COMPARISON OF SYNTHETIC INSECTICIDE AND BOTANICAL EXTRACTS AGAINST BRINGAL SHOOT AND FRUIT BORER (LEUCINODES ORBONALIS)

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ABSTRACT

To evaluate the comparative efficacy of synthetic insecticide and botanical extracts against the fruit and shoot borer of brinjal under field condition a study was carried outatAgricultural Research Institute, Tarnab during 2021. Experiment was laid out in Randomized Complete Block Design (RCBD) comprising of six treatments. Treatments includedparthenium leaf extract, neem seed extract, neem oil,tobacco leaf extract and flubendiamide. Results revealed that in shoot infestation, lowest percent shoot infestation after 1st, 2nd and 3rd spray was observed in plots treated with flubendiamide (10.22, 4.33 and 1.22) followed by neem oil (12.22, 7.55 and 5.22), neem seed extract (13.00, 8.88 and 6.66), tobacco leaf extract (13.66, 10.22 and 8.33) and parthenium leaf extract (15.77, 13.88 and 12.22) was recorded least effective against the Brinjal fruit and shoot borer. Similarly in fruit infestation, lowest percent fruit infestation after 1st, 2nd and 3rd spray was observed in plots treated with flubendiamide (6.10, 3.66 and 0.66) followed by neem oil (8.0, 6.44 and 5.33), need seed extract (9.00, 7.99 and 6.44), tobacco leaf extract (10.10, 8.99 and 7.77) and parthenium leaf extract (10.66, 9.66 and 8.66) respectively. Among the entire tested treatments flubendiamide treated plot showed highest marketable yield 11010 kg/ha while the lowest yield was recorded in untreated plot 3717 kg/ha.Flubendiamide showed highest Cost Benefit Ratio (1:40.51) while lowest was recorded by tobacco leaf extract (1:10.33).The results concluded that neem oil and neem seed extract are the best possible alternativeof synthetic pesticides flubendiamide and are recommended to be included in IPM programs against brinjal shoot and fruit borer.

Key Words: Brinjal, Botanical, shoot borer, Parthenium, Tarnab.

INTRODUCTION

Brinjal (*Solanummelongena* L.), the most important and frequently grown vegetable crop associated with family Solanaceae (Kantharajha and Golegaonkar, 2004). The average production of about 50 million tons cultivated with an area of 1.5 million ha. The brinjal holds significant importance in Asia (Thapa, 2010). The In Indo-Pak, the production is around 87000 tons cultivated with an area of 8500 ha (FAO, 2018) and is considered as native land for the crop (Dunlop, 2006).

The brinjal is very much exposed to insect pest and is attacked by them from the time of sowing till harvesting. Among these insect pests, fruit and shoot borer (*Leucinodes orbonalis*), white fly (*Bemisia tabaci*), aphid (*Aphis gossyppi)* and Jassids (*Amrasca bigutulla*) holds much importance (Latif *et al*., 2009). These insect pests cause significant reduction in quality and quantity of yield by attacking different growth stages of crop. Worldwide, the brinjal crop is very much affected by shoot and fruit borer and is considered as major insect pest of the crop (Chakraborty and Sarkar 2011).

In Asia, shoot and fruit borer is one of the major and serious pests of the crop, especially in Sri Lanka, Bangladesh, Nepal, India, Thailand, Pakistan, Cambodia, Vietnam, Laos, Philippines, Sahara and Africa. The shoot and fruit borer greatly disturbed the yield and cause 85-90% yield losses in South Asia (Misra, 2008; Thapa, 2010; Jagginavar *et al.*, 2009). The incidence of the pest is much in an area with humid and hot climatic conditions (Srinivasan, 2009).

The larva of the shoot and fruit borer at vegetative, fruit and flowering stage bore into the tender shoots (CABI, 2007). The flower infestation is not very much common, but after infestation the fruit production become limited or stop (Alam *et al.*, 2006). The borer also infests midrib and leaf and petiole and cause drooping and withering of shoot and young leaves (AVRDC, 1998; Alpureto, 1994). The infestation of borer after the onset of fruit becomes disappear completely or negligible.

