Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP2: 339-347

Jai Pratap Singh
Department of Entomology, Narendra Deva University of Agriculture & Technology Kumarganj Faizabad, Uttar Pradesh, India

Roopesh Singh
Department of Entomology, Narendra Deva University of Agriculture & Technology Kumarganj Faizabad, Uttar Pradesh, India

Sarvesh Singh
Assistant Professor, SoAg, ITM University, Gwalior, Madhya Pradesh, India

Correspondence
Roopesh Singh
Department of Entomology, Narendra Deva University of Agriculture & Technology Kumarganj Faizabad, Uttar Pradesh, India

National Conference on Conservation Agriculture
(ITM University, Gwalior on 22-23 February, 2018)

Efficacy of newer insecticides and biopesticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee brinjal (*Solanum melongena* L.)

Jai Pratap Singh, Roopesh Singh and Sarvesh Singh

Abstract
There are 26 insect-pests species and few non insect-pests species infesting brinjal of which the shoot and fruit borer, *Leucinodes orbonalis* (Guen.); Budworms, *Scrobipalpa blasigona;* whitefly, *Bemisia tabaci* (Genn.); leafhopper, *Amarasca devastans* (Distant); jassid, *A. biguttula biguttula* (Ishida) are major one. The brinjal shoot and fruit borer is considered the main constraint as it damages the crop throughout the year. The yield loss due to the pest is to the extent of 70-92 per cent. Among the various insecticides evaluated against brinjal shoot and fruit borer (*L. orbonalis*), Emamectin benzoate 5 SG @ 12.5g a.i./ha treated plots showed lowest infestation and gave higher fruit yield (253.12) followed by Flubendiamide 480 SC (249.33) and Novaluron 10 EC (243.63). The boipestici NSKE 5% most effective followed by *Bacillus thuringensis, Verticellium lecanii* and *Beauveria bassiana*. The highest cost: benefit ratio was obtained from NSKE 5% (1:24.40) followed by Indoxacarb 14.5 SC (1:24.13) and Emamectin benzoate 5 SG (1:24.03) which were also economical than other treatments.

Keywords: *Bacillus thuringensis, Leucinodes.* *Orbonalis, Verticellium lecanii, Beauveria bassiana,* Biopesticides

Introduction
Brinjal (*Solanum melongena* Linnaeus) also known as eggplant is referred as “King of vegetables”, originated from Indian sub-continent, with as the probable centre of origin (Gleddie *et al.*, 1986 [10]; Omprakash and Raju, 2014 [19]. It is called brinjal in India, and *Aubergine* in Europe. The name *eggplant* derives from the shape of the fruit of some varieties, which are white and shape very similarly to chicken eggs. Eggplant or aubergine belonging to the family “Solanaceae”, the family contains more than 2450 species distributed in 95 genera (Mabberley, 2008 [18]. Vegetables play an important role in human nutrition and health by providing minerals, micronutrients, vitamins, antioxidants and dietary fibre. Vegetable cultivation is a significant part of the national agricultural economy, especially in the developing world (Srivastav, 2012 [48]. It occupies an important position among the other regular vegetable crops that are available throughout the year and popular vegetable grown as poor man’s crop in India. Brinjal, *Solanum melongena* L. is one of the major vegetables in India extensively grown under diverse agro-climatic conditions throughout the year it contributes 9 percent of the total vegetable production of the country.

The India covered 92.05 mha area under vegetable cultivation with production 1624 mt and productivity of 17.62 mt/ha. India has second rank in both area and production and 8th in productivity in all brinjal growing country. The productivity of brinjal is highest in Egypt with 49.2 t/ha it more than world average i.e. 25 t/ha (Anonymous, 2014 [3]. A substantial proportion of brinjal yield is lost due to biotic and abiotic stresses. Brinjal (*Solanum melongena* L.) crop is infested with plethora of insect-pests right from seedling stage to senescence crop. It harbours more than 140 species of insect-pests (Prempong and Bauhiun, 1977 [37] and Sohi, 1996 [46]. Butani and Verma (1976) [5] and Nayar *et al.* (1976) [31] have however listed only 36 and 53 insects, respectively on this crop. There are 26 insect-pests species and few non insect-pests species infesting brinjal of which the shoot and fruit borer, *Leucinodes orbonalis* (Guen.); Budworms, *Scrobipalpa blasigona;* whitefly, *Bemisia tabaci* (Genn.); leafhopper, *Amarasca devastans* (Distant); jassid, *A. biguttula biguttula* (Ishida); epilachna beetle, *Henosepilachna vigintioctopunctata* (Fab.); aphid, *Aphis gossypii* (Glover.); mealy bug, *Centroccocus insolitus* (Guen.); lace wing bug, *Urentiushy stricellus* (Richt.) and non insect pest, red spider mite, *Tetranichus macfurlanei* (Andre) cause severe damage, necessitating initiation of control measures quite frequently (Vevai, 1970 [49]; Owusu-Ansah *et al.*, 2001 [33]; Srinivasan, 2009 [48]; Mochiah *et al*., 2011 [24]; MoFA, 2011 [25]. Of these, the brinjal shoot and fruit borer is considered the main constraint as it damages the crop throughout the year. This pest reported from all brinjal growing area of the world. It is known to damage shoot and fruits of brinjal in all stages of its growth. The yield loss due to the pest is to the extent of 70-92 per cent (Nair, 1995 [27]. Infestation due to leaf hopper, white fly and shoot and fruit borer results in about 70-92 per cent loss in yield of brinjal (Mishra, 2008 [23]; Jagginavar *et al*., 2009 [13]. Patnaik, 2000 [35] for instance reported that *L. orbonalis* damage to fruit in the field ranges from 47.6 per cent to 85.8 per cent of harvest.

Among the insect pests the most destructive and serious pest of brinjal is brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee. It remained a major pest of brinjal since two decades. The main difficulty in evolving a suitable control measure against this pest is that it belongs to one of the most serious categories of insect pest internal feeder. Once the larva bores into petiole and midrib of leaves and tender shoots, it causes dead hearts. In later stages, it also bore into flower bud and fruits. The brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera) is the most important insect pest of brinjal and the apparent yield loss varying from 20-90% in various parts of the country (Raju *et al*., 2007), 85–90% have been reported (Patnaik 2000 [35]; Misra 2008 [23]; Jagginavar *et al*. 2009 [13]. It is estimated that the economic injury level equals to 6% infestation of shoot and fruit in India (Alam *et al.*, 2003 [1].

