

Management of Litchi Fruit Borer, *Conopomorpha sinensis* Bradley using Bio-rational Insecticides

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Abstract

Background and Objective: Of all the fruits available in the market during the months of May-June in Bangladesh, fresh Litchi is always of very high demand due to its unique taste, flavour and colour. But the cultivation of this juicy and delicious fruit is affected quite frequently by a number of insect pests of which Litchi Fruit Borer (LFB), *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae) is the most common. This study was made to evaluate some bio-rational insecticides for managing LFB to prepare from natural sources which are safer and less toxic to human and animals than chemical one's. **Materials and Methods:** Experiments were carried out in the litchi orchard consecutively for two years at Gopalpur, Tangail, Bangladesh. Four botanicals and two natural fermentation products were sprayed as treatments on litchi tree to follow randomized complete block design with 3 replications. An untreated control was also maintained to compare the effect of treatments. **Results:** Spinosad showed the least fruit infestation (2.84%) followed by Abamectin (5.69%), Neem leaf extract (11.33%) and the rest more than 12%. Among the tested insecticides, Spinosad, Abamectin and Neem leaf extract were found to be the most efficient on infestation reduction 95.28%, 90.54%, 81.17% with increase fresh fruit 59.01%, 57.77%, 55.08%, respectively but economically higher benefit was obtained from Neem leaf extract (10.84:1) and Abamectin (9.75:1). **Conclusion:** Neem leaf extract and Abamectin both could be used as safer alternative to synthetic chemical pesticides for

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the management of *C. sinensis* and farmers may reduce the losses and increase their income.

Keywords: Litchi, Bio-rational insecticides, Litchi fruit borer, Control.

Introduction

The litchi (*Litchi chinensis* Sonn.) is one of the most popular fruits of Bangladesh which belongs to the family Sapindaceae⁸. It has high nutritive value and refreshing taste contains carbohydrates, vitamin A, vitamin B, vitamin C, carotenoids, phosphorus, calcium, irons and polyphenols²⁵ and provides livelihood opportunities to litchi growers. The main areas of litchi cultivation are Rangpur, Dinajpur, Rajshahi, Jessore, Khulna, Dhaka, Kushtia, Sylhet and Chittagong and these areas have been prioritized as potential litchi production districts in Bangladesh⁸. In 2018, it is grown in an area of 40889 acres of land with production of 94160 MT in Bangladesh, out of which leading districts occupies more than 22 % area and 26% production⁵. The farmers are facing heavy loss every year because of the damage caused by several insect pests³. Among them, litchi fruit borer, *Conopomorpha sinensis* Bradley is one of the major threats to the cultivation of litchi^{3,11}. It damages fruit 30-52%, 7-70%, 60- 80% in Bangladesh, India and China, respectively^{10,2,20,24}. Adult female of *Conopomorpha sinensis* lay eggs near fruit stalk and neonates after hatching immediately penetrate the fruit, feed on seed neck resulting in drying up of fruit stalk that ultimately leads to fruit drop and thus farmers incur huge loss¹⁵. To prevent the loss caused by this insect 100 percent farmers in Bangladesh depend on synthetic toxic chemical insecticides spraying for several times²³. Litchi growers spray pesticides multiple times (16-20 times) during the fruiting season to keeps plants pest free even without knowing the spraying chemicals²³. Litchi farmers spraying poisonous insecticides protecting fruits from pest, but does not know the correct doses even the harmful effects of the insecticides on health or environment¹⁸. It has reported that incorrect dose and 3 times in a week applying pesticide on the fruit up to harvest to save insect and thereby increasing spray frequency every year in litchi growing areas, especially in Dinajpur district, the litchi growing capital of Bangladesh¹⁸. It has also reported for the past few years that farmers use excessive pesticides on litchi fruits without potential benefits^{3,18}. This is most likely

to cause serious health hazard to the consumers along with desirable environmental components. For example, during 30 May to 20 June 2015, 11 children aged between 2 to 6 who were living near a litchi orchard died after consuming contaminated fallen or picking toxic litchis in Kaharol and Birganj Upazila under Dinajpur district, Bangladesh¹⁸. The repeated applications have induced resistance of pests against pesticides and have boosted up the many minor pests as the major pests of litchi¹. One of the alternative ways to reduce use of synthetic pesticides may be to develop bio-rational pesticide based approaches. It refers to product from natural sources to prepare animals, plants and microorganisms which are safer and less toxic to human and animals than the chemical pesticides¹. Moreover, they get decomposed more quickly than the conventional synthetic pesticides. In Bangladesh, till now research efforts have been unexpectedly slow and limited for the development of bio-pesticide based pest management for different crops¹. As a result, the availability of bio-rational pesticide based management for litchi is lagging behind seriously for years. Thus the farmers of Bangladesh rely solely on synthetic pesticides use for litchi fruit borer management. Bio-rational insecticides can offer much more targeted activity against a desired pest than to conventional pesticides. It often is effective in very small quantities thereby offering lower exposure. So, extensive and systematic research and development works on application of bio-rational pesticide for the management of litchi fruit borer is now as burning issue. Therefore, to develop bio-rational insecticide based management strategy for litchi fruit borer some bio-rational insecticides were evaluated in the field against this destructive pest.

