Plant Archives Vol. 14 No. 2, 2014 pp. 649-654 *ISSN 0972-5210*

AN OVERVIEW OF INTEGRATED MANAGEMENT OF *LEUCINODES ORBONALIS* IN BRINJAL CROP IN EASTERN UTTAR PRADESH, INDIA

Dharmendra Kumar* and M. Raghuraman[1]

Deptt. of Entomology and Agril. Zool., Institute of Agricultural Sciences, BHU, RGSC, Barkachha, Mirzapur (U.P.), India.
Department of Entomology and Agril. Zool., Institute of Agricultural Sciences, BHU, Varanasi - 221 005 (U.P.), India.

Abstract

The present studies on the Integrated Pest Management (IPM) for brinjal fruit and shoot borer (*Leucinodes orbonalis*) in the field trial was conducted at Banaras Hindu University at Vegetable Research Farm during 2011 and 2012. In strategy of IPM for the control of brinjal fruit and shoot borer (*Leucinodes orbonalis*) consists of resistant cultivar, sex pheromone, cultural, mechanical and biological control methods. Brinjal cultivars such as Krishna, Pusa anmol, Pusa purple cluster, Navkiran and Pusa purple long-74 possess appreciable levels of resistance to *Leucinodes orbonalis*. For the control of *Leucinodes orbonalis* the use of sex pheromone traps based on (E)-11-hexadecenyl acetate and (E)-11-hexadecen-1-ol to continuously trap the adult males significantly reduced the pest damage on brinjal. In addition, prompt destruction of pest damaged brinjal shoots and fruits at regular intervals and withholding of pesticide use to allow proliferation of local natural enemies especially the parasitoid, *Trathala flavoorbitalis* reduced the *Leucinodes orbonalis* population. The IPM strategy was profit margins and production area significantly increased whereas pesticide use and labor requirement decreased for those farmers, who adopted this IPM technology. The effort also made to expand the *Leucinodes orbonalis* is management with the help of production and management practices such as the remove the infected parts.

Key words : Brinjal, *Leucinodes orbonali*, integrted pest management.

Introduction

Solanaceous vegetables *viz.,* brinjal, chilli, potato and tomato are grown throughout the year in all parts of country. These solanaceous vegetables are mainly used for culinary purpose. They are rich source of vitamins, minerals, proteins, carbohydrates and trace elements. Some of the solanaceous vegetables contain alkaloid *viz*., solanin (brinjal) and capsicin (chilli), which have medicinal properties. Like many other crops, China is a leader in vegetable production followed by India and Egypt and also in top position in brinjal production. Vegetable cultivation in India has assumed greater importance during the last decade. In India, during 1991-92 the total vegetable production, productivity and area was 58.53 m MT, 10.5 Mt/ha and 5.6 m ha respectively; whereas, in 2010-11 it increased to 146.55 m Mt, 17.3MT/ha and 8.49 ha respectively. In India, the leading vegetable producing state is West Bengal (18.2%) followed by U.P. (12.1%), Bihar (10%), Andhra Pradesh (8.1%) and Gujrat (6.4%). The share of total Area under vegetable production is highest in West Bengal (15.9%) followed by Bihar (9.9%), U.P. (9.8%) and Andhra Pradesh (7.7%), (Database NHB, 2010-11).

Brinjal fruit and shoot borer *Leucinodes orbonalis* Guenee (Lepidoptera : Pyrallidae) is one of the most destructive pests on brinjal in South and Southeast Asia. Larvae of this insect bore inside plant shoots and fruits adversely affecting plant growth, yield and fruit quality, and thus making it unfit for human consumption. Hence, the farmers in the region rely exclusively on the application of chemical insecticides to combat *Leucinodes orbonalis*, which has resulted in a tremendous misuse of pesticides in an attempt to produce damage-free marketable fruits. In addition to the adverse effects on environment and human health, such pesticide use increases the cost of production making brinjal expensive for poor consumers. Plant diversity is a critical factor determining animal diversity (Hunter and Price, 1992), however, this relationship between plant and herbivore diversity could be nonlinear. Among them some insect pest like as shoot and fruit borer, leafhoppers, stem borer, leaf webber, aphids, whitefly, thrips and the non-insect pests like mites especially the spider mites are the main bottle necks in brinjal productivity as reported by Rizvi