Although insecticidal control is one of the common means against the fruit borer, many of the insecticides applied are not effective in the satisfactory control of this pest. Brinjal being a vegetable crop, use of chemical insecticides will leave considerable toxic residues on the fruits. Beside this, sole dependence on insecticides for the control of this pest has led to insecticidal resistance by the pest (Natekar *et al.*, 1987 [29]; Harish *et al.*, 2011 [12]. Hence, use of organic amendments, plant products and microbial origin insecticides with new molecules of insecticide is one of the important considerations can bethe novel approaches to manage the pest. The role of microbial insecticides, in lepidopterous insect pest management has obvious advantages in terms of effectiveness, specificity and safety to non-target organisms and other components related to biosphere. Microbial insecticides such as entomopathogenic fungi can provide an alternative and also more environmentally friendly option to control insect pests. More than 700 species of entomopathogenic fungi currently known, only 10 species have been presently being exploited for insect control (Robert and Hajek, 1992 [40]. Considering above facts, the present investigation was carried on evaluation of newer molecules of insecticides for their bio-efficacy against BSFB.

Materials and Methods

The experiment were laid out during the Rabi season of 2013-14 and 2014-15 in a randomized block design having plot size of 3x3 m. Thirty days old seedlings were transplanted in the fields with 75 cm x 60 cm spacing at Student's Instructional Farm, N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). Six number of Brinjal variety was raised for checking infestation and intensity and Brinjal variety, NDB-2 was raised for as per recommended package of practices for the crop production guide for vegetables crops.

Brinjal crop was regularly monitored at weekly intervals for recording infestation and intensity of major insect-pests occurring from after transplanting to 140 days after transplanting in experimental plots. The occurrence of insect-pests was recorded on 10 randomly selected plants from each plot

Table 1: Mode of observation of insect-pests

S No.	Insect-pests		Mode of observation
	Common Name	Scientific Name	
1	Jassid	*Amrasca biguttula biguttula* (Ishida.)	Number of Nymph and Adult present on 3 leaves, one each from lower, middle and upper part of 10 randomly selected plants/plot.
2	Whitefly	*Bemisia tabaci* G.	Number of Nymph and Adult present on 3 leaves, one each from lower, middle and upper part of 10 randomly selected plants/plot.
3	Hadda beetle	*Henosepilachna vigintiopunctata* F.	Number of Nymph and Adult present on 3 leaves, one each from lower, middle and upper part of 10 randomly selected plants/plot.
4	Brinjal Shoot and fruit borer	*Leucinodes orbonalis* G.	Healthy and *L. orbonalis* damaged shoots before fruiting at weekly interval and total damaged fruits at each picking at fruiting stage were recorded by selecting 10 plants randomly.

Three spray application of respective insecticide, first at appearance of shoot damage and second at fruit initiation were made on the using manually operated knapsack sprayer. The observations on number of healthy and damage shoots were made on 10 randomly selected plants in each treatment replication-wise, pre-treatment observation was taken on 1 day before treatment post treatment observation were taken on 7th and 14th days after first spray. In similar way, observations number of healthy and damage fruits were also made. Based on these observations, percentages of damaged shoots and fruits were worked out and subjected to ANOVA after transforming them to arcsine (Gomez and Gomez, 1984 [11].

Bioefficacy of fourteen insecticidal treatments comprising biopesticides- Bacillus thuringiensis var. Kurstaki, Verticellium lecanii, Beauveria bassiana, NSKE, Spinosad, Flubendiamide, Emamectin benzoate, Novaluron, Indoxacarb, Fipronil, Imidacloprid, Dimethoate and Abamectin was determined during both the years and each treatment was replicated thrice.

Economics of treatments:

The cost benefit ratio was determined for each treatment by using the following formula

$$\text{Cost : benefit ratio} = \frac{\text{Value of saved yield over control (Rs/ha)}}{\text{Total cost of plant protection (Rs/ha)}}$$

Total cost of protection included cost of test materials and chemicals + labour charge + sprayer charge.

Preparation of NSKE

Fresh ripe neem seeds were collected, cleaned and dried in shade and stored in Laboratory. After removing the seed coat, kernels were crushed and grind into powder with the help of pestle and mortar. In order to prepare 5 per cent NSKE, 250 gm grind kernel powder was soaked into 500 ml of water for 24 hours. Thereafter, it was centrifuged at 4000 rpm for 30 minutes and filtered with the help of muslin cloth. The volume of filtrate was made 500 ml by adding water and kept as stock solution for its test under field condition.

Determination of amount of insecticides:

The required amount of insecticides was calculated by using the formula as given below:

The volume of spray solution was diluted by mixing water @ 500-600 lit/ha.

Result and Discussion

The result obtained in determination of infestation and intensity of major insect–pests of brinjal during both the years of study revealed that higher infestation and intensity were recorded during Rabi 2014-15 than Rabi 2013-14.

Four species of insects, viz., Jassid (Amrasca biguttula biguttula), White fly (Bemisia tabaci), Hadda beetle (*Henosepilachna vigintioctopunctata*) and brinjal shoot and fruit borer (*Leucinodes orbonalis*) have been found causing severe damage to brinjal. These insects have also been reported as major parts of this crop at several places (Butani and Verma, 1976 [5] and Bhuduria *et al.,* 1999 [4].

The nymph and adults of jassid were noticed sucking sap from lower surface of the leaves of brinjal (Nayer *et al.*, 1976 [31]. Nair, (1995) [27] and Raghupathi *et al*., (2003) have been reported it infesting brinjal by sucking the sap from the under surface of leaves and causing yellowing, bronzing and even drying up of leaves. The jassids first appeared 10 days after transplanting at 50th SW to 1st SW week and then stop but it next appearance was started from 5th SW up to 22nd SW during both the year. The maximum intensity and infestation were observed in variety Panjab sadabhar followed by Utkal madhuri, Swetha, Swarna shyamaly, Swarna shymali and minimum in Swarna mani which was found accordance with the finding of Devi *et al*., (2015) [7]; Patel *et al*., (2015) [34]; Malini *et al*., (2013) [19] and Ghosh and Senapati (2003) [19].

White fly (*B. Tabaci*) one of the major sap feeders and has been also reported by Lu and Lee (1987) [17]. Raghupathi *et al*., (2003) [38] have also reported that its nymph and adults suck the cell sap from leaves and chlorotic spots, yellowing of leaves. White fly per leaf amongst varieties were however higher and more variable in 2014-15 than in 2013-14. Muthukumar and Kalyanasundarm (2003b) [26] found that *B. tabaci* observed from the first week after transplanting and persisted throughout the season and cause yield reduction and economic loss. The incidence and infestation was recorded peak at 14th SW to 17th SW varied from variety to variety during both the year of *Rabi*, 2013-14 and 2014-15 Patel *et al*., (2015) [34]. Appearances of this pest was recorded 10 days after transplanting at 50th SW to 1st SW week first time and 5th SW up to 22nd SW second time during both the years. Maximum infestation and intensity was recorded in Panjab sadabhar and minimum in Swarna mani during both the years similar results has been reported by several workers (Patel *et al*., 2015 [34] and Singh *et al*., 2005) [34].

