Journal of Plant Development Sciences

Meerut, India

MINI REVIEW

MANAGEMENT OF BRINJAL SHOOT AND FRUIT BORER, *LEUCINODES ORBONALIS* (GUENEE) BY USING BIO RATIONAL PESTICIDES

Dhanshri Sinha[1], Fanendra Kumar [1] and G.P. Painkra*[2]

1. M.Sc. (Ag.) Entomology scholar, Indira Gandhi Krishi Vishwavidyalaya, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur-497001 (C.G.) India
2. Indira Gandhi Krishi Vishwavidyalaya, College of Agriculture and Research station, Shankargarh-497118, Distt-Balrampur- Ramanujganj (C.G.) India

Received-20.12.2024, Revised-12.01.2025, Accepted-26.01.2025

Abstract: Brinjal is attacked by many harmful insect and pests but brinjal shoot and fruit borer is leading over the other pests which cause a significant loss and required management for profit making. Farmers use chemical insecticides to increase the yield of crop which is not righteous for environment and soil atmosphere. These pesticides spread into the air, water bodies like rivers, canals, soil due to their regular use in the form of spraying, powders, solutions in the agricultural land which increase soil infertility and make soil unfit for microorganisms. To combat from such situation bio pesticides use in place of chemical insecticides that not only control the insect pests but harmless for environment. Bio rational pesticide is made up of natural source and good for long term usages because it not poses risk of residue and maintain the natural ecosystem.

Keywords: Brinjal, Bio rational pesticides, Shoot & fruit borer, *Leucinodes orbonalis*, Management

INTRODUCTION

Vegetables are important for human health because of their vitamins, minerals, phytochemical compounds, and dietary fibre content. Especially antioxidant vitamins (vitamin A, vitamin C, and vitamin E) and dietary fibre content have important roles in human health. Brinjal (*Solanum melongena* L.) is an important solanaceous vegetables that is widely cultivated and consumed in Asia (Tripura *et al*., 2017), Central America and some parts of Africa (Harish *et al*., 2011).Brinjal commonly known as eggplant, belongs to the Solanaceae family, encompassing over 2,450 species across 95 genera with a chromosome number of 2n=24, brinjal has historical significance in India, dating back over 4,000 years, and is considered indigenous to the Indian subcontinent. It holds a prominent status as the "Monarch of Vegetables," with India being the second-largest global producer after China. Despite its colloquial label as the "poor man's" food, eggplant is commercially important, contributing significantly to both kitchen gardens and market prices India is the second largest producer of brinjal being cultivated over an area of 749,000 (ha), production of 12874,000 (MT) with an average annual production of 17.5 million tons per ha in the year 2017-18. In India, it is widely grown in West Bengal, Odisha, Gujarat, Madhya Pradesh, Chhattisgarh, Maharashtra, Andhra Pradesh, Haryana, Assam, Uttar Pradesh, Jharkhand, and Tamil Nadu.

It is importance due to its nutritional, medicinal, as well as commercial value, 100gm edible portion of brinjal supplies 40 gm carbohydrates, 1.40gm of proteins, 0.30gm of mineral and vitamins A, B and C (68,69). The fruits of brinjal are the reasonable sources of vitamins and minerals and it is rich in total water-soluble sugars, free reducing sugars, amide proteins among other nutrients.

The brinjal crop is subjected to attack by number of insect pests right from nursery stage till harvesting (Regupathy *et al*., 1997). The most important and destructive ones are the shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) it is the most obnoxious, detrimental and ubiquitous pest of brinjal and damage both, vegetative as well as reproductive stages. The damage initiates at seedling stage and continues till the fruit harvesting. Larva bores into petioles and midribs of large leaves and young shoots, at the initial stages of plant growth, leads to closing the entry holes with their frass and feeding inside the shoot, finally drooping and withering of the shoot occurs. In the later stages of fruit formation, the larva bores into the flower buds and fruits through the calyx, the entry holes on the fruit are not visible as these are either recovered or covered with frass and the faded depressions of entry holes are seen. The large one or more round exit holes are visible on the fruits. Affected fruits get rotten from inside and such

