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Comparative Efficacy of Pyrethroid and Neonicotinoid Insecticides to Manage Litchi Fruit Borer

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Abstract: Lychee is damaged by the litchi fruit borer (LFB), *Conopomorpha sinensis* severely reduces the yield and marketable quality of the fruits, and farmers face a substantial financial loss. An experiment was conducted for two consecutive years in the commercial litchi orchard. The study evaluated the efficacy of some insecticides under the group of pyrethroids, such as cypermethrin (Ripcord 10 EC), deltamethrin (Decis 2.5 EC), and fenvalerate (Fenfen 20 EC), neonicotinoids as imidacloprid (Imitaf 20 SL), thiamethoxam (Actara 25 WG), and pre-formulation of chlorantraniliprole+thiamethoxam (Voliam flexi 300 SC) and organophosphate (Hilthion 57 EC). All insecticides are used with recommended doses against *C. sinensis* to develop an appropriate management strategy. Among the treatments, spraying of voliam flexi 300 SC observed the maximum reduction of infestations over the control trees (99.47%), followed by imitaf, actara, decis, ripcord, fenfen, and hilthion. The highest benefit-cost ratio was obtained from the treated fruit trees with voliam flexi (12.11:1) and near about in fenfen and decis. Considering the effectiveness, spraying of voliam flexi at the rate of 0.5 ml per litre of water, followed by two sprays, first at ten days after the fruit set and then 20 days after the first spray. It is the most promising insecticidal approach for managing C. *sinensis* and may reduce the health risk to humans and save desirable components of the environment.

Keywords: Lychee; Fruit borer; Pyrethroid; Neonicotinoid insecticides.

INTRODUCTION

Lychee (*Litchi chinensis* Sonn.) is the most popular fruit in Bangladesh and belongs to the Sapindaceae family. It is known for its delicious flavored juicy aril with high nutritional value and refreshing taste. It has 7 to 21% sugar, 0.7 percent protein, 0.3 percent fat, 0.7 percent minerals (mostly calcium and phosphorus), and is a good source of vitamins C (64mg/100 g pulp), A, B1, and B2 (Singh, 2002). Bangladesh's agro-climatic conditions are conducive to the successful production of lychee. It grows almost all over the country but commercially in the region as Rajshahi, Pabna, Rangpur, Dinajpur, Jessore, Mymensingh, Tangail, and Dhaka districts (FAO, 2001). In 2018, the total area under litchi cultivation was 40889 acres of land, and annual production was 94160 MT in Bangladesh (BBS). Recently, lychee cultivation has been increasing in different regions of the country. It may be due to its high demand with the economic return. The litchi growers are suffering huge losses every year with the damage caused by several insect pests. Among the several insect pests, the litchi fruit borer, *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae), is considered destructive to the lychee in the Indian sub-continent (FAO, 2001; Sharma, 1985). Nowadays, it is regarded as a severe damaging pest of lychee in Bangladesh (Alam *et al.*, 2004). It causes considerable yield losses and economic injury by the larvae penetrating the fruits if not managed. So, properly maintaining LFB is essential to farmers for the profitable cultivation of litchi fruits. LFB is the most critical factor in causing severe damage to immature and ripened litchi fruits, resulting in lower yields (Alam, 2011; Alam *et al.*, 2019; Bhatia *et al.*, 2000; Hossain, 2011). In Bangladesh, India, China, Thailand, and Taiwan, according to the report of Hossain (2011), Bhatia *et al.* (2000), Tsang *et al.* (2011), Jumroenma *et al.* (2000), and Hung *et al.* (2008) that litchi fruit borer attack varied from 30-52%, 13.6 to 64.9%, 60 to 80%, 57.39%, and 96.1 to 100%, respectively. As LFB is an internal feeder insect of fruit, after infestation, it is difficult to control to spray with traditional pyrethroid insecticides such as ripcord, decis, fenfen, and organophosphate insecticides like hilthion. The litchi growers of Bangladesh frequently use these types of insecticides to manage LFB in lychee, which they fail to protect as preventive or kill the pest as curative measures. So, they do not have the proper remedy for spraying such insecticides.

