Journal of Agroforestry and Environment

Volume 18, Issue 2, 2025

Journal DOI: https://doi.org/10.55706/jae
Journal homepage: www.jagroforenviron.com

Management of Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis*) Using Bio-Rational Pesticides

Md. Forhad Hossain[1], Md. Harunur Rashid, Hasan Fuad El Taj[1] and Md. Alamgir Hossain[1*]

[1]Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

*Correspondence: alamgir@hstu.ac.bd, alamgirhstu@gmail.com; Phone: +88-01712572211

Received: 20/05/2025
Accepted: 29/07/2025
Available online: 06/08/2025

Abstract: Brinjal is one of the most important vegetables but frequently attacked by brinjal shoot and fruit borer (BSFB), a major constraint of brinjal production. A field trial was conducted to evaluate the efficacy of four bio-rational insecticides viz., T_1 = Cyproflanilide, T_2 = Azadirachtin, T_3 = Spinosad and T_4 = Buprofezin against BSFB on brinjal in RCBD (Randomized Complete Block Design) with three replications. The study was carried out from October 2023 to April 2024 at the field laboratory of the Department of Entomology at Hajee Mohammad Danesh Science and Technology University in Dinajpur, Bangladesh. The Spinosad-treated plots had the highest number of healthy shoots (71.00) but the untreated control had the lowest (43.00). The untreated control had the highest infested shoots (21.67), while the Spinosad-treated plots had the fewest (7.67). Spinosad (T_3) treated plots showed the highest reduction (70.94%) of infested shoot over untreated control. Similarly, the highest (52.33) number of healthy fruits were observed from the Spinosad treated plants while the lowest (19.33) from the untreated control that offered maximum reduction (71.64%) of damaged fruits above the untreated control. Spinosad yielded the highest weight of healthy fruits (4.90 kg/plot), but the untreated control had the lowest (2.00 kg/plot). Similarly, Spinosad treated plants had the lowest (0.66 kg/plot) weight of infested fruits, but untreated control exhibited the highest (2.60kg/plot) infested fruits. So, Spinosad could be utilized to defend brinjal against BSFB maintaining food security and biosafety.

Key words: Brinjal; Bio-rational pesticides; Potency; Brinjal shoot and fruit borer

INTRODUCTION

Brinjal (*Solanum melongena* L., Solanacae) is an important cosmopolitan delicious economic and popular vegetable after potato (Kantharajha and Golegaonkar, 2004; Shelton et al., 2020). Commercially this crop is cultivated of hot and humid prevail climates of South East Asia like Bangladesh (Thapa, 2010). The production of this crop in Bangladesh is still very low and far below as compared to international standard. The main obstacle to the production of brinjal is that several insect pests attack the crop (Sharma and Tayde, 2017). Of them, the most damaging pest of brinjal is the brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) (Saimandir and Gopal 2012; Nusra et al., 2020). BSFB larvae can significantly reduce yield by up to 90% (Kodandaram et al., 2017, Gautam et al., 2019). They damage flowers, fruits, tender shoots, and petioles (CABI, 2007); however, after fruit set, shoot infestations decline entirely (Naqvi et al., 2009) or become insignificant (Kumar and Dharmendra, 2013). Flower infestation is very uncommon and infested flowers are incapable of producing fruit (Alam et al., 2006). Additionally, they destroy fruits by feeding on their mesocarp (Neupane, 2001), rendering them unfit for human consumption (Baral et al., 2006). A larva may typically infest 4-7 fruits in its lifetime and destroy 80% of the vitamin C content (Sharma, 2002).