*Corresponding Author

fruits lose their market value. Besides these epilachna beetle, *Epilachna vigintioctopunctata* (F.) (Coleoptera: Coccinellidae); leaf roller, *Antoba olivacea* Wlk. (Lepidoptera:Noctuidae), hairy caterpillar, *Selepa docilis* Butler (Lepidoptera: Noctuidae) cutworm, *Agrotis ipsilon*(Rott), Lepidoptera-Noctuidae, Semilooper, *Plusia orichalces* (Fb), Ledoptera-Noctuidae,Tobacco caterpillar, *Spodoptera litura*, Lepidoptera-Noctuidae, leaf hopper, *Amrasca bigututtula biguttula*,Homoptera- Cicadellidae, white fly, *Bemisia tabaci*, Homoptera- Aleyrodidae, Aphid, *Aphis gossypii* (Homoptera-Aphididae), lace wing bug, *Urentius echinus*(Hemiptera-Tingidae),Leaf miner, *Phytomyza atricornis* (Diptera- Agromyzidae) and leaf thrips, *Callothrips indicus* (Thysanoptera-Thripidae) are the major harmful insect-pests of brinjal crop (Chand,1995).

For management of these pests, the conventional pest management practices often provide unsatisfactory results. Further, the use of chemical pesticide results in insecticide resistance, pest resurgence and pesticide residue. Therefore, an attempt was made to study the efficacy of microbial preparations, biorational and neem-based insecticides against major pests of brinjal.

Several chemical insecticides have been reported to be effective against these pests (Singh and Nath, 2007 and Gautam *et al*., 2008), but they are ecologically unacceptable. Brinjal crop is harvested at regular intervals and the use of toxic pesticides is not advisable. Repeated use of broad-spectrum synthetic chemicals also results in environmental contamination, bioaccumulation and bio magnification of toxic residues and disturbance in ecological balance (Dadmal *et al*. 2004). Sole dependence on several broad-spectrum insecticides for the control of these pests has led to insecticidal resistance, resurgence of minor pests and destruction of natural enemies. Biopesticides are usually inherently less toxic than conventional pesticides. It generally affects only the target pest and closely related organisms, in contrast to broad spectrum, conventional pesticides.

Management of shoot and fruit borer

Bio pesticides are more beneficial than chemical or synthetic ones because they are less harmful to non-target organisms, less likely to cause resistance, and biodegradable (Siam *et al*. 2021). Emamectin benzoate 5 SG, Buprofezin 25 SC, *Beauveria bassiana*, Spinosad 45 SC, Cypermethrin 25 EC, Rynaxypyr (Chlorantraniliprole) 20 SC and Neem oil 1500 ppm against shoot and fruit borer, *Leucinodes orbonalis* in brinjal were found effective in reducing the infestation of shoot and fruit borer. Application of Rynaxypyr (Chlorantraniliprole) 20 SC @ 150 ml/ha was found most effective in reducing the incidence of shoot and fruit borer at all observational interval and it was followed by Emamectin benzoate 5 SG @ 200 gm/ha and Spinosad 45 SC @ 200 ml/ha. The *Beauveria bassiana* @ 2.5 kg/ha was recorded least effective. (Saran *et al*.2018). Larva of this pest is the damaging stage to brinjal crop. Larvae bore inside the shoots petioles and fruits and reduce the crop yields up to 80% damage to fruits has been identified. Available management tools are not being enough to control the population of this pest and in such condition, it is needful to have a holistic approach towards IPM practices. In this article, several control measures for *L. orbonalis* including resistant varieties, cultural methods, physical and mechanical barriers, sex pheromones, bio-pesticides and bio-control agents; chemical and botanical means are outlined and evaluated with supportive facts and figures with reference to previous works and researches in this area. (Abhisek and Dwedi, 2021).

