Original Research Article

Management of Fruit and Shoot Borer, *Leucinodes Orbonalis* (Guenee)through Sequential Application of Selected Insecticides and Biorationals in Brinjal

ABSTRACT

Background: Brinjal (*Solanum melongena* Linn.) (2n =24) is the most popular vegetable crop which is also known as eggplant or aubergine or guinea squash, belongs to the nightshade family Solanaceae, and principally regarded as "King of the Vegetables". It has high yielding potential and can be grown throughout the year under diverse agro climatic conditions, especially in tropical and sub-tropical environment.

Methods: An experiment was conducted during summer 2023 at AHRS,Bavikere, to check the schedule of varying insecticide combinations for their efficacy against *Leucinodes orbonalis*

Result: The results of the present field experiment conducted during summer 2023 revealed that amongst different insecticidal schedules tested, 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 proved effective in reducing the damage of *L. orbonalis* and also demonstrated a strong economic viability with a notably high cost-benefit ratio.

Key words: Brinjal, *Leucinodes,* insecticides, damage

INTRODUCTION

Brinjal (*Solanum melongena* Linn.) (2n =24) is the most popular vegetable crop which is also known as eggplant or aubergine or guinea squash, belongs to the nightshade family Solanaceae, and principally regarded as "King of the Vegetables". It has high yielding potential and can be grown throughout the year under diverse agro climatic conditions, especially in tropical and sub-tropical environment.Brinjal has its centre of origin in the Indian sub-continent (Omprakash and Raju, 2014).

In India, brinjal is grown over an area of 0.743 million hectares of agricultural land, with a production of 12.77 million tonnes per year and productivity of nearly 17.17 MT/ha (Anon., 2022). The major brinjal growing states in India are Bihar, Orissa, Karnataka, Andra Pradesh, Maharashtra, West Bengal, Uttar Pradesh and states with coordinating climatic conditions within the tropics and subtropics. In Karnataka, brinjal is being grown in an area of 1.58 lakh ha with a production of 402.5 metric tonnes (3.13% share) and a productivity of 25.4 metric tonnes per hectare (Anon., 2016).Brinjal has been reported as Ayurvedic medicine for curing diabetes; beside it is also used as a good appetizer, aphrodisiac, cardiac tonic, laxative and reliever of inflammation and found as an excellent remedy for those who are suffering from liver complaints (Lalita and Kashyap, 2020).

Owing to the accessibility of brinjal produce all through the year, the production of the crop is regulated by different biotic and abiotic factors and amongst those factors, insectpests play a pivotal role for lowering the yield of brinjal by attacking the crop right fromnursery stage till harvesting. Brinjal is attacked by almost 142 species of insect pests, four species of mites and nematodes in different parts of the world (Jat and Shrisvastva, 2023). Several insect pests attack brinjal crop, of which aphid (*Aphis gossypii* Glover), whitefly (*Bemisiatabaci* Lind.),jassid (*Amrascabiguttulabiguttula* Ishida), spotted leaf beetle (*Epilachnavigintioctopunctata* Fab.), brinjal shoot and fruit borer (BSFB) (*Leucinodes orbonalis*Guenee), brinjal leaf beetle (*Psylliodes bali* Jacoby) and leaf folder (*Eublemma oleracea* Walk.) are common pests (Patra *et al.,* 2016).

Among these pests, brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenée) (Lepidoptera: Crambidae) is one of the most important, severe pests of brinjal which is a primary constraint in brinjal production.At early stage of the crop growth, adult female moth lays eggs mostly on lower side of the young leaves near the midrib and at the top of shoot or sometimes even on the tender shoots itself. After hatching, young larvae bore into the young leaves nearmidrib or tender shoot and close the opening with frass and feed within the shoot or midrib of the leaves. Drooping, wilting,or withering of shoots are the typical symptoms of shoot damage during early stage of crop growth.After fruit formation, larvae generally enter from underside of the calyx or bud or fruit. The entry hole is closed with frass. Infestation to the buds results in flower drop. The holes seen on the fruits are actually the exit holes of the larvae. Such infested fruits are partially unfit for human consumption and fetch less price in the market (Shigaonkar*et al.*, 2022).This pest damages brinjal crop with the yield loss up to 60-80 per cent or can even cause 100% damage if no control measures are taken (Thakare *et al.*, 2021).