Bangladeshi farmers mostly use insecticides to control BSFB for quick remedies (Singh and Singh, 2002, Latif et al., 2010). According to a survey, 98% of farmers used insecticides, with 60% applying them at least 120 -140 times over a growing season (Alam et al., 2003; Rashid *et* al., 2004). However, non-judicious use of pesticides has serious detrimental effects (Patel et al., 2015). Researchers are worldwide now currently attempting to develop alternatives of synthetic insecticides to protect crops from pests (Latif et al., 2010; Isman, 2006). The new generation insecticides could offer several advantages over conventional pesticides like high selectivity, excellent efficacy, safe to beneficial insects, economical, less prone, biodegradable, compatible with other pesticides, and environmentally safe (Stevenson et al., 2017). Besides, they are bio-rational, disrupts the normal growth and development and eventually causing to triggers death. But research on the bio-rational insecticides against the BSFB are scanty (Latif et al., 2009). So, keeping importance of BSFB, a field trial was conducted to evaluate the potential of four bio-rational insecticides viz., Cyproflanilide, Azadirachtin, Spinosad and Buprofezin against BSFB.

MATERIALS AND METHODS

Experimental Site and Soil Properties

The experiment was carried out from October 2023 to April 2024 in the field laboratory of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The land was sandy loam having p^H 5.52 with electrical conductivity 2.0 mS/m and medium inorganic matter with Agro-ecological zone 1 (AEZ-1) of Old Himalayan Piedmont Plain.

Land Preparation

The study was set up by three replications using a Randomized Complete Block Design (RCBD). A power tiller was used to prepare the land for a good tilth. The stubbles and uprooted weeds were removed from the field and the land levelled prior to transplanting. The plots were 3 m x 3 m in size, with 1.5 m separating each plot and 2 m from each block. Rows were kept one meter apart, and plants were kept 60 cm apart.

Crop culture

Applied 15 tons of cow dung while 115, 72 and 75 kg of N, P_2O_5 and K_2O fertilizers, respectively per hectare (Tripura *et al.,*2017). Half of cow dung and a basal dose of P_2O_5 were applied at the time of land preparation. Rest cow dung, P_2O_5, and one-third of K_2O were applied on the field when the seedlings were transplanted. The remaining K_2O and full N were used as a top dressing. One third urea as first top dressing was allocated at 15 days after transplant. One-third of N and P_2O_5 were top-dressed at first blooming while remaining urea and MP at the first fruiting stage. The BARI begun-9 variety was sown in a seed bed (5 m × 1 m) at the first week of October 2023. Healthy brinjal seedlings of forty days-old (3/4 leaf stage) were transplanted in the experimental plots.

Treatments

Four different bio-rational insecticides were tested to evaluate the potency against the BSFB. They were sprayed (Table 1) just once shoot infested at 10 days intervals using hand sprayer fitted with a hollow cone nozzle and operated at optimum bar pressure. First spray was done at vegetative stage just after started of shoot infestation. Consequently, two sprays were applied on 10 days of intervals on crop in the fruiting stage. Only water was applied to untreated control plots. Precautions were taken to prevent drift to the experimental plots. Treatments were assigned at afternoon since fewer pollinator active at that time.

Table 1. Tested different bio-rational insecticides

Treat ments	Trade name and formulation	Common name	Dose (mlL^{-1})	Registrat -ion holder
T_1	Cyproflanilide 10% DC	Diamide	2 ml	Auto Crop Care Ltd.
T_2	Bioneem plus 1.0 EC	Azadirac htin	2 ml	Ispahani Agro Ltd.
T_3	Tracer 45 SC	Spinosad	0.4 ml	Auto Crop Care Ltd.
T_4	Award 40 SC	Buprofez in	0.4 ml	Square Pharma. Ltd.
T_5	Untreated control	-	-	-

Data Collection

Data were collected on the number of infested shoots plant^{-1}, number of healthy shoots five plant^{-1}, number of infested fruits five plant^{-1}, number of healthy fruits five plant^{-1}, healthy fruits plot^{-1}, infested fruits plot^{-1}, total yield plot^{-1}, yield increase over control due to treatments. Number of healthy shoots and fruits were determined by direct counting. Percent infested shoots and fruits, and shoots and fruits infestation reduction over control were determined by following formulae:

Shoot infestation (%) by number $= \frac{\text{Number (No.)of IS}}{\text{No. of HS + No. of IS}} \times 100$ (Yousafi et al., 2015)

Fruit infestation (%) by number $= \frac{\text{Number (No.)of IF}}{\text{No. of HF + No. of IF}} \times 100$ (Yousafi et al., 2015)

Shoot infestation (%) reduction $= \frac{\text{Control}-\text{Treatment}}{\text{Control}} \times 100$ (Faruq et al., 2021)

Fruit infestation (%) reduction $= \frac{\text{Control}-\text{Treatment}}{\text{Control}} \times 100$ (Faruq et al., 2021)

Data Analysis

SPSS software was used for analysis of variance (ANOVA) on the data. The Duncan Multiple Range Test (DMRT) was used to perform mean separation.