Azadirachtin 1500 ppm, *Metarhizium anisopliae, Beauveria bassiana, Verticillium lecanii, Bt. Kurstaki, NSKE* 5% and untreated control to evaluate the bio-efficacy of these treatments against shoot and fruit borer *Leucinodes orbonalis*. The result indicated that before spray population of the pest suggest nonsignificant distribution, however the treatments of Azadirachtin 1500 ppm, *Bt. Kurstaki* and NSKE 5% were found significantly effective for managment of shoot and fruit borer at 3,7 and 14 days after all three-spray followed by *Beauveria bassiana, Metarhizium anisopliae* and *Verticillium lecanii*. (Soulakhe *et al*. 2021).

Nine treatments viz., Neem oil 1% (T1), Karanj oil 1% (T2), Beauveria bassiana 1× 1012 spores/ml (T3), Metarrhizium anisopliae 1× 1012 spores/ml (T4), Neem oil- Bb- Neem oil (T5), Neem oil – Ma – Neem oil (T6), Karanj oil –Bb –Karanj oil (T7), Karanj oil –Ma-Karanj oil (T8) and Untreated control (T9). Neem oil 1% proved to be most effective in controlling the population of brinjal shoot and fruit borer by recording minimum shoot and fruit infestation of 5.80 and 6.65% respectively followed by Neem oil-Ma-Neem oil. However, Karanj oil 1% proved to be least effective (Abirami *et al*. 2023).

Azadirachtin 1% EC @ 2ml/L was found superior than other treatments with 10.92% mean shoot infestation and 10.04% mean fruit infestation, respectively followed by Karanjin 2% EC @ 2ml/L (13.42% shoot and 12.83% fruit infestation). Azadirachtin 1% EC @ 2ml/L also registered as highest marketable fruit yield (38.75 q/ha). It can be concluded that Azadirachtin could be proved effective in the management of brinjal shoot and fruit borer under organic farming and IPM programmes (Karmakar *et al*. 2018). Efficacy of new introduced insecticidal molecules and *Bt* formulations against shoot and fruit borer, *Leucinodes orbonalis* Guen. in brinjal under *terai* conditions. The indoxacarb 14.5% SC to be the most effective treatment against the pest and it was at par with spinosad, emamectin benzoate, diafenthiuron, endosulfan and halt during both the years (Singh, 2010).

Nine insecticides were evaluated against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. The treatment of cypermethrin (0.007%) proved most effective followed by carbaryl (0.20%) and endosulfun (0.07%). Nimbecidine (1.5 I/ha) was found least effective in reducing shoot and fruit infestation followed by Neemgold (1.2 II ha) and Bacillus thruingiensis (B.t.) alone (0.012%), whereas, B:t. + carbaryl (0.012 + 0.10%), B.t. + endosulfan (0.012 +0.035%) and malathion (0.05%) existed in middle order of efficacy(Jat and Pareek,2001).

Efficacy of certain insecticides and bio-pesticides against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee)". The efficacy result showed that the T5 Emamectin benzoate 5SG @ 50gm/lit was found most effective and showed (8.71%) shoot infestation and per cent fruit infestation (7.22%) followed by T2 Spinosad 45 SC @ 0.02ml/lit (10.13) and (7.69), T1 Cypermethrin 25 EC @ 2ml/lit (11.51) and (8.56), T6 Chlorpyriphos 20EC @ 4gm/lit (12.23) and (9.47), T3 Neem Oil 2% @ 2ml/lit (13.55) and (10.00), T7 NSKE 5% @ 2ml/lit (13.72) and (10.57) and T4 *Bacillus thuringiensis* @ 5gm/lit (15.31) and (11.48) respectively(Shyamrao *et al*. 2018). Among the insecticides examined, Spinosad had the greatest efficacy in suppressing the brinjal fruit and shoot borer, resulting in the largest yield of marketable fruits. The treatments with *Bacillus thuringiensis* (Bt) had the lowest yield. Biopesticides are being used. Biopesticides, such as Spinosad, provide an environmentally benign method to pest management by avoiding potential harm to beneficial insects and lowering chemical residues on harvested produce (Singh *et al*.2023).

