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EFFICACY OF DIFFERENT APPROACHES TO CONTROL LITCHI FRUIT BORER

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Abstract

Litchi is affected by number of pests, among them litchi fruit borer (LFB)**,** *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae) is serious one which causes considerable yield loss. This study aimed to evaluate the efficacy of different options for the management of LFB. The research work was conducted in an orchard at Gopalpur under Tangail district of Bangladesh consecutively for two seasons to manage LFB using mosquito net, two types of bags, three botanicals and five synthetic insecticides as spray material to find out the most efficient one based on the highest reduction of fruit infestation (RFI) over control along with benefit cost ratio (BCR). White butter paper bagging showed highest RFI (100%) with 51.66% increase of fresh fruit (FF) over control and BCR 7.47:1. Neem oil was significantly effective in RFI over control (78.73%) with BCR 8.67:1. Novastar 56 EC (Bifenthrin+ Abamectin) was the most effective among the chemical treatments recording 98.08 % RFI with increase of 51.18 % FF over control and BCR 6.06:1. Based on BCR, performance of different treatments could be ranked as Neem oil > Paper bagging > Novastar. So, Paper bagging as safe technique, Neem oil at the rate of 6 ml/L of water as an eco-friendly tactic and Novastar 56 EC @ 1 ml/L of water as least harmful approach could be recommended to protect litchi from the attack of LFB and ensure higher number of fresh fruits.

Keywords: Litchi, *Conopomorpha sinensis*, mechanical, botanical, insecticide.

Introduction

Litchi (*Litchi chinensis* Sonn.) is one of the most popular fruits of Bangladesh. It is an important sub-tropical evergreen fruit crop having juicy white aril with high nutritive value, attractive colour and refreshing taste known as the queen of the fruits (Purbey and Kumar; Srivastava *et al.*, 2015). Agro-climatic condition of Bangladesh is conducive to the successful production of litchi and this popular fruit grows almost all over the country. During the recent years due to its ever increasing demand both in domestic and international market, it has risen to the status of a very important commercial fruit in Bangladesh providing livelihood opportunities to the people (Alam, 2011). But very unfortunately, the Litchi farmers are facing some problems during cultivation mainly insect pests, of which litchi fruit borer is the most common and serious pest in Bangladesh (Alam, 2004; Alam, 2011). Even in the previous century litchi fruit borer was

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considered to be a minor pest. But now a-days, it is regarded as a major pest of litchi, especially in Indian sub-continent (Sharma, 1985), a region of ever-changing climate scenario (Srivastava and Nath, 2015). If proper steps are not taken against this pest in time, it causes mass infestation to the fruit and farmers suffer from a huge financial loss (Alam *et al*., 2004). Annual yield loss in fruit ranges from 30%-52% due to insect pest infestation and that is one of the major causes for low production of litchi in Bangladesh (Alam, 2011). To overcome this loss, different types of insecticides are used frequently by the farmers of Bangladesh. It was evident that about hundred percent farmers in Bangladesh depends on the use of toxic insecticides in controlling fruit borer and spraying frequency of the farmers reached 20 times more during fruiting season covering the duration of 50-70 days to protect the fruits from the pest attack (Taher, 2020). Due to the absence of effective and economic control measures, the litchi growers are spraying different insecticides to control the pest without any potential benefits. The use of such type of insecticide increases the cost of production, exposes farmers and consumers to toxic residues, pollutes the environment and leads to insecticide resistance in insects. In June 2012, 14 children aged from 2 to 10, got affected with insecticides and died by consuming toxic Litchis living near the litchi orchard in Dinajpur and Thakurgaon Districts of Bangladesh (IEDCR, 2012). For avoiding these facts, management of litchi fruit borer requires strategies which should be more effective, safer and cheaper. Despite this situation, a few attempts have been made earlier to manage this serious pest by adopting different tactics. Considering all the views mentioned above, the present study was undertaken to find out the suitable management techniques for the management of LFB.