The profitable cultivation of brinjal makesfarmers inevitable to protect the crop from shoot and fruit borer damage using synthetic insecticides heavily. But the overuse or exclusive use of a single class of insecticide can lead to the development of insecticide resistance. This can result in the insecticide becoming less effective, leading to an increased use of the insecticide or need to switch to a more potent and often more toxic insecticide.

Given this scenario, sequential scheduling of insecticides plays an important role in delaying or completely preventing build-up of resistance to insecticides and offers effective management of brinjal shoot and fruit borer. Sequential scheduling of insecticides involves rotating different classes of insecticides over a period of time to reduce likelihood of resistance development and to improve control. Furthermore, different insecticides have varying modes of action, which means that they target different stages of the pest's life cycle. It is, therefore, needed to evaluate few insecticidal schedules involving some new insecticidal compounds for effective control of this pest.

MATERIAL AND METHODS

The field experiment to know the effective insecticidal schedule for the management of brinjal shoot and fruit borer in brinjal was conducted during summer 2023 at Agricultural and Horticultural Research Station (AHRS), Bavikere, KeladiShivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The experiment was carried out in randomized complete block design (RCBD) with seven treatments including untreated check and three replications. The seedlings of the hybrid “Harsha” released by Kalash Seeds Pvt. Ltd were raised in nursery beds during March 2023 and thirty days old uniform healthy seedlings of Harsha were transplanted to the main field at 90 cm × 60 cm spacing in plots of 3.6 m × 3 m. The crop was raised by following recommended agronomic practices except protection schedule against brinjal shoot and fruit borer, but plant protection measures were taken as and when necessary to check the sucking insects as well as foliage feeders.

In the present investigation, nine insecticides*viz.*,spinosad 45 SC (Tracer) @ 0.4 ml/l, chlorantraniliprole 18.5 SC (Coragen) @ 0.3 ml/l, azadirachtin 10,000 ppm (Agroneem) @ 2.0

ml/l, lufenuron 5 EC (Subject) @ 1.0 ml/l, emamectin benzoate 1.9 EC (Emma) @ 0.3 ml/l, abamectin 1.9 EC (Abacin) @ 0.1 ml/l, malathion 50 EC (Killers) @ 2.0 ml/l, *Bacillus thurengiensis* var. kurstaki (BARC *Bt*) @ 2.0 g/l and spinetoram 11.7 SC (Summit) @ 1.0 ml/l having different mode of action were imposed in six schedules along with untreated check against brinjal shoot and fruit borer (Table 1). The insecticides emamectin benzoate 1.9 EC and abamectin 1.9 EC were used in combination @ 0.4 ml/l. The insecticide spray solution was freshly prepared at the site of the experiment just before spraying. The required quantity of insecticide per plot was thoroughly mixed in a small quantity of water and then poured into the bucket containing the remaining quantity of water. The spray solution was thoroughly mixed before spraying and frequently stirred during the spray. A high-volume knapsack sprayer was used for spraying insecticides with a spray volume of 500 L/ha. In all the treatments, sequence of insecticides was sprayed at 15 days interval tillharvest (@ 40, 55, 70 and 85 DAT) to evaluate which sequence appears effective in managing the shoot and fruit borer. The influence of different insecticidal schedules on per cent shoot damage, per cent fruit damage, marketable yield was recorded, and cost benefit ratio was also calculated.