After hatching, the larva bore into the fruit and closed its entrance hole by releasing extracts (Alam *et al*., 2006). The larva after feeding on mesocarp of the fruit cause rottening of fruit, making it un-edible for human (Neupane, 2001; Baral*et al.*, 2006). The larva span can infest up to 4 to 7 fruits during its full life, results in decreasing vitamin C contents up to 80% (Jayaraj and Manisegaran, 2010; Sharma, 2002). In Pakistan, shoot

and fruit borer is a major problem for farmers in areas where brinjal is grown. In Sahiwal, for the control of this pest, application of pesticide is very common twice a week.

Excessive use of conventional pesticides may increase the production cost and greatly decreases the efficiency against shoot and fruit borer. Since insecticide have several health hazardous effects, there is a need to use environmentally safe insecticides or less number of sprays and doses of insecticides. The present study was carried out to evaluate the efficacy of different insecticides to find the best practice if insecticides have to be applied for management of the borer.

MATERIALS AND METHODS

To study the comparative efficacy of synthetic insecticide and botanical extracts against the fruit and shoot borer of brinjal under field conditions, the current experiment wascarried outin the AgricultureResearch Institute, Tarnab during 2021.Seedling of Brinjal (Shamli) was purchased from farmer field at ARI-Tarnab Peshawar.The seedling was transplanted to the pre-prepared field in the month of March, 2021.

Experiment was conducted in Randomized Complete Block Design (RCBD) comprises of six treatments with three replications. The field was well prepared before the transplantation of brinjals nursery. The size of each plot was 5m x 4m with four rows. Row-row and plant-pant distance was maintained at 1m and 30 cm respectively. The distance between treatment and replication was one meter (buffer zone). Standard agronomic practices such as irrigation, hoeing and weeding were carried out according the recommended procedures.

Treatments used

Neem seeds, tobacco leaves were obtained from the agricultural fields at ARI Tarnab Peshawar while Neem oil and flubendiamide (synthetic insecticide) was purchased from pesticides local market GurrMandi Peshawar. The following treatments (Table 1) were used in the current study.

	Treatment	**Common Name**	**Scientific name brand name**
T1	Partheniumleaf extract	Parthenium	*Partheniumhysterophonus*
T2	Neem Seed extract	Naeem Seed	*Azadirachtaindica*

T3	Neem oil	Neem oil	-
T4	Tobacco leaf extract	Tobacco	*Nicotianatabacum*
T5	Flubendimide	Flubendimide	Belt 48SC
T6	Control	-	-

Preparation of plant extract

Leaves each of *Azadirachtaindica* (Neem), *Nicotianatobacum* (Tobacco) and *Partheniumhesterophorus* (Parthenium) were collected from the field, dried under shade and then grinded into fine powder with a grinder. To prepare 10 % stock solution of each treatment 100-gram powder was soaked in 1/3 liter of water and left for 24 hours. After this the mixture was filtered through a clean muslin cloth and the clear filtrate was mixed with the remaining 2/3 liter of water. Five percent concentration for field application was prepared from the stock solution. The prepared extracts were sprayed with a knapsack hand sprayer.

Application of insecticide

The synthetic insecticide belt (Flubendiamide) was purchased from local market and applied as per recommended dose.

Percent Shoot and fruit infestation

To record the infested shootsdata, numbers of all the infested and healthy shoots were recorded on six randomly selected plants in two central rows of each plot. Damaged shoots by borers were identified by noticing the wilting in the terminal shoots at vegetative stage of the crop. Data were recorded one day before the spray and then 3, 7, and 14 days after the spray. Shoots infested in all the randomly examined plants were tagged to avoid recounting during the next data.