Moreover, the farmers' indiscriminate use of pesticides (pyrethroids) to control fruit borers seems highly exposed to *C. sinensis* (Kumar *et al*., 2011) and has posed several adverse effects, such as exposing farmers and consumers to toxic residues, polluting the environment, and leading to insecticide resistance to insects. Many scientists reported that such spraying tendencies increase the frequency of insecticides applied per unit area. It has been reported that spraying frequency reached 20 times to control litchi fruit borer in some litchi growing areas of Bangladesh in a season (Taher, 2020). Bangladesh Agricultural Research Institute (BARI) discovered a high level of pesticide residue, such as organophosphorus (malathion), in 14 percent of Dinajpur litchis and reported that chemical residue remained in fruits for 10 to 12 days after application (Roy and Karmakar, 2015). Farmers' first choice for controlling LFB is still spraying insecticides. So, it is highly needed to explore insecticide with the acute penetrating capability to host for an alternative use when it comes to insect contact quickly due to killing. Hence, appropriate use of insecticides and the use of insecticides having a selective mode of action are recommended for insect pest management. Considering insecticide ingredients, systemic mode of action under the neonicotinoid, namely imitaf, actara, and voliam flexi may be effective for managing LFB. This group is recommended by IRAC (Insecticide Resistance Action Committee) for controlling lepidopteran insect pests, which have excellent safety selectivity to mammals and beneficial insects. Despite its importance, no attempts have been made to manage this severe pest using neonicotinoid insecticides, especially in Bangladesh. Therefore, keeping all these crucial perspectives, an effort was made to evaluate the efficacy of conventional pyrethroid and newer systemic insecticides against litchi fruit borer to develop a suitable management strategy.

MATERIALS AND METHODS

Study Location

A field study was carried out in an orchard at the village of Vutia in the Dhopakandi Union of Gopalpur Upzilla under the Tangail district of Bangladesh (Figure 1) from 2015 to 2016 March to June. It is situated in the Old Brahmaputra Floodplain Agroecological Zone. The soil of this area is loamy in texture, plane, average soil fertility low to medium, the reaction of soil in neutral to moderately acidic and land type medium-high. The weather is subtropical as 19-34^{0}C, 67-80 % R.H. and 19-311 mm precipitations.

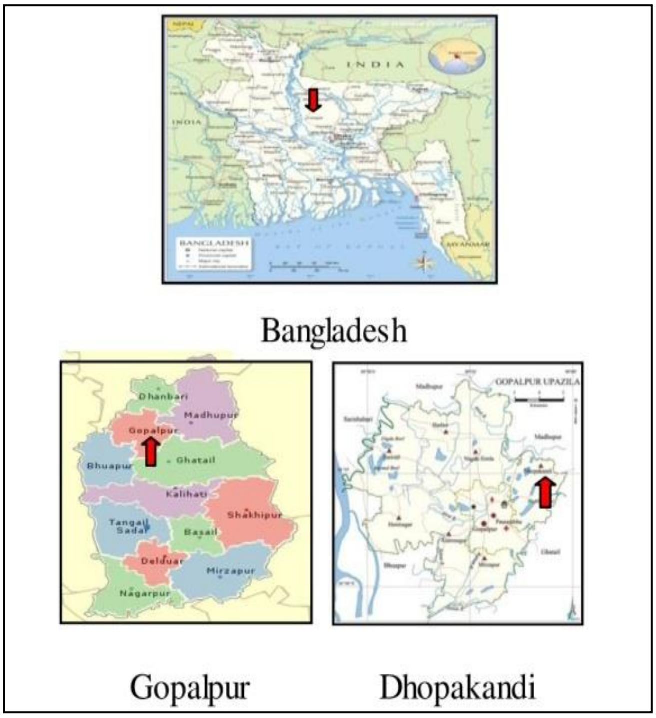

Figure 1. Showing Tangail, Gopalpur, and Dhopakandi (Marked as the red arrow).

