A Review on efficacy effect of newer insecticides and biopesticides against brinjal fruit and shoot borer (*Leucinodes orbonalis)* Guenee

Abstract:-

Eggplant (*Solanum melongena*) holds significant importance as a vegetable in regions characterized by hot and wet climates. Brinjal plants face infestations from 26 insect pests and several non-insect species, with the brinjal shoot and fruit borer (*Leucinodes orbonalis*) standing out as a primary threat. This pest poses a significant challenge, causing crop damage year-round. Yield losses attributable to this pest range from 70 to 92 percent. This scenario has presented a challenge for farmers engaged in the commercial cultivation of brinjal. Upon reviewing research papers, it was discovered that newer insecticides and biopesticides exhibited notable superiority. Spinosad 45SC emerged as the top performer, followed by Indoxacarb 14.5SC and Emamectin benzoate 0.5SG.

Keywords- *Leucinodes Orbonalis,* Biopesticides, SG, SC, biopesticides, fruit borer, organic produce

INTRODUCTION

"Brinjal cultivation in India grapples with significant challenges posed by a variety of pests at different growth stages. Among these, the shoot and fruit borer (*Leucinodes orbonalis*) is widely acknowledged as the most devastating, while other pests like the epilachna beetle (*Epilachna vigintioctopunctata* Fab.), jassid (*Amrasca biguttula biguttula* Ishida), aphid, thrips, and whiteflies (*Bemicia tabaci* Gennadius) further exacerbate the situation"**(Abhishek and Dwivedi 2021)**. Infestation on brinjal can reach as high as 75 to 92%. Brinjal crop in India is consistently attacked by at least 50 insect pests, with Aphids, Jassids, Whiteflies, and Shoot and Fruit Borers classified as major pests that regularly affect the crop**(Pooja and Kumar, 2022). "**Among the insect pests, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) is the most significant". [51] It stands out as the most destructive and consistently recurring pest, causing substantial crop losses(**Umapathy *et al*., 1991**) and further more liable for weakening of natural product this characteristic ultimately impacts the market value of organic produce (**Mathiranjan *et al*., 2000)** and (**Das *et al*.,2008**). The infestation intensity by the pest can reach levels as high as over 90% (**Bhutani *et al*., 1976**; **Kalloo *et al*., 1988**). Yield losses have been estimated to range from 86% (**Naresh *et al*., 1986**) in Haryana to approximately 83 to 91% in Uttar Pradesh (**Patel *et al*., 2021**).

DAMAGING PATTERN AND BIOLOGY OF *Leucinodes orbonalis*

During the initial stages of the crop, the female moth typically deposits eggs on the undersides of leaves near the midrib, at the apex of shoots, or sometimes even on tender shoots themselves(**Basu *et al.*, 1968; Singh and Singh 2003**). Symptoms such as drooping, wilting, or withering of shoots are commonly observed during the early stages of growth as a result of shoot damage. (**Srinivasan *et al*., 1998; Rakibuzzaman *et al*., 2019)**. Following fruit formation, larvae typically penetrate from the underside of the calyx, bud, or fruit(**Briere *et al*., 1999**). The observed holes on the fruits serve as the exit points for the larvae(**Singh and Singh, 2003**). Each year, significant damage is observed, adversely impacting both the quality and yield of the harvest(**Colinet *et al*., 2015).**

It alone accounts for damage as high as 85.90%, with documented instances of up to 100% damage as well. The larvae bore into tender shoots, leading to wilting and dead hearts. As they progress, they bore into tender fruits, rendering them unfit for human consumption. Currently, (*Leucinodes orbonalis*) is recognized as a primary pest of brinjal, causing significant damage as both a shoot and fruit borer in established crops in the main field **(Halder *et al.*, 2015).**

Damage is inflicted by caterpillars that start off creamy white when young but transition to a light pink hue as they mature, reaching a length of 18-23 mm when fully grown. Typically, larvae undergo 5-6 instars during their development (**Raina and Yadav 2017)**

It appears to closely align with the developmental stages of *Leucinodes orbonalis*, known as the eggplant fruit and shoot borer. Let's dissect these stages:

Newly hatched larva: Upon hatching, the larvae are minuscule and exhibit a creamy or dirty white hue, accompanied by a dark brown or light black head. They possess three pairs of thoracic legs and five pairs of pro-legs, a characteristic shared by many moth larvae, including *Leucinodes orbonalis*.