Author for correspondence : E-mail: vermaento@gmail.com

(1996). For instance, the share of the cost of pesticide to total material input cost was 55% for brinjal and it ranked first when compared to tomato (31%) and cabbage (49%) in the Philippines (Orden *et al.*, 1994), any single method of pest management cannot achieve a level of *Leucinodes orbonalis* control acceptable to producers in the region. The integrated pest management (IPM) techniques could provide satisfactory control, but it should be simple and economic. Some IPM models have been suggested by different worker and institution and farmers were given training on IPM. However, the impact of the IPM training was ambivalent, as the farmers increased the level of pesticide use after receiving training (Potutan *et al*., 1997). Probably the absence of economical IPM solutions for this pest was a key constraint in the region. The IPM strategy is composed of healthy seedling production, use of resistant cultivars and *Leucinodes orbonalis* sex pheromone to continuously trap the adult males, prompt destruction of pest damaged brinjal shoots and fruits at regular intervals and withhold pesticide use to allow proliferation of local natural enemies to encourage the pest suppression.

Resistant cultivars against *Leucinodes orbonalis*

In crop, the insect resistance plants is a vital component of integrated pest management (IPM) and is considered as non-monetary input. The tolerant and resistant both cultivars are helpful in IPM as the insecticide use is reduced and it also improves the performance of natural enemies in plants. Now resistant varieties have successfully developed in many crops such as rice, wheat, corn, soybean, tomato, potato, etc for the management of the key pest pests. Despite the attempts which have been made to explore resistant sources as well as to develop resistant varieties against *Leucinodes orbonalis* in the region, there is no commercial cultivar with appreciable levels of resistance has been developed; Because, the many of the screening programs involved only few brinjal accessions and the programs were not mostly continued, which may be due to scarcity of adequate levels of resistance. Local five brinjal cultivars studied for resistance to brinjal shoot and fruit borer in at vegetable research farm, Banaras Hindu University Varanasi during 2011 and 2012, revealed that the percent fruit damage was recorded maximum from *Leucinodes orbonalis* the cultivar such as Krishna (35.32), Pusa anmol (33.27), Pusa purple cluster (32.18) while the minimum recorded from the Navkiran (13.72) and Pusa purple long-74 (17.63). Whereas the maximum percent shoot damage was recorded from Krishna (5.82), Pusa anmol (4.74) and Pusa purple cluster (3.73) whereas the minimum recorded from the Navkiran (2.81) and Pusa purple long-74 (2.13). So the Krishna shows the susceptible cultivar than other cultivar whereas the Navkiran show the resistant cultivar against the brinjal fruit and shoot borer. No any cultivars under these were immune to brinjal shoot and fruit borer. Efforts have also been made in India with few dozens of eggplant accessions and they ended with few or none as resistant to *Leucinodes orbonalis*. The similar results were also recorded by (Mannan *et al*., 2003) has screening some variety for the resistant against the *Leucinodes orbonalis* in Bangladesh involved only 24 local and exotic brinjal accessions and only one accession exhibited comparatively lower infestation, but it was a low yielding accession. Another screening program involved only 20 accessions and none of them exhibited significant levels of resistance was reported by Hossain *et al*. (2002). Some other workers such as Singh and Kalda (1997), Behera *et al.* (1999), Doshi *et al.* (2002) are shown the similar results on the cultivars that efforts have also been made in India with few dozens of brinjal accessions and they ended with few or none as resistant to *Leucinodes orbonalis*. The uncultivated such as *Solanum* species (*anomalum, gilo, incanum, indicum, integriifolium, khasianum, sisymbriifolium, xanthocarpum* etc) were reported to possess high resistance to *Leucinodes orbonalis* reported by Singh and Kalda (1997), Behera and Singh (2002). However, the resistance in these wild species should carefully be evaluated and confirmed before attempting to transfer the resistance to cultivated brinjal, because *S. indicum* had been reported as an alternate host to *Leucinodes orbonalis* was reported by Isahaque and Chaudhuri (1983), although it was reported as a resistant source in other reports. In addition, the crossing and hybridization of cultivated brinjal with its wild relatives generally pose difficulties due to breeding incompatibilities (Dhankhar *et al.*, 1982) and in several cases, crosses were only successful if *in vitro* embryo rescue was employed (Kashyap *et al.*, 2003). *Leucinodes orbonalis* resistant cultivars for several countries in the region, except Bangladesh. Turbo, a commercial F1 hybrid grown in Thailand also exhibited significant resistance to *Leucinodes orbonalis* in Thailand and Taiwan was reported by Srinivasan *et al.* (2005).