Grub and adult of *Henosepilachna vigintioctopunctata* started its activity with scrapping of chlorophyll epidermal layer of leaves of brinjal. Similar damage of this pest had been recorded by several earlier workers (Nayar *et al.,* 1976 [31]; Nair, 1995 [27] and Raghupathi *et al*., 2003) [38].The maximum infestation and intensity was recorded in Swarna shree followed by Panjab sadabhar, Utkal madhuri, Sewtha, Swarna shyamali and Swarna mani. The incidence and infestation of this pest started from 7th SW and continued up to 22nd SW with varying infestation throughout the crop period during *Rabi*, 2013-14 and 2014-15. Its incidence peaked from 7 to 9 weeks after transplantation, with range from 0.32 to 4.80 adults per three leaves during first year and 0.31 to 6.4 adults per three leaves during second year. Ghosh and Senapathi (2001) [9] reported that epilachna beetle in terai region was found active from April to middle of October on brinjal. It was higher infestation per cent 42.02 to 61.92 per cent damage leaves in different varieties during March - April but declined thereafter (Muthukumar and KalyanaSundaram, 2003b) [26].

Brinjal shoot and fruit borer, *Leucinodes orbonalis* G., observations were recorded as per cent shoot and fruit damage infestation and was worked out on the basis of number of healthy and damaged shoots and fruits. The attack of *L. orbonalis* caused shedding of flower buds and bored holes of fruits plugged with excreta. The results of two consecutive years revealed that the larval population of *Leucinodes orbonalis* Guenee fluctuated to a great deal not only from year to year but also in different months. The infestation percent varied from 0.13 in Panjab sadabhar to 11.59 in Swarna mani throughout the period under study of first year and 0.16 to 15.18 per cent shoot damage in second year. However, 17.01 and 17.33 per cent minimum to 40.88 and 38.15 per cent maximum fruit infestation in first year and 15.07 and 15.13 per cent minimum to 41.62 and 38.78 per cent maximum fruit infestation in second year were observed in Panja sadabhar and Swarna mani.

This variation in infestation could be due to arrival of brinjal fruit of different varieties. Mehto *et al.,* (1981)(22) also observed this pest round the year on brinjal crop. The results of present study are in agreement with these of Kabir *et al.* (1994)(14) who mentioned that brinjal shoot and fruit borer, damaged 10-20% brinjal fruits and sometimes the infestation reached upto 40%. mentioned that infestation to fruit borer in brinjal varied variety to variety. Kumar and Sadashiva (1996) [15] stated that brinjal shoot and fruit borer is a serious pest of eggplants and even a ready brinjal crop could collapse (10-50% infestation), if strict monitoring of the pests is not managed while Mall *et al.* (1996) [20] considered fruit borer disastrous for the brinjal.

The peak period of this pest was varied between 10th SW to 12th SW for shoot infestation and 16th to 19th SW in different varieties. The larval intensity was observed range from 0.17 to 2.75 in first year and 0.14 to 3.56 in second year was observed. The results derive ample support from the findings of Naresh *et al.,* (1986) [28] who recorded maximum larval population of *L. orbonalis* during the month of May. Samal (2008) [41] further reported that during summer season larval peak of all instars were noticed during the late vegetative to flowering stage in the 14th SMW. The results of present study was accordance with the findings of several workers (Patel *et al*., 2015; [38] Shukla and Khatri, 2010) [43].

Based on per cent shoot infestation Flubendiamide 480 SC @ 190g a.i./ ha treated plot in brinjal at 7th and 15th days after 1st spray, 0.83 and 3.12 per cent shoot damage (Table-1 and 2) which significantly superior to other treatments followed by Emamectin benzoate 5 SG > Novaluron 10 EC > Spinosad 45 SC > Indoxacarb 14.5 SC > Fipronil 5SC > Imidacloprid 17.8 SL > Dimethoate 30 EC > NSKE 5% > Abamectin 1.9 EC >

Bacillus thuringensis > *Verticellium lecanii* > *Beauveria bassiana* compared to control, all the treatments were found effective and significantly superior over the control. The Flubendiamide was most effective for controling shoot infestation followed by Emamectin benzoate observe by Shah *et al*., (2012).

The fruit damage indicated that all insecticidal treatments recorded significantly lower per cent fruit damage than control. The chronological order of insecticides based on per cent fruit damage and reduction over control Emamectin benzoate 5SG > Flubendiamide 480SC > Novaluron 10 EC > Indoxacarb 14.5 SC > Spinosad 45 SC > Fipronil 5 SC > Dimethoate 30 EC > Imidacloprid 17.8 SL > Abamectin 1.9 EC > NSKE 5% > Bacillus thuringensis > Verticellium lecanii> Beauveria bassiana > control. Emamectin benzoate was found significantly superior to other insecticides. Flubendiamide and Indoxacarb, the next effective insecticides, were significantly differ to rest of the insecticides the present findings also confirmed by Shah *et al*., 2012(42); Singh, 2010 [45]; Chatterjee and Roy, 2004 [6]; Patra *et al*., 2009 [36].

Emamectin benzoate 5 SG showed moderate level of efficacy providing 62.8% reduction of BSFB population over control. Spinosad 45 EC at 0.01% found effective in reducing shoot and fruit borer infestation and in increasing fruit yield. The total number of drooping shoots was minimum (4.17) in emamectin benzoate followed by endosulfan (6.83) and Novaluron (7.00), as compared to spinosad (9.17), deltamethrin (11.67) and Bacillus thuringiensis (13.17) reported by Devi and Singha (2012) [8]; Anil and Sharma, (2010) [2] and Nayak *et al*., (2011) [30].

As regards yield also all the treatments were effective and significantly superior over untreated check. Most of these treatments had enhanced and saved the yield when applied against L. orbonalis on brinjal Patra *et al*., 2009; Anil and Sharma, 2010 and Nayak *et al*., 2011 [30]. Emamectin benzoate 5 SG treated plot gave maximum fruit yield (235.45 and 270q/ha) however, it at par with Flubendiamide 480 SC with 232.34 and 266.31q/ha fruit yield was recorded. Emamectin Benzoate, Methoxyfenozide and Bacillus thuringiensis (Berliner) also performed well in reducing damage and increasing yield. A pesticides belonging to newer molecule, Abamectin significantly incurred highest marketable yield and lower shoot/fruit infestation. Similar observation recorded by Latif, *et al*., (2009) [16] Flubendiamide applied at 2% shoot+2% fruit infestation reduced the highest percent of shoot (87.46%) and fruit (81.43%) infestation over control and also produced the highest healthy (13.26 t/ha).