2nd instar larva: Resembles the first instar larva but is larger in size and may appear somewhat darker in color. This is also common in many moth larvae as they moult and grow between instars.

3rd instar larva: Longer than the 2nd instar larva and darker in color. The prothoracic legs, the legs near the head, are dark brown in color. This stage represents further growth and development.

4th instar larva: Takes on a more pinkish coloration. This could indicate changes in the larva's diet or metabolism as it progresses through its development.

5th instar larva: It displays a pinkish-brown coloration with three clearly defined segments in the thorax and five pairs of well-developed prolegs. This is likely the final instar before pupation.

These descriptions align well with the developmental stages typically observed in *Leucinodes orbonalis* larvae. Monitoring these stages can be crucial for implementing control measures effectively and managing infestations in eggplant crops**(Shaukat *et al*.,2018).**

The pupal duration of the brinjal shoot and fruit borer (BSFB) varies: during summer, it typically spans 7-10 days, whereas in winter, it extends to 13-15 days**(Shaukat *et al.*,2018).** Pupation of this pest typically occurs in the soil, as well as in dried shoots, leaves, or plant debris that have fallen to the ground**(Butani and Verma 1976).** The BSFB moth presents a white hue, featuring a blackish-brown spot on both the thorax and abdomen dorsum. Its wings are whitish with a pinkish-brown tinge and are adorned with small hairs along the apical and anal margins(**Raina and Yadav 2018).**

Table 1. Newer insecticides and their mode of actions on insect pests

S.No.	Newer insecticides	Mode of action
1	(Chlorantraniliprole) C18H14BrCL2N5O2	Coragen binds to a specific receptor in muscles known as the ryanodine receptor. When chlorantraniliprole attaches to this receptor, it prompts muscle cells to release calcium, resulting in abnormal muscle function. This results in paralysis and eventual demise of the insect. The ryanodine receptor differs between insects and mammals, with coragen binding much more strongly to the insect receptor (Cordova *et al*., 2006 & Sattele *et al*., 2008). It primarily affects insects when ingested (FHHERA, 2019). Additionally, coragen is toxic to insect eggs, larvae, and pupae upon contact (Brugger *et al*., 2018 & Krishan *et al*., 2021).
2	(Flubendiamide) C23H22F7IN2O4S	Masaki *et al.* (2006) showed that FBD stimulates Ca2+ pump activity is hindered by reducing the coupling between RyRs and the pump, leading to a decrease in internal calcium concentration. This particular mode of action of FBD causes various disruptions in muscle function in the target insect, resulting in symptoms of poisoning such as rapid cessation of feeding and contractile paralysis and regurgitation leading to the death of insect.
3	(Thiacloprid) C10H9CIN4S	Thiacloprid is an insecticide of the neonicotinoid class. Its mechanism of action is akin to other neonicotinoids and entails disrupting the insect's nervous system through. stimulating nicotinic acetylcholine receptors(USEPA.2012 & Schuld and Schmuck., 2000).
4	(Carbofuran) C10H12O2	It is a systemic insecticide, Carbofuran also has contact activity against pests. It is one of the most toxic pesticides still in use (APDM 2020).
5	(Indoxacarb) C22H17CIF3N3O7	Insecticidal activity takes place by blocking the sodium channels in the insect nervous system, and it enters through both stomach and contact routes(USEPA 2000).
6	(Emmamectin benzoate) C49H75NO13	Upon application to foliage, emamectin benzoate permeates the leaf tissue, creating a reservoir within treated leaves. This reservoir offers residual activity against pests that feed on foliage and ingest the substance during feeding. The proposed formulation aims to translocate within the tree's vascular system upon injection(USEPA 2009).
7	(Spinosad) C83H132N2O20	Spinosad's specific mode of action involves modifying the function of nicotinic and GABA-gated ion channels, leading to rapid excitation of the insect's nervous system. This results in involuntary muscle contractions, tremors, paralysis, and ultimately, death (Fulton *et al*., 2013).