Observations on per cent shoot damage by brinjal shoot and fruit borer was recorded from five randomly selected plants one day before the first spray and five days and ten days after each spray/treatment application, and the observations were converted into per cent infestation. The mean per cent shoot infestation was calculated using the formula as suggested by Thakare *et al.*, 2021

$$\text{Per cent shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

The observations on per cent fruit damage was recorded at each picking by counting number of damaged fruits and total number of fruits per plot and the observations were converted into per cent infestation. The mean per cent fruit infestation was calculated using the formula as suggested by Iesa (2021)

$$\text{Per cent fruit infestation} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

The marketable yield was calculated by adding the yield of healthy fruits picking wise. Later, marketable plot yield was converted into hectares using the formula as suggested by Sheojat*et al.* (2022)

$$\text{Yield (kg/ha)} = \frac{\text{Yield/plot}}{\text{Plot size}} \times 10000$$

The yield (kg/ha) was then converted to tonnes/ha by dividing the mass/ area value by 1000. The cost benefit ratio was calculated by considering the cost of protection of different treatments, cost of production and market price of brinjal. Cost effectiveness of each treatment was assessed based on net returns. Total cost of production includes both cultivation as well as plant protection charges.

Gross return = Marketable yield × Market price

Net return = Gross return – Total cost of cultivation

$$\text{Cost benefit ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

The data pertaining to shoot and fruit infestation were subjected for arc sine transformation before statistical analysis. The yield data was analysed directly.Therecorded data from field experiments were subjected for ANOVA and F- test as per RCBD requirement. The means have been separated and compared through CD and DMRT as per Gomez and Gomez (1984). The data recorded during the course of investigation, were also analysed with the help of computer software “OPSTAT” developed by Sheoran (1998).

RESULTS AND DISCUSSION

The pooled analysis of data reveals that all insecticidal schedules were effectiveover the untreated check in reducing both shoot damage (Table 2) and fruit damage (Table 3), as well as in increasing marketable yield (Table 4) and providing a better return on investment (Table 5). The shoot infestation recorded on the day before spraying (DBS) did not differ significantly across treatments, indicating uniform pest incidence (13.16 to14.73 %). The pooled analysis data of four sprays in six schedules during summer 2023 revealed that, the shoot damage remained persistent throughout the season, but there was a significant difference amongst sequences. The schedule (T1) having spinosad 45 SC @ 0.4ml/l- *Bacillus thurengiensis* var. *kurstaki* @ 2.0g/l- emamectin benzoate + abamectin 1.9 EC @ 0.4ml/l- azadirachtin 10,000ppm @ 2ml/l was found to be quite promising by limiting damage to 9.95 per cent only. The next best sequences were (T2)chloranraniliprole 18.5 SC @ 0.3ml/l - spinosad 45 SC @ 0.4ml/l- lufenuron 5 EC @ 1.0ml/l- *Bacillus thurengiensis* var. *kurstaki* @ 2.0g/l (10.96 %) and (T3) azadirachtin 10,000ppm @ 2ml/l- lufenuron 5 EC @ 1.0ml/l- chloranraniliprole 18.5 SC @ 0.3ml/l- spinetoram 11.7 SC @ 1.0 ml/l (11.58 %) which were on par with each other, followed (T5) emamectin benzoate + abamectin 1.9 EC @ 0.4ml/l- spinetoram 11.7 SC @ 1.0 ml/l- chloranraniliprole 18.5 SC @ 0.3ml/l- lufenuron 5 EC @ 1.0 ml/l (13.57 %), (T4) lufenuron 5 EC @ 1.0ml/l- *Bacillus thurengiensis* var. *kurstaki* @ 2.0g/l- azadirachtin 10,000ppm @2ml/l- spinosad 45 SC @ 0.4ml/l (13.63%) and (T6) malathion 50 EC @ 2ml/l- chloranraniliprole 18.5 SC @ 0.3ml/l-malathion 50 EC @ 2ml/l- chloranraniliprole 18.5 @ 0.3ml/l (14.85%) which were on par with each other, whereas the highest shoot damage was recorded in the untreated check (19.98%).