Sex pheromones

Monitor as well as mass trapping of male insects by sex pheromones are important component of IPM programs. The (E)-11-hexadecenyl acetate (E11-16: Ac) as the major component of *Leucinodes orbonalis* sex pheromone in China was identified by Zhu *et al.* (1987) and synthesized this chemical in the laboratory and used at the rate of 300-500 µg per trap to attract the

Leucinodes orbonalis males in the field condition. Attygalle *et al.* (1988) and Gunawardena *et al.* (1989) also identified the presence of this compound from the sex pheromone glands of *Leucinodes orbonalis* in Sri Lanka. Although, it attracted male moths in the laboratory, its performance under field conditions was inferior to live virgin female moths was reported by Gunawardena (1992), Gunawardena *et al*. (1989). The report of other workers also show such as Srinivasan and Babu (2000) are showed the results of E11-16:AC when used alone or in combination with E11-16:OH attracted significantly high numbers of male moths in India and Bangladesh, although E11-16:OH alone showed no attraction at any concentration. Hence, the *Leucinodes orbonalis* sex pheromone was included as a potential component in the *Leucinodes orbonalis* IPM program that was field experiment was conducted at the Banaras Hindu University, vegetable research farm, nearer to central office. Funnel traps and Delta traps could be used for the *Leucinodes orbonalis* sex pheromone lures in field conditions. However, the trap design that would attract more numbers of insects will vary from one location to the other. Hence, it had to be confirmed in repeated field experiments. Field experiment was conducted at the Banaras Hindu University, vegetable research farm, nearer to central office. Funnel traps consistently caught less *Leucinodes orbonalis* male moths than Delta traps in Gujarat, whereas funnel traps performed better than delta and water-trough traps in Uttar Pradesh was reported by Alam *et al*. (2003). Similarly, delta traps caught and retained ten times more moths than either *Spodoptera* or uni-trap designs in Bangladesh was reported by Cork *et al.* (2003). The height of trap will also vary with locations. Such as the Cork *et al.* (2003) reported that the traps placed at crop canopy level caught significantly more male moths than traps placed 0.5 m above or below the crop canopy while the traps installed 0.25 m above crop canopy caught higher moths than either at crop canopy or at 0.25 m below crop canopy in Uttar Pradesh was reported by Alam *et al*. (2003). Prasad *et al*. (2005) reported that the traps should be erected at every 10 m or less for effective attraction. In general, it has been suggested to place the traps at a density of 100 per ha was reported by Cork *et al*. (2003). Thus, the *Leucinodes orbonalis* sex pheromone traps as a component of IPM significantly reduced the fruit damage and increased the yield. In addition, small and medium sized entrepreneurs were also involved in such activities to encourage commercialization of sex pheromone and promote the use of this pest control tactic as a part of IPM.