Table 2. Bio pesticide and their mode of action on insect pest

S.No.	Bio pesticide	Mode of action
1	*Bacillus thuringiensis*	The most widely accepted primary mode of action of the Bt toxin is the lysis of epithelial cells in the insect's midgut. The toxin operates externally to the cells, entering the plasma membrane without accessing the cytoplasm. (Liu *et al*. 2018)
2	*Beauveria bassiana*	Insect death is caused by starvation as the fungus takes over the internal structures of the insect, ultimately resulting in outward penetration of the cuticle and sporulation on the mummified body of the host (Urquiza *et al*.,2015).
3	*Metarhizium anisopliae*	The fungus *Metarhizium anisopliae* strain F52 infects insects upon contact. Upon attaching to the insect's outer surface, the fungus spores germinate and initiate growth. By penetrating the insect's external exoskeleton, they rapidly multiply inside, ultimately leading to the insect's demise(USEPA 2003).
4	Neem oil	Most active component for repelling and killing pests (USEPA.,2012)

Efficacy of various insecticides and biopesticides

"Research on chemical control of *L. orbonalis* demonstrated that treatments with Emamectin benzoate 5% SG and Coragen 18.5% SC were the most effective. Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP insecticides were determined to be the least effective against shoot and fruit borer. The remaining treatments, including Spinosad 45% SC, Lambda cyhalothrin 5% EC, and Pyriproxyfen 5% EC + Fenpropathrin 15% EC, were observed to be moderately effective" (Vinayaka *et al*.,2019) Naik and his co-workers study resulted that In the chemical control trial, profenofos at 0.1% and spinosad at 0.015% were identified as the most effective in reducing shoot infestation of *L. orbonalis*, while also resulting in higher brinjal fruit yield. Among the 15 treatments tested, profenofos demonstrated the highest effectiveness, followed by spinosad when used individually. Combining profenofos and spinosad with novaluron and Azadirachtin proved highly effective in reducing the population of *L. orbonalis*, while also resulting in higher yields (Naik *et al.,* 2008). In another trial, Emamectin benzoate 5SG at 50gm/lit emerged as the most effective, exhibiting 8.71% shoot infestation and 7.22% fruit infestation. Following closely were Spinosad 45 SC at 0.02ml/lit with 10.13% shoot infestation and 7.69% fruit infestation, and Cypermethrin 25 EC at 2ml/lit with 11.51% shoot infestation (Shyamrao *et al.,*2018)**.**

“The following treatments were applied three times at fifteen-day intervals, starting from the onset of BSFB infestation: chlorantraniliprole 18.5 SC (0.4ml/l), spinosad 45 SC (0.5ml/l), chlorpyriphos 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), and chlorpyriphos 20EC (2.5 ml/l) were included in the study. The mean shoot infestation was lowest in coragen-treated plots (6.32%), followed by spinosad, chlorpyriphos, and indoxacarb. Among the bio-pesticides, Beauveria and Bt were identified as effective treatments in reducing shoot infestation. Coragen achieved the lowest fruit infestation rate (8.25%) and the highest marketable fruit yield (250.30q/ha), followed by spinosad and chlorpyriphos”(Tripura *et al.*, 2017). “Among the various insecticidal treatments, the application of Emamectin benzoate 25 WG at 0.4gm/lit resulted in the lowest fruit damage at 6.95%, accompanied by the highest yield of 351.46 qt/ha. However, it performed equally well as Spinosad 45 SC at 0.5 ml/lit, which had a fruit damage rate of 8.06% and a yield of 341.75 q/ha”(Mane and Kumar 2020). The bio-insecticides and botanicals examined comprised Emamectin benzoate 5 SG at a rate of 75 g a.i/ha, Spinosad 45 SL at 18 g a.i/ha, NSKE at 5%, Karanj seed extract at 5%, Onion extract at 5%, Garlic extract at 5%, Tobacco extract at 5%, Cannabis (bhang) leaf extract at 5%, and Wood ash at 10 g per plant. These were compared against a control group. The results indicated that plots treated with Emamectin benzoate 5 SG (75 g a.i/ha) showed the lowest infestation levels and yielded the highest fruit yield at 313.85 q/ha. Following closely were Spinosad 45 SL (18 g a.i/ha) and NSKE (5%), which yielded 300.58 and 284.33 q/ha of fruit, respectively. Conversely, the least effective treatment was Wood ash (10 g/plant), yielding only 225.14 q/ha of healthy fruits. The highest cost-benefit ratio was achieved with Emamectin benzoate 5 SG at 75 g a.i/ha (1:21.23) treated plots. While Tobacco leaf extract 5% treated plots were environmentally friendly, they exhibited the lowest cost-benefit ratio at 1:1.27. This study underscores the potential of bio-insecticides and botanicals in effectively managing brinjal shoot and fruit borer infestations(Verma *et al.*, 2021).