Experimental Design and Application of Treatment

The experiment was laid out in a randomized complete block design with eight treatments. The efficacies of treatments such as Ripcord 10 EC (Cypermethrin), Decis 2.5 EC (Deltamethrin), Fenfen 20 EC (Fenvalerate) as Pyrethroid; Imitaf 20 SL (Imidacloprid), Actara 25 WG (Thiamethoxam), Voliam flexi 300 SC (Chlorantraniliprole +Thiamethoxam) as Neonicotinoid and Hilthion 57 EC as Organophosphate, including untreated control were evaluated. Each treatment was replicated three times. The insecticide with recommended doses for each treatment was diluted with water and sprayed separately with the help of a foot pump sprayer. Spraying was done by the insecticide outer and inner canopy in all directions of trees. Two sprays for neonicotinoid, four pyrethroid, and organophosphate insecticides were done in a season. Each season, the first spray was given ten days after the fruit set and the second spray 20 days after the first spray by the neonicotinoid insecticides. In the case of pyrethroid and organophosphate insecticides, the first spray was done at the inflorescence stage before flowering to protect egg-laying and hatching of insect pests, then repeated three times at 15 days interval starting10 days after fruit set.

Data Collection and Analysis

Each replicate randomly took the hundred ripened fruits, and the number of healthy and infested fruits was recorded. Collected samples were opened, and observed damage by the *C. sinensis* (Figure 2) if a larva of *C. sinensis* was present inside the fruit or if the evidence of entrance holes or insect excreta. The collected data were transformed to necessary wherever needed. The benefit-cost

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ratios (BCR) were calculated for an acre of land from the treatment expenditure and the total return from the marketable fruits to determine a cost-effective one. The data of different parameters and years were analyzed by MSTAT-C computer software. The significance of the treatments was determined by developing an analysis of variance (ANOVA), and the means were compared by DMRT (Duncan's Multiple Range Test) at p<0.05.

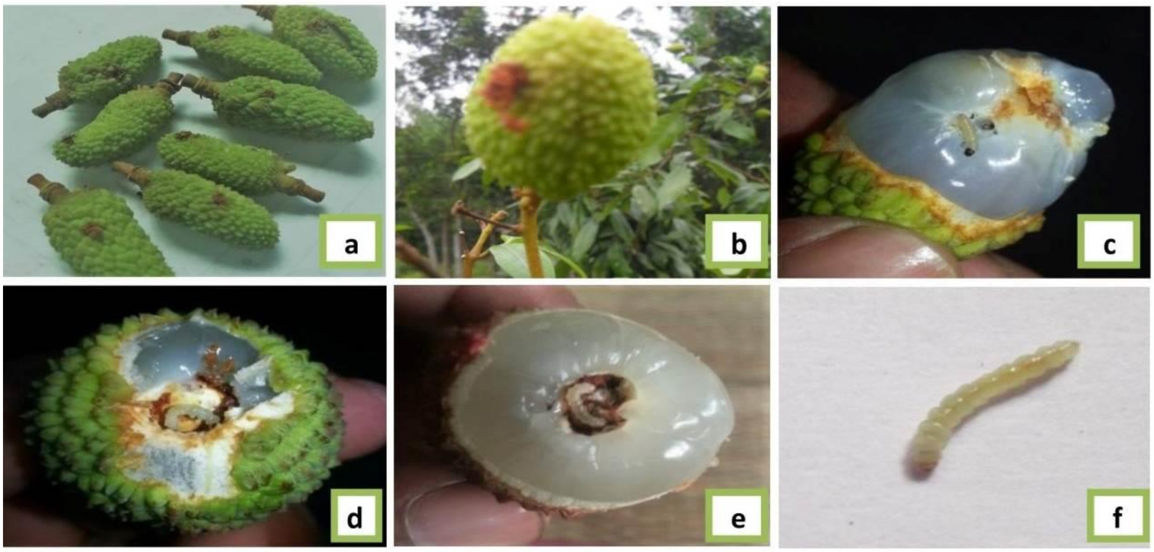

Figure 2. Showing (a) infested young dropping fruits (b) infested fruit with excreta at color-changing stage (c) pulp attacked fruit by larvae (d) peduncle infested maturing fruit (e) seed tip infested fruit with larva (f) a larva of *C. sinensis.*

RESULTS

The study results are described in the following heads that performed better compared to untreated control (Table 1).