Materials and Methods

The present study was conducted in a litchi orchard at Gopalpur Upazilla under the district of Tangail, Bangladesh during 2015 and 2016, March to June to find out the efficacy of different bio-rational insecticides against *C. sinensis*. The experiment composed of total seven treatments viz. bio-rational insecticides namely Neem leaf extract @ 20 ml/L water, Bishkatali leaf extract @ 20 ml/L water, Neem oil @ 6 ml/L water, Karanja oil @ 6 ml/L water, Spinosad (Tracer 45 SC) 0.4 ml/L and Abamectin (Sunmectin^{1.8} EC) @ 1.2 ml/L and an untreated control. The

experimental plants were Madrazi and Bombai varieties which were approximately 10-15 years old. In each treatment 3 trees were assigned, each plant was considered as a replicate. First spray of insecticides was done in inflorescence stage to avoid egg laying and hatching of insect. Then insecticides were sprayed three times started within 10 days of fruit set at 15 days interval with the help of foot pump sprayer. Two kg of fresh leaves and small branches of Neem (*Azadirachta indica*) and Bishkatali (*Persicaria hydropiper*) cutting into small pieces was mixed with required amount of water separately. The water was boiled for 25-30 minutes. The solution was kept for about 2 hours for cooling and filtered then to make a volume up to 10 litres²³. Neem (*Azadirachta indica*) oil and Karanja (*Pongamia pinnata*) oil were used separately to dilute into water with trix @ 0.5 ml/L of water. The mixture was then shaken for a few minutes to prepare a uniform solution for using as botanical insecticides. Randomly 50 fruits were collected from each tree after harvesting. Collected samples were dissected and observed for the presence of *C. sinensis* or *C. Sincensis* - damage symptoms. Damage caused by the larvae in the litchi fruits was confirmed (Figure 1) when a larva of *C. sinensis* or damage symptom/ holes/ insect excreta was found. The treatments were evaluated based on the percent fruit infestation, decrease and increase of infested and healthy fruit over control. The benefit cost ration (BCR) was calculated for each treatment. BCR was calculated by dividing the total benefit by insecticide application cost for each treatment. Data were analysed using the statistical program MSTAT-C and means were separated using DMRT (Duncan's Multiple Range Test).

Results

The mean data of two consecutive years experiment showed that all the treatments significantly reduced the fruit infestation done by litchi fruit borer comparing to control (Table 1). The least fruit infestation (2.8%) was observed in Spinosad treated trees followed by Abamectin (5.69%). The second lowest fruit infestation was recorded from Neem leaf extract (11.33%) followed by Neem oil (12.91%) and Bishkatali leaf extract (16.25%) with closely related to Karanja oil (22.7%). The fresh fruit was increased over control at the rate of 55.08%, 52.44%, 54.27%, 48.29%, 59.01% and 57.77% in Neem leaf extract, Bishkatali leaf extract, Neem oil,

Karanja oil, Spinosad and Abamectin, respectively (Table 1). Here, it was clear that the highest percent fresh fruit increase over control was obtained from Spinosad treated trees followed by Abamectin and Neem leaf extract. Among the treatments Karanja oil provided the lowest (48.29%) percent increase of fresh fruit over control.

Table 1 - Effect of bio-rational insecticides on percentage fruit infestation

| Treatments | Mean data of two consecutive years | | |
|-------------------------|------------------------------------|-------------------------------------|---------|
| | % fruit infestation | % fresh fruit increase over control | BCR |
| Neem leaf extract | 11.33 c | 55.08 | 10.84:1 |
| Bishkatali leaf extract | 16.25 c | 52.44 | 9.65:1 |
| Neem oil | 12.91 c | 54.27 | 9.08:1 |
| Karanja oil | 22.97 b | 48.29 | 7.15:1 |
| Spinosad 45 SC | 2.84 d | 59.01 | 3.24:1 |
| Abamectin 1.8 EC | 5.69 d | 57.77 | 9.75:1 |
| Control | 60.17 a | 0.00 | 0.00 |
| SEm(±) | 0.421 | - | - |
| LSD | 1.298 | - | - |
| Level of significance | 0.01 | - | - |
| CV (%) | 11.76 | - | - |

The values having different letter(s) in a column are significantly different at 1% level.