All combination of bio-pesticides were effective but Lycomax + Biotin M + Antario and Lycomax + Biotin M + Fytomax 3% found most potent and control 88.43 and 84.06 percent shoot infestation; 69.67 and 66.44 percent fruit infestation by count; 72.70 and 70.49 percent fruit infestation by weight, respectively (Mollah *et al*.2022). Chlorantraniliprole 18.5 SC, Flubendiamide 39.35 SC, and Novaluron 5.25% + Emamectin Benzoate 0.9% SC were the most successful treatments in terms of lowest shoot infestation (2.24-6.05%) and fruit infestation (number basis: 11.01-13.29% and weight basis: 11.94-15.75%). *Bacillus thuringiensis* var. *kurstaki* and Chlorantraniliprole 18.5 SC both produced the highest commercial fruit yields, ranging from 13.54 to 14.54 t/ha and 14.11 to 14.51 t/ha, respectively. Azadirachtin 50,000 ppm was found to be the least effective (Sarkar *et al*. 2022).

three bacterial fermented biopestcides *viz*., spinosad, emamectin bennzoate and abamectin and one insect growth regulator, buprofezin were Biopesticides were applied either individually or in some selected combinations *viz*., buprofezin + emamectin benzoate, buprofezin + abamectin, buprofezin + spinosad. The best result was found in case of combined treatment buprofezin + emamectin benzoate treated plots (70.75% shoot and 63.99% fruit protection (Islam *et al*. 2016). Peak shoot infestation reached 32.38 larvae/ plant by the third week of February (7th SMW), while fruit infestation peaked at 40.49 per plant in the second week of February (6th SMW). Shoot infestation correlated positively with maximum temperature (r=0.55*) and negatively with evening relative humidity (r=-0.74**) and rainfall (r=-0.53*). Fruit infestation showed a strong negative correlation with evening relative humidity (r=-0.79***). (Rajasekhar *et al*. 2024).

The best and most economical treatment was Chlorantriniliprole @ 18.5 EC (1:10.2) which was on par with Emamectin benzoate @ 5 SG (1:9.8) followed by Carbosulfan 25 EC (1:7.3), *Beauveria bassiana* (1:6.4) Spinosad @ 45 % SC (1:5.5), followed by *Bacillus thuringiensis* (1:5.2) and, Neem oil (1:4.3) as compared to control (1:3.1). The percent infestation of the shoot and fruit borer on brinjal 3rd, 7th, and 14th day after the first spray reveal that all the chemical treatments were significantly superior over control. (Vyas and Tayde, 2022).

The result showed that the spinosad 45% EC was found most effective and showed (8.81) percent shoot infestation, (9.29) percent fruit infestation and (1:7.20) B:C ratio were recorded followed by Imidacloprid 17.8 SL (10.95), (11.14) and (1:5.84), Emamectin benzoate 5 SG (12.27), (12.67) and (1:5.38), Karanj oil 2% (14.81), (16.83) and (1:3.35), Neem oil 2% (13.91), (15.62) and (1:3.87), NSKE 5% (16.76), (20.80) and (1:2.20), *Beauveria bassiana* (16.20), (18.25) and (1:2.53), and Untreated control (24.39), (30.32) and (1:1.69) respectively.