RESULTS

A. *Effects of treatments against BSFB on shoot infestation*

Treatments by different bio-rational insecticides had potential effects against BSFB on healthy and infested shoots of brinjal (Figure 1). Significantly ($P < 0.05$, df = 4, F = 13.55) the Spinosad-treated plot had the highest number of healthy shoots (71.00) of all the treatments. Conversely, the fewest (43.00) number of healthy shoots were observed from the untreated control. Similarly, statistically ($P < 0.05$,

DOI: https://doi.org/10.55706/jae1816

df = 4, F = 22.43) the lowest (7.67) number of infested shoots were found in Spinosad tested plants but the highest (21.67) from the untreated control. Likewise ($P < 0.05$, df = 4, F = 73.75), the highest infested shoot (33.61%) was calculated in the untreated control whereas the lowest (9.8%) from the Spinosad treated plot. The Spinosad (T_3) treated plot showed the highest reduction (70.94%) over the untreated control.

B. Effects of treatments against BSFB on fruit weight by number

Statistically ($P < 0.05$, df = 4, F = 22.41) the weight of healthy and infested fruits by number affected due to treated insecticides against the BSFB (Figure 2). Significantly the highest (52.33) number of healthy fruits were found from the Spinosad treated plot while the lowest (19.33) from the untreated control. Remarkably ($P < 0.05$, df = 4, F = 16.12) the lowest number of infested fruits (8.67) were recorded from the Spinosad treated plants while the untreated control had the highest infested fruits (21.67). Again, statistically ($P < 0.05$, df = 4, F = 26.48) the highest infested fruits (52.90%) were counted in the control plots but the lowest (15.00%) in Spinosad treated plant. All of the treatments decreased the percentage of infested fruits but the Spinosad (T_3) showed the highest reduction (71.64%) over untreated control. Similarly, statistically ($P < 0.05$, *df* = 4, F = 6.97) Spinosad yielded the highest healthy fruits (4.90 kg/plot), but the untreated control had the lowest (2.00 kg/plot). Spinosad treated plants had the lowest (0.66 kg) weight of infested fruits but the untreated control exhibited the highest (2.60kg) infested fruits. Also, statistically ($P<0.05$, df=4, F=86.22) the untreated control calculated the highest (56.5%) infested fruits but the Spinosad assigned plant had the lowest (12.5%). All treatments significantly reduced the fruit infestation but the Spinosad (T_3) showed the highest reduction (77.87%) over untreated control.

C. Effects of insecticides on yield (kg/plot)

Based on the yield, the Spinosad treated plot had the highest yield (5.56 kg $plot^{-1}$), while plots treated with Azadirachtin and Cyproflanilide showed the statistically similar in yield Figure 4. Conversely, untreated control provided the statistically similar yield.

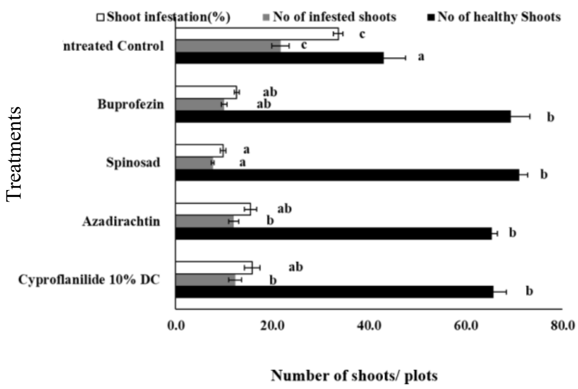

Figure 1. Efficacy of four different bio-rational insecticides on shoot infestation (by number) against brinjal shoot and fruit borer