Figure 1 - Damage fruits by litchi fruit borer (a) Near stalk affected young litchi with excreta (b) Seed tip spoiled maturing fruit with *C. sinensis* larva (c) Seed neck feeding fruit by larva (d) Larva of *C. sinensis* (3rd instars')

In case of benefit cost ratio, the highest value (10.84:1) was obtained from Neem leaf extract treated trees followed by Abamectin (9.75:1), Bishkatali leaf extract (9.65:1), Neem oil (9.08:1) and Karanja oil (7.15:1). The lowest (3.24:1) BCR was found from spinosad (Table 1). The highest reduction of percent fruit infestation over control was recorded from the treatment of Spinosad (95.28%) followed by Abamectin (90.54%), Neem leaf extract (81.17%) and Neem oil (78.54%). The moderate was 72.99% in Bishkatali leaf extract. The lowest percent reduction of fruit infestation over control was obtained from the plants treated with Karanja oil (61.82%).

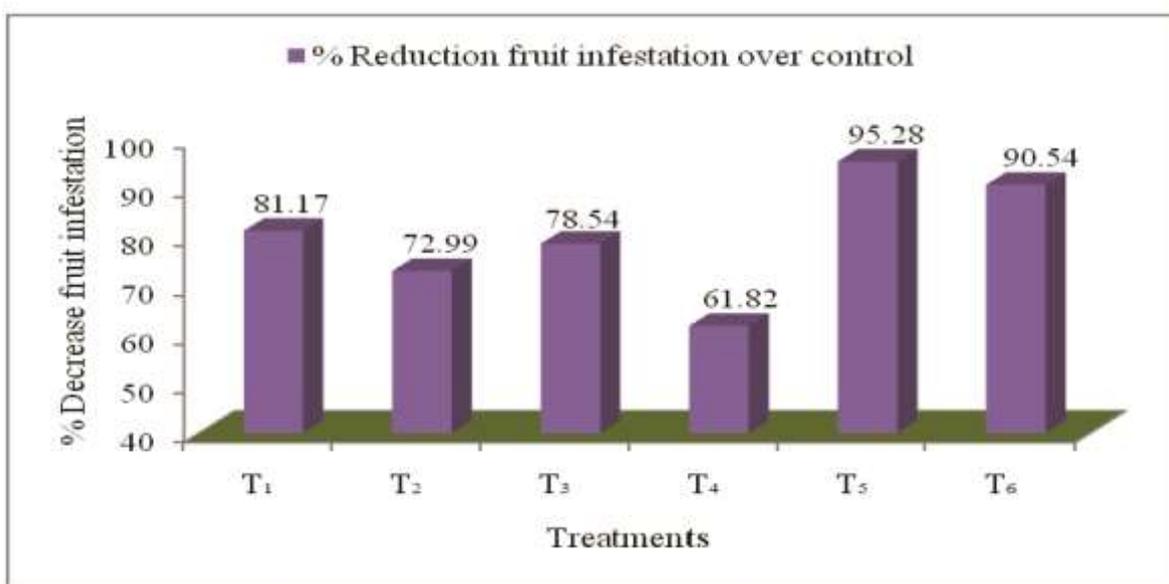


Figure 2 - Effect of bio-rational insecticides on the percent reduction of fruit infestation over control. Legend: T₁= Neem leaf extract, T₂= Bishkatali leaf extract, T₃= Neem oil, T₄= Karanja oil, T₅= Tracer 45 SC (Spinosad) and T₆= Sunmectin1.8 EC (Abamectin)

Discussion

From the results of this study it was revealed that all bio-rational insecticides used in the experiment performed significantly better in controlling fruit borer. This attribute was might be due to the highest insecticidal activity of these natural products on the litchi fruit borer. Among the treatments, Spinosad 45 SC was the most effective in reducing fruit infestation, percentage reduction of infested fruit over control and percentage increase of fresh fruit over control. These results are comparable to the findings of Ranjan et al.17 who reported that spraying of natural pesticide, Spinosad 45 SC twice at flush stage and fruit colour break stage afforded maximum protection to the litchi from the pests

recording lowest fruit damage (6.30 percent) due to litchi fruit borer and provided the maximum marketable fruit yield with C / B = 10.2:1. In the present study Spinosad 45 SC showed significantly better performance in all measured criteria except BCR. It was the lowest in all treatments because of its higher application cost goes down the profit margin resulted in the lower benefit cost ratio. It is concluded that 4 times spray application is better than two times for managing LFB.

The natural product Abamectin was the next in reducing fruit infestation, reduction of infested fruit over control and increase of fresh fruit over control in percentage. This findings can be compared with the findings of Srivastava et al.²¹ who conducted an experiment based on different insect growth regulators as bio-rational approaches for managing litchi fruit borer to report that Diflubenzuron 25 WP recorded the lowest borer infestation (12.39%) followed by Novaluron 10 EC (13.67%) against the highest borer infestation (59.35%) in control. The highest reduction in borer infestation was found in Diflubenzuron 25 WP (80.65%) followed by Novaluron 10 EC (77.50%). To compare present and earlier study it showed that Abamectin was the most efficient in controlling litchi fruit borer with higher BCR.

