INTERNATIONAL JOURNAL OF PLANT PROTECTION
VOLUME 9 | ISSUE 1 | APRIL, 2016 | 1-7

● e ISSN-0976-6855 | Visit us : *www.researchjournal.co.in*

IJPP

RESEARCH PAPER

DOI : 10.15740/HAS/IJPP/9.1/1-7

Bioefficacy of newer insecticides and biopesticides against brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee (Lepidoptera : Pyralidae)

■ J.P. SINGH*, P.K. GUPTA, U. CHANDRA AND VIMAL KUMAR SINGH
Department of Entomology, N.D. University of Agriculture and Technology, FAIZABAD (U.P.) INDIA

ARITCLE INFO

Received : 30.12.2015
Revised : 01.02.2016
Accepted : 15.02.2016

KEY WORDS :
Bacillus thuringensis, Leucinodes. orbonalis, Verticellium lecanii, Beauveria bassiana, Biopesticides

***Corresponding author:**

ABSTRACT

A field experiment were carried out for two consecutive *Rabi* seasons 2013-14 and 2014-15 at Student's Instructional Farm, N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). 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 boipesticide NSKE 5 per cent most effective followed by *Bacillus thuringensis, Verticellium lecanii* and *Beauveria bassiana*. The highest cost: benefit ratio was obtained from NSKE 5 per cent (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.

How to view point the article : Singh, J.P., Gupta, P.K., Chandra, U. and Singh Vimal Kumar (2016). Bioefficacy of newer insecticides and biopesticides against brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee (Lepidoptera : Pyralidae). *Internat. J. Plant Protec.*, **9**(1) : 1-7.

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; Omprakash and Raju, 2014). 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). 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). 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 per cent 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). 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 Bauhim, 1977 and Sohi, 1996). Butani and Verma (1976) and Nayar *et al.* (1976) have however listed only 36 and 53 insects, respectively on this crop.

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 per cent in various parts of the country (Raju *et al.*, 2007), 85–90 per cent have been reported (Patnaik, 2000; Misra, 2008 and Jagginavar *et al*., 2009). It is estimated that the economic injury level equals to 6 per cent infestation of shoot and fruit in India (Alam *et al.*, 2003).

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 and Harish *et al.,* 2011). Hence, use of organic amendments, plant products and microbial origin insecticides with new molecules of insecticide is one of the important considerations can be the 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 (Roberts and Hajek, 1992). Considering above facts, the present investigation was carried on evaluation of newer molecules of insecticides for their bio-efficacy against BSFB.

MATERIAL 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.). Brinjal variety, NDB-2 was raised as per recommended package of practices for the crop production guide for vegetables crops. 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).

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:

$$\text{Required amount of insecticides} = \frac{\text{Volume of water (lit./ha) x Desired concentration (\%)}}{\text{\% strength of insecticide formulation}}$$

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

RESULTS AND DISCUSSION

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 per cent > 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; Singh, 2010; Chatterjee and Roy, 2004 and Patra *et al.*, 2009.

Dutta *et al.*, 2007 reported Emamectin benzoate 5 SG showed moderate level of efficacy providing 62.8 per cent reduction of BSFB population over control. Spinosad 45 EC at 0.01 per cent found effective in reducing shoot and fruit borer infestation and in increasing fruit yield (Deshmukh and Bhamare, 2006 and Singh *et al.*, 2009). 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 (2014); Anil and Sharma (2010) and Nayak *et al.* (2011).

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. 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) Flubendiamide applied at 2 per cent shoot+2 per cent fruit infestation reduced the highest per cent 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 per cent (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

Table 1 : Effect of insecticides against Brinjal shoot and fruit borer on Brinjal based on damage per cent during *Rabi* 2013-14

Sr. No.	Treatments	Dose a.i/ha	Pre treatment	Per cent shoot damage 1st spray		Pre treatment	Per cent fruit damage 2nd spray		Per cent fruit damage 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)
	S.E.±		0.89	0.38	0.55	0.51	0.44	0.45	0.30	0.54
	C.D. (P=0.05) 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

Table 2 : Effect of insecticides against Brinjal shoot and fruit borer on Brinjal based on damage per cent during *Rabi* 2014-15

Sr. No.	Treatments	Dose a.i/ha	Pre treatment	Per cent shoot damage 1st spray		Pre treatment	Per cent fruit damage 2nd spray		Per cent fruit damage 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)
	S.E.±		0.54	0.57	0.37	0.66	0.52	0.42	0.39	0.47
	C.D. (P=0.05) 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 3 : Cost: benefit ratio of the treatments against Brinjal shoot and fruit borer during 2013-14