The chronological order of insecticides based on cost benefit ratio was NSKE 5% (1:21.13) > Bacillus thuringensis (1:19.60) Emamectin benzoate 5 SG (1:19.07) > Dimethoate 30 EC (1:18.99) > Indoxacarb 14.5 SC (1:18.98) > Beauveria bassiana (1 :17.76) Verticellium lecanii (1:17.27) > Imidacloprid 17.8 SL (1:16.57) > Spinosad 45 SC (1:11.32) > Flubendiamide 480 SC (1:10.70) > Fipronil 5 SC (1:10.17) > Novaluron 10 EC (1:8.15) and Abamectin 1.9 EC (1:3.07). Emamectin benzoate, Flubendiamide, Novaluron and Spinosad recorded comparatively lower cost benefit ratio in spite of their higher effectiveness, yield and net profit, because of very high price of these insecticides.

Table 2: Shoot and fruit infestation and intensity of shoot and fruit borer (*Leucinodes orbonalis*) larvae on 6 brinjal varieties during *Rabi* season 2013-14

SW	UTKAL MADHURI				SWARNA MANI				SWARNA SHREE			
	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)
		By Number	By Weight			By Number	By Weight			By Number	By Weight	
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.33	0.00	0.00	0.26	0.41	0.00	0.00	0.29	0.25	0.00	0.00	0.44
5	2.09	0.00	0.00	0.52	3.00	0.00	0.00	0.33	1.50	0.00	0.00	0.20
6	3.12	0.00	0.00	0.58	4.15	0.00	0.00	0.42	3.03	0.00	0.00	0.45
7	3.34	0.00	0.00	1.48	4.89	0.00	0.00	0.38	2.70	0.00	0.00	0.56
8	8.04	0.00	0.00	1.97	8.98	0.00	0.00	1.35	8.35	0.00	0.00	1.35
9	4.24	6.93	5.63	1.94	11.06	8.50	7.84	1.45	3.27	5.44	5.58	1.80
10	9.51	13.51	12.90	2.33	11.59	19.72	17.07	1.89	9.10	11.51	14.72	1.67
11	5.09	21.65	21.77	1.88	5.39	20.11	19.35	2.27	4.95	16.55	14.74	2.75
12	4.33	22.49	21.40	2.46	5.75	23.87	23.95	2.61	3.25	16.38	17.19	2.37
13	4.33	24.40	25.16	2.23	4.93	26.56	27.29	2.06	3.61	16.84	18.82	2.04
14	3.33	22.55	22.18	2.30	4.18	18.35	17.73	2.43	2.61	12.23	13.11	1.71
15	0.00	25.73	23.85	2.51	0.00	22.98	22.55	2.33	0.00	18.53	17.71	2.60
16	0.00	27.48	27.05	2.12	0.00	27.47	26.05	2.98	0.00	19.76	19.28	1.02
17	0.00	27.54	25.09	1.94	0.00	35.88	34.68	1.83	0.00	26.62	26.78	1.90
18	0.00	28.69	28.05	2.23	0.00	40.88	38.15	1.80	0.00	30.68	28.06	2.20
19	0.00	23.84	23.90	1.52	0.00	37.00	37.64	1.83	0.00	26.13	26.57	1.72
20	0.00	19.25	18.21	0.70	0.00	31.64	31.09	1.40	0.00	21.81	22.11	1.42
21	0.00	21.84	20.86	0.64	0.00	24.11	24.6	1.05	0.00	20.21	19.11	0.78
22	0.00	21.24	19.92	0.17	0.00	14.35	13.92	0.31	0.00	10.30	10.45	0.43

SW	PANJAB SADABHAR				SWETHA				SWARNA SHYAMALI			
	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)
		By Number	By Weight			By Number	By Weight			By Number	By Weight	
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.13	0.00	0.00	0.31	0.37	0.00	0.00	0.33	0.44	0.00	0.00	0.18
5	0.95	0.00	0.00	0.22	2.91	0.00	0.00	0.34	3.75	0.00	0.00	0.44
6	2.02	0.00	0.00	0.34	3.53	0.00	0.00	0.37	4.32	0.00	0.00	0.40
7	2.17	0.00	0.00	0.49	8.18	0.00	0.00	0.24	8.94	0.00	0.00	0.34
8	2.39	0.00	0.00	1.27	3.76	0.00	0.00	1.35	5.76	0.00	0.00	1.50
9	4.45	4.89	4.97	1.03	10.14	7.11	5.88	2.07	12.23	8.17	8.84	1.88
10	4.69	6.25	7.04	1.12	9.49	15.97	16.46	2.09	11.93	17.54	20.66	1.97
11	2.39	9.33	8.37	2.85	5.76	16.13	16.70	2.02	7.38	17.57	18.12	3.01
12	1.56	14.01	15.32	2.59	4.58	19.21	19.03	2.17	6.95	22.00	21.58	3.18
13	1.45	12.05	11.39	1.17	4.61	20.15	20.81	1.98	5.21	22.89	23.05	3.08
14	0.95	5.31	6.45	1.87	3.61	17.07	16.88	1.80	4.71	19.25	20.03	2.30
15	0.00	14.78	15.22	1.70	0.00	21.22	21.19	1.75	0.00	22.32	22.84	2.46
16	0.00	13.63	13.10	0.44	0.00	22.84	21.33	1.97	0.00	29.17	26.63	2.01
17	0.00	14.43	14.91	1.39	0.00	32.65	33.67	2.44	0.00	34.76	34.80	2.16
18	0.00	16.21	16.97	1.08	0.00	37.23	37.06	1.53	0.00	37.94	38.65	1.44
19	0.00	17.01	17.33	0.73	0.00	35.22	36.08	1.85	0.00	37.39	38.69	2.21
20	0.00	14.74	15.24	0.76	0.00	26.28	23.45	1.70	0.00	32.87	33.43	1.54
21	0.00	12.58	15.1	0.15	0.00	22.05	22.47	0.89	0.00	27.31	25.34	1.12
22	0.00	7.20	7.27	0.17	0.00	13.76	13.22	0.46	0.00	15.87	17.27	0.95

Table 3: Shoot and fruit infestation and intensity of shoot and fruit borer (*Leucinodes orbonalis*) larvae on 6 brinjal varieties during *Rabi* season 2014-15