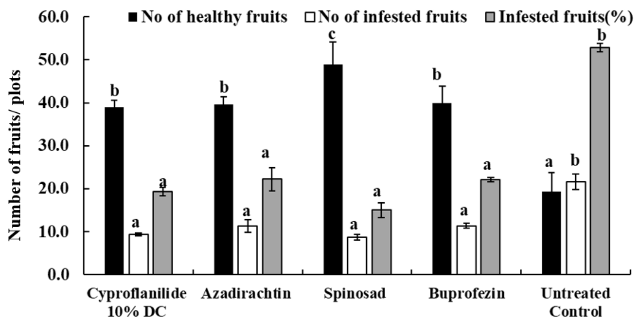

Figure 2. Efficacy of four different bio-rational insecticides on fruit infestation (by number) against brinjal shoot and fruit borer

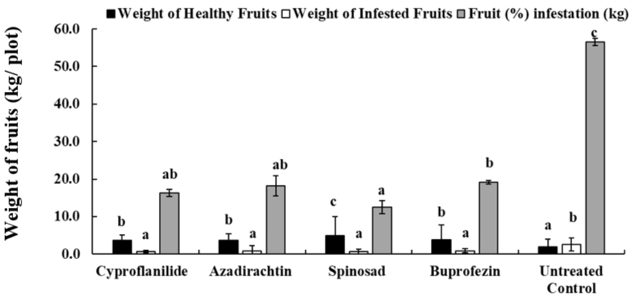

Figure 3. Efficacy of four different bio-rational insecticides on fruit infestation by weight (kg) against brinjal shoot and fruit borer

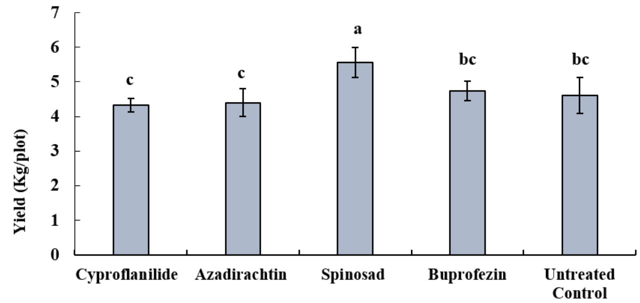

Figure 4: Efficacy of four different bio-rational pesticides on fruit yield (kg/plot) of brinjal against brinjal shoot and fruit borer

DISCUSSIONS

Results revealed that the tested bio-rational insecticides had profound effects on healthy and infested shoots against the BSFB (Fig. 1). All of the treatments considerably decreased the shoot infestation due to treatments applied. Present findings are parallel with the results of Tripura et al. (2017). They cited that bud attack was found minimum in Spinosad 45 SC treated plot. Present findings are also comparable with the result of Akter et al. (2017). They experienced that Tracer 45 SC performed the best in reducing 85.60% shoot infestation over control against BSFB. Various scholars in other field experimented trail and found good results on Spinosad 2.5 SC assigned plots (Adiroubane and Raghuraman, 2006; Patra et al., 2009).

The applied bio-rational insecticides had promising effects on healthy fruits and consequently offered lowest

DOI: https://doi.org/10.55706/jae1816

infested fruits against the BSFB (Figure 2). Novel innovative research proven that the diverse pesticides i.e. IGRs, bacterial extracts etc. have been successfully used by a number of researchers to combat the BSFB (Patra et al., 2009; Mamun et al., 2014, Singh and Sachan, 2015). All the applied insecticides showed the promising results but Spinosad (T_3) treated plot at 0.4 ml/L water showed the highest (71.64%) reduction of infested fruits over untreated control. Present outcomes are also comparable of the observations as stated by Akter et al. (2017). They opined that highest number of healthy fruits were counted from Spinosad treated plots. Also, Spinosad treated plots showed the highest reduction of infested fruits while compared to untreated control. These results are also analogous with the findings of Awal et al. (2015). They found the highest healthy fruits of brinjal plot^{-1} from Spinosad treatment. Parallel results were also cited by (Awal *et al.,*2015) using Spinosad against BSFB.