Percent shoot infestation was calculated by using the following formula:

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

The observations on the damage fruits were recorded on ten randomly tagged plants per plot before insecticide application and at 3, 7 and 14 days after spraying. The fruit damage was assessed based on bore holes found on the fruit. The total number of fruits and infested fruits in ten randomly selected plants per plot were counted and the per cent shoot / fruit damage were calculated by using formula:

Percent Fruit Infestation

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

Yield (Kg ha^{-1})

To record the yield of brinjal,data of every picking was documented. The total yield of plot was combined to find the total yield. Yield was converted into yield kg ha^{-1} by following formula:

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

Cost Benefit Ratio

Estimation of Cost Benefit Ratio from the yield of brinjal fruits and cost for individual treatment application was found, so that we can suggest farmer the most profitable and environmental friendly treatment application.

Statistical Analysis

Analysis of variance was found for the mentioned parameters and means were separated using LSD test at 5% level of significance with help of Statistix 8.1.

RESULTS

Percent Shoot infestation

Table 4.1 shows percent infestation of brinjal shoot and fruit borer.After three days of spray, data showed the highest shoot infestation percentage was noted in control plot (27.00) while lowest percent shoot infestation was recorded in Flubendiamide (13.00) which was significantly different from Neem oil treatment (15.00). Tobacco leaf extract, neem seed extract and parthenium leaf extract (16.00, 16.00 and 16.33) were statistically non-significant with each other respectively.

Maximum shoot infestation was recorded in control plot (25.00) whereasminimum was recorded in Flubendiamide (8.00) after 7 days of spray. Among the botanical treatments, neem oil had shoot infestation of 10.00 which was statistically significant from neem seed extract 11.00. Whereas tobacco leaf extract and parthenium leaf extract was statistically non-significant with 12.00 and 15.00 percent shoot infestation respectively.

Similarly, 14 days after of spray, percent shoot infestation was maximally recorded in control pot (26.00) while minimum infestation was recorded in

Flubendiamide treated plot (9.66). Among botanicals, neem oil and neem seed extract there is insignificance recorded (1166 and 12.00) which was significantly different from Tobacco leaf extract (13.00) followed by parthenium leaf extract (16.00).

Table also showed the mean percent shoot infestation, which was significantly lower in all the tested treatments in comparison with the check where infestation was higher recorded (25.66). However, after first application, all the tested treatments fluebendimide, neem oil, neem seed extract, tobacco leaf extract and parthenium leaf extract showed lowest percent of shoot infestation (10.22, 12.22, 13.00, 13.66, and 15.77) but non-significant with each other.

Table 4.1: Shoot infestation (Percent) after first spray application in brinjal crop in ARI Tarnab Peshawar.

Treatments	Shoot infestation (%)				
	DBS	**3DAS**	**7DAS**	**14 DAS**	**Mean**
Parthenium leaf extract	18.00	16.33b	15.00b	16.00b	15.77b
Need Seed extract	19.00	16.00b	11.00d	12.00d	13.00d
Neem oil	20.00	15.00c	10.00f	11.66d	12.22e
Tobacco leaf extract	18.00	16.00b	12.00b	13.00c	13.66c
Flubendimide	26.00	13.00d	8.00e	9.66e	10.22f
Control	27.00	26.00a	25.00a	26.00a	25.66a
LSD $_{(0.05)}$	Ns	0.42	0.38	0.54	0.26

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

Table 4.2 showed percent shoot infestation after 2nd spray. Day before spray, maximum shoot infestation was recorded in control plot (26.00) while minimum infestation was recorded in Flubendiamide treated plot (9.66). There was non-significant difference found between neem oil and neem seed extract (11.66 and 12.00) which was statistically different tobacco leaf extract (13.00)followed by parthenium leaf extract (16.00).

After 3 days of spray, maximum number of shoot infestation was recorded in control plot (24.66) while minimum infestation was recorded in Flubendiamide treated

plot (5.00). Among botanicals, statistically non-significant difference was found between all the treatments (7.00, 9.00, 11.00 and 14.00).