(Jat and Shrivastva 2023) The study demonstrated that all treatments were significantly superior to the control group. In terms of economic viability, the newer insecticides, namely Spinosad 45 SC, followed by Indoxacarb 14.5 SC and Emamectin benzoate 5 SG, showed promising patterns. It can be concluded that the most effective control of brinjal shoot and fruit borer was achieved with the insecticide Spinosad 45 SC after two sprays at the recommended intervals and doses.

Conclusion- The BSFB, known as an oligophagous pest, mainly targets brinjal and other vegetables belonging to the *Solanaceae* family. Its brief life cycle and habit of boring into plants hinder the growth and development of brinjal crops, causing substantial losses for farmers. In efforts to control this primary pest, farmers often resort to excessive and indiscriminate use of insecticides. However, this approach results in lingering effects on human health, pest resurgence, environmental damage, and the depletion of natural enemy populations in fields.

To address the adverse effects linked with insecticide usage, adopting biological control agents for managing BSFB becomes the preferred strategy. These agents provide a safe solution for the environment, posing no threat to human health and representing a completely eco-friendly approach.

Future aspects- Opting for biological control agents instead of insecticides is crucial for safeguarding the environment and sustaining populations of natural enemies.

References

1. Vinayaka KS, Balbir Singh, SS Yadav and Sudhanshu Bala Nayak**.** Efficacy of Different Insecticide against brinjal fruit borer (*Leucinodes orbonalis* Guenne) and their impact on fruit yield. *Journal of Entomology and Zoology Studies* 2019; 7(3): 63-66
2. Ajit Tripura, ML Chatterjee, Rachna Pande and Sandipp Patra**.** Biorational management of brinjal shoot and fruit borer (*Leucinodes orbonalis* guenee) in mid hills of Meghalaya. *Journal of Entomology and Zoology Studies* 2017; 5(4): 41-45
3. Ankur Prakash Verma, Umesh Chandra, Anuj Shakya, Reetesh Pratap Singh, Bhupendra Singh and Khursheed Alam. Efficacy of bio-insecticide and Botanicals against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee). *The Pharma Innovation Journal* 2021; 10(12): 1071-1077
4. PD Mane and Randhir Kumar . Bio-efficacy of new chemicals against shoot and fruit borer (*Leucinodes orbonalis*) of brinjal. *Journal of Entomology and Zoology Studies* 2020; 8(6): 1692-1693
5. Nawale Jayant Shyamrao, Ashwani Kumar, Patil AA and Narode MK. Efficacy of Certain insecticide and bio-pesticide against brinjal shoot and fruit borer(*Leucinodes orbonalis* Guenee). *Journal of Entomology and Zoology Studies* 2018; 6(5): 292-295

6. Naik CV, Rao PA, Krishnayya PV, Rao VS. Seasonal Incidence and Management of *Leucinodes orbonalis* Guenee on Brinjal. *Annals of Plant Protection Sciences* 2008;16(2):329-332.
7. Raina J, Yadav GS. Influence of abiotic factors on population dynamics of *Leucinodes orbonalis* Guenee on brinjal in Hissar agro-climatic conditions. *Annals of Plant Protection Sciences*. 2017;25(2):277-280