SW	Utkal madhuri				Swarna mani				Swarna shree			
	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)
		By Number	By Weight			By Number	By Weight			By Number	By Weight	
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.32	0.00	0.00	0.16	0.43	0.00	0.00	0.32	0.27	0.00	0.00	0.19
4	2.60	0.00	0.00	0.64	3.55	0.00	0.00	0.31	2.87	0.00	0.00	0.43
5	3.04	0.00	0.00	0.58	4.40	0.00	0.00	0.38	2.50	0.00	0.00	0.55
6	4.71	0.00	0.00	0.80	5.85	0.00	0.00	0.87	3.92	0.00	0.00	1.13
7	5.80	0.00	0.00	1.31	6.76	0.00	0.00	1.25	4.01	0.00	0.00	1.11
8	6.68	0.00	0.00	1.97	8.49	0.00	0.00	1.45	6.04	0.00	0.00	1.80
9	10.14	10.02	9.42	1.59	11.94	12.13	11.03	1.60	9.19	9.21	9.85	1.60
10	11.43	13.76	15.99	2.33	13.21	16.10	17.17	3.27	11.05	12.55	12.95	2.05
11	10.85	14.42	15.26	2.35	14.33	24.98	24.80	2.56	9.82	19.53	19.96	1.79
12	10.36	20.05	20.95	2.48	15.81	27.47	25.55	2.68	10.19	19.26	19.53	1.96
13	7.14	18.91	19.17	2.23	9.55	33.38	33.50	1.83	8.13	22.01	23.34	1.72
14	4.33	15.42	15.82	2.06	5.75	27.62	26.23	2.23	3.25	21.20	21.10	1.98
15	3.33	19.90	20.52	1.88	4.18	36.59	33.21	2.61	2.61	21.63	22.82	2.37
16	0.00	21.24	21.40	2.89	0.00	37.78	36.02	2.56	0.00	24.86	24.48	3.56
17	0.00	31.38	32.09	2.76	0.00	36.65	35.14	2.98	0.00	25.81	24.82	2.27
18	0.00	36.20	35.04	2.37	0.00	41.62	38.78	2.08	0.00	25.85	26.12	2.15
19	0.00	31.48	32.09	1.40	0.00	31.64	29.09	1.36	0.00	20.72	19.61	1.43
20	0.00	24.06	22.40	2.08	0.00	30.09	29.62	1.43	0.00	17.81	18.06	1.66
21	0.00	23.91	23.6	1.16	0.00	30.52	30.78	1.27	0.00	19.50	17.33	1.03
22	0.00	12.76	12.90	1.74	0.00	24.81	23.56	1.58	0.00	18.31	16.92	1.62

SW	PANJAB SADABHAR				SWETHA				SWARNA SHYAMALI			
	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)	Shoot Damage (%)	Fruit Damage (%)		Intensity (No./plant)
		By Number	By Weight			By Number	By Weight			By Number	By Weight	
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.16	0.00	0.00	0.00	0.36	0.00	0.00	0.09	0.63	0.00	0.00	0.14
4	1.68	0.00	0.00	0.77	2.93	0.00	0.00	0.46	3.33	0.00	0.00	0.95
5	1.77	0.00	0.00	0.49	3.78	0.00	0.00	0.24	4.57	0.00	0.00	0.34
6	2.12	0.00	0.00	0.93	4.96	0.00	0.00	1.06	5.91	0.00	0.00	1.24
7	2.69	0.00	0.00	1.03	5.83	0.00	0.00	1.15	6.86	0.00	0.00	1.05
8	2.01	0.00	0.00	2.03	6.24	0.00	0.00	2.07	8.80	0.00	0.00	1.88
9	4.47	5.86	5.79	1.27	12.29	10.34	9.63	1.60	10.85	10.14	8.88	1.97
10	4.96	6.45	7.08	2.85	12.20	13.76	15.22	3.02	12.61	15.87	17.77	3.51
11	5.32	12.33	13.33	2.17	9.87	22.72	22.94	1.73	14.75	23.57	23.34	3.33
12	3.29	14.86	14.04	1.87	10.27	23.34	22.83	2.05	15.76	29.17	28.13	2.55
13	3.41	15.07	15.65	1.73	8.80	26.94	27.44	1.85	10.05	34.70	33.48	2.21
14	1.56	16.00	16.47	1.69	4.58	23.68	23.44	2.79	6.95	27.90	28.79	2.91
15	0.95	15.34	15.09	2.59	3.61	27.83	27.94	3.17	4.71	37.19	36.47	3.18
16	0.00	16.59	16.31	2.01	0.00	32.24	30.67	3.30	0.00	39.14	39.05	3.40
17	0.00	14.07	14.58	1.44	0.00	30.81	28.58	2.47	0.00	34.90	34.94	2.01
18	0.00	15.07	15.13	2.14	0.00	30.60	30.48	2.94	0.00	37.41	35.77	2.66
19	0.00	12.85	12.35	1.29	0.00	27.72	25.95	1.38	0.00	33.30	31.73	1.98
20	0.00	10.76	10.81	1.95	0.00	21.89	30.72	1.80	0.00	31.90	31.16	1.85
21	0.00	12.87	11.94	0.66	0.00	23.15	23.13	1.43	0.00	29.80	29.20	1.14
22	0.00	13.16	12.32	0.59	0.00	20.77	19.73	0.86	0.00	24.81	22.84	1.53

Table 4: Effect of insecticides against Brinjal shoot and fruit borer on Brinjal based on damage per cent during *Rabi* 2013-14

