EFFICACY OF SYNTHETIC INSECTICIDES AND BIO PESTICIDE AGAINST BRINJAL FRUITS AND SHOOTS BORER (*leucinodes orbonalis* GUENEE) AT DISTRICT PESHAWAR

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ABSTRACT

Study was carried out to check the effectiveness of different novel insecticides and neem leaf extract against the fruit and shoot borer under field condition Tarnab, Peshawar during the year 2020. Experiment was laid out in randomized complete block design (RCBD) with 6 treatments and 3 replications. Treatments contain Emamectin benzoate (Wel Star 1.9 EC), Cypermethrin (Win25% EW), Chlorpyrifos (Custom 40% EC), Thiamethoxam+ Chlorantraniliprole (Voliam flexi 300 SC) and neem leaf extract (5%). Results showed that the lowest percent infestation of shoot after 1st and 2nd spray was recorded in voliam flexi (38.38 and 11.58) while in term of percent fruit infestation similar data was observed (4.10 and 2.00) after 1st and 2nd spray. However, the highest cost benefit ratio was recorded in voliam flexi treated plot (1: 48.13) followed by chlorpyrifos (1: 40.88), emamectin benzoate (1: 36.65), cypermethrin (1: 31.25) while the lowest CB ratio was recorded in neem treated plot (1: 1.21). The results concluded that the best possible control was recorded voliam flexi and chlorpyrifos and recommended for the infestation of brinjal shoot and fruit borer.

Keywords: *Leucinodes orbonalis*, brinjal, insecticides, plant extract, brinjal fruit and shoot borer

INTRODUCTION

Brinjil (*Solanum melongena* L.) commonly known as aubergine or eggplant is an essential vegetable after potato and tomato in the family Solanaceae (FAO, 2016). The crop is cultivated throughout the world. The main growing countries of the crop are Egypt, Turkey, Iraq, India, Indonesia, China and Pakistan (Daunay, 2008). It is an essential source of vitamins, dietary fiber, minerals, body building proteins, antioxidants and nutrients (Matsubara *et al.*, 2005). The crop is considered as cash crop for farmers and is grown in both harif and rabi seasons commercially and in kitchen gardens.

The average of brinjal is 54077210 tons cultivated with an area of 1864556 ha worldwide. In Pakistan, the production of brinjal is 87587 tons/ annum grown with an area of about 7585 ha. Punjab is the most dominant province in brinjal production with cultivated area of 4460 ha and productivity of 54223 tons followed by Baluchistan (12273 tons), Sindh (8212 tons) and Khyber Pakhtunkhwa (9214 tons/ annum) respectively. The annual export of brinjal in Pakistan was 4000 kg worth 0.6 miilion during 2012-14 (Pakistan Bureau of Statistics, 2015-16).

Several insect pests i.e. lace wing bug (*Urentius echinus*), coccinalid beetle (*Epilachna vigintioctopunctata*), leaf roller (*Eublemma olivacea*), brinjal stem borer (*Euzophera perticella*) and brinjil shoot and fruit borer *(Leucinodes orbonalis*) attack on brinjal at different growth stages (Kassi *et al.*, 2018) that affect the yield of the crop immensely. Among these pests brinjal shoot and fruit borer possesses prime importance (Latif*et al.*, 2009). Brinjil shoot and fruit borer is a monophagous pest and greatly affect the quality and yield of crop. It is native pest of African and Asian subcontinent (Thapa, 2010; Jagginavar *et al.*, 2009; Misra, 2008).

The larva of BSFB is very ddestructive and cause 20-60% injury to fruits and 12-16% in shoots (Maureal, *et al*., 1982). The larva of BSFB have 5 instars which required 22 days in winter and 12-15 days in summer for completion (Kumar and Johnsen, 2000). Full grown larva pupate on the fallen plant debris inside soil with depth of 1-3 cm (Alam *et al.*, 2003). The pupal stage takes 6-17 days after which small white adult emerge. The whole life cycle completes in 22-55 days. The pest is active throughout the year and have 5 generations per year (Alam*et al.*, 2003).