Similarly, the fruit damage got to decline with the advancement of the season. Sequential application of (T2)chloranraniliprole 18.5 SC @ 0.3ml/l - spinosad 45 SC @ 0.4ml/l- lufenuron 5 EC @ 1.0ml/l- *Bacillus thurengiensis* var. *kurstaki* @ 2.0g/l was found to be quite promising by limiting the damage to 29.51 per cent damage and this was on par with T1(30.86%) and T3 (36.08%). The highest fruit damage was recorded in the untreated check(56.36%).

Ultimately, six different schedules of insecticides / biorationals could render better marketable yield with the advancement of the season. Infact, all insecticides in different logical sequences proved effective in minimising the fruit damage, resulting in increased marketable fruit yield. The sequence (T2) chloranraniliprole 18.5 SC @0.3ml/l - spinosad 45 SC @ 0.4ml/l- lufenuron 5 EC @ 1.0ml/l- *Bacillus thurengiensis* var. *kurstaki* @2.0g/l was found to be quite promising by recording the highest marketable fruit yield of 24.85 t/ha and this was followed by T1 (23.55 t/ha), T3 (18.74 t/ha) and (T4) Lufenuron (16.89 t/ha). On the contrary the lowest marketable fruit yield was recorded in the untreated check (7.30 t/ha). There was around 16.25 t/ha (T1), 17.55 t/ha (T2), 15.24 t/ha (T3), 11.06 t/ha (T4), 11.44 t/ha (T5) and 9.59 t/ha (T6) increase in yield when compared to control plot yield, among which, yield increase over control was highest in sequence T2, followed by T1, T3, T5, T4 and T6.

The data presented in Table 5 reveals that highest cost benefit ratio of 5.07 was registered in sequence T2, followed by T1(4.93), T3 (4.59), T5 (3.83), T4 (3.80), T6 (3.46), whereas lowest cost benefit ratio was recorded in untreated check (1.93).This highlights the importance of implementing the insecticidal schedules, particularly T2 and T1, as they have shown to provide the highest economic returns relative to the costs incurred.

From the present study it is evident that newer insecticides with novel mode of action and biorationals proved highly effective against FSB and could yield better biologically and economically as well. The effectiveness of chlorantraniliprole in reducing borer damage align with the findings of various researchers. Mishra (2011) discovered that chlorantraniliprole@ 40 and 50 g/hashall reduce approximately 95-97 per cent shoot damage, 87-90 per cent fruit damage. Similarly, Saha *et al.* (2014) and Devi *et al.* (2015) also endorsechlorantraniliprole efficacy against brinjal shoot and fruit borer. Studies by Sajjan and Rafee (2015) also confirmed the synthetic chemicaltargeting the ryanodine receptor (chlorantraniliprole), as the most effective against the brinjal shoot and fruit borer in eggplant crop.

Spinosad efficacy against FSB has been evidently proved better by Anoorag and Simon (2010) wherein only 9.84 percent shoot infestation, 7.35 percent fruit infestation based on weight was observed. This treatment also led to an increased yield of brinjal fruit, reaching 239.30 q/ha. Abdullah *et al.* (2014) also noted that among the treatments, spinosad was the most effective in reducing shoot and fruit infestation.Furthermore, Tripura *et al.* (2017) found that among the bio-pesticides, foliar application of *Bt*at 2 g/l of water yielded the lowest shoot and fruit infestation rates, along with the highest marketable yield.The results of efficacy of emamectin benzoate + abamectin and lufenuron align with Rahman *et al.* (2019) who recorded the lowest shoot (6.71%) and fruit (11.58%) infestation fromemamectin benzoate + abamectin 6WG treated plots @ 0.50 g/l that was followed by,lufenuron 5 EC @ 1.0 ml/l (6.89% shoot; 14.51% fruits). They observed a similar trend in case of marketable fruit yield as well.The effectiveness of azadirachtin is supported by the findings of Srinivasan and Sundarababu (1998), who reported that neem-based insecticides were highly effective in reducing the incidence of brinjal shoot and fruit borer.