Materials and Methods

The experiment was carried out during 2014 and 2015, March to June at Gopalpur, Tangail following 11 treatments to find out the effectiveness of different management tactics (mechanical, botanical and insecticides) on litchi fruit borer, in an orchard of approximately one acre in size. Over this period of time, fruit infestations by *C. sinensis* were evaluated in this orchard (Variety: Madrazi and Bombai). The experiment was designed in Randomized Complete Block Design with 3 replications. The treatments *viz.* covering of fruit by mosquito net, bagging of fruit with mosquito net bag and white butter paper bag, Bishkatali leaf extract at the rate of 20 ml/L of water, Neem oil and Karanja oil @ 6 ml/L of water, Cypermethrin (Ripcord 10 EC) 1ml/L of water, Thiamethoxam (Actara 25 WG) 0.5g/L of water, Bifenthrin+Abamectin (Novastar 56 EC)1ml/L of water, Deltamethrin (Decis 2.5 EC) 1ml/L of water, Carbaryl (Sevin 85 SP) 2g/L of water and untreated control were evaluated. In each treatment, three trees were assigned and comprising each tree for one replication. One tree in all replication was assigned as control. All the spray

materials were applied 3 rounds; first spray was done 10 days after fruit formation and it was repeated two times at 15 days interval. The mechanical tactic was started within 10 days after fruit set. The nylon mosquito net was cut into pieces of different sizes and was used to cover litchi fruit a part of the tree (Fig. 1.a). The mosquito net was used after preparing a bag of the size of 18 inch x 14 inch. The paper bag was purchased from Dhaka, size of 12 inch x 8 inch. A few fruit bunches were tied together and then covered with Net bag and Paper bag (Fig.1. b & c). One kg of fresh Bishkatali leaves was mixed with required amount of water then boiled for 25-30 minutes, after cooling and filtration, making a volume up to 5 litres. Neem oil and Karanja oil were separately diluted into water with dish washing liquid (Trix mint) @ 0.5 ml/L of water, mixture was shaken two minutes to prepare a uniform solution and then used as botanical insecticides. The spraying was done on outer and inner canopy of the tree in all the directions with the help of foot pump sprayer. The observations of fruit infestation by *Conopomorpha sinensis* were recorded from harvested fruits. The peduncle of harvested fruit was opened and presence of larva or their excreta or entrance holes was considered as infested fruits (Fig.1. d & e). Number of fresh and infested fruits were counted and recorded from randomly selected 50 fruits per treatment and percentage of fruit infestation, reduction of infestation, percent increase of fresh fruits and benefit cost ratio (BCR) were calculated. The data of two years were used to calculate the mean and finally these were analyzed using MSTAT-C software and the means were separated by DMRT (Duncan's Multiple Range Test). Percent fresh fruit increase over control and benefit cost ratio were calculated per acre by the following formulae:

$$\% \text{ FF increase over control} = \frac{\text{No. of fresh fruit in treated tree} - \text{No.of fresh fruit in control tree}}{\text{Number of fresh fruit in treated tree}} \text{x}100$$

$$\text{Benefit-cost ratio} = \frac{\text{Value of treated fruit} - \text{Value of untreated fruit}}{\text{Cost of treatment application for each tactic}}$$

Fig.1 (a) Netting (b) Net bagging (c) Paper bagging (d) Entrance holes with excreta (e) Seed tip infested mature fruit with larva

Results and Discussion

The data of all the management approaches significantly ($p \leq 0.01$) reduced the fruit infestation in comparison to untreated control. Different management tactics showed significant effect in controlling litchi fruit infestation are described in following heads and data are presented in Table 1 and Table 2.

Efficacy of different tactics in suppressing percentages of fruit infestation

Effect of different tactics on fruit infestation was highly significant. The hundred percent protection of infestation was recorded by Paper bagging. The least infestation was found in Net bagging (0.66%) followed by Netting (2.96%). Hwang and Hung (1993) reported that the litchis with bagging could completely prevent the fruits from *C. sinensis* and did not affect the growth of fruits.

Significant variation was observed in percentage of borer infested litchi due to botanical insecticides. The lowest percentage of fruit infestation was noticed from Neem oil (10.99%) and the moderate in Bishkatali leaf extract (15.10%) followed by Karanja oil (18.83%). These findings comparable with the work of Ranjan and Singh (2003) who observed 38.0% fruit infestation when treated with neem oil. The efficacy of three botanicals was as the following order to neem leaf extract> bishkatali leaf extract>neem oil reported by Miah *et al.* (2017).

All the chemical treatments significantly ($p \leq 0.01$) reduced the fruit infestation. The minimum fruit infestation was 0.99% observed in Bifenthrin+Abamectin (Novastar 56 EC). The second lowest was registered in Thiamethoxam (Actara 25 WG) 4.03% followed by Deltamethrin (Decis 2.5 EC) 5.23%, Carbaryl (Sevin 85 SP) 6.02% and Cypermethrin (Ripcord 10 EC) 7.69%. The findings of present study are in a good agreement with Jumroenma *et al*. (2000) who found that the use of insecticides gave better performance against LFB ranging from 2.88-10.85 % at the harvesting period. Hung *et al.* (2008) reported that chemical sprays in litchi can effectively reducing the fruit damages caused by *C. sinensis* ranging from 8-16.5%.