The fruit borers greatly reduced vitamin C content up to 80% (Sharma, 2002). A single larva is sufficient to cause injury to 4-7 healthy fruits (Jayaraj and Manisegaran, 2010). The average fruit infestation in Pakistan recorded 50-70%. Farmers mainly depend on synthetic insecticides for control of insect pest. The use of high toxicity insecticides are not necessary as the bringal is consume fresh in Pakistan. Based on the above-mentioned facts the current research was carried to check the effectiveness of novel insecticides and neem extract against the fruit and shoot borer under field condition.

MATERIALS AND METHODS

The present experiment was conducted at Agricultural Research Institute, Tarnab, Peshawar, during 2021 to study the efficacy of six insecticides against *L. orbonalis* under field conditions.

Plot size

Brinjal was sown under field conditions by keeping plant to plant distance 30 cm and row to row distance 60 cm.

Treatments

Six insecticides i.e Emamectin benzoate (Wel Star 1.9 EC), Cypermethrin (Win25% EW), Chlorpyrifos (Custom 40% EC), Thiamethoxam+ Chlorantraniliprole (Voliam flexi 300 SC) and neem leaf extract 5%were tested along with a control.

Experimental design

The experiment was laid out in Randomized complete block design (RCBD) with 3 replications.

Percent Shoot and fruit infestation

Percent shoot and fruit infestation was calculated by using the following formula:

$$Percent\ Shoot\ Infestation = \{Number\ of\ infested\ shoots\ /total\ number\ of\ shoots\}x100$$

$$Percent\ Fruit\ Infestation = \{Number\ of\ infested\ fruits\ /total\ number\ of\ fruits\}x100$$

Yield (Kg ha^{-1})

The yield of each plot after every picking was recorded separately and was combined to find total yield. The yield was converted into yield kg ha^{-1} by following formula:

$$\text{Yield (kg ha}^{-1}\text{)} = \frac{\text{Yield plot}^{-1}\text{ (kg)}}{\text{Area of plot (m}^2\text{)}} \times 10{,}000\text{m}^2$$

Cost Benefit Ratio

The Cost Benefit Ratio was estimated from the yield of brinjal fruits and the cost of each treatment application, in order to find out the most economical and effective treatments for the management of shoot and fruit borer in brinjals.

$$\text{Cost benefit ratio} = \frac{\text{Value of yield over control}}{\text{Total cost of plant protection}}$$

Statistical Analysis

The data were subjected for statistical analysis by using Statistix 8.1 for ANOVA.

RESULTS

Shoot infestation

Percent brinjal shoot infestation before and after 1st spray is shown in Table 1. Before spray showed no difference between the treatments. After 1 day of spray, data showed the highest infestation in T6 (68.66) while the lowest percent infestation was recorded T3 (49.00) followed by T1 (52.33) which was significantly different from T2 (55.33) while T5 and T6 is significantly similar with each other (57.33 and 57.66).

Similarly, after 3 days of spray, highest infestation was recorded in T6 (67.33) and the lowest infestation was recorded in T2 (43.33) which is significantly similar with T1 (44.33), T4 (44.33) and T3 (46.33) while significantly different from T5 (52.66).

However, after 7 days of spray, highest infestation was recorded in T6 while lowest was recorded in T4 (33.00) followed by T3 (39.33) which was significantly similar with T1 and T2 (40.00) but significantly different from T5 (56.66).

After 10 days of spray, increased in shoot infestation was recorded among all the treatment except T4 and T2. Table showed that highest infestation was recorded in T6 (68.66) while the

lowest percent infestation was recorded in T4 and T2 (18.33) which were significantly similar with each other but different from the rest of treatments T3 (44.0), T1 (44.33), T5 (60.33).

Mean column in Table showed that percent shoot infestation was expressively inferior in all the tested treatments compared with control plot where pest infestation was recorded higher (67.91%). However, after 1st spray, voliam flexi, Chlorpyrifos, cypermethrin, Emamectin benzoate, neem leaf extract (38.38, 39.24, 44.66, 45.24, 56. 67) showed lowest percent of shoot infestation.