Percent of Fruit Infestation

All the insecticides significantly (P ≤0.05) reduced the fruit infestation caused by *C. sinensis.* Among the treatments found a highly decreased percentage of fruit infestation in voliam flexi (0.33%), which was statistically similar to the imitaf (3.09%), followed by actara (4.17%), decis (6.90%), ripcord (8.80%), fenfen (9.82%) and hilthion (10.34%) in comparison to their untreated control value (57.22%).

Percent of Reduction fruit infestation

Spraying insecticides was significantly effective in diminishing the fruit infestation compared to control. The infestation reduction over control was the highest (99.42%) in voliam flexi, followed by imitaf (94.60%), actara (92.71%), decis (87.94%), ripcord (84.62%), fenfen (82.84%) and hilthion (81.93%) (Figure 3).

Percent of Fresh fruit increase

The most efficient treatment against *C. sinensis* was increasing fresh fruit among insecticides. The highest percentages of fresh fruit increased over control in voliam flexi (57.08%), followed by imitaf (55.86%), actara (55.36%), decis (54.05%), ripcord (53.09%), fenfen (52.56%) and hilthion (52.29%).

Table 1. Effect of different insecticides on percentage fruit infestation of two seasons (mean).

Treatments	% fruit infestation	% fresh fruit increase	BCR
Ripcord 10 EC	8.80 b	53.09	11.95:1
Decis 2.5 EC	6.90 bc	54.05	11.97:1
Fenfen 20 EC	9.82 b	52.56	11.98:1
Hilthion 57 EC	10.34 b	52.29	10.90:1
Imitaf 20 SL	3.09 de	55.86	11.78:1
Actara 25 WG	4.17 cd	55.36	9.40:1
Voliam flexi 300 SC	0.33 e	57.08	12.11:1
Control	57.22 a	-	-
SEm(±)	0.37		
LSD	1.13		
Level of significance	0.01		
CV (%)	15.43		

The values having a different letter(s) in a column are significantly different at the 5% level.

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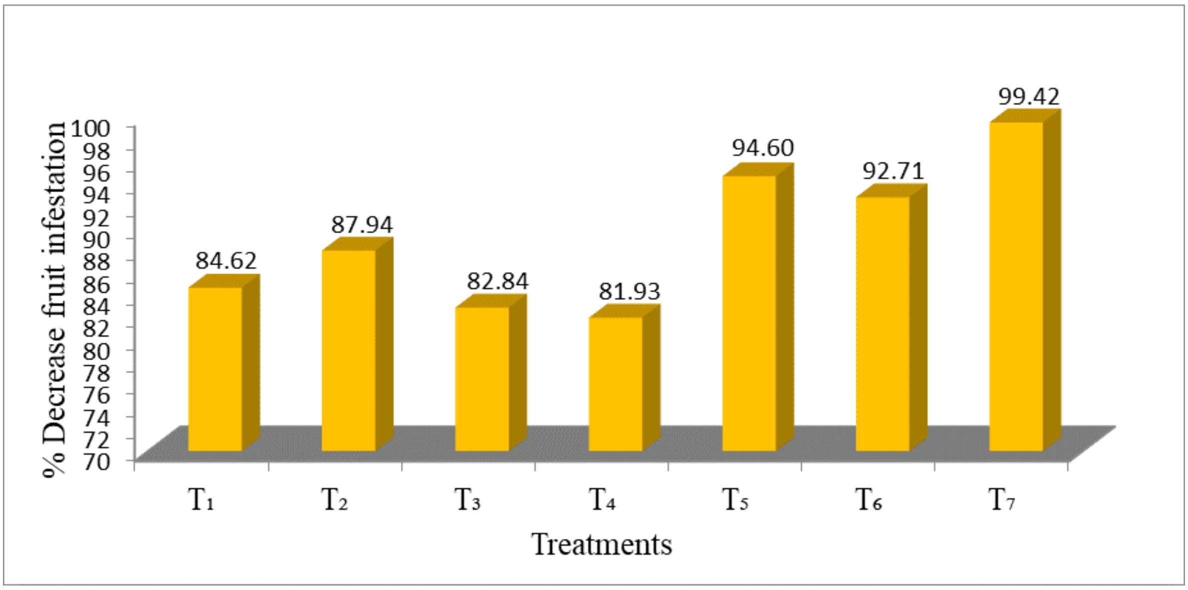
Benefit-cost ratios (BCR)