Sr. 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 control (q/ha)	Value of saved yield (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	C:B Ratio
T_1	NSKE	12.5	12.5	37.5	30	2175	175.57	45.96	45963	175573	43788	21.13
T_2	*Bacillus thuringiensis*	2.5	2.5	7.5	150	2175	172.24	42.63	42633	172243	40458	19.60
T_3	*Verticilium lacanii*	2.5	2.5	7.5	150	2175	167.17	37.56	37557	167167	35382	17.27
T_4	*Beavariya bassiana*	2.5	2.5	7.5	125	1988	164.92	35.31	35307	164917	33319	17.76
T_5	Dimethoate	1 lit	1	3	500	2550	178.05	48.44	48437	178047	45887	18.99
T_6	Emamectine benzoate	12.5	0.25	0.75	6000	5550	235.45	105.84	105843	235453	100293	19.07
T_7	Spinosad	73	0.16	0.48	15400	8442	225.16	95.55	95547	225157	87105	11.32
T_8	Novaluron	100	1	3	3660	12030	227.69	98.08	98080	227690	86050	8.15
T_9	Indoxacarb	50	0.4	1.2	3200	4890	222.44	92.83	92830	222440	87940	18.98
T_{10}	Fipronil	100	2	6	1300	8850	219.62	90.01	90010	219620	81160	10.17
T_{11}	Abamectine	14.4	0.76	2.28	4500	11310	164.31	34.70	34700	164310	23390	3.07
T_{12}	Flubediamide	190	0.19	0.57	15000	9600	232.34	102.73	102730	232340	93130	10.70
T_{13}	Imidacloprid	50	0.28	0.84	2500	3150	185.97	56.36	56357	185967	53207	17.89
T_{14}	Control						129.61			129610		

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

Table 4 : Cost: benefit ratio of the treatments against Brinjal shoot and fruit borer during 2014-15

Sr. 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 control (q/ha)	Value of saved yield (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	C:B Ratio
T_1	NSKE	12.5	12.5	37.5	30	2175	190.51	53.07	53070	190510	50895	24.40
T_2	*Bacillus thuringiensis*	2.5	2.5	7.5	150	2175	186.32	48.88	48883	186323	46708	22.48
T_3	*Verticillium lacanii*	2.5	2.5	7.5	150	2175	182.59	45.15	45147	182587	42972	20.76
T_4	*Beavariya bassiana*	2.5	2.5	7.5	125	1988	178.65	41.21	41207	178647	39219	20.73
T_5	Dimethoate	1 lit	1	3	500	2550	198.17	60.73	60727	198167	58177	23.81
T_6	Emamectine benzoate	12.5	0.25	0.75	6000	5550	270.79	133.35	133347	270787	127797	24.03
T_7	Spinosad	73	0.16	0.48	15400	8442	258.78	121.34	121337	258777	112895	14.37
T_8	Novaluron	100	1	3	3660	12030	259.57	122.13	122127	259567	110097	10.15
T_9	Indoxacarb	50	0.4	1.2	3200	4890	255.46	118.02	118020	255460	113130	24.13
T_{10}	Fipronil	100	2	6	1300	8850	251.17	113.73	113733	251173	104883	12.85
T_{11}	Abamectine	14.4	0.76	2.28	4500	11310	194.09	56.65	56650	194090	45340	5.01
T_{12}	Flubediamide	190	0.19	0.57	15000	9600	266.31	128.87	128873	266313	119273	13.42
T_{13}	Imidacloprid	50	0.28	0.84	2500	3150	201.65	64.21	64210	201650	61060	20.38
T_{14}	Control						137.44			137440		

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

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 3 and 4).

REFERENCES

Alam, S.N., Rashid, M.A., Rouf, F.M.A., Jhala, R.C., Patel, J.R., Satpathy, S., Shivalingaswamy, T.M., Rai, S., Wahundeniya, I., Cork, A., Ammaranan, C. and Talekar, N.S. (2003). 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, 66 p.

Anil and Sharma, P.C. (2010). Bioefficacy of insecticides against *Leucinodes orbonalis* on brinjal. *J. Environmental Biol.,* **31**(2): 399-402.

Anonymous (2014). Indian Horticulture Database, National Horticulture Board, Ministry of Agriculture, Government of India. (http://nhb.gov.in/area-pro/database-2011.pdf). pp.1-296.

Butani, D.K. and Verma, S. (1976). Pests of vegetables and their control brinjal. *Pesticides*, **10**(2): 32-35.

Chatterjee, M.L. and Roy, S. (2004). Bio-efficacy of some insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. and effect of novaluron on natural enemies of brinjal pests. *Pestol.,* **27**(10): 52-56.

Deshmukh, R.M. and Bhamare, V.K. (2006). Field evaluation of some insecticides against eggplant shoot and fruit borer, Leucinodes orbonalis Guenee. *Int. J. Agric. Sci.,* **2** (1): 247–249.