Cultural and mechanical control

It is the very initial and agronomical methods for the pest control. The involvement of cultural control methods the manipulation of crop environment as well as management while in mechanical control involves the use of mechanical forces or manual operations to interfere with the insect shelter, feeding and reproduction. The agronomic practices such as sanitation of the field before, during and after the cropping, removal of the alternate food sources for the pests and mechanical barriers are some of the cultural and mechanical control measures to manage *Leucinodes orbonalis* in the field. Srinivasan and Babu (1998), Murthy and Nandihalli (2003), Reddy and Kumar (2004) are showed that the some alternate host of the *Leucinodes orbonalis* such as *Solanum nigrum*, *S. indicum*, *S. torvum*, *S. myriacanthum*, tomato and potato. But, it may be a rare occurrence, and it is not clear about population abundance of *Leucinodes orbonalis* that would migrate from these plants, the new plantings or seedling nurseries can be kept free of or away from these *Solanum* species and fields. However, the adult moth that emerged from the pupae in soil or migrate from near brinjal crops is important sources of infestation. Alam *et al*. (2003) are showed that the known sources of infestation, dry brinjal stalks from previous crop that have been stored by the farmers as fuel for cooking serve as another important source of *Leucinodes orbonalis* infestation. Sometimes, farmers may grow their brinjal seedlings in the vicinity of dry brinjal stubble heaps, which may likely to get infested by those moths emerging from the stubble heaps. In general, it would be ideal to grow the seedlings away from the dry brinjal stubble heaps, or under net-tunnels, if it is grown in the vicinity of dry brinjal stubble heaps. Removal and destruction of the infested shoots and fruits with *Leucinodes orbonalis* at regular intervals have been suggested as an effective strategy to manage the *Leucinodes orbonalis* on brinjal in South and Southeast Asia are reported by as other worker such as Arida *et al.* (2003) and Satpathy *et al.* (2005). Such type of pruning is especially important in early stages of the crop growth, and this should be continued until the final harvest. This will be more effective when, it is being followed by grower community in a particular region than an individual grower. In addition, this pruning will not adversely affect the plant growth as well as yield. As the adults of *Leucinodes orbonalis* are relatively small moths and weak fliers, it was hypothesized that the inter-field movement could effectively be restricted by erecting suitable barriers. This was tested by erecting 2 m high barrier such as nylon net around the brinjal soon after

transplanting. The use of barriers combined with prompt destruction of the *Leucinodes orbonalis* infested shoots significantly reduced the damage to shoots than by using either the barrier or the sanitation alone was reported by Alam *et al.* (2003). However, the damage to fruits was not so significant, although the reduction in damage over untreated control was about 33%. Protective cultivation such as net-house or poly-house production systems is emerging in states like Punjab in India. Kaur *et al.* (2004) was also found that sanitation and neem spraying recorded 50% lower fruit damage in net-house cultivation than the damage under open field conditions in Punjab. Hence, the field sanitation and the mechanical barriers could significantly reduce the population of *Leucinodes orbonalis* and damage could be an effective component in *Leucinodes orbonalis* IPM programme. However, feasibility of economic point of view to adopting net-barriers should be considered while promoting this technology among resource poorer brinjal growers.