The benefit-cost ratio varied depending on the cost of treatments and the number of fresh fruits obtained. The maximum benefit-cost ratio was 12.11:1 in voliam flexi and the second highest was more than 11.00:1 in fenfen, decis, ripcord, and imitaf, followed by hilthion (10.90:1), and the lowest (9.40:1) in actara (Table 1).



Legend: T_1= Ripcord 10 EC, T_2= Decis 2.5 EC, T_3= Fenfen 20 EC, T_4= Hilthion 57 EC, T_5= Imitaf 20 SL, T_6= Actara 25 WG and T_7= Voliam flexi 300 SC.

Figure 3. Efficacy of different insecticides in the reduction percent of fruit infestation over control

DISCUSSION

The data obtained from the study showed that all chemical insecticides significantly reduced fruit infestation to lychee compared to untreated control. All investigated results were higher in neonicotinoid insecticides than pyrethroid and organophosphate. It may be a systemic mode of action of the neonicotinoids, which was more effective than the contact mode of action of pyrethroids and organophosphates. Many researchers mentioned systemic insecticides as the most efficient for controlling internal feeders like litchi fruit borer (Purbey, 2016; Rahman *et al.*, 20216; Majlish *et al.*, 2015; Rahman *et al.*, 2013). Among insecticidal control techniques, voliam flexi was the best over the treatments in the present study's measured attributes. Because voliam flexi 300 SC is prepared by pre-formulating two systemic insecticides (thiamethoxam+ chlorantraniliprole), it was most efficient against C. sinensis and provided the best results. Besides, voliam flexi showed a specific impact on C. sinensis, a minimal amount with low-frequency spraying; it quickly produced necessary actions, resulting in the most potent knockdown to the larvae.

Moreover, the efficacy of voliam flexi was better than applying single insecticides. These results were supported by Alam *et al*. (2019), who reported that the treatment (chloran traniliprole10% + thiamethoxam 20%) 300 SC provided a better result both in terms of mean fruit infestation (13.10 %) and yield per plant in the number basis. The chlorantraniliprole (18.5% SC) was found to be most efficient against *C. sinensis*, as Upadhyay *et al.* (2020) reported.

Imitaf 20 SL (imidacloprid) was moderately effective in reducing the percentage of fruit infestation and increased yield among systemic insecticides. However, its higher application costs reduced the profit margin and showed a lower benefit-cost ratio. Purbey (2016) reported that spraying systemic insecticides like thiacloprid and imidacloprid is the most effective against LFB. Similarly, Jumroenma *et al.* (2000) reported that imidacloprid's efficacy was high for controlling LFB.

Actara 25 WG (thiamethoxam) was third in effectiveness in controlling LFB, but higher application cost goes down the benefit margin, and found benefit-cost ratio lowest among the treatments. A less effective insecticide was thiamethoxam than other treatments against litchi fruit borer, as written by Alam *et al.* (2019). On the contrary, Sahoo *et al*. (2010) reported thiamethoxam found moderate efficacy against litchi fruit borer.

In the present study, pyrethroid insecticides showed higher BCR than imitaf and actara, but other parameters were lower than neonicotinoid insecticides. Decis 2.5 EC (deltamethrin) performed better in all measured criteria than other pyrethroid and organophosphate insecticides. According to Hung *et al.* (2008), deltamethrin was more resistant to fruit borer. Manueke *et al.* (2020) also reported that deltamethrin is more effective in controlling litchi fruit borer.