Similarly, maximum infestation in shoot was recorded in control plot (23.66) while minimum percent infestation was recorded in Flubendiamide treated plot (3.00) after seven days. Statistically data showed that non-significant difference was found between all botanicals (5.00, 6.00, 7.00 and 13.00).

After 14 days maximum shoot infestation was recorded in control plot (24.00) while minimum shoot infestation was recorded in Flubendiamide treated plot (5.00). Among the botanicals neem oil, neem leaf extract, tobacco leaf extract and parthenium leaf extract), statistically different from each other with 10.66, 11.66, 12.66 and 14.66 respectively.

Means column of Table 4.2 showed that percent shoot infestation was significantly lowest in all the tested plots as compared to control plot (24.11%). After second spray, lowest %shoot infestation was recorded in Flubendiamide (4.33) followed by neem oil (7.55), neem seed extract (8.88) and tobacco leaf extract (10.22) while parthenium leaf extract (13.88) was recorded comparatively less effective in brinjal against brinjal shoot borer infestation.

Table 4.2: Shoot infestation (Percent) after second spray application in brinjal crop in ARI Tarnab.

Treatments	**Shoot infestation (%)**				
	DBS	**3DAS**	**7DAS**	**14 DAS**	**Mean**
Parthenium leaf extract	16.00b	14.00b	13.00b	14.66b	13.88b
Need Seed extract	12.00d	9.00d	6.00d	11.66d	8.88d
Neem oil	11.66d	7.00e	5.00e	10.66e	7.55e
Tobacco leaf extract	13.00c	11.00c	7.00c	12.66c	10.22c
Flubendimide	9.66e	5.00f	3.00f	5.00f	4.33f
Control	26.00a	24.66a	23.66a	24.00a	24.11a
LSD $_{(0.05)}$	0.54	0.42	0.42	0.63	0.39

Mean in columns followed by the same letters are non-significant 5 % level of probability. Mean column in Table 4.3 showed that percent shoot infestation was

significantly lowest in all the tested plots as compared to control plot (22.66%). Whereas after third spray, lowest %shoot infestation was recorded in Flubendiamide (1.22) followed by neem oil (5.22) then neem seed extract (6.66) and tobacco leaf extract (8.33) while parthenium leaf extract (12.22) was recorded comparatively less effective in brinjal against brinjal shoot borer infestation.

After three days of spray, maximum shoot infestation was recorded in control plot (23.00) whereas minimum infestation was recorded in Flubendiamide treated plot (1.66). Similarly, statistically significant difference was found among botanicals viz., neem oil, need seed extract, tobacco leaf extract and parthenium (6.00, 8.00, 9.00 and 13.00) respectively.

Seven days after the spray, data showed that highest percent shoot infestation was recorded in control plot (22.00) while 1.34 percent infestation was recorded in Flubendiamide treated plot. Data showed that non-significant difference was found between neem oil and neem seed extract (4.00 and 5.00) followed by tobacco leaf extract (7.00) which was significantly different from parthenium leaf extract (11.33).

After 14 days, maximum shoot infestation was recorded in control plot (23.00) while 0.67 percent shoot infestation was recorded in Flubendiamide treated plot. Among the botanicals (neem oil, neem leaf extract, tobacco leaf extract and parthenium leaf extract), statistically significant different to each other (5.66, 7.00, 9.00 and 12.33) respectively.

Table 4.3: Shoot infestation (Percent) after third spray application in brinjal crop.