The sequence containing Chlorantraniliprole 18.5 SC @ 0.3 ml/L - Spinosad 45 SC @ 0.4 ml/L - Lufenuron 5 EC @ 1.0 ml/L - *Bacillus thuringiensis* var. kurstaki @ 2.0 g/L demonstrated remarkable success in reducing the damage caused by *L. orbonalis* along with economic viability and high cost-benefit ratio (Udikeri *et al*. 2024). Eight treatments: T1- *Metarhizium anisopliae* @ 6 g/L, T2- *Beauveria bassiana* @ 6 g/L, T3 -*Lecanicillium lecanii* @ 4 g/L, T4- *B thuringiensis* @ 2 ml/L, T5 - Spinosad @ 0.4 ml/L, T6-Azadirachtin @ 1500 ppm, 5 g/L, T7- *Heterorhabditis indica* @ 10 g/L and T8 - untreated control. Three sprays were applied at 21 day intervals and data on shoot and fruit infestation, recorded at each spraying and picking, included the per cent of shoot infestation. The results revealed that the initial population of the pest before the spray indicated a non-significant distribution. However, after spray, the result revealed that the T5 -Spinosad @ 0.4 ml/L was found to be a significantly effective treatment against shoot and fruit borer, which was comparable to T6-Azadirachtin @ 1500 ppm, at 3, 7, and 14 days post-spraying Following closely in efficacy were *B thuringiensis* and *Metarhizium anisopliae*.

The treatments *viz.* chlorantraniliprole 18.5 SC (0.4ml/l), spinosad 45 SC (0.5ml/l), chlorfenapyr 10 SC (2ml/l), indoxacarb 14.5 SC (1ml/l), *Bacillus thuringiensis* (*Bt*) (2g/l), azadirachtin 0.03EC (5ml/l), *Metarhizium anisoplae* (2.5g/l), *Beauveria bassiana* (2.5g/l), chlorpyriphos 20EC (2.5 ml/l) were applied thrice at fifteen days interval starting from initiation of BSFB infestation. Mean shoot infestation was minimum in chlorantraniliprole plots (6.32%) followed by spinosad, chlorfenapyr, indoxacarb. Among bio-pesticides, *Beauveria* and *Bt* were found effective treatments in reducing shoot infestation. Chlorantraniliprole recorded lowest fruit infestation (8.25%) and highest marketable fruit yield (250.30q/ha) followed by spinosad and chlorfenapyr (Tripura *et al*. 2017).

Metarhizium anisopliae and *Beauveria bassiana* (talc formulation @ 5 gm/L), *M. anisopliae* and *B. bassiana* (potato dextrose broth @107 spores/ml), *Bt* formulation @ 1 ml/L, spinosad 45 SC @ 0.4 ml/L, Azadirachtin 1% @ 2 ml/L and Malathion 50 EC @ 2 ml/L against *Leucinodes orbonalis*, *Epilachna vigintioctopunctata*, *Antoba olivacea* and *Selepa docilis*. Spinosad 45 SC was found to be effective in reducing shoot and fruit infestation by *L. orbonalis*. Azadirachtin 1% was found to be most effective in controlling leaf infestation by *E. vigintioctopunctata*. *Bt* formulation was highly effective for early larval instars of *A. olivacea*. However, for later instars, malathion 50 EC was found to be effective. (Gowrish *et al*. 2015).

CONCLUSION

Biorational management is a greatest way to control the insects-pests population. application of biopesticides in combination with *Btk* 5 % increased the control of BSFB that results increased marketable yield and gross yield (Mollah *et al*., 2023). the treatments of Azadirachtin 1500 ppm, *Bt*.Kurstaki and NSKE 5% were found significantly effective for management of shoot and fruit borer (Soulakhe *et al*.,2021).The maximum fruit yield was recorded with the application of Neem oil 1% (Abiram et al., 2023). It can be concluded that Azadirachtin could be proved effective in the management of brinjal shoot and fruit borer under organic farming and IPM programmes. (Karmakar *et al*., 2018). From this study, it was concluded that Abamectin and *Btk* is the most viable bio-rational options for L. orbonalis management. (Mainali *et al*., 2013). Thus, combined application of biorationals can efficiently manage brinjal insect-pests without risk of pesticide resistance, pest resurgence and secondary pest outbreak. The biopesticides with target specificity and quick decomposablewhich help to sustain productivity in an eco-friendly manner and are highly beneficial than chemical insecticides.