S. No.	Treatments	Dose a.i/ha	Pre Treatment	Per cent shoot damage		Pre Treatment	Per cent fruit damage			
				1st spray			2nd spray		3rd spray	
				7 DAS	14 DAS		7 DAS	14 DAS	7 DAS	14 DAS
T_1	NSKE	12.5	7.11(15.43)	4.70(12.51)	6.25(14.56)	7.82(16.24)	5.57(13.63)	9.42(17.87)	7.83(16.23)	11.21(19.55)
T_2	*Bacillus thuringiensis*	2.5	7.24(15.56)	5.03(12.94)	6.95(15.28)	5.91(14.06)	6.70(15.00)	10.46(18.86)	8.49(16.94)	12.24(20.45)
T_3	*Verticillium lacanii*	2.5	5.84(13.92)	5.60(13.69)	7.22(15.59)	5.40(13.42)	7.38(15.75)	11.91(20.15)	9.85(18.28)	13.44(21.49)
T_4	*Beavariya bassiana*	2.5	7.18(15.54)	5.77(13.89)	7.46(15.83)	7.53(15.92)	7.45(15.83)	13.03(21.15)	10.88(19.25)	13.98(21.95)
T_5	Dimethoate	1 lit	6.74(15.02)	3.74(11.14)	5.73(13.83)	5.26(13.21)	3.08(3.08)	7.60(15.99)	3.91(11.40)	7.77(16.18)
T_6	Emamectine benzoate	12.5	8.02(16.43)	1.23(6.37)	3.13(10.16)	6.44(14.70)	1.52(7.07)	6.12(14.32)	1.48(6.96)	4.20(11.83)
T_7	Spinosad	73	8.41(16.45)	2.60(9.22)	3.87(11.18)	6.44(14.70)	2.76(9.51)	7.13(15.49)	3.12(10.17)	6.10(14.30)
T_8	Novaluron	100	6.67(14.73)	1.73(7.52)	3.55(10.84)	7.01(15.32)	2.14(8.42)	6.84(15.16)	2.25(8.63)	4.77(12.59)
T_9	Indoxacarb	50	6.81(15.05)	2.61(9.28)	4.84(12.70)	6.08(14.26)	2.46(9.01)	6.95(15.28)	2.42(8.92)	5.93(14.09)
T_{10}	Fipronil	100	6.77(15.07)	2.70(9.44)	4.64(12.44)	6.99(15.32)	2.92(9.81)	7.23(15.60)	3.68(11.06)	6.40(14.61)
T_{11}	Abamectine	14.4	6.03(14.18)	4.80(12.65)	7.38(15.76)	7.50(15.88)	4.53(12.29)	8.01(16.44)	4.64(12.44)	7.93(16.35)
T_{12}	Flubediamide	90	8.53(16.96)	0.83(5.18)	3.12(10.15)	6.93(15.26)	1.92(7.76)	6.61(14.90)	1.71(7.50)	4.54(12.29)
T_{13}	Imidacloprid	50	7.03(15.34)	2.80(9.63)	5.48(13.52)	6.76(15.06)	3.21(10.31)	7.29(15.66)	4.21(11.84)	6.95(15.28)
T_{14}	Control	12.5	6.64(14.90)	7.87(16.29)	11.41(19.74)	6.19(14.34)	8.06(16.49)	11.93(20.16)	16.95(24.31)	30.49(33.51)
SEm±			0.89	0.38	0.55	0.51	0.44	0.45	0.30	0.54
CD at 5% level			2.59	1.09	1.60	1.49	1.27	1.30	0.88	1.57

*The data in parenthesis is arc sine transformed value

Table5: Effect of insecticides against Brinjal shoot and fruit borer on Brinjal based on damage per cent during *Rabi* 2014-15

S. No.	Treatments	Dose a.i/ha	Pre Treatment	Per cent shoot damage		Pre Treatment	Per cent fruit damage			
				1st spray			2nd spray		3rd spray	
				7 DAS	14 DAS		7 DAS	14 DAS	7 DAS	14 DAS
T_1	NSKE	12.5	6.44(14.66)	2.84(8.41)	5.12(13.08)	8.14(16.57)	5.73(13.84)	9.60(18.05)	7.56(15.92)	12.49(20.65)
T_2	*Bacillus thuringiensis*	2.5	5.11(13.06)	3.05(10.02)	5.95(14.11)	8.14(16.53)	7.06(15.38)	10.59(18.98)	9.09(17.53)	14.44(22.33)
T_3	*Verticillium lacanii*	2.5	5.99(14.15)	4.05(11.61)	6.02(14.17)	6.77(15.08)	8.44(16.88)	12.30(20.53)	11.16(19.52)	15.36(23.07)
T_4	*Beavariya bassiana*	2.5	5.51(13.57)	4.27(11.92)	6.33(14.57)	7.83(16.25)	9.10(17.54)	13.68(21.70)	12.59(20.78)	15.39(23.09)
T_5	Dimethoate	1 lit	5.10(13.03)	2.70(9.46)	4.85(12.72)	7.70(16.09)	3.74(11.09)	7.44(15.08)	3.89(11.37)	5.31(13.32)
T_6	Emamectine benzoate	12.5	5.61(13.68)	0.88(5.12)	1.93(7.98)	7.85(16.23)	1.20(6.22)	4.44(12.14)	1.43(6.86)	3.36(10.54)
T_7	Spinosad	73	5.85(13.99)	1.43(6.82)	2.65(9.36)	7.10(15.43)	2.88(9.72)	5.37(13.40)	3.18(10.27)	4.06(11.58)

T_8	Novaluron	100	5.63(13.73)	1.32(6.57)	1.80(7.71)	6.93(15.22)	1.94(7.95)	5.66(13.75)	2.66(9.28)	4.44(12.15)
T_9	Indoxacarb	50	5.80(13.91)	2.07(8.24)	3.13(10.15)	7.72(16.11)	2.68(9.41)	5.83(13.96)	2.94(9.87)	4.88(12.76)
T_{10}	Fipronil	100	5.52(13.58)	2.27(8.65)	3.49(10.77)	7.14(15.43)	3.35(10.54)	6.91(15.23)	3.31(10.49)	5.21(13.20)
T_{11}	Abamectine	14.4	4.24(11.86)	4.32(11.98)	5.51(13.05)	8.65(17.10)	4.36(12.06)	8.47(16.92)	4.73(12.54)	6.61(14.89)
T_{12}	Flubediamide	90	4.89(12.73)	0.44(3.77)	1.47(6.94)	7.55(15.94)	1.53(7.05)	4.94(12.84)	1.98(8.09)	3.81(11.25)
T_{13}	Imidacloprid	50	5.39(13.42)	2.62(9.24)	4.79(12.60)	7.81(16.22)	4.31(11.98)	7.73(16.14)	3.99(11.52)	5.98(14.16)
T_{14}	Control	12.5	5.46(13.41)	8.63(17.07)	9.97(19.02)	7.60(15.98)	9.14(17.60)	14.27(22.16)	20.66(27.02)	32.34(34.65)
SEm±			0.54	0.57	0.37	0.66	0.52	0.42	0.39	0.47
CD at 5% level			1.57)	1.65	1.08	1.93	1.51	1.22	1.12	1.36

*The data in parenthesis is arc sine transformed value

Table 6: Cost: benefit ratio of the treatments against Brinjal shoot and fruit borer during 2013-14