Biological control

The number of natural enemies such as predators, parasitoids and entomopathogens have been recorded against *Leucinodes orbonalis* in different countries. The role in keeping the population of *Leucinodes orbonalis* at levels below causing economic damage is not significant. However, *Trathala flavoorbitalis* seems to be a potential natural enemies in biological control for *Leucinodes orbonalis* among all these natural enemies, because of the presence in several countries in the region as well as its efficient rate of parasitism in field conditions. But, it is not a specific parasitoid of *Leucinodes orbonalis* as decreased the population of this natural enemies in those farmers field who adopted synthetic chemicals as the pest control strategy. The natural enemies (predators, parasitoids and entomopathoges) are mmost important for the balance of the nature which is already present in the nature. The predators such as *Campyloneura* sp (Mirida : Heteroptera) was recorded by Tewari and Moorthy (1984), Tripathi and Singh (1991). Whereas the *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Brumoides suturalis* (Coccinellidae : Coleoptera) was recorded by Kadam *et al.* (2006). The parasitoids as the *Pseudoperichaeta* sp (Tachinidae : Diptera) was recorded by Patel *et al.* (1971) and *Phanerotoma* sp (Braconidae : Hymenoptera) (Patel *et al.*, 1971; Sandanayake and Edirisinghe, 1992). *Itamoplex* sp (Ichneumonidae : Hymenoptera) are reported by Verma and Lal (1985), *Diadegma apostata* (Ichneumonidae: Hymenoptera) are reported by Krishnamoorthy and Mani (1998). The Entomopathogens such as fungus (*Bipolaris tetramera*) was reported as the most effective. Baculovirus was reported by Tewari and Singh (1987) and Nuclear polyhedrosis virus (NPV) reported by Tripathi and Singh (1991). Alam *et al.* (2003) are reported that the socioeconomic studies in Bangladesh revealed that the adoption of IPM strategy and population of *Leucinodes orbonalis* has reduced about 30% of the total production cost when compared to the non-IPM adopters. In West Bengal, the IPM adopters has reduced their labor requirements by 5.9%, sprayed pesticides 52.6% less often than before and increased their brinjal production area by 21.6%. Baral *et al*. (2006) has studies that the economic surplus model revealed an internal rate of return of 38% and a benefit cost ratio of 2.78. It has clearly been proven that this IPM technology has positive impacts on the lives of brinjal growers in the region. Although, *T. flavoorbitalis* has been recorded on *Leucinodes orbonalis* in several countries, its potential role in *Leucinodes orbonalis* management has not been studied in detail. In addition to *T. flavoorbitalis*, *Goryphus nursei* (Ichneumonidae : Hymenoptera) was recorded in. The level of parasitism by *T. flavoorbitalis* has significantly increased after withholding the pesticide use was found by Alam *et al*. (2003). Hence, *T. flavoorbitalis* would be an ideal bio-control agent for *Leucinodes orbonalis* in IPM program in this region.

Hence, the IPM program of *Leucinodes orbonalis* in addition to the up scaling of the IPM technology, partnerships will be strengthened with the existing national IPM programs in the region to enhance the capacity building on eco-friendly management practices, which are not deleterious effect on human beings and economically suitable and socially well acceptable. The profit margins significantly increased whereas pesticide use and labor requirement are decreases.

References

Alam, S. N., M. A. Rashid, F.M.A. Rouf, R. C. Jhala, J. R. Patel, S. Satpathy, T. M. Shivalingaswamy, S. Rai, I. Wahundeniya, A. Cork, C. Ammaranan and N. S. Talekar (2003). Development of an integrated pest management strategy for brinjal fruit and shoot borer in South Asia, Technical Bulletin TB28, AVRDC - The World Vegetable Center, Shanhua, Taiwan, pp 66 .

Arida, G.S., A.A. Duca, B.S. Punzal and E.G. Rajotte (2003). Management of the brinjal fruit and shoot borer, *Leucinodes orbonalis* (Guenee): Evaluation of farmer's indigenous practices. In: *Overview of the Southeast Asia Site in the Philippines*, 45-47.

Attygalle, A. B., J. Schwarz and N. E. Gunawardena (1988). Sex pheromone of brinjal shoot and pod borer *Leucinodes orbonalis* Guenee (Lepidoptera : Pyralidae : Pyraustinae). *Z. Naturforsch*, **43** : 790-792.

Baral, K., B. C. Roy, K. M. B. Rahim, H. Chatterjee, P. Mondal, D. Mondal, D. Ghosh and N. S. Talekar (2006). Socio-economic parameters of pesticide use and assessment of impact of an IPM strategy for the control of brinjal fruit and shoot borer in West Bengal, India. *Technical Bulletin No. 37*. AVRDC publication number 06-673. AVRDC - The World Vegetable Center, Shanhua, Taiwan. pp36.