The outcomes of the present study suggests that the applied treatments especially Spinosad (Tracer 45 SC) achieved the topmost in confirming a greater quantity and weight of healthy fruit in comparison to the untreated control. The effectiveness of Spinosad is consistent with the results of previous researchers. They claimed that Spinosad had the highest brinjal yield and was the most effective in reducing shoot and fruit infestation by (Abdullah et al., 2014, Gowrish et al., 2015). Parallel results were reported by Awal et al. (2015). They found the highest weight of healthy fruits of brinjal plot^{-1} from the Spinosad treatments. Similar results were also cited by (Akter et al., 2017) who concluded that the highest weight of healthy fruits of brinjal plot^{-1} from Spinosad treatment.

Spinosad an incredible insecticide is highly effective on diverse insect pests (Thompson and Hutchins, 1999). The efficacy of Spinosad is in conformity with the conclusions of earlier studies (Akter et al., 2017). They reported that among the applied treatments, Spinosad was found to be most effective in reducing shoot and fruit infestation of brinjal. Higher efficacy of Spinosad against brinjal shoot and fruit borer was also reported by many researchers (Latif et al., 2009; Singh and Sachan, 2015). Spinosad (Tracer 45 SC) would be a good fit for integrated pest management (IPM) against BSFB for efficient brinjal production since it is comparatively harmless for ecosystems and natural enemies (Awal et al., 2015).

Although to differing degrees, BSFB infestations were found throughout the growing season although the the degree of infestation fluctuated. This aligns with findings of previous studies where untreated plots consistently showed higher susceptibility to BSFB larvae during early stage of plant (Ghodake et al., 2024). Islam et al. (2019) found that the lowest fruit infestation was calculated in Spinosad treated plot while untreated plot showed the highest result. The finding of that study is similar with the present study. Mannan et al. (2015) reported that the fruit infestation reached the highest level (38.56%) at 14th week of transplanting.

Usually, shoot and fruit borer larvae are typically managed through the randomly application of pesticides (Mukherjee, 2003) that boost up limitless residual effects in the ecosystem's (Rashid et al., 2004; Patel et al., 2015). Bio-rational pesticides especially Spinosad undoubtedly as alternative in pest control initiatives, particularly for BSFB. The trailed Spinosad could offer significant advantages for our country on sustainable BSFB management, ensuring food security and biosafety in such a changing climate.

CONCLUSION

Tested all four bio-rational insecticides viz., Cyproflanilide, Azadirachtin, Spinosad and Buprofezin were found effective as compare to untreated control in combating BSFB on brinjal. But Spinosad (Tracer 45 SC) was found very potent contrast to other treatments. Therefore, it may be concluded that Spinosad (Tracer 45 SC) could be used in protecting the brinjal crop against BSFB as it is natural origin, biodegradable and safe for mammal to enhancing biosafety and food security.

Acknowledgement

The authors acknowledge the Institute of Research and Training (IRT), HSTU, for financial support as research grants.

Conflict of Interest

The authors declare no conflicts of interest.

REFERENCES

Abdullah, M.D., Mamun, A.L., Islam, K.S., Jahan, M. and Das, G. 2014. Effect of spinosad and sex pheromone alone and in combination against the infestation of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. International Journal of Research in Biological Sciences. 4(1): 20-24.

Adiroubane, D. and Raghuraman, K. 2006. IPM in brinjal shoot and fruit borer management. Journal of Biopesticides. 1(2): 124-129.

Akter, S., Alam, M.Z., Rahman, M.M. and Aka, A.M. 2017. Evaluation of some management options against brinjal (*Solanum melongena* L.) shoot fruit borer (*Leucinodes orbonalis* Guenee). The Agriculturists. 15(1): 49-57.