Percent brinjal shoot infestation before and after 2nd spray is shown in Table 2. Before spray data showed that T6 (65.66) followed by T5 (55.33) minimum infestation was recorded in T4 (20.33). However, after 1 day of spray highest pest infestation was observed in T6 (65.66) while minimum percent shoot infestation was recorded in T4 (17.33).

After 3 days of spray, T6showed highest pest infestation (60.66) while minimum infestation was recorded in T4 (12.33). Similarly, after 7 days of spray, highest pest infestation was observed in T6 (59.00) while minimum infestation in shoot was recorded in T4 (10.00).

After 10 days of spray, slightly increased was noticed in shoot infestation. Maximum infestation was recorded in T6 (62.6) while minimum infestation was recorded in T4 (6.66) which was significantly similar with T2 (7.66) followed by T3 (33.66) and T1 (40.66) which were statistically significant with eeach other but statistically different from T5 (54.33).

Mean column in Table showed that percent shoot infestation was significantly inferior in all the treatments compared with control plot where infestation was noted higher (61.99%). However, after first spray, all the tested treatments voliam flexi, Chlorpyrifos, cypermethrin, Emamectin benzoate, neem leaf extract (11.58, 12.66, 38.32, 40.41, 51. 08) showed lowest percent of shoot infestation.

Table 1: Percent infestation of brinjal shot borers after 1st spray during 2020

Treatments	Time interval of percent shoot infestation					
	DBS	1DAS	3DAS	7DAS	10DAS	Mean
Emamectin benzoate (T1)	61.66^{bc}	52.33^{c}	44.33^{c}	40.00^{c}	44.33^{c}	45.24^{c}
Chlorpyrifos (T2)	63.00^{bc}	55.33^{bc}	43.33^{c}	40.00^{c}	18.33^{d}	39.24^{d}
Cypermethrin (T3)	58.66^{d}	49.00^{d}	46.33^{c}	39.33^{c}	44.00^{c}	44.66^{c}
Voliam Flexi (T4)	63.66^{b}	57.66^{b}	44.33^{c}	33.00^{d}	18.33^{d}	38.38^{d}
Neem leaf extract (T5)	60.33^{bc}	57.33^{b}	52.66^{b}	56.66^{b}	60.33^{b}	56.67^{b}
Control (T6)	70.33^{a}	68.66^{a}	67.33^{a}	67.00^{a}	68.66^{a}	67.91^{a}
$LSD_{(0.05)}$	n.s	0.54	0.42	0.42	0.63	-

Mean in columns followed by the same letters are non-significant 5 % level of probability
DBS= Day before spray, DAS= Day after spray

Table 2: Percent infestation of brinjal shot borers after 2nd spray during 2020

Treatments	Time interval of percent shoot infestation					
	DBS	1DAS	3DAS	7DAS	10DAS	Mean
Emamectin benzoate (T1)	48.00^{d}	44.66^{d}	39.66^{c}	36.66^{c}	40.66^{c}	40.41^{c}
Chlorpyrifos (T2)	22.00^{bc}	17.66^{bc}	14.00^{c}	11.33^{d}	7.66^{d}	12.66^{c}
Cypermethrin T3)	47.00^{bc}	46.66^{c}	44.33^{c}	30.66^{c}	33.66^{c}	38.32^{c}
Voliam flexi (T4)	20.33^{b}	17.33^{b}	12.33^{c}	10.00^{d}	6.66^{d}	11.58^{d}
Neem leaf extract (T5)	55.33^{cd}	51.33^{b}	48.33^{b}	50.33^{b}	54.33^{b}	51.08^{b}
Control (T6)	68.66^{a}	65.66^{a}	60.66^{a}	59.00^{a}	62.66^{a}	61.99^{a}
$LSD_{(0.05)}$	1.02	0.56	0.47	0.45	0.71	-

Mean in columns followed by the same letters are non-significant 5 % level of probability
DBS= Day before spray, DAS= Day after spray

Fruit infestation

Table 3 revealed the percent fruit infestation after 1st spray. The finding indicated highest percent fruit infestation in T6 (35.66%) while minimum infestation was recorded in T4 (4.10%) followed by T2, T3 and T1 was significantly different to each other (6.00, 9.00 and 10.66) while T5 was least effectiveness showed (15.10%).