CONCLUSION

Based on the present findings, it can be concluded that the sequential application spinosad 45 SC @ 0.4ml/l - *Bacillus thuringiensis* var. *kurstaki* @ 2.0g/l - emamectin benzoate + abamectin

1.9 EC @ 0.4ml/l - azadirachtin 10,000 ppm @ 2ml/l reduce shoot damage by FSB and is quite remunerative.Chlorantraniliprole 18.5 SC @ 0.3ml/l - spinosad 45 SC @ 0.4ml/l - lufenuron 5 EC @ 1.0 ml/l - *Bacillus thuringiensis* var.*kurstaki* @ 2.0g/l also appear better. This sequence lies in its exceptional performance in minimizing fruit damage and maximizing marketable yield. This sequence not only proved effective in reducing the impact of *L. orbonalis* but also demonstrated a strong economic viability with a notably high Cost-Benefit ratio. This suggests that adopting sequence T2 can lead to significant improvements in both pest management and economic returns for brinjal cultivation.

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 biological sciences,* **4**(1):20-24.

Anonymous, 2016, National Horticultural Mission - 2016.

Anonymous, 2022, Area, production and productivity of brinjal in Karnataka and India (2021-2022-1st advance estimates), Indiastat.com.

Anoorag, R. T. And Simon, S., 2010. Efficacy of spinosad and neem products against shoot and fruit borer (*Leucinodes orbonalis* Guen.) of brinjal (*Solanum melongena* L.). *Journal of biosciences,* **3**: 208-209.

Devi, L. L., Ghule, T. M., Chatterje, M. L. And Senapati, A. K., 2015, Effectiveness of biorational insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis*Guenee and on yield. *Ecology, Environment and Conservation,* **21**(2):783-788.

Gomez, K. A. And Gomez, A. A., 1984, Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley and Sons Publishers, New York. pp.680.

Iesa, M. A., 2021, Biology of brinjal shoot and fruit borer (*Leucinodes orbonalis*Guenee) and screening of various genotypes for resistance. *Turkish Online Journal of Qualitative Inquiry,* **12**(6): 6025- 6032.

Jat, H. K. AndShrisvastva, V. K., 2023, Cost: benefit analysis of newer insecticides used in control of brinjal shoot and fruit borer (*Leucinodes orbonalis*Guenee) at Gwalior region of Madhya Pradesh. *Journal of pharmaceutical innovation*, **12**(3): 3091-3093.

Lalita, S. And Kashyap, L., 2020, Biology and mechanisms of resistance to brinjal shoot and fruit borer: A review. *Journal of Entomology and Zoology Studies,* **8**(2): 2111-2118.

Mishra, H. P., 2011, Bio-efficacy of chlorantraniliprole against shoot and fruit borer of brinjal, *Leucinodes orbonalis*Guenee. *Journal of insect science*, **24**(1):60-64.

Omprakash, S. And Raju, S.V.S., 2014, A brief review on abundance and management of major insect pests of brinjal (*Solanum melongena* L.). *International journal of applied biology and pharmaceutical technology,* **5**(1): 228-238.

Patra, S., Thakur, N. S. AndFirake, D. M., 2016, Evaluation of bio-pesticides and insecticides against brinjal shoot and fruit borer (*Leucinodes orbonalis*Guenee) in Meghalaya of North-Eastern India.*International Journal of Bio-resource and Stress Management,***7**(5): 1032-1036.

Rahman, M. W., Gopal, D. And Uddin, M. M., 2019, Field efficacy of some new insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis*(Guen.) (Lepidoptera: Pyralidae) and their toxic effects on natural enemies. *Journal of Bangladesh Agricultural University,* **17**(3): 319-324.