Behera, T. K. and N. Singh (2002). Inter-specific crosses between brinjal (*Solanum melongena* L.) with related *Solanum* species. *Science Horticulture - Amsterdam*, **95** : 165-172.

Behera, T. K., N. Singh, T. S. Kalda and S. S. Gupta (1999). Screening for shoot and fruit borer incidence in brinjal genotypes under Delhi condition. *Indian Journal of Entomology*, **61(4)** : 372-375.

Cork, A., S. N. Alam, F. M. A. Rouf and N. S. Talekar (2003). Female pheromone of brinjal fruit and shoot borer, *Leucinodes orbonalis* : trap optimization and preliminary mass trapping trials. *Bulletin of Entomological Research*, **93** : 107-113.

Dhandapani, N., U. R. Shelkar and M. Murugan (2003). Bio-intensive pest management in major vegetable crops : An Indian perspective. *Journal of Food Agriculture and Environment*, **1(2)** : 330-339.

Dhankhar, B. S., N. Kishore, D.R. Sharma and M.L. Pandita (1982). Susceptibility of *Solanum khasianum* to brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.). *Journal of Research Haryana Agricultural University,* **12(3)** : 523-524.

Doshi, K. M., M. K. Bhalala, K. B. Kathiria and A.S. Bhanvadia (2002). Screening of brinjal genotypes for yield, fruit borer infestation, little leaf incidence and quality traits. *Capsicum and Brinjal Newsletter*, **21** : 100-101.

Gunawardena, N. E. (1992). Convenient synthesis of (E)-11-hexadecenyl acetate, the female sex pheromone of the brinjal moth *Leucinodes orbonalis* Guenee. *Journal of the National Science Council of Sri Lanka*, **20(1)** : 71-80.

Gunawardena, N. E., A. B. Attygalle and H. M. W. K. B. Herath (1989). The sex pheromone of the brinjal pest, *Leucinodes orbonalis* Guenee (Lepidoptera): problems and perspectives. *Journal of the National Science Council of Sri Lanka*, **17(2)** : 161-171.

Hossain, M. M., M. Shahjahan, M. Abdus Salam and M. A. Begum (2002). Screening of some brinjal varieties and lines against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. *Pakistan Journal of Biological Sciences*, **5(10)** : 1032-1040.

Isahaque, N.M.M. and R. P. Chaudhuri (1983). A new alternate host plant of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. in Assam. *Journal of Research Assam Agricultural University*, **4** : 83-85.

Kadam, J. R., U. D. Bhosale and A. P. Chavan (2006). Influence of insecticidal treatment sequences on population of *Leucinodes orbonalis* and its predators. *Journal of Maharashtra Agricultural Universities*, **31(3)** : 379-382.

Kashyap, V., S. Vinod Kumar, C. Collonnier, F. Fusari, R. Haicour, G. L. Rotino, D. Sihachakr and M. V. Rajam (2003). Biotechnology of brinjal. *Scientia Horticulturae - Amsterdam*, **97** : 1-25.

Kaur, S., S.S. Bal, G. Singh, A.S. Sidhu and T.S. Dhillon (2004). Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee through net house cultivation. *Acta Horticulturae*, **659** : 345-350.

Hunter, M. D. and P. W. Price (1992). Playing chutes and ladders heterogeneity and the relative roles of bottom- and top-down forces in natural communities. *Ecology*, **73(3)** : 724-732.

Krishnamoorthy, A. and M. Mani (1998). New record of parasitoid *Diadegma apostata* (G.) on brinjal shoot and fruit borer. *Insect Environment*, **4(3)** : 87.

Murthy, P. N. and B. S. Nandihalli (2003). Crop loss estimation caused by *Leucinodes orbonalis* Guenee in potato. *Pest Management in Horticultural Ecosystem*, **9** : 59-62.