8. Jyoti Raina, GS Yadav. BSFB: Bio-ecology and management. *Journal of pharmacognosy and phytochemistry*, 2018;7(4):444-449.
9. R Srinivasan. Integrated pest management for BSFB in south and Sotheast Asia: past, present and future. *Journal of Biopesticides*, 2008, 105-112.
10. Cordova, D.; Benner, E. A.; Sacher, M. D.; Rauh, J. J.; Sopa, J. S.; Lahm, G. P.; Selby, T. P.; Sevenson, T. M.; Flexner, L.; Gutteridge, S.; Rhoades, D. F.; Wu, L.; Smith, R. M.; Tao, Y. Anthranilic Diamides: A New Class of Insecticides with a Novel Mode of Action, Ryanodine Receptor Activation. *Pestic Biochem Phys* 2006, 84, 196–214.
11. Sattelle, D. B.; Cordova, D.; Cheek, T. R**.** Insect Ryanodine Receptors: Molecular Targets for Novel Pest Control Chemicals. *Invert Neurosci* 2008, 8, 107–119.
12. *US Department of Agriculture, Marketing and Regulatory Programs*, Animal and Plant Health Inspection Service, 2019.
13. Brugger, K. E.; Xole, P. G.; Newman, I. C.; Parker, N.; Scholz, B.; Suvagia, P.; Walker, G.; Hammond, T. G. Selectivity of Chlorantraniliprole to Parasitoid Wasps. *Pest Manag Sci* 2010, 66, 1075–1081.
14. Krishnan, N.; Zhang, Y.; Aust, M. E.; Hellmich, R. L; Coats, J. R.; Bradbury, S. P. Monarch Butterfly (*Danaus Plexippus*) Life-Stage Risks from Foliar and Seed-Treatment Insecticides. *Envir Tox Chem* 2021, 40 (6), 1761–1777.
15. Masaki, T., Yasokawa, N., Tohnishi, M., Nishimatsu, T., Tsubata, K., Inoue, K., Hirooka, T., 2006. Flubendiamide, a novel Ca2+ channel modulator, reveals evidence for functional cooperation between Ca2+ pumps and Ca2+ release. Mol. *Pharmacol.* 69, 1733–1739.
16. Thiacloprid Pesticide Fact Sheet, United States Environmental Protection Agency Archived 2012-06-27.
17. Schuld M, Schmuck R (2000). "Effects of Thiacloprid, a New Chloronicotinyl Insecticide, On the Egg Parasitoid *Trichogramma cacaoeciae"*. Ecotoxicology. **9** (3): 197–205.
18. Ravichandra, N.G. (2018). *Agrochemicals in Plant Disease Management*. Scientific Publishers. p. 110.
19. M.H. Fulton, P.B. Key, M.E. DeLorenzo (2013) Insecticide Toxicity in Fish Physiology Volume 33, 2013, Pages 309-368 *Fish Physiology* .

20. Liu L, Chen Z, Yang Y, Xiao Y, Liu C, Ma Y, Soberón M, Bravo A, Yang Y, Liu K (2018) A single amino acid polymorphism in ABCC2 loop 1 is responsible for differential toxicity of *Bacillus thuringiensis* Cry1Ac toxin in different Spodoptera (Noctuidae) species. *Insect Biochem Mol Biol* 100:59–65.
21. Ortiz-Urquiza, Z. Luo, and N. O. Keyhani, "Improving mycoinsecticides for insect biological control," *Applied Microbiology and Biotechnology*, vol. 99, no. 3, pp. 1057–1068, Feb. 2015.
22. Hansa Kumari Jat and Dr. VK Shrisvastva, "Cost benefit analysis of newer insecticide used in control of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) at Gwalior region of Madhya Pradesh", *The Pharma Innovation Journal* 12(3): 3091-3093, 2023.
23. *Pesticide Product Information System*; U.S. Environmental Protection Agency, U.S. Government Printing Office: Washington, DC, 2012
24. Basu AC, Pramanik LM. Acaricidal tests of nine pesticides against the two-spotted spider mite, a serious pest of brinjal (eggplant) in west Bengal. *Journal of Economic Entomology* 1968;61(3):768-770.
25. Butani DK, Verma S. Pests of vegetables and their control Brinjal. Pesticides 1976;17(9):6-13
26. Briere JF, Pracros P, Le Roux AY, Pierre JS. A novel rate model of temperature-dependent development for arthropods. *Environmental Entomology* 1999;28(1):22-9
27. Colinet H, Sinclair BJ, Vernon P, Renault D. Insects in fluctuating thermal environments. *Annual Review of Entomology* 2015;7(60):123-40.
28. Das BC, Sarker PK, Rahman MM. Aphidicidal activity of some indigenous plant extracts against bean aphid Aphis craccivora Koch (Homoptera: Aphididae). *Journal of Pest Science* 2008;81(3):153-9.
29. Kalloo G. Solanaceous crops. *Vegetable breeding* 1988;2:520-70.
30. Mathirajan VG, Natarajan K, Kuttalam S, Chandrasekaran S, Regupathy A. Efficacy of lambda cyhalothrin (karate 5 EC against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.). *Pesticide Research Journal* 2000;12(1):117-119.
31. Rakibuzzaman M, Mahato AK, Husna MA, Maliha M, Jamal Uddin AF. Influence of natura one and neem oil on growth and yield of brinjal (*Solanum melongena*). *Journal of bioscience and Agriculture Research* 2019;20(02):1694-9.