After 2nd spray maximum percent infestation in fruit was recorded in T6 (32.00%) while minimum infestation was recorded in T4 (2.00%) followed by T2, T3 and T1 was significantly different to each other (2.98, 4.50 and 5.53) while T5 was least effectiveness showed (10.10%).

Table 3: Percent infestation of fruit borers after 1st and 2nd spray during 2020

Treatment	**Time interval of fruit infestation**	
	1st spray	**2nd spray**
T1Emamectin benzoate	10.66b	5.53b
T2Chlorpyrifos	6.00d	2.98d
T3Cypermethrin	9.00e	4.50c
T4Voliam flexi	4.10c	2.00
T5Neem leaf extract	15.10f	10.10b
T6Control	35.66a	32.00a
LSD (0.05)	0.36	0.46

Mean in columns followed by the same letters are non-significant 5 % level of probability

Cost benefit analysis of different synthetic insecticides against the brinjal fruit and shoot borers

Results revealed that maximum net return was observed in Voliam flexi followed by Chlorpyrifos treated plot followed by Emamectin benzoat than Cypermethrin while minimum return was observed neem leaf extracts. Furthermore, CBR showed that Voliam flexi is more cost-effective (48.13) in reducing the pest. While minimum Cost benefit ratio was recorded (1.21) in control.

Table 4: Cost Benefit Ratio of different treatments used against Brinjal Shoot and fruit borer at Peshawar, during 2020.

Treatment	Yield kg/ha	Marketable output	Cost of control			Return over control (D)	CBR C/D
			Cost of preparation	Cost of application	Total cost		
Emamectinbenzoat	12698	507920	6000	2400	8400	307920	1:36.65
Chlorpyrifos	13230	531200	5700	2400	8100	331200	1:40.88
Cypermethrin	10000	400000	4000	2400	6400	200000	1:31.25
Voliam flexi	14500	652500	7000	2400	9400	452500	1:48.13
Neem leaf extract	7000	280000	4165	2400	6565	80000	1:1.21
Control	5000	200000	_	_	_	_	_

DISCUSSION

Present study was conducted to check the effectiveness of novel insecticides and neem leaf extract against the fruit and shoot borer under field condition. The findings of our investigation showed that voliam flexi was most effective followed by other treatments used. These findings are similar to the findings of Kabir *et al.* (1994) and Rahman *et al.* (2009) where insecticides control the pest well showing lowest shoot oinfestation (7.59%). Jat and Pareek (2001), Singh and Singh (2003) and Duara *et al.* (2003) recorded that cypermethrin was very much effective against BSFB. Jat and Pareek (2001) also reported that nimbicidine (neem origin formulation) was least effective as compare to synthetic insecticides. However, Srinivasan (2008) observed that nimbicidine gave best results in controlling the pest than control.

According to Prakash (1988), the insecticides were very prominent in suppressing the pest population below economic injury level. These findings are in line with research work carried out by Shah *et al.* (2012), who observed that flubendiamide (Belt 48SC) and

wmamectin benzoate (Timer 1.9EC) notable to give high yield and minimize the pest infestation. In the current study, mean infestation recorded after 7 and 14 days of spray was recorded lowest in emamectin benzoate and flubendiamide. However, flubendiamide reduced the pest population for 2 weeks and provided better results. These findings are in line with Ruhul *et al.* (2014), who reported that extracts of neem seed and neem oil were similar with each other. The results revealed that need oil extracts provided better control with percent shoot infestation (13.03) followed by neem seed (15.42) after 7 days of spray.

All the treatments were found profitable in controlling the pest. Voliam flexi was considered best with highest CBR (1: 48.13) followed by chloropyrifos (1: 40.88) while the lowest was recorded in neem leaf (1: 1.21).

CONCLUSION AND RECOMMENDATIONS

- All the treatments were found superior than control in managing the shoot and fruit borers.
- Brinjal shoot and fruit infestation was efficiently controlled by Voliam flexi.
- In term of cost benfit ratio voliam flexi and chlorpyrifos are good replacements of other insecticides against brinjal shoot and fruit borer.
- Based on present studies, it is recommended to voliam flexi and chlorpyrifos against brinjal shoot and fruit borer infestation rather the rest of treatments. However, voliam flexi and chlorpyrifos gives us best cost benefit ratio as compared to other treatments.