Devi1, N.S. and Singha, L.B. (2014). Comparative Efficacy and Economic Feasibility of Certain Bio Rational Insecticides and Endosulfan against *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in Eggplant. *Internat. J. Sci. & Res.* (IJSR), **3**(8): 454-457

Dutta, N.K., Alam, M.S., Nasiruddin, M., Das, A.K. and Munmun, T.S. (2007). Efficacy of some new chemical insecticides against Brinjal Shoot & Fruit Borer (Leucinodes orbonales Guen.). *J. Subtropical Agri. Res. and Devel*., **5**(3) : 301-304.

Gleddie, S., Keller, W.A. and Setterfield, G. (1986). Somatic embryogenesis and plant regeneration from cell suspension derived protoplasts of *Solanum melongena* (egg plant). *Canadian J. Bot.,* **64**: 355- 361.

Gomez, K.A. and. Gomez, A.A (1984). *Statistical procedures for agricultural research*. John Wiley and Sons, New York, U.S.A.

Harish, D.K., Agasimani, A.K., Imamsaheb, S.J. and Patil, Satish S. (2011). Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. *Res. J. Agric. Sci.,* **2**(2): 221-225.

Jagginavar, S.B., Sunitha, N.D. and Biradar, A.P. (2009). Bioefficacy of flubendiamide 480SC against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen. Karnataka *J. Agric. Sci*., **22**(3): 712–713.

Latif, M.A., Rahman, M.M., Alam, M.Z. and Hossain, M.M. (2009). Effect of flubendiamide and some other insecticides on arthropod's biodiversity used to control brinjal shoot and fruit borer (*Leucinodes orbonalis* G.). *Internat. J. Agric. Environ. & Biotechnol.,* **2**(2):173-179.

Mabberley, D.J. (2008). *Mabberley's Plant-Book*. Cambridge University Press.

Misra, H.P. (2008). New promising insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Pest Manage. *Hort. Ecosys*., **14** (2): 140–147.

Natekar, M.G., Samarjit Rai and Agnihotri, N.P. (1987). Bioefficacy of synthetic pyrethroids and their residues in brinjal fruit. *Pestol.,* **11**:18-22.

Nayak, U.S., Baral, K., Rath, L.K. and Mandal, P. (2011). Relative efficacy of certain new generation pesticides against brinjal fruit and shoot borer *Leucinodes orbonalis* Guene. *J. Plant Protec. & Environ.*, **8**(2):108-109.

Nayar, K.K., Ananthcakrishanan, T.N. and Devid, B.V. (1976). Lepidoptera; *In General and Applied Entomology*. Tata Mc Grow Hill Publishing Co. Ltd. New Delhi, p. 509.

Omprakash, S. and Raju, S.V.S. (2014). A brief review on abundance and management of major insect pests of Brinjal (*Solanum melongena* L.). *Internat. J. Biol. & pharmaceutical Technol.,* **5**(1) : 228-234.

Patnaik, H.P. (2000). Flower and fruit infestation by brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee – damage potential vs. weather. *Veg. Sci.*, **27**(1): 82–83.

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

Prempong, K. and Bauhim (1977). Studies on the insect-pests of egg plant, Solanum Melongena linr in China. *Bulletin the Institute Fundamental de Affrique Neire seria A.*, **39**(3): 627-641.

Raju, S.V.S., Bar, U.K., Shanker, U. and Kumar, S. (2007). Scenario of infestation and management of egg plant shoot and fruit borer, *L. orbonalis* Guen. in India. *Resistant Pest Management Newsletter*, **16**(2) : 14-16.

Roberts, D.W. and Hajek, A.E. (1992). Entomopathogenic fungi as biopesticides In : *Frontiers in industrial Mycology* (ed. Leathan, G.F.) Chapman and Hall, New York, pp. 144-159.

Shah, K.D., Bharpoda, T.M. and Jhala, R.C. (2012). Bio-efficacy of newer molecules of insecticides against brinjal shoot and fruit borer, *leucinodes orbonalis* guenee (lepidoptera : pyralidae). *AGRES- An Internat. e-J.*, **1**(2):186-200.

Singh, D.K., Ramesh Singh, Datta, S.D. and Singh, S.K. (2009). Seasonal incidence and insecticidal management of shoot and fruit borer (Leucinodusorbonalis L.) in brinjal. *Ann. Hort.*, **2**(2):187-190.

Singh, S. S. (2010). Comparative efficacy of certain bio-rational insecticides and *Bacillus thuringiensis* based bio-insecticides against *Leucinodes orbonalis* Guen. in urinal. *Indian J. Hort.*, 67(3).

Sohi, A.S. (1996). Studies on brinjal little leaf virus and its vector, M.Sc. Thesis Punjab Agricultural University, Ludhiana, PUNJAB (INDIA). 74p.

Srivatav, D. (2012). 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, India.