Treatments	**Percent shoot infestation**				
	DBS	**3DAS**	**7DAS**	**14 DAS**	**Mean**
Parthenium leaf extract	14.66b	13.00b	11.33b	12.33b	12.22b
Need Seed extract	11.66d	8.00d	5.00d	7.00d	6.66d
Neem oil	10.66e	6.00e	4.00d	5.66e	5.22e
Tobacco leaf extract	12.66c	9.00c	7.00c	9.00c	8.33c
Flubendimide	5.00f	1.66f	1.34e	0.67f	1.22f
Control	24.00a	23.00a	22.00a	23.00a	22.66a
LSD $_{(0.05)}$	0.63	0.79	1.08	1.28	0.95

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

DBS: Days before spray, DAS: Days after spray

PercentFruit infestation

Table 4.4 showed the percent fruit infestation after first spray. The finding showed the maximum percent fruit infestation (11.66) was recorded in control plot while minimum (6.10) infestation was recorded in Flubendiamide. Among botanicals, all the treatments neem oil (8.00), neem leaf extract (9.00) and tobacco leaf extract (10.10) were significantly different to each other while parthenium leaf extract showed least effectiveness resulting 10.66 percent fruit infestation.

Table 4.4: Fruit infestation (Percent) after first spray application in brinjal crop in ARI.

Treatments	**Fruit infestation (%)**
Parthenium leaf extract	10.66b
Neem Seed extract	9.00d
Neem oil	8.00e
Tobacco leaf extract	10.10c
Flubendimide	6.10f
Control	11.66
LSD $_{(0.05)}$	0.36

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

Table 4.5 showed the percent fruit infestation after the second spray. Maximum percent fruit infestationwas recorded in control plot (10.32) while minimum infestation was recorded in Flubendiamide (3.66). Among botanicals, all the treatments *viz.*, neem oil, neem leaf extract, tobacco leaf extract and parthenium leaf extract was significantly different to each other (6.44, 7.99, 8.99 and 9.66%) respectively.

Table 4.5: Fruit infestation (Percent) after second spray application in brinjal crop inARI.

Treatments	**Fruit infestation (%)**
Parthenium leaf extract	9.66b
Neem Seed extract	7.99d

Neem oil	6.44e
Tobacco leaf extract	8.99c
Flubendimide	3.66f
Control	10.32a
LSD $_{(0.05)}$	0.46

Table 4.6 showed the decrease in infestationpercentage in fruit after third application. Highest fruit infestation percentage was recorded in check (9.32) whereas minimum infestation was recorded in Flubendiamide (0.66). Among botanicals, all the treatments neem oil, neem leaf extract, tobacco leaf extract and parthenium leaf extract was significantly different to each other (5.33, 6.44, 7.77 and 8.66%) respectively.

Table 4.6: Fruit infestation (Percent) after third spray application in brinjal crop in ARI.

Treatment	**Fruit infestation (%)**
T1Parthenium leaf extract	8.66b
T2Neem Seed extract	6.44d
T3Neem oil	5.33e
T4Tobacco leaf extract	7.77c
T5Flubendimide	0.66f
T6Control	9.32a
LSD $_{(0.05)}$	0.56

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

Marketable Yield of brinjal (kg ha^{-1})

Yield of brinjal(kg ha^{-1}) is presented in Table 4.7. Data showed highest yield was obtained in Flubendiamide (11010) treated plot followed by neem oil (9082) which was significant with treatment neem seed extract (8072) followed by treatment tobacco leaf extract (7038) and parthenium leaf extract (5040) which have significantly higher yield than control plot (3717).

Table 4.7: Marketable yield of brinjal in kg per/ha

Treatments	**Marketable Yield**
Parthenium leaf extract	5040e
Neem Seed extract	8072c
Neem oil	9082b

Tobacco leaf extract	7038d
Flubendimide	11010a
Control	3717f
LSD $_{(0.05)}$	389.3

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

Table 4.8: CBR of management practicesapplied against Brinjal Shoot and fruit borer at ARI.