REFERENCES

Abirami, S., Nayak, M. and Tomar, D. (2023). Efficacy of botanicals and bio-pesticide against shoot and fruit borer in Brinjal. *Annals of Plant and Soil Research*, **25**(1): 84-92.
Google Scholar

Abhishek, T.S. and Dwivedi S.A. (2021). Review on integrated management of brinjal shoots and fruit borer, *Leucinodes orbonalis* (Guenee). *Journal of Entomology and Zoology Studies*, **9**(1): 181-189.
Google Scholar

Dadmal, S. M., Nemade, S. B. and Khare, M. D. (2004). Field screening of brinjal cultivar for resistance to *Leucinodes orbonalis* (Guenee), *Pest Management in Horticultural Ecosystems*, **10** (2): 145-150.
Google Scholar

Gautam, C. P. N., Verma, R. A., Gautam, R.D. and Khan, M. A. (2008). Comparative efficacy of insecticides, bio-pesticides and botanicals against *Leucinodes orbonalis* Guenee infesting brinjal. *Ann. Pl. Protec. Sci*., **16** (2): 309-311.
Google Scholar

Gowrish, K.R., Ramesha, B. and Ushakumari, R. (2015). Biorational management of major pests of brinjal. *Indian Journal of Entomology*, **77**(1): 51-55.
Google Scholar

Harish, D., Agasimani, A.D., Imamsaheb, S.J. and Patil, S.S. (2011). Growth and yield parameter parameters in brinjal as influenced by organic nutrient management and plant protection conditions. *Res. J. Agric. Sci*., **2** (2): 221–225.
Google Scholar

Islam, T., Das, G. and Mahir Uddin, M. (2016). Field evaluation of promising biorational pesticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. *J. Biopest*, **9** (2):113-118.
Google Scholar

Jat, K.L. and Pareek, B.L. (2001). Field Evaluation of ecofriendly insecticides against brinjal shoot and fruit Borer, *Leucinodes orbonalis* Guen. *Indian J. Plant Prot*., **29** (1 &2): 53-56.
Google Scholar

Karmakar, S.K., Samanta, S., Sen, K., Manger, A., Padhi, GK., Das, U. and Samanta, A. (2018). Bio-pesticidal management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *Journal of Entomology and Zoology Studies*, **6**(4):1142-1145.
Google Scholar

Khajuria, S., Rai A. K. and Lata K. (2017). Evaluation of ipm modules for the management of brinjal shoot and fruit borer*guj. J. Ext. Edu*., **28**(1): December: 155-157.
Google Scholar

Kushwaha, T.K. and Painkra, G.P. (2016). Efficacy of botanical certain insecticides against

shoot and fruit borer [(*Leucinodes orbonalis* (Gunee.)] on *kharif* season brinjal [*Solanum melongena* (L.)] under field condition. International *Journal of Agricultural Science and Research*, **6** (4): 205-210.
Google Scholar

Mainali, R.P. (2014). Biology and management of eggplant fruit and shoot borer, *Leucinodes orbonalis* Guenee (lepidoptera: pyralidae): a review. *Int J Appl Sci Biotechnol*., **2**(1): 18-28.
Google Scholar

Mainali, R.P.,Thapa, R.B., Pokhrel, P., Dangi, N. and Aryal, S. (2013). Bio- rational management of eggplant fruit and shoot borer, *Leucinodes orbonalis* Guenee, (Lepidoptera: Pyralidae) in Lalitpur, Nepal. *Journal of Plant Protection Society*, **4**: 235-247.
Google Scholar

Mallick, J. R., Dash S. and Patnaik, H.P. (2019). Bio-rational and cost-effective control of shoot and fruit borer incidence on Brinaj. *Journal of Entomology and Zoology Studies*, **7**(1): 1026-1029.
Google Scholar