32. Singh YP, Singh PP. Bioefficacy of insecticides in combination with carbofuran against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) at medium high altitude hills of Meghalaya. *Indian Journal of Plant Protection* 2003;31(2):38-41.
33. Srinivasan G, Babu PCS, Reddy PP, Kumar NKK, Verghese A. Advances in IPM for horticultural crops. In: Proceedings of the first national symposium on pest management in horticultural crops: *environmental implications and thrusts* 1998, 87-93.
34. Umapathy G, Baskaran P. Bioefficacy of certain synthetic pyrethroids against major pests of brinjal. *Madras Agric.* J 1991;78:8-10.
35. Akhilesh Kumar Patel, Pradeep Kumar, Lokesh Kumar Harinkhede, Amit Kumar Patel and Brajendra Ahirwar. Comparative efficacy of different botanicals and biopesticides for management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) under Bundelkhand region: *The Pharma Innovation Journal* 2021; SP-10(9): 470-474.
36. Pooja, G. S. and Kumar, A. (2022). Field efficacy and economics of different insecticides against brinjal shoot and fruit borer *(Leucinodes orbonalis* Guenee). *The Pharma Innovation Journal,* (7): 4545-4548.
37. Jaydeep Halder, Totan Adak and Sujan Majumder. Bioefficacy, phytotoxicity and insecticide residue dynamics of chlorantraniliprole in brinjal (*Solanum melongena*) under field condition. *Indian Journal of Agricultural Sciences* **92** (10): 1219–1224, October 2022.
38. Naresh JS, Malik VS, Balan JS. Estimation of fruit damage and larval population of brinjal fruit borer, Leucinodes orbonalis Guenee and its parasitism by Trathala sp. on brinjal. *Bulletin of Entomology New Delhi* 1986;27(1):44-7.
39. Halder J, Kushwaha D and Rai A B. 2020. Biology and feeding potential of *Eocanthecona furcellata* (Wolff) on its lesser known prey, *Spilosoma obliqua* (Walker). *Journal of Biological Control* 34(2): 109–12.
40. Halder J, Kushwaha D, Rai A B, Singh A and Singh B. 2017. Potential of entomopathogens and neem oil against two emerging insect pests of vegetables. *Indian Journal of Agricultural Sciences* 87(2): 220–24.
41. Sahu M, Adak T, Patil N B, Pandi G G P, Gowda G B, Yadav M K, Annamalai M, Golive P and Jena M. 2019. Dissipation of chlorantraniliprole in contrasting soils and its

effect on soil microbes and enzymes. *Ecotoxicology and Environmental Safety* 180: 288–94.

42. Vijayasree V, Bai H, Beevi S N, Mathew T B, Kumar V, George T and Xavier G. 2013. Persistence and effects of processing on reduction of chlorantraniliprole residues on cowpea fruits. *Bulletin of Environmental Contamination and Toxicology* 90(4): 494–98.
43. Singh M, Sachan SK. Comparative efficacy of some biopesticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee in Brinjal. *Plant Archives* 2015;15(2):805-8.
44. Srinivasan R. Integrated Pest Management for eggplant fruit and shoot borer (*Leucinodes orbonalis*) in south and south east Asia: Past, Present and Future. *Journal of Biopesticides* 2008;1(2):105-12.
45. Jat KL, Pareek BL. Field evaluation of ecofriendly insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Indian Journal of Plant Protection 2001;29(1):53-6.
46. Jyothi DP. Biorational approaches for the management of brinjal shoot and fruit borer (*Doctoral dissertation* UAS, Dharwad) 2006.
47. Choudhary B. Vegetables. National book trust, New Delhi 1970, 25-50.
48. Anand GS, Sharma RK, Shankarganesh K. Evaluation of bio-efficacy and compatibility of emamectin benzoate with neem based biopesticide against fruit borers of brinjal and okra. *Indian Journal of Agricultural Sciences* 2014;84(6):746-53.
49. Dhankar BS. Progress in resistance studies in the eggplant (*Solanum melongena* L.) against shoot and fruit borer (*Leucinodes orbonalis* Guen.) infestation Trop Pest Manag 1988;34:343-345.
50. Dhaliwal NK, Aggarwal N. Development and survival of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee (Crambidae: Lepidoptera) at constant and alternating temperatures. *International Journal of Tropical Insect Science* 2021;41(2):1717-28.
51. Ashadul MI, Hussain MA, Shapla SA, Mehraj H, Uddin AJ. Plant extract for the management of brinjal shoot and fruit borer (Leucinodes orbonalis Guenee). American-Eurasian J. Agric. & Environ. Sci. 2014;14(12):1409-14.