Fenfen 20 EC (fenvalerate) was moderately effective against LFB. This finding disagreed with the work of Singh *et al.* (2003), who observed that fenvalerate was most

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effective in controlling the fruit borer of lychee. Ripcord 10 EC and hilthion 57 EC were similarly as effective as fenfen (P ≤0.05). Cypermethrin was more effective against *C. sinensis,* as Hwang and Hung (1993) reported. There have been contradictory reports on the effects of insecticides on fruit infestation, its dose, frequency, and selection of insecticides to specific pests. Mode of action, the stage of fruit development when sprayed, persistency, different agro-climatic situations where experiments were conducted, and variety, all of which may be attributed to these promising results of other insecticides in their investigation. The finding of this study suggested that insecticide application must be carried out on target. It does not cause disturbance to the environment, especially non-target insects but can efficiently kill target insects. The evidence is especially voliam flexi 300 SC was relatively safe because of its limited dose and frequency compared to the overuse of conventional pyrethroid and organophosphate insecticides. Its application within 10 DAFS to the litchi fruit borer was more efficient in lychee. So, voliam flexi 300 SC may use to manage the litchi fruit borer. Nevertheless, its impact on natural enemies and the health risk of residue needs to be considered.

CONCLUSION

Litchi fruit borer larva is an internal feeder of fruit. They can escape contact with insecticides when they remain inside the fruit but will be affected by systemic insecticides. But litchi fruit borer moth can be exposed to contact insecticides and affected. The data revealed that the neonicotinoid insecticide of Voliam flexi 300 SC (Chlorantraniliprole 20% +Thiamethoxam 20%) @ 0.5ml per liter of water was the most effective in controlling litchi fruit borer. It was more effective against LFB even on long rainy days after application than other insecticides and economically beneficial proved in the present study. So, it may be investigated on a large scale in litchi orchards of farmers, and insecticide residue effect analysis is needed.

REFERENCES

Alam, S.K.F. Patra, B. and Samanta, A. 2019. Evaluation of Some New Insecticide Mixtures for Management of Litchi Fruit Borer. Journal of Entomology and Zoology Studies, 7(1):1541-1546.

Alam, S.N. 2011. Insect Pest Management for Quality Horticultural Crop Production in Bangladesh. Entomology Division, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. Hortex Newsletter, 11(2) pp. 7.

Alam, S.N. Rahman, A.M.Z. Mia, R.U. and Sarkar, M.A. 2004. Studies on the Fruit Borer Control in Litchi. Bangladesh Agricultural Research Institute, Annual Report 2003-2004.

BBS, 2018. Statistical Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics (BBS), Statistics and Information Division, Ministry of Planning, Government of the People's Republic of Bangladesh. pp. 210.

Bhatia, R. Sharma, R. and Agnihotri, R. P. 2000. Field Evaluation of Insecticides for the Control of Litchi Fruit Borer *Conopomorpha cramerella* (Lepidoptera: Gracillariidae) on Litchi (*Litchi chinensis*) in Himachal Pradesh. Indian Journal of Agriculture, 70(5):301-304.

FAO, 2001. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific. Bangkok, Thailand. Papers of Expert Consultation on "Lychee Production in the Asia-Pacific Region. Manuscripts on "Lychee Production in Bangladesh." FAO/RAP Publication: 2001/09.

Hossain, S.M.M. 2011. A Quarterly Publication of the Horticulture Export Development Foundation (Hortex Foundation) Dhaka, 11(2) pp. 1.

Hung, S.C. Ho, K.Y. and Chen, C.C. 2008. Investigation of Fruit Damages of Litchi Caused by *Conopomorpha sinensis* Bradley and *Bactrocera dorsalis* (Hendel) in Chiayi. Journal of Taiwan Agricultural Research, 57**:**143-152.

Hwang, J.S. and Hung, C.C. 1993. Control of the litchi fruit borer, *Conopomorpha sinensis* Bradley, with bagging method and insecticides**.** Plant Protection Bulletin 35(3):225-238.