Effect of different management approaches on percentage reduction of fruit infestation

The effect of all approaches on the reduction percentage of fruit infestation varied significantly. The hundred percent reduction of fruit infestation over control was observed in harvested fruits treated with Paper bagging, whereas 98.72% in Net bagging and 94.27% in Netting. Similarly the highest reduction of fruit infestation over control was found 96% when the litchi was bagged reported by Alam *et al.* (2004).

The effectiveness of botanical insecticides on the reduction of infestation over control was 78.73 % in Neem oil followed by Bishkatali leaf extract (70.77%) and 63.55% in Karanja oil. This results was nearer with Dong *et al.* (2006) who reported that sprayed with azadirachtin against fruit borer the reduction of infestation was 89.4% and 87.5%, respectively. Sahoo *et al.* (2007) also reported that the azadirachtin was significantly superior over the untreated control.

Due to the effect of synthetic insecticides on the reduction percentage of fruit infestation over control was the highest (98.08%) in Novastar 56 EC followed by Actara 25 WG (92.20%), Decis 2.5 EC (89.88%), Sevin 85 SP (88.35%) and the lowest was 85.11% in Ripcord10 EC (Fig.2). These results were close confirmatory with the work of Hwang and Hung (1993) who reported that insecticides were more effective against *C. sinensis* as their control rate reached above 95%. Similarly, Ping (2006) observed the efficacy of six insecticides against LFB and reported their control effects as 73.68 % to 83.41%, respectively.

Effectiveness of different approaches and their impact on the percent increase of fresh fruit

The number of fresh fruits varied between the level of pest infestation and the efficacy of applied management tactics. The percentage of fresh fruit increased over control showed significant level of success. In view of mechanical control effect, the fresh fruit was increased over control at the rate of 50.19%% in Netting, 51.34% in Net bagging and 51.66% in Paper bagging. These findings are nearly agreed with the results of Purbey and Kumar (2015) who reported that there was a 33.58% - 41.38 % healthy fruit found in all bagged fruits as compared to control.

In term of botanical treated trees, the fresh fruit was increased over control at the rate of 43.06% in Bishkatali leaf extract, Neem oil (45.69%) and Karanja oil (40.45%). Dong *et al.* (2006) reported that fresh fruit increased remarkably by spraying azadirachtin against fruit borer.

Due to the insecticidal treatments, the fresh fruit was increased over control at the rate of 47.63%, 49.63%, 51.18%, 48.99% and 48.56% by spraying of Ripcord, Actara, Novastar, Decis, and Sevin, respectively. These results are comparable to the findings of Ranjan *et al.* (2019) who reported that spraying of insecticides, recording lowest fruit damage due to litchi fruit borer and increased the maximum marketable fruit.

Economic analysis of different control measures

The benefit cost ratio (BCR) varied depending on the cost of treatment application and increasing fresh fruit with market price. In case of mechanical treated trees, the highest benefit cost ratio was 7.47:1 in Paper bagging followed by Net bagging (5.69:1) and Netting (3.17:1). It is to be noted that all the mechanical treated trees provided maximum number of fresh fruit but the higher application cost, the method brought down the profit margin and showed lower BCR. Moreover, bagging was most effective and eco-friendly management technique for controlling LFB. Similar to the present study reported by Waite and Hwang (2002).

Due to the botanical treated trees, the highest benefit cost ratio was 8.67:1 in Neem oil followed by Bishkatali leaf extract (8.50:1) and Karanja oil (6.45:1). Similar findings were reported by Gupta *et al.* (2000) to evaluate neem plant products and the maximum benefit cost ratio was found by neem oil followed by neem leaf extract.