The results of the plant product indicated that all the botanicals showed high protection against litchi fruit attack by *C. sinensis* compare to control. This attribute was might be due to the toxic and antifeedant effect of these plant products to the LFB. Among botanicals, Neem leaf extract showed highest efficiency in controlling LFB in the present study. In respect of percentage fruit infestation, reduction fruit infestation over control, increase fresh fruit over control and benefit cost ratio was higher than other botanicals. It might be due to repellent action of the Neem extract to *C. sinensis*. The order of comparative efficacy was as Neem leaf extract >Neem oil > Bishkatali leaf extract > Karanja oil. This finding is in agreement with the works of Miah et al.¹⁴ who conducted an experiment to evaluate the efficacy of three botanicals and reported that the order of comparative efficacy was as the following order Neem leaf extract> Bishkatali leaf extract>Neem oil.

The infestation reducing range was 11.33% to 22.97 % treated with botanicals in the present study. This findings comparable with the work of

Ranjan and Singh¹⁶ who observed 38.0% and 38.3% fruit infestation when treated with Neem oil (0.2%) and Nimbicidine (0.25%). It agreed with Kumar et al.¹¹ who carried out field trial to develop bio-rational approaches for managing litchi fruit borer reported that reduced borer infestation 12.65%. Similarly, the finding of Kumar and Kumar^{12,13} for minimizing the fruit borer using bio-rational approaches. It has also reported by Srinivasan et al.²² in terms of efficacy is similar to foliar application of Neem as well as foliar application of the chemical insecticide Imidacloprid and opined Neem can be very well components in bio-rational pest management approaches. These inconformity results may be varied with plant species, extract concentrations, dissolved ingredients in water of different levels and time as well as exposure periods. It is clear that Neem leaf extract had the highest insecticidal activity in the present study.

The present findings on reduction of fruit infestation over control ranged from 69.54% to 82.28%. This results was close confirmatory with Dong et al.⁶ who reported that sprayed with Azadirachtin @ 6 ml/L and 3 ml/L against fruit borer results the reduction of infestation as 89.4% and 87.5%, respectively. Similarly, Kumar et al.¹¹ carried out field trial to develop bio-rational approaches for managing litchi fruit borer showed 69.34% reduction of fruit infestation over control.

The result on BCR in botanicals was the highest in Neem leaf extract. This finding are in agreement with Amin⁴ who reported that botanicals increased net return with higher benefit cost ratio and save the environment. Similarly, Gupta et al.⁹ conducted an experiment to evaluate Neem plant products reported that maximum net profit and benefit cost ratio was given by Neem oil followed by Neem leaf extract and Neem karnel. Sahoo et al.¹⁹ carried out a field study spraying with varied doses of Azadirachtin to observe and reported that all the doses were significantly superior over the untreated control and Azadirachtin 1% EC @ 6 ml/L was found to be most effective and profitable. The present and earlier result revealed that Neem leaf extract was more toxic to *C. sinensis* than other botanicals providing higher fresh litchi fruit with low application cost resulted highest BCR.

The finding of this study based on bio-rational approaches hold a good promise in litchi fruit borer management. It showed that Neem leaf extract

and Abamectin 1.8 EC both are cost effective natural insecticides may be incorporated to the farmers' field. Therefore, a further study on residue analysis of Abamectin is mandatory so that it can be more ecologically safe and free from residual problems to human. It can therefore, be concluded that 4 times spraying schedule at inflorescence stage including 3 times after fruit set 15 days interval is the most effective for managing LFB. It was feasible and profitable to introduce into LFB management.

Conclusion

All the bio-rational pest management approaches used in the present study showed significant reduction of the losses. The treatment Spinosad 45 SC at the rate of 0.4ml/L water showed superior result but in consideration of benefit cost ratio Neem leaf extract at the rate of 20 ml/L water exhibited better performance followed by Abamectin at the rate of 1.20 ml/L water both was affordable and simple to use to suit the needs and situations of resource litchi farmers. It may encourage wider adoption to replace synthetic pesticides that might lead to desirable economic, health and environmental benefits. However, their compatibility against target pest and non-target organism in a specific environment or production system should be carefully investigated further in large scale under farmer's field conditions.

Significance Statement

The present study gives excellent indication to the farmers and special attention to the researchers for managing litchi fruit borer using bio-rational insecticides. Because of, it may be considered cheaper than traditional synthetic pesticides one along with the most safety for living non target-organisms with environment and to minimize the use of harmful insecticides.

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