Saha, T., Chandran, N., Kumar, R. And Ray, S. N., 2014, Field efficacy of newer insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis*Guenee (Lepidoptera: Pyralidae) in Bihar. *Pesticide Research Journal,* **26**(1):63-67.

Sajjan, A. A. And Rafee, C. M., 2015, Efficacy of insecticides against shoot and fruit borer, *Leucinodes orbonalis*(Guen.) in brinjal. *Karnataka Journal of Agricultural Sciences*,**28**(2):284-285.

Sheojat, B. N. K. S., Dwivedi, S., Kumar, N. And Naveen, C. A., 2022, Efficacy and Economics of newer insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis*Guenee (Lepidoptera: Pyralidae) in the Gwalior region of Madhya Pradesh. *Biological Forum*, **14**(2): 149-154.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C. And Pannu, R. S., 1998, Statistical Software Package for Agricultural Research Workers. *Recent Advances in Information Theory, Statistics & Computer Applications by D.S. Hooda & R.C. Hasija Department of Mathematics Statistics,* CCS HAU, Hisar, Haryana (India), **8**(12): 39-143.

Shigaonkar, R. S., Shinde, B. D., Shelke, S. B., Chopkar, P. S., Durge, S.M. And Choudhari, R.J., 2022, To screen some brinjal cultivars against shoot and fruit borer, *Leucinodes orbonalis*. *Journal of Pharmaceutical Innovation,***11**(1): 1337-1341.

Srinivasan, G.And Sundarababu, P.C., 1998, Management of brinjal shoot and fruit borer *Leucinodes orbonalis*Guencee (Lepidoptera: Pyralidae) using neem products and insecticides. In: Proceedings of First National Symposium on Pest Management in Horticultural Crop. IIHR, Bangalore, 15th–17th October, 1997, 87–93.

Thakare, V. S., Undirwade, D. B., Kulkarni, U. S. And Ghawade, S. M., 2021, Screening of brinjal genotypes for resistant reaction against brinjal shoot and fruit borer (BSFB) *Leucinodes orbonalis*Guenee. *Journal of Entomology and Zoology Studies*, **9**(1):1653-1657.

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.

Table 1. Schedule of insecticides for *Leucinodes orbonalis*management

Treatment	Schedule of insecticides			
	40 DAT*	**55 DAT**	**70 DAT**	**85 DAT**
T_1	Spinosad 45 SC	*Bacillus thurengiensis* var. kurstaki	Emamectin benzoate + abamectin 1.9 EC	Azadirachtin 10,000 ppm

T_2	Chlorantranilipr-ole 18.5 SC	Spinosad 45 SC	Lufenuron 5 EC	*Bacillus thurengiensis* var. kurstaki
T_3	Azadirachtin 10,000 ppm	Lufenuron 5 EC	Chlorantraniliprole 18.5 SC @0.3	Spinetoram 11.7 SC
T_4	Lufenuron 5. EC	*Bacillus thurengiensisvar*. kurstaki	Azadirachtin 10,000 ppm	Spinosad 45 SC
T_5	Emamectin benzoate + abamectin 1.9 EC	Spinetoram 11.7 SC	Chlorantraniliprole 18.5 SC	Lufenuron 5 EC
T_6 *(RPP)	Malathion 50 EC	Chlorantraniliprole 18.5 SC	Malathion 50 EC	Chlorantraniliprole 18.5 SC
T_7	Untreated Check			