Treatments	**Marketable yield (kg /ha) A**	**Gross income B**	**Cost of control C**	**Return over Control D=B-C**	**Net Increased over control E=D-C**	**CBR F=D/C**
T_1	5040	252000	6400	66150	59750	10.33
T_2	8072	403600	8400	217750	209350	25.92
T_3	9082	454100	8100	268250	260150	33.11
T_4	7038	351900	9400	166050	156650	17.66
T_5	11010	550500	9000	364650	355650	40.51
T_6	3717	185850				

Economic analysis of different treatments

Table 4.8 revealed detailed information regarding the cost of control by each management practice used in minimizing the pest population. Table shows that all the management practices used in the study were found effective and has cost benefit ratio greater than the basic unit. Flubendiamide showed highest CBR (1:40.51) followed by neem oil treatment (1:33.11). Neem seed extract was next most profitable treatment (1:25.9) followed by tobacco leaf extract (1:17.66). While minimum profit was showed by treatment parthenium leaf extract with lowest CBR value (1:10.33).

DISCUSSION

Study was conducted to evaluate and compared the effect of synthetic insecticide and botanical extracts against brinjal shoot&fruit Borer.

From our studies it was concluded that the synthetic insecticide applied was the most effective treatment. Rahman *et al.* (2009) and Kabir *et al.* (1994) also tested insecticides and their findings revealed that shoot infestation was minimized by the application of the insecticides.Jat and Pareek (2001) observed that population of brinjal

shoot and fruit borer was lowered by application of insecticide. Moreover, the least effectiveness of neem-based formulation nimbicidine was reported by Jat and Pareek (2001) than synthetic chemical insecticide, which was similar to the result obtained in the present study, but Srinivasan (2008) reported that nimbicidine provided best effectiveness compared control.

Prakash (1988) studied the effect of insecticides on the density of plant borers that caused infestation on crops of value.Our results are also supported by the findings obtained by Shah *et al.* (2012), they used different treatments and found out that emamectin benzoate and flubendiamideshowed farmer friendly results in reducing the population of fruit and shoot borer which in turn helped in obtaining high economical yield. An integrated pest management strategy was designed by Latif *et al.* (2009a) which revealed that use of flubendiamide with clean sanitation and management of pest y means of labor and reduce the population effectively and aid in obtaining a cost-effective yield.

The findings of our experiment are also in agreement with that of Latif et al. (2010), who designed an experiment that was focused on the reducing the larval population by application of flubendiamide. Their findings revealed that the population of the larval period of fruit and shoot borer were effective reduced by flubendiamide. From the experiment in laboratory, it was concluded that flubendiamide reduced fruit infestation by more than 70 percent which was the highest than all other treatments applied in the experiment. Pest belonging to order Lepidoptera had also been affected negatively by the application of Flubendiamide (Haider et al., 2014).

From our study to find an environment friendly way of reducing the population of fruit and shoot borer plant extract neem seed extract and neem oil were used to minimize pest population and increase the yield.Our findings are in agreement with that of Ruhul et al. (2014) who applied neem oil and neem seed extract and the results revealed that shoot infestation was less than 20 percent in plots treated with neem.Similarity in findings was found with that of Sahana and Tayde, (2017)who applied plant extracts and a synthetic insecticide to minimize the population of brinjal shoot and fruit borer. Their findings revealed that insecticide spinosad effectively reduced the population followed by neem oil and pongamia oil.The overall findings of our studies show that population of the shoot and fruit borer were effectively minimized by all the treatments used in the study.Result of our experiment and that of Sahu et al., (2017) are in parallel which revealed that population of borer feeding on shoot and fruit of brinjal was effectively reduced by neem.

Mochiah et al., (2011), also applied various plant extracts to minimize the population of brinjal borer and found that neem oil yielded better results than extract of garlic.

REFERENCES

Alam, S.N., M.I. Hossain, F.M.A. Rouf, R.C. Jhala, M.G. Patel, L.K. Rath, A. Sengupta, K. Baral, A. N. Shylesha, S. Satpathy, T. M. Shivalingaswamy, A. Cork and N. S. Talekar. 2006. Implementation and promotion of an IPM strategy for control of eggplant fruit and shoot borer in South Asia. Tech. Bull. 36. AVRDC publication number 06-672. AVRDC -The World Vegetable Center, Shanhua, Taiwan. pp. 74.