Table1. Effect of different management approaches on fruit infestation and fresh fruit increase of litchi during 2014 and 2015 at Gopalpur, Tangail (mean)

Treatments	% fruit infestation	% reduction of fruit infestation over control	Number of fresh fruit/ acre	% fresh fruit increase over control
Netting	2.96 e	94.27	172051.90 c	50.19
Net bagging	0.66 e	98.72	176129.80 b	51.34
Paper bagging	0.00 e	100	177300.00 a	51.66
Bishkatali leaf ext.	15.10 b	70.77	150527.70 i	43.06
Neem oil	10.99 c	78.73	157814.70 h	45.69
Karanja oil	18.83 b	63.65	143914.40 j	40.45
Ripcord 10 EC	7.69 d	85.11	163665.60 g	47.63
Actara 25 WG	4.03 d	92.20	170154.80 d	49.63
Novastar 56 EC	0.99 e	98.08	175544.70 b	51.18
Decis 2.5 EC	5.23 d	89.88	168027.20 e	48.99
Sevin 85 SP	6.02 d	88.35	166626.50 f	48.56
Control	51.66 a	0.00	85706.82 k	0.00
Level of signific.	0.01	-	0.01	-
CV (%)	16.22	-	0.30	-

The values having different letter(s) in a column are significantly different at 5% level. CV (%) = Co-efficient of variation

According to chemical insecticides, the highest BCR was 6.06:1 in Novastar followed by Decis (5.66:1), Ripcord (5.15:1), Sevin (3.19:1) and Actara (3.02:1). These findings are in agreement to the works of Ranjan *et al.* (2019) who reported that spraying of insecticide, provided the maximum marketable fruit and thus highest benefit cost ratio was 10.2:1. Bhatia *et al*. (2000) conducted a study on the fruit borer control of litchi using six different insecticides and found the highest efficacy with all of the tested insecticides resulted in high returns.

Table 2. Benefit cost ratio analysis in respect of effectiveness of different tactics during 2014 and 2015 (mean)

Treatments	Value of fresh fruit/acre	Value of infested fruit/acre	Total (Tk.)	Value over control (Tk.)	Application cost/ acre (Tk.)	BCR
Netting	387116.80	4198.46	391315.30	125200.40	39440	3.17:1
Net bagging	396292.10	936.14	397228.20	131113.40	23049	5.69:1
Paper bagging	398925.00	0.00	398925.00	132810.10	17784	7.47:1
Bishkat.lea. ext.	301055.40	21417.84	322473.20	56358.35	6630	8.50:1
Neem oil	315629.50	15588.20	331217.70	65102.79	7513	8.67:1
Karanja oil	287828.80	26708.47	314537.30	48422.40	7513	6.45:1
Ripcord 10 EC	286414.90	10907.50	297322.30	31207.46	6054	5.15:1
Actara 25 WG	297770.90	5716.15	303487.10	37372.18	12390	3.02:1
Novastar 56 EC	307203.30	1404.22	308607.50	42492.60	7014	6.06:1
Decis 2.5 EC	294047.60	7418.23	301465.80	35350.96	6246	5.66:1
Sevin 85 SP	291596.40	8538.77	300135.20	34020.32	10662	3.19:1
Control	192840.30	73274.54	266114.90	0.00	0.00	0.00

For calculating BCR: To use the number of fresh fruit 177300/acre obtained from the trial trees, fresh fruit market price 2.25Tk/litchi (mechanical), 2Tk/litchi (botanical),1.75Tk/litchi (insecticidal), 0.80Tk/litchi (infested), labour cost for treatment application =400Tk/day (8 hours day), sprayer rent for spraying insecticides = 50 Tk/day and treated material price.

Over all, it was found that the tested treatments in the present study showed the high efficacy in reducing fruit infestation and producing maximum fresh fruit to compare untreated control but application cost of some tactics was higher, resulted in the lower BCR than that of others. Dissimilarities in results between the previous and the present study may be due to the meteorological parameters, frequency of spray material and mode of action, application time, variety of litchi and price. The finding of this study based on different approaches hold a good promise in litchi fruit borer management. It showed that Butter paper bag, Neem oil and Novastar 56 EC (Bifenthrin+Abamectin) was the cost effective and eco-friendly technologies which may be incorporated to the farmers' field.

Conclusion

It is apparently found that infesting litchi by fruit borer elicits the greatest economic effects. From this study the results revealed that litchi fruit borer could be controlled using mechanical, botanical and chemical control tactics. It can be concluded that the use of chemical insecticides might be reduced with the increase of some promising tactics like Paper bagging as mechanical and Neem oil as

botanical treatment. Besides, new generation insecticide; Novastar 56 EC (Bifenthrin+Abamectin) may be used for the better management of LFB by maintaining the pre-harvest intervals (PHI) following the proper doses of this insecticide with optimum spray schedules.

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