*RPP- Recommended Package of Practise, DAT- Days After Transplanting

Treatments (Schedules)	Mean shoot damage (%)									
	DBS*	40 DAT*		55 DAT		70 DAT		85 DAT		Pooled mean (%)
		5 DAS*	10 DAS	5 DAS	10 DAS	5 DAS	10 DAS	5 DAS	10 DAS	
T_1	13.16 (21.26)^{a}	7.63 (16.00)^{d}	11.22 (19.54)^{e}	10.66 (19.04)^{c}	11.36 (19.66)^{d}	10.34 (18.75)^{c}	8.78 (17.21)^{b}	10.16 (18.56)^{b}	9.45 (17.87)^{bc}	9.95(18.38)^{d}
T_2	13.18 (21.26)^{a}	8.34 (16.76)^{d}	13.91 (21.87)^{de}	12.89 (21.02)^{c}	14.52 (22.38)^{c}	11.29 (19.63)^{bc}	8.54 (16.96)^{b}	9.95 (18.34)^{b}	8.24 (16.67)^{c}	10.96 (19.33)^{cd}
T_3	13.41 (21.42)^{a}	9.20 (17.61)^{cd}	15.57 (23.22)^{cd}	12.97 (21.08)^{c}	14.57 (22.43)^{c}	11.64 (19.93)^{bc}	9.85 (18.29)^{b}	8.75 (17.18)^{b}	10.12 (18.45)^{bc}	11.58 (19.90)^{c}
T_4	13.87 (21.84)^{a}	11.45 (19.77)^{bc}	19.00 (25.81)^{bc}	16.73 (24.14)^{b}	16.31 (23.81)^{bc}	13.84 (21.84)^{b}	10.88 (19.25)^{b}	10.73 (19.08)^{b}	10.16 (18.57)^{bc}	13.63 (21.67)^{b}
T_5	13.18 (21.28)^{a}	10.31 (19.15)^{bc}	17.57 (24.77)^{bcd}	16.92 (24.27)^{b}	18.37 (25.37)^{b}	14.46 (22.33)^{b}	9.48 (17.9)^{b}	9.50 (17.93)^{b}	12.02 (20.25)^{b}	13.57 (21.59)^{b}
T_6	14.73 (22.57)^{a}	13.46 (21.51)^{b}	21.32 (27.49)^{b}	17.34 (24.61)^{b}	18.86 (25.74)^{b}	14.77 (22.58)^{b}	11.09 (19.43)^{b}	11.56 (19.85)^{b}	10.41 (18.78)^{bc}	14.85 (22.67)^{b}
T_7	14.26 (22.18) ^{a}	17.33 (24.59) ^{a}	28.53 (32.27)^{a}	21.82 (27.84)^{a}	22.32 (28.19)^{a}	21.35 (27.49)^{a}	16.64 (24.04)^{a}	15.42 (23.05)^{a}	16.47 (22.57)^{a}	19.98 (26.55)^{a}
S.Em(±)	0.84	0.73	1.02	0.78	0.76	0.88	0.84	0.93	0.75	0.40
C.D. @ 5%	NS*	2.27	3.14	2.43	2.34	2.73	2.59	2.87	2.31	1.25
CV(%)	10.63	11.43	9.72	8.74	7.94	11.03	13.56	14.86	12.13	5.20

Table 2. Mean per cent shoot damage by *Leucinodes orbonalis*as influenced by different protection regimes

*DAT- Days After Transplanting, *DBS- Day Before Spraying, *DAS- Days After Spraying, *NS- Non-Significant,
Figures in parentheses are arc sine transformed values. Means followed by the same letter do not differ significantly by DMRT (P=0.05)

Table 3. Mean per cent fruit damage by *Leucinodes orbonalis*as influenced by differentprotection regimes