S. No.	Treatments	Dose a.i/ha	Quantity required lit/kg/ha	Total quantity of insecticide lit/kg/ha	Cost of insecticides Rs/ lit/kg	Cost of treatment (Rs)	Yield (q/ha)	Saved yield over comtrol (q/ha)	Value of saved Yield (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	C:B Ratio
T1	NSKE	12.5	12.5	37.5	30	2175	175.57	45.96	45963	175573	43788	21.13
T2	*Bacillus thuringiensis*	2.5	2.5	7.5	150	2175	172.24	42.63	42633	172243	40458	19.60
T3	*Verticillium lacanii*	2.5	2.5	7.5	150	2175	167.17	37.56	37557	167167	35382	17.27
T4	*Beavariya bassiana*	2.5	2.5	7.5	125	1988	164.92	35.31	35307	164917	33319	17.76
T5	Dimethoate	1 lit	1	3	500	2550	178.05	48.44	48437	178047	45887	18.99
T6	Emamectine benzoate	12.5	0.25	0.75	6000	5550	235.45	105.84	105843	235453	100293	19.07
T7	Spinosad	73	0.16	0.48	15400	8442	225.16	95.55	95547	225157	87105	11.32
T8	Novaluron	100	1	3	3660	12030	227.69	98.08	98080	227690	86050	8.15
T9	Indoxacarb	50	0.4	1.2	3200	4890	222.44	92.83	92830	222440	87940	18.98
T10	Fipronil	100	2	6	1300	8850	219.62	90.01	90010	219620	81160	10.17
T11	Abamectine	14.4	0.76	2.28	4500	11310	164.31	34.70	34700	164310	23390	3.07
T12	Flubediamide	190	0.19	0.57	15000	9600	232.34	102.73	102730	232340	93130	10.70
T13	Imidacloprid	50	0.28	0.84	2500	3150	185.97	56.36	56357	185967	53207	17.89
T14	Control						129.61			129610		

Labour charge for spray= Rs 150x3=450
Sprayer charge= Rs 50x2=100
Product price= Rs 1000/ Quintal

Table7: Cost: benefit ratio of the treatments against Brinjal shoot and fruit borer during 2014-15

S. No.	Treatments	Dose a.i/ha	Quantity required lit/kg/ha	Total quantity of insecticide lit/kg/ha	Cost of insecticides Rs/ lit/kg	Cost of treatment (Rs)	Yield (q/ha)	Saved yield over comtrol (q/ha)	Value of saved Yield (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	C:B Ratio
T1	NSKE	12.5	12.5	37.5	30	2175	190.51	53.07	53070	190510	50895	24.40
T2	*Bacillus thuringiensis*	2.5	2.5	7.5	150	2175	186.32	48.88	48883	186323	46708	22.48
T3	*Verticillium lacanii*	2.5	2.5	7.5	150	2175	182.59	45.15	45147	182587	42972	20.76
T4	*Beavariya bassiana*	2.5	2.5	7.5	125	1988	178.65	41.21	41207	178647	39219	20.73
T5	Dimethoate	1 lit	1	3	500	2550	198.17	60.73	60727	198167	58177	23.81
T6	Emamectine benzoate	12.5	0.25	0.75	6000	5550	270.79	133.35	133347	270787	127797	24.03
T7	Spinosad	73	0.16	0.48	15400	8442	258.78	121.34	121337	258777	112895	14.37
T8	Novaluron	100	1	3	3660	12030	259.57	122.13	122127	259567	110097	10.15
T9	Indoxacarb	50	0.4	1.2	3200	4890	255.46	118.02	118020	255460	113130	24.13
T10	Fipronil	100	2	6	1300	8850	251.17	113.73	113733	251173	104883	12.85
T11	Abamectine	14.4	0.76	2.28	4500	11310	194.09	56.65	56650	194090	45340	5.01
T12	Flubediamide	190	0.19	0.57	15000	9600	266.31	128.87	128873	266313	119273	13.42
T13	Imidacloprid	50	0.28	0.84	2500	3150	201.65	64.21	64210	201650	61060	20.38
T14	Control						137.44			137440		

Labour charge for spray= Rs 150x3=450
Sprayer charge= Rs 50x2=100
Product price= Rs 1000/ Quintal

References

1. Alam SN, Rashid MA, Rouf FMA, Jhala RC, Patel JR, Satpathy S. *et al*. Development of an integrated pest management strategy for eggplant fruit and shoot borer in South Asia, Technical Bulletin TB28, AVRDC - The World Vegetable Center, Shanhua, Taiwan, 2003, 66.
2. Anil, Sharma PC. Bioefficacy of insecticides against *Leucinodes orbonalis* on brinjal. Journal of