REFRENCES

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 eggplant fruit and shoot borer in South Asia. Shanhua, Taiwan:AVRDC—the World Vegetable Center. Technical Bulletin No. 28. AVRDC. 03-548. 56 pp.

Ali, M. I. and M. S. Rahman. 1980. Field evaluation if wilt disease and shoot and fruit borer attack of different cultivators of brinjal. Bangladesh. J. Agric. Sci. 7(2):193-194.

Anwar, S., J.M. Mari, M.A. Khanzada and F. Ullah. 2015. Efficacy of insecticides against infestation of brinjal fruit borer, Leucinodes orbonalis Guenee (Pyrallidae: Lepidoptera) under fieldconditions. Journal of Entomology and Zoology Studies. 3(3): 292-295.

CABI, Centre for Agriculture and Bioscience International 2007. Crop protection compendium. CAB International.

Daunay, M. C. 2008. Eggplant. In: Prohens J. and F. Nuez (Eds.). Vegetables II. Handbook of Plant Breeding II. Springer, New York, NY.FAO. 2003. Eggplant integrated pest management an ecological guide. FAO inter country programmed for integrated pest management in vegetables in South and Southeast Asia. Bangkok, Thailand. pp. 177.

FAO, 2016. FAO STAT Production Data bases. In FAO STAT Production Databases. Feinstein, L. (1952). Insecticides from plants. Insects (The Year Book), United States Depart. Agric. Washington D. C. pp. 222-229.

FAO. 2000. Agricultural production data collection. Feinstein, L. Insecticides from plants. Insects (The Year Book). Agric. Prod. data collect.

Gautam, M., S. Kafle, B. Regmi, G. Thapa, and S. Paudel. 2019. Management of brinjal fruit and shoot borer (*Leucinodes orbonalis Guenee*) in Nepal. Acta ScienWfic Agriculture. 3(9): 188-195.

Haider, I, M. Akhter and A. M. Sabir. 2014. Evaluation of different insecticides against rice leaffolder *Cnaphalocrocis midinalis* (Guenee) under field conditions. Pak. J. Zool. 46: 1458-1461.

Jagginavar, S. B., N.D. Sunithaand A.P. Biradar. 2009. Bio efficacy of flubendiamide 480 SC against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen.Karnataka Journal of Agricultural Sciences. 22(3): 712-713.

Jat, K. L. and B. L. Pareek. 2001. Field evaluation of ecofriendly insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. Indian J. Plant Protec.29 (1-2): 53-56.

Javed, H., S.S. Hussain, K. Javed, T. Mukhtar and N.A. Abbasi. 2017. Comparative infestation of brinjal stem borer (*Euzophera perticella*) on six auberginecultivars and correlation with some morphological characters. Pakistan Journal of Agricultural Sciences. 54(4).

Jayaraj, J. and S. Manisegaran. 2010. Management of fruit and shoot borer in brinjal. The Hindu Sci-Tech. Agri. College and Res. Inst. Madurai

Kabir, K. H., F. M. A. Roul, M. N. Islam and P. K. Malaker. 1994. Efficacy of different insecticides in controlling brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen.University J. Zool., Raj. University. 13(1-8):15.

Kalawate, A. and M. D. Dethe. 2005. Bio efficacy study of biorational insecticide on brinjal. J. Bio. Pest. 5(1): 75-80.

Kassi, A.K., H. Javed and T. Mukhtar. 2019. Screening of different aubergin cultivars against infestation of brinjal fruit and shoot borer (*Leucinodes orbonalis* Guenee). Pak. J. Zool. 51(2): 603-609.

Kumar, P. and S. Johnsen. 2000. Life cycle studies on fruit and shoot borer (Leucinodes orbonalis) and natural enemies of insect -pests of eggplant (*Solanum melongena*). Journal of Applied Biology. 10(2):178-184.

Latif, M., *et al.* 2019."Regulatory efficacy of novel insecticides against major pests of vegetables in Faisalabad, Pakistan. Pakistan Journal of Agricultural Research. 32(1): 41.