Treatments (Schedules)	Mean fruit damage (%)				Pooled mean (%)
	First picking	Second picking	Third picking	Fourth picking	
T_1	38.40 (38.28)[cd]	34.47 (35.93)[d]	24.20 (29.44)[d]	26.37 (30.88)[de]	30.86 (33.74)[c]
T_2	33.29 (35.21)[d]	37.78 (37.91)[d]	31.22 (33.95)[d]	15.74 (23.24)[f]	29.51 (32.90)[c]
T_3	41.63 (40.18)[cd]	44.28 (41.71)[cd]	35.31 (36.44)[cd]	23.11 (28.69)[ef]	36.08 (36.91)[c]
T_4	55.75 (48.31)[b]	50.82 (45.47)[bc]	45.23 (42.26)[abc]	34.81 (36.15)[cd]	46.65 (43.08)[b]
T_5	47.64 (43.64)[bc]	57.74 (49.45)[ab]	42.93 (40.93)[bc]	40.66 (39.61)[bc]	47.24 (43.42)[b]
T_6	56.49 (48.73)[b]	59.10 (50.26)[ab]	47.88 (43.78)[ab]	48.11 (43.91)[b]	52.89 (46.66)[b]
T_7	61.83 (52.08)[a]	59.19 (51.3)[a]	51.14 (45.54)[a]	53.31 (47.37)[a]	56.36 (49.72)[a]
S.Em(±)	1.74	2.13	2.05	2.00	1.54
C.D. @ 5%	5.39	6.59	6.34	6.17	4.75
CV(%)	6.20	7.34	8.82	9.79	6.05

Figures in parentheses are arc sine transformed values. Means followed by the same letter do not differsignificantly by DMRT (P=0.05)

Table 4. Influence of different protection regimes on brinjal marketable fruit yield

Treatments (Schedules)	Marketable yield (t/ha)				Pooled yield (t/ha)
	First picking	Second picking	Third picking	Fourth picking	
T_1	22.92^{a}	23.19^{a}	24.65^{a}	23.56^{c}	23.55^{ab}
T_2	24.30^{a}	22.07^{ab}	23.19^{ab}	29.85^{a}	24.85^{a}
T_3	22.81^{a}	18.02^{c}	21.70^{b}	27.63^{b}	22.54^{b}
T_4	16.88^{c}	20.20^{b}	17.02^{cd}	20.21^{d}	18.36^{c}
T_5	20.96^{b}	16.15^{c}	18.74^{c}	19.11^{d}	18.74^{c}
T_6	19.85^{b}	17.26^{c}	16.15^{d}	14.30^{e}	16.89^{c}
T_7	4.37^{d}	11.20^{d}	7.44^{e}	8.19^{f}	7.30^{d}
S.Em(±)	0.67	1.39	1.07	1.53	1.31
C.D. @ 5%	2.07	4.28	3.29	4.71	3.89
CV(%)	5.42	11.82	8.66	11.43	12.14

Means followed by the same letter donot differ significantly by DMRT (P= 0.05)

Table 5. Cost benefit ratio of different protection regimes tested against*Leucinodes orbonalis*

Treatments (Schedules)	Parameters						
	Marketable yield (t/ha)	Gross returns *(₹ /ha)	Inputs and other expenditure (₹ /ha)	Plant protection cost (₹ /ha)	Total cost of cultivation (₹ /ha)	Net returns (₹ /ha)	C:B ratio
T_1	23.55	588750	95252	24275	119527	469223	1: 4.93
T_2	24.85	621250	95252	27375	122627	498623	1: 5.07
T_3	22.54	563500	95252	27489	122741	440759	1: 4.59
T_4	18.36	459000	95252	25600	120852	338148	1: 3.80
T_5	18.74	468500	95252	26964	122216	346284	1: 3.83
T_6	16.89	422250	95252	26750	122002	300248	1: 3.46
T_7	7.3	182500	95252	-	95252	109917	1: 1.91

*Cost of marketable fruits - ₹ 25/kg, Cost of labour – ₹ 280/ person

Cost of chemicals (₹): Lufenuron 5 EC (250 ml) – 900, Spinetoram 11.7 SC (20 ml) – 298, Malathion 50 EC (500 ml) – 300, Spinosad 45 SC (75 ml) – 2065,Emamectin benzoate 1.9 EC (100 ml) – 256, Abamectin 1.9 EC (50 ml) – 350, *Btkurstaki*(50 g) – 150, Azadirachtin 1000 ppm (100 ml) - 450, Chlorantraniliprole 18.5 SC (60