman MM. 2006. Vegetable IPM in Bangladesh. Radcliffe's IPM world textbook. University of Minnesota, St. Paul, MN. USA.

Sharma A, Rana RS, Sharma KC, Singh S and Kumar A. 2017. Studies on biological parameters of *Leucinodes orbonalis* Gunee on brinjal under laboratory conditions. Journal of Entomology and Zoology Studies, *5*: 415-419.

Reddy CSTS and Kumar A. 2022. Efficacy of selected insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenee). The Pharma Innovation Journal, *11*: 1327-1330.

Roy UK. 2014. Farmers' attitude towards integrated pest management (IPM) practices in vegetable cultivation (Doctoral dissertation, Department of Agricultural Extension & Information system).

Yasmin F, Shipa AS, Amin MR, Swapon MAH and Hossain MM. 2021. Field screening of brinjal germplasm for resistance against shoot and fruit borer. Bangladesh Journal of Ecology, *3*: 11-16.