Jumroenma, K. Aromna, S.S. Undhawutti, C. and Namruangsri, W. 2000. Litchi Fruit Borer and Appropriate Control. Entomology and Zoology Gazette. Thai Agricultural Research Journal, 22(1): 2-16.

Kumar, V. Kumar, A. and Nath, V. 2011. Emerging Pests and Diseases of Litchi (*Litchi chinensis* Sonn.). Pest Management in Horticulture Ecosystem, 17(1): 11–13.

Manueke, J. Assa, B.H. Mamahit, J.M.E. Tarore, D. and Tallei, T.E. 2020. Direct Application of Synthetic Pyrethroid Insecticides on Clove Stem Borer (*Hexamitodera semivelutina* Hell.). Journal of Entomology, 17 (1): 1-5.

Majlish, A.K. Uddin, M.M. Jahan, M. and Rahman, M.M. 2015. Comparative efficacy of different botanicals and chemical insecticides for controlling rice stem borer. Journal of Bangladesh Agricultural University, 13: 183-189.

Roy, P. and Karmakar, K. 2015. Pesticide in Litchi Kills Kids, Again. Available at: https://www.thedailystar.net/frontpage/pesticide-litchi-kills-kids-again-103651 (accessed on June 23, 2022)

Rahman, M.A. Uddin, M.M. Haque, M.A. and Rahman, M.M. 2016. Comparative efficacy of different tactics for the management of okra shoot and fruit borer, *Earias vittella* (fab.) Under field conditions. International Journal of Applied Sciences and Biotechnology, 4: 74-78. doi:10.3126/ijasbt.v4i1.14465.

Rahman, M.M. Uddin, M.M and Shahjahan, M. 2013. Management of okra shoot and fruit borer, *Earias Vittella* (Fab.) using chemical and botanical insecticides for different okra varieties. International Research Journal of Applied Life Sciences, 2: 1-9.

Purbey, S.K. 2016. Round Table Conference on Litchi Borers' Jointly Organized by the ICAR-National

DOI: https://doi.org/10.55706/jae1505

Research Centre for Litchi (NRCL). Meeting Report, Current Science, 110(5): 758-759.
Sahoo, A. K. Anusmriti, R. and Ray, S.K. 2010. Comparative Efficacy of Insecticides and Neem Formulations Against Litchi Fruit Borer, *Conopomorpha cramerella* Snellen (Gracillariidae: Lepidoptera). Journal of Plant Protection Sciences, 2(2): 92-94.
Singh, H. Dhillon, B.S. and Mahajan, B.V.C. 2003. Studies on the Biological Parameters and Effective Control of Nut Borer (*Blastobasis sp*) in Litchi (*Litchi chinensis*). Indian Journal of Agricultural Research, 37(4): 279-282.
Singh, R.B. 2002. Edited Manuscripts of Papers Presented at the Expert Consultation on "Lychee Production in the Asia-Pacific Region," held in Bangkok, Thailand, 15-17 May 2001, RAP publication 2002/04. pp. 2-3.
Sharma, D.D. 1985. Major Pests of Litchi in Bihar. Indian Farming, 32(2): 25-26.
Taher, M.A. 2020. Development of an Appropriate Management Strategy for Litchi Fruit Borer, *Conopomorpha sinensis* Bradley using Non-Chemical and Chemical Approaches. Ph.D. Dissertation, Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
Tsang, W. Yo, L.S. Achterberg, C.V. and Liang, G.W. 2011. A new Species of *Phanerotoma wesmael* (Hymenoptera: Braconidae: Cheloninae), a Parasitoid of *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae) from South China. Journal Jennings: Zootaxa, 28:53–58.
Upadhyay, S.K. Aryal, S. Bhusal, B. and Chaudhary, B. 2020. Evaluation of Insecticides for the Management of Litchi Fruit and Shoot Borer. Journal of Nepal Agricultural Research Council, 6:85-91.

DOI: https://doi.org/10.55706/jae1505