Environmental Biology. 2010; 31(2):399-402.
3. Anonymous. Indian Horticulture Database, National Horticulture Board, Ministry of Agriculture, Government of India. (http://nhb.gov.in/area-pro/database-2011.pdf). 2014, 1-296.
4. Bhadauria NKS, Bhadauria NS, Jakhmola SS. Insect-pests complex of brinjal *Solanum melongena* Linn. in North – West Madhya Pradesh. Advances in Plant Sciences. 1999; 12(2):607-608.
5. Butani DK, Verma S. Pests of vegetables and their control brinjal. Pesticides. 1976; 10(2):32-35.
6. Chatterjee ML, Roy S. Bio-efficacy of some insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. and effect of novaluron on natural enemies of brinjal pests. Pestology. 2004; 27(10):52-56.
7. Devi P, Gawde P, Kostha VK. Screening of some brinjal cultivars for resistance to shoot and fruit borer (*Leucinodes orbonalis* Guenee). The Ecoscan, An International Quarterly Journal of Environmental Sciences. 2015; 10(1):247-251.
8. Devi1 NS, Singha LB. Comparative Efficacy and Economic Feasibility of Certain Bio Rational Insecticides and Endosulfan against *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in Eggplant. International Journal of Science and Research. 2014; 3(8):454-457.
9. Ghosh SK, Senapathi SK. Biology and seasonal abundance of jassid infesting brinjal in terai of West Bengal. Environment and Ecology. 2003; 21(3):716-719.
10. Gleddie S, Keller WA, Setterfield G. Somatic embryogenesis and plant regeneration from cell suspension derived protoplasts of *Solanum melongena* (egg plant). Canadian Journal of Botany. 1986; 64:355-361.
11. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. Edn.1, Vol.1, John Wiley and Sons, New York, 1984.
12. Harish DK, Agasimani AK, Imamsaheb SJ, Patil Satish S. Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. Research Journal of Agricultural Sciences, 2011; 2(2):221-225.
13. Jagginavar SB, Sunitha ND, Biradar AP. Bioefficacy of flubendiamide 480SC against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen. Karnataka J Agric. Sci. 2009; 22(3):712-713.
14. Kabir KH, Roul FMA. Effect of pesticides application on brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Zool. Rajshahi Univ. 1994; 13(12):111-118.
15. Kumar NKK, Sadashiva AT. Solanum macrocarpon: a wild species of brinjal resistant to brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.). Insect Envir. 1996; 2(2):41-42.
16. Latif MA, Rahman MM, Alam MZ, Hossain MM. Effect of flubendiamide and some other insecticides on arthropod's biodiversity used to control brinjal shoot and fruit borer (*Leucinodes orbonalis* G.). International Journal of Agriculture Environment & Biotechnology, 2009; 2(2):173-179.
17. Lu FM, Lee HS. Seasonal occurrence of the insect pests of eggplant. Plant Protection Bulletin, 1987; 29(1):61-70.
18. Mabberley DJ. Mabberley’s Plant-Book. Cambridge University Press, 2008.
19. Malini CD, Prasanna KP, Gopalakrishnan TR. Screening brinjal genotypes for resistance to jassid (Amrasca biguttula biguttula [Ishida]). Journal of Tropical Agriculture. 2013; 51(1-2):42-50.
20. Mall NP, Pandey RS, Singh SV, Singh SK. Seasonal incidence of insect-pests and estimation of the losses caused by shoot and fruit borer on brinjal. Indian Entomol. 1996; 54(3):241-247.
21. Mandal SMA, Dash D, Mishra PR. Performance of brinjal cultivars against fruit and shoot borer, *Leucinodes orbonalis* Guen. Journal of Applied Zoological Researches. 2005; 16(2):195-197.
22. Mehto DN, Lall BS. Comparative susceptibility of different brinjal (*Solanum melongena*) cultivars against fruit and shoot borer (*Leucinodes orbonalis* L.). Indian Journal of Entomology. 1981; 43(1):108-109.
23. Misra HP. 2008. New promising insecticides for the manage¬ment of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Pest Manage. Hort. Ecosys. 1981; 14 (2):140-147.
24. Mochiah MB, Banful B, Fening KN, Amoabeng BW, Offei Bonsu K, Ekyem S. *et al*. Botanicals for the Management of Insect Pests in Organic Vegetable Production. Journal of Entomology and Nematology, 2011; 3(6): 85-97.
25. Mo FA. Ghana Commercial Agriculture Project (GCAP) Pest Management Plan (PMP). Ministry of Food and Agriculture, Ghana. Final Report, 2011, 85.
26. Muthukumar M, Kalyanasundaram M. (b). Efficacy of certain insecticides against major sucking insects of brinjal (*Solanum melongena* L.) South Indian Horticulture. 2003; 51(1/6):207-213.
27. Nair MRGK. Insect and mites of crops in india. Indian Council of Agriculture Research, New Delhi, 1995, 408.
28. Naresh JS, Malik VS, Balan JS, Estimation of fruit damage and larval population of brinjal fruit borer, *Leucinodes orbonalis* Guen. and its parasitism by Trathala sp. on brinjal. Bulletin of Entomology, 1986; 27: 44-47.
29. Natekar MG, Samarjit Rai, Agnihotri N P. Bioefficacy of synthetic pyrethroids and their residues in brinjal fruit. Pestology. 1987; 11:18-22.
30. Nayak US, Baral K, Rath LK, Mandal P. Relative efficacy of certain new generation pesticides against brinjal fruit and shoot borer *Leucinodes orbonalis* Guene. Journal of Plant Protection and Environment, 2011; 8(2):108-109.
31. Nayar KK, Ananthcakrishanan TN, Devid BV Lepidoptera. In General and Applied Entomology. Tata Mc Grow Hill Publis. Co. Ltd. New Delhi, 1976, 509.
32. Omprakash S, Raju SVS. A brief review on abundance and management of major insect pests of Brinjal (*Solanum Melongena* L.). International Journal of biology and pharmaceutical Technology. 2014; 5(1):228-234.
33. Owusu-Ansah F, Afreh-Nuamah K, Obeng-Ofori D, Ofosu-Budu KG. Managing infestation levels of major insect pests of garden eggs (*Solanum integrifolium* L.) with aqueous neem seed extracts. Journal of the Ghana Science Association. 2001; 3(3):70-84.
34. Patel HV, Radadia GG, Chavda SK. Seasonal incidence of major insect pests of brinjal crop during summer season. Insect Environment (a supplement of Current Biotica), 2015; 20(4):149-151.
35. Patnaik HP. Flower and fruit infestation by brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee – damage po¬tential vs. weather. Veg. Sci. 2000; 27(1):82-83.
36. Patra S, Chatterjee ML, Mondal S, Samanta A. Field evaluation of some new insecticides against brinjal shoot

and fruit borer, *Leucinodes orbonalis* (Guen.). Pesticide Res. J. 2009; 21(1):58-60.
37. Prempong K, Bauhim J. Studies on the insect-pests of egg plant, *Solanum Melongena* linr in China. Bulletin the Institute Fundamental de Affrique Neire seria A. 1977; 39(3):627-641.
38. Raghupathy A, Chandramohan N, Palanisamy S, Gunathilagaraj K. Pests, Symptoms and Description, A Guide on Crop Pests. KRS Printers, Coimbatore, 2003, 276.
39. Raju SVS, Bar UK, Shanker U, Kumar S. Scenario of infestation and management of egg plant shoot and fruit borer, L. orbonalis Guen. in India. Resistant Pest Management Newsletter. 2007; 16(2):14-16.
40. Roberts DW, Hajek AE. Entomopathogenic fungi as biopesticides In: Frontiers in industrial Mycology Ed. Leathan, G.F. Chapman and Hall, New York, 1992, 144-159.
41. Samal T. Studies on the field life table of *Leucinodes orbonalis* Guenee and its strategic control in brinjal. A Ph.D. thesis submitted to the Department of Entomology, College of Agriculture, OUAT, and Bhubaneswar, 2008.
42. Shah KD, Bharpoda TM, Jhala RC. Bio-efficacy of newer molecules of insecticides against brinjal shoot and fruit borer, *leucinodes orbonalis* guenee (lepidoptera: pyralidae). AGRES-An international e-journal, 2012; 1(2):186-200.
43. Shukla A, Khatri SN. Incidence and abundance of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee. The Bioscan, 2010a; 5(2):305-308.
44. Singh S, Kumar A, Awasthi BK. Study of sucking and leaf feeding insect in relation to weather parameters on the brinjal crop. Veg. Sci. 2005a; 32(2):210-212.
45. Singh SS. Comparative efficacy of certain bio-rational insecticides and Bacillus thuringiensis based bio-insecticides against *Leucinodes orbonalis* Guen. in brinjal. Indian Journal of Horticulture, 2010, 67(3).
46. Sohi AS. Studies on brinjal little leaf virus and its vector, M.Sc. Thesis Punjab Agricultural University Ludhiana. 1996, 74.
47. Srivatav D. Gene targeting based genetic Transformation In brinjal (*Solanum melongena* L.) Ph. D. Thesis Department of Biotechnology, University School of Biotechnology, Guru Gobind Singh Indraprastha University Sector 16c, dwarka, Delhi, 2012.
48. Srinivasan R. Insect and Mite Pests on Eggplant: A Field Guide for Identification and Management. AVRDC–The World Vegetable Center, Shanhua, Taiwan. AVRDC Publication No. 09-729, 2009, 64.
49. Vevai EJ. Know your crop, its pest problems and control of pests on Brinjal. Pesticides. 1970; 4(10):26-33.