Alam, S.N., Hossain, M.I., Rouf, F.M.A., Jhala, R.C., Patel, M.G., Rath, L.K., Sengupta, A., Baral, K., Shylesha, A.N., Satpathy, S., Shivalingaswamy, T.M., Cork, A. and Talekar, N.S. 2006. Implementation and promotion of an IPM strategy for control of eggplant fruit and shoot borer in South Asia. Technical Bulletin no. 36. AVRDC Publication number 06-672. AVRDC-The World Vegetable Center, Shanhua, Taiwan, 74.

Alam, S.N., Rashid, M.A., Rouf, F.M.A., Jhala, R.C., Patel, J.R., Satpathy, S., Shivalingaswamy, T.M., Rai, S., Wahundeniya, I., Cork, A., Ammaranan, C., Talekar, N.S. 2003. Development of an integrated pest management strategy for eggplant fruit shoot borer \in South Asia. Shanhua, Taiwan 2003. AVRDC-the world vegetable center. Technical Bulletin no. 29. AVRDC publication no. 56: 03-548.

Awal, A., Rahman, M.M., Alam, M.Z. and Khan, M.M.H. 2015. Diversity and equitability of insect pests and natural enemies in brinjal field treated with insecticides. Jahangirnagar University Journal of Biological Sciences. 4(1): 71-80.

Baral, K., Roy, B.C., Rahim, K.M.B., Chatterjee, H., Mondal, P., Mondal, D., Ghosh, D. and Talekar, N.S. 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. Tech. Bull., 37. No. 06-673. AVRDC-The World Vegetable Center. Shanhua, Taiwan, p.36.

DOI: https://doi.org/10.55706/jae1816

CABI (Centre for Agriculture and Bioscience International). Crop Protection Compendium 2007. CAB International. (Available at: http://www. cabicompendium. org/cpc

Faruq, M.O., Latif, M.A., Khan, M.M.H., Das, G.P. and Uddin, M.R. 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.

Gautam, M., Kafle, S., Regmi, B., Thapa, G. and Paude, S. 2019. Management of brinjal fruit and shoot borer (*Leucinodes orbonalis* Guenee) in Nepal. Acta Scientific Agriculture, *3*(9): 188-195. DOI: 10.31080/ASAG.2019.03.0632

Ghodake, R.D., Hole, U.B., Kharbade, S.B., Bagde, A.S. and Galande, S.M. 2024. Efficacy of bio-rational pesticides for the management of *Leucinodes orbonalis* Guenee, infesting brinjal (On Fruit). International Journal of Statistics and Applied Mathematics. 9(2), 40-45.

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

Isman, M.B. 2006. Extracted from the neem tree (*Azadirachta indica*), azadirachtin acts as an antifeedant, insect growth regulator, and repellent. It disrupts hormonal balance in insects, inhibiting their growth and reproduction, thereby reducing pest populations. Azadirachtin is noted for its minimal environmental impact and safety for humans and beneficial insects. Pest Management Science. 62(8): 651-659.

Kodandaram, M.H. Rai, A.B., Sharma, S.K. and Singh, B. 2017. Shift in the level of susceptibility and relative resistance of brinjal shoot and fruit borer *Leucinodes orbonalis* (Guen.) to diamide insecticides. Phytoparasitica. 45: 151-154.

Kumar, S. and Dharmendra, S. 2013. Seasonal incidence and economic losses of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Agricultural Science Digest, 33: 98-103.

Latif, M.A., Rahman, M.M. and Alam, M.Z. 2010. Efficacy of nine insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in eggplant. Journal of Pesticides Science. 83: 391-397.

Latif, M.A., Rahman, M.M., Alam, M.Z. and Hossain, M.M. 2009. Evaluation of flubendiamide as an IPM component for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Munis Entomology and Zoology. 4(1): 257-267.

Mamun, M.A.A., Islam, K.S., Jahan, M. and Da, G. 2014. Comparative potency of three insecticides against the infestation of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Scholars Academic Journal of Biosciences. *2*(6): 364-369.

Mannan, M.A., Islam, K.S. and Jahan, M. 2015. Brinjal shoot and fruit borer infestation in relation to plant age and season. Bangladesh Journal of Agricultural Research. 40(3): 399-407.