Mollah, M. M. I., Hassan, N., Khatun, S. and Rahman, M. M. (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.
Google Scholar

Maru, N.K. and Kumar, A. (2018). Comparison of bio-rational and bio-intensive IPM modules for safe pesticide residue and management of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee with economics. *Journal of Entomology and Zoology Studies*, **6**(6): 256-265.
Google Scholar

Chand, P. (1995). A text book on Agricultural and forest pests and their management. Oxford and IBH publishing Co.Pvt. Ltd. New Delhi PP 123-128.
Google Scholar

Regupathy, A., Palanisamy, S., Chandramohan, N. and Gunathilagaraj, K. (1997). *A guide on crop pests*. Sooriya Desk Top Publishers, Coimbatore, 264 p.
Google Scholar

Saran, S., Singh, D.V, Singh, A., Kumar, S. and Kumar, U. (2018). Bio-efficacy of selective eco-friendly insecticides and bio pesticides against shoot and fruit borer, *Leucinodes orbonalis* (Guenee) in brinjal. *Journal of Pharmacognosy and Phytochemistry*,**7**(6): 1690-1694.
Google Scholar

Shankar, B.K. and Tripathi, P. (2021). Bio-rational approaches for management of major brinjal pests: A review. *The Pharma Innovation Journal*, SP-**10**(5): 378-38.
Google Scholar

Sarkar, S., Pal, S., Sahoo, S., Laskar, N. and Ghosh, J. (2022). Field efficacy study of different biorationals and insecticides against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) under terai region of west Bengal. *Uttar Pradesh Journal of Zoology*, **43**(16): 57-66.
Google Scholar

Shyamrao, N. J., Kumar, A., Patil, A.A and Narode, M.K. (2018). Efficacy of certain insecticides and bio-pesticides against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee). *Journal of Entomology and Zoology Studies*, **6**(5): 292-295.
Google Scholar

Siam, M.A.H., Nasuruddin, M., Azadi, M.A. and Choudhary, M.R. (2021). Larvicidal efficacy of three indigenous plant extracts against the mosquito larvae, Culex quinquefasciatus say (Diptera-Culicidae). *Bangladesh Journal of Environmental Science*, **40**:60-69.
Google Scholar

Siam, M. A. H., Arafeen, M.S., Dey, D. and Owaresat, J.K. (2024). Biology and Management of Eggplant (S*olanum melongena* L.) Shoot and Fruit Borer: A Review. *J. Bangladesh Agril Univ* **22**(3). 267-276.
Google Scholar

Singh, J.P. and Nath, V. (2007). Field evaluation of insecticides and neem formulations for the managementof brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee). *Indian Journal of Entomology*, **69**(4):341-344.
Google Scholar

Singh, S.S. (2010). Comparative efficacy of certain bio-rational insecticides and *Bacillus thuringiensis* based bio-insecticides against *Leucinodes orbonalis* Guen. in brinjal. *Indian J. Hort. 67(3), September:* 353-356.
Google Scholar

Singh, G., Singh, D.V., Yadav A., Anokhe, A. and Gautam, M.P. (2023). Evaluation of biopesticides and newer insecticides on fruit yield to improve the cost-benefit ratio. *The Pharma Innovation Journal*, SP-**12**(7): 1192-1197.
Google Scholar

Soulakhe, A.B., Bantewad, S.D. and Jayewar, N.E. (2021). Biorational management of brinjal shoot and fruit borer *Leucinodes orbonalis. The Pharma Innovation Journal*, **10**(8):617-623.
Google Scholar

Tripura, A., Chatterjee, M.L., Pande, R. and Patra, S. (2017). Biorational management of brinjal shoot and fruit borer (*Leucinodes orbonalis*guenee) in mid hills of Meghalaya. *J. Entomol. Zool. Stud*., **5** (4): 41–45.
Google Scholar