Alpuerto, A.B. 1994. Ecological studies and management of brinjal fruit and shoot borer, LeucinodesorbonalisGuenee. Ind. J. Agric. Sci. 52: 391-395.

AVRDC. 1994. Eggplant entomology. Control of eggplant fruit and shoot borer. Progress Report. Asian Vegetable Research and Development Center, (AVRDC), Shanhua. Taiwan. pp. 88.

Baral, K., B. C. Roy, K. M. B. Rahim, H. Chatterjee, P. Mondal, D. Mondal, D. Ghosh and N. S. Talekar. 2006. Socio-economic parameters of pesticide use and assessment of impact of an IPM strategy for the control of eggplant fruit and shoot borer in West Bengal, India. Tech. Bull. 37: 1-36.

CABI, 2007. Crop protection compendium. CAB International. (Available at: http://www. Cabicompendium.org/cpc).

Chakraborty S and P. Sarkar. 2011. Management of LeucinodesorbonalisGuenee on eggplants during the rainy season in India. J Plant Protec Res 51(4):325–328.

Dunlop, F. 2006. Revolutionary Chinese cookbook. Recipes from Hunan Province. Ebury Press. pp. 202.

FAO. 2018. FAOSTAT. Http://www.fao.org/faostat/en/#data/QC (Retrieved on 03- 04-2020).

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

Kantharajha, A. and P. Golegaonkar. 2004. Somatic embryogenesis in eggplant. Scient. Hort. 99: 107-117.

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

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

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, LeucinodesorbonalisGuen.University J. Zool. Raj. University. 13(1-8): 15.

Latif, M.A., M.M. Rahman, M.Z. Alam and M.M. Hossain. 2009a. Evaluation of Flubenbendiamide as an IPM component for the management of brinjal shoot and fruit borer, LeucinodesorbonalisGuenee. Mun. Ent. Zool. 4: 257-267.

Latif, M.A., M.M. Rahmah, M.R. Islam and M.M. Nuruddin. 2009b. Survey of arthropod biodiversity in the brinjal field. J. Ent. 6: 28-34.

Latif, M.A., M. M. Rahman and M. Z. Alam. 2010. Efficacy of nine insecticides against shoot and fruit borer, LeucinodesorbonalisGuenee (Lepidoptera: Pyralidae) in eggplant. J. Pestic. Sci. 83(3): 391-397.

Misra, H.P. 2008. New promising insecticides for the management of brinjal shoot and fruit borer, LecinodesorbonalisGuenee. Pest Manage. Hort. Ecosystem. 14:140-147.

Neupane F.P. 2001. Crop pest and their management (4th ed.) (Nepali language). SajhaPrakashan, Pulchwok. Lalitpur, Nepal. pp. 582.

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

Rahman, M.M., M.M. Rahman and M. R. Ali. 2009. Evaluation of Some Selected Options for Managing Brinjal Shoot and Fruit Borer in Two Intensive Brinjal Growing Areas. World J. Zool. 4(3): 169-175.

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

Sharma, D.R. 2002. Bio-efficacy of certain insecticide and biopesticides against major pest of brinjal under field condition. M.Sc. Thesis. Indian Agric. Res. Inst. New Delhi, India, pp. 160.

Srinivasan, R. 2009. Insect and mite pests on eggplant: a field guide for identification and management. AVRDC Publication No. 09-729. AVRDC – The World Vegetable Center, Shanhua, Taiwan. pp. 64.

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

Thapa, R.B. 2010. Integrated management of brinjal fruit and shoot borer, LeucinodesorbonalisGuen: Axiaoman L, Aocheng C, Dongdong Y, Canbin O, Qiuxia W, Yuan L. (2019) Overview of mechanisms and uses of biopesticides. Int. J. Pest manage. 1–8.