Orden, M. E. M., M. G. Patricio and V. V. Canoy (1994). Extent of pesticide use in vegetable production in Nueva Ecija : Empirical evidence and policy implications. *Research and Development Highlights* 1994, Central Luzon State University, Republic of the Philippines. 196-213.

Patel, R. C., J. C. Patel and J. K. Patel (1971). New records of parasites of *Leucinodes orbonalis* Guen. from Gujarat. *Indian Journal of Entomology*, **33** : 358.

Potutan, G. E., L. G. Janubas, J. Marnado, J. Holmer and W. H. Schnitzler (1997). Peri-urban vegetable production, consumption and marketing in Cagayan de Oro, Philippines. Kasetsart *Natural Sciences*, **32** : 61-66.

Prasad, H., H. M. Singh and A. K. Singh (2005). Effective range of sex pheromone of *Leucinodes orbonalis* Guen. *Journal of Applied Zoological Researches*, **16(1)** : 8182.

Reddy, N. A. and C. T. A. Kumar (2004). Insect pests of tomato, *Lycopersicon esculentum* Mill. in eastern dry zone of Karnataka. *Insect Environment*, **10** : 40-42.

Sandanayake, W. R. M. and J. P. Edirisinghe (1992). *Trathala flavoorbitalis* : parasitization and development in relation to host-stage attacked. *Insect Sciences and its Applications*, **13(3)** : 287-292.

Satpathy, S., T. M. Shivalingaswamy, Akhilesh Kumar, A. B. Rai and Mathura Rai (2005). Biointensive management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.). *Vegetable Science*, **32(1)** : 103-104.

Singh, T. H. and T. S. Kalda (1997). Source of resistance to shoot and fruit borer in brinjal (*Solanum melongena* L.). *PKV Research Journal*, **21(2)** : 126-128.

Srinivasan, G. and P. C. S. Babu (1998). Life table studies on shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) on brinjal, tomato and potato. Advances in IPM for horticultural crops. Proceedings of

the First National Symposium on Pest Management in Horticultural Crops: environmental implications and thrusts, Bangalore, India 15-17 October, 1997.

Rizvi, S. M. A. (1996). Management of insect pests of okra and brinjal. In: *Plant Protection and Environment*, 173-188.

Srinivasan, G. and P. C. S. Babu (2000). Sex pheromone for brinjal shoot and fruit borer, *Leucinodes orbonalis*. *Indian Journal of Entomology*, **62** : 94-95.

Srinivasan, R., C. C. Huang and N. S. Talekar (2005). Characterization of resistance in brinjal to brinjal fruit and shoot borer. In : Proc. of the National Symposium on Recent Advances in Integrated Management of Brinjal Shoot and Fruit Borer, October 3-4, 2005, Varanasi, India. 90-93.

Tewari, G. C. and P. N. K. Moorthy (1984). New records of two parasites of brinjal shoot and fruit borer, *Leucinodes orbonalis. Guen. Entomon*., **9** : 63-64.

Tewari, G. C. and S. J. Singh (1987). New record of a baculovirus disease in *Leucinodes orbonalis* Guen. *Current Science*, **56** : 671-672.

Tripathi, S. R. and A. K. Singh (1991). Some observations on population dynamics of brinjal borer, *Leucinodes orbonalis* (Guen.) (Lepidoptera: Pyralidae). *Annals of Entomology*, **9(1)** : 15-24.

Verma, T. S. and O. P. Lal (1985). A new record of *Itamoplex* sp. (Hymenoptera : Ichneumonidae) parasitizing brinjal shoot and fruit borer in Kulu valley, Himachal Pradesh. *Bulletin of Entomology*, **26** : 219-222.

Zhu, P., F. Kong, S. Yu, Y. Yu, S. Jin, X. Hu and J. Xu. (1987). Identification of the sex pheromone of brinjal borer *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae). Zeitschrift Fur Naturforschung C-A. *Journal of Biosciences*, **43** : 1347-1348.