Latif, M., M. Abbas, F. Hafeez and D. Hussain. 2019. Regulatory efficacy of novel insecticides against major pests of vegetables in Faisalabad, Pakistan. Pak. J. Agric. Res. 32(1): 41-45.

M. M. Rahman., K. S. Islam, M. Jahan and M. A. Uddin. 2009. Efficacy of some botanicals in controlling brinjal shoot and fruit borer, Leucinodes orbonalis. Progress Agric. 20(1-2): 35 – 42.

Mainali, R.P. 2014. Biology and management of eggplant fruit and shoot borer, *Leucinodes orbonalis Guenee* (Lepidoptera: Pyrallidae). International Journal of Applied Sciences and Biotechnology. 2(1): 18-28.

Mandal, S., N.J. Singh and A. Konar. 2010. Efficacy of synthetic and botanical insecticide against whitefly *(Bemicia tabaci*) and shoot and fruit borer (*Leucinodes orbonalis*) on brinjal (*Solanum melongena* L.) Journal of Crop and Weed. 6(1): 49-51

Matsubara, K., T. Kaneyuki, T. Miyake and M. Mori. 2005. Antiangiogenic activity of nasunin, an antioxidant anthocyanin, in eggplant peels. Journal of Agricultural and Food Chemistry 53: 6272–6275.

Maureal, A.M., L.M. Noriel and N.M. Esguerra. 1982. Life history and behavior of eggplant fruit borer. Annal. Trop. Res. 4(3): 178.

Md, S.I., A.R.C. Md, A.M. Md, F.M. Md, H. Kamrul and U.K. Ahsan. 2019. Management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) using selected bio-rational insecticides. Fundamental and Applied Agriculture. 4(4): 1025-1031.

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

Murugesan, N. and T. Murugesh. 2009. Bio efficacy of some plant products against brinjal fruit borer, (*Leucinodes orbonalis Guenee*) (Lepidoptera: Pyrallidae) Journal of Biopesticides. 2(1): 60-63.

Muthukrishnan, N., M. Visnupriya, W. Babyrani and C. Muthiah. 2013. Persistence toxicity and field evaluation of spinetoram 12SC against shoot and fruit borer, *Leucinodes orbonalis Guenee* in brinjal. Madras Agricultural Journal. 100 (4-6): 605-608.

Prakash, O. 1988. Schedule of insecticidal application against insect pest complex of brinjal with special reference to brinjal shoot and fruit borer, *Leucinodes orbonalis*. Indian J. Entom. 50(1): 16-19.

Rahman, M.M., K.S. Islam, M. Jahan and M.A. Uddin. 2009. Efficacy of some botanicals in controlling brinjal shoot and fruit borer, (*Leucinodes orbonalis* Guenee). Progressive Agriculture. 20(1-2): 35-42.

Shah, K.D., T.M. Bharpoda and R.C. Jhala. 2012. Bio-efficacy of newer molecules of insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae). AGRES. An International e-Journal. 1:186-200.

Sharma, H.C. and R. Ortiz. 2002. Host plant resistance to insects: an eco-friendly approach for pest management and environment conservation. Journal of Environmental Biology. 23(2): 111-135.

Singh, Y.P. and P.P. Singh. 2003. Bio-efficacy of insecticides in combination with carbofuran against brinjal shoot and fruit borer, (*Leucinodes orbonalis* Guen.) at medium high altitude hills of Meghalaya. Indian J. Plant Protec. 31(2):38-41.

Srinivasan, R. 2008. Integrated Pest Management for eggplant fruit and shoot borer (*Leucinodes orbonalis*) in South and South East Asia: Past, Present and Future. J. Biopestic. 1(2): 105-112.

Srinivasan, R. and C.C. Huang. 2009. The effect of simulated borer infested shoot pruning on yield parameters of eggplant. Journal of Asia-Pacific Entomology. 12(1): 41-43.

Thapa, R. B. 2010. Integrated management of brinjal fruit and shoot borer, (*Leucinodes orbonalis Guen*): An overview. J. Inst. Agric. Anim. Sci. 30(32): 1-16.