Mukherjee, I. 2003. Pesticide residues in vegetables in and around Dehli. Environmental Monitoring and Assessment. 3(7): 265-271.

Naqvi, A.R., Pareek, B.L. and Mitharwal, B.S. 2009. Seasonal incidence of shoot and fruit borer, *Leucinodes orbonalis* Guenee infesting in hyper arid regions of Rajhistan, Journl of Insect Science. 22: 195-198.

Neupane, F.P. 2001. Crop Pest and Their Management (4th ed.) (Nepali language). Sajha Prakashan, Pulchwok. Lalitpur, Nepal. p. 582.

Nusra, F., Paranagama, P.A., Amarasinghe, L.D. and Udukala, D.N. 2020. Pheromone baited biopesticide for control of *Leucinodes orbonalis* Guenee in brinjal plant. Frontiers in Bioscience-Elite. 12: 35-47.

Patel, L.C., Konar, A. and Sahoo, C.S. 2015. Biophysical screening of brinjal genotypes against fruit and shoot borer, *Leucinodes orbonalis* (Guenee). The Bioscan. 10: 905-909.

Patra, S., Chatterjee, M.L., Shanowly, M. and Samanta, A. 2009. Field evaluation of some new insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.). Pesticide Research Journal. 21(1): 58- 60.

Rashid, M.A., Alam, S.N., Rouf, F.M.A. and Talekar, N.S. 2004. Socio-economic parameters of eggplant pest control in Jessore District of Bangladesh. Shanhua, Taiwan: AVRDC-the world vegetable centre. AVRDC Publication No. 29, pp. 03-556.

Saimandir, J. and Gopal, M. 2012.Evaluation of synthetic and natural insecticides for the management of insect pest control of eggplant (*Solanum melongena* L.) and pesticide residue dissipation pattern. American Journal of Plant Sciences. 3: 214-227.

Sharma, J.H. and Tayde, A.R. 2017. Evaluation of bio-rational pesticides, against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen. On brinjal at Allahabad Agroclimatic region. International Journal of Current Microbiology and Applied Sciences. 6(6): 2049-2054.

Sharma, D.R. 2002. Bioefficacy of certain insecticide and biopesticides against major pest of brinjal under field condition. M.Sc. thesis. Indian Agric. Res. Inst. New Delhi, India. p. 160.

Shelton, A.M., Sarwer, S.H., Hossain, M.J., Brookes, G. and Paranjape, V. 2020. Impact of Bt brinjal cultivation in the market value chain in five districts of Bangladesh. Frontiers in Bioengineering and Biotechnology. 8: 541115.

Singh, M. and Sachan, S.K. 2015. Comparative efficacy of some biopesticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee in brinjal. Plant Archive. 15(2): 805-808.

Singh, Y.P. and Singh, P.P. 2002. Natural parasites and extent of parasitism to shoot and fruit borer (*Leucinodes orbonalis*) of brinjal (*Solanum melongena*) at medium high-altitude hills of Meghalaya. Indian Journal of Entomology. 64 (2): 222-226.

Stevenson, P.C., Isman, M.B. and Belmain, S.R. 2017. Nowadays, the new generation insecticide molecules could offer several advantages over conventional pesticides like high selectivity, excellent efficacy at low dosage, least harmful to beneficial insects, economical, less prone, biodegradable, compatible with other low-risk pesticides, and environmentally safe as well. Frontiers in Plant Science. 8: 17.

Thapa, R.B. 2010.Integrated management of brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen: An overview. Journal of the Institute of Agriculture and Animal Science. 30 & 32: 1-16.

Thompson, G. and Hutchins, S. 1999. Spinosad Pesticide Outlook. 10(2): 78-81.

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. Journal of Entomology and Zoology Studies. 5(4): 41-45.

Yousafi, Q., Azal, M. and Aslam, M. 2015. Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee, with selected insecticides. Pakistan Journal of Zoology. 47(5): 1413-1420.

DOI: https://doi.org/10.55706/jae1816