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RESEARCH PAPER

Toxicity of Botanicals on Eggplant Lace Bug, *Gargaphia solani* Heidemann

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ABSTRACT

The experiment was carried out to investigate the effect of botanicals on eggplant lace bug, *Gargaphia solani* at the field of Patuakhali Science and Technology University (PSTU) during the period from May 2016 to April 2017. The experiments were laid out in RCBD with three replications for each treatment. Six treatments ie.T_0 (control; 100% water), T_1 (10% leaves extract of *Polygonum hydropiper* L.), T_2 (10% flowers extract of *Azadirachta indica*), T_3 (10% flowers extract of *Swietenia macrophylla* L.), T_4 (10% leaves and flowers extract of *Heliotropium indicum*) and T_5 (10% bulb extract of *Allium sativum* L.) were used on lace bug to determine the performance of botanicals. Water was used as the solvent for extracting from the plant parts using a centrifuge. The highest mortality rate of lace bug was observed in T_2 (63.00%), followed by T_1 (59.00%) and lowest mortality rate was observed in T_0 (8.66%) at 1% and 5% level of significance.

Key words: Bishkathali, Eggplant lace bug, *Gargaphia solani*, garlic, hatishur, neem

Introduction

Very recent the eggplant lace bug, *Gargaphia solani* (Hemiptera: Tingidae) is a great concern to agriculture because they are familiar as a significant insect pests of eggplant, and they reach high population densities within very short time and can give 7 to 8 generation per year thereby damaging the crops severely. Still now *Gargaphia solani* is treated as minor agricultural pests with narrow host range that feeds on the flowering plant family Solanaceae, being found on a range of *Solanum* species including tomato, potatoes and eggplant (Drake and Ruhoff, 1965).

In Bangladesh eggplant (*Solanum melongena)* is one of the most common and popular vegetable, grown round the year having two major growing seasons as summer and winter.

Eggplant lace bug is also important pest of Solanaceae family. It attacks a narrow range of vegetable plants like potatoes, tomatoes and often go undetected until the infested plants show severe damage. Both adults and nymphs have piercing-sucking mouthparts and remove sap as they feed from the underside of the leaf. Lace bug damages the foliage of trees and shrubs detracts greatly from the plants' beauty, reduces the plants' ability to produce food, decreases plant vigor and causes the plant to be more susceptible to damage by other insects, diseases or unfavorable weather conditions. Repeated, heavy infestations of lace bugs may be the primary cause of plant death (Sparks *et al*., 2015).

Different strategies are under practice to control these insect pests. Chemical control is most commonly used as effective method, and farmers are still relying on the chemicals to control variety of insect pests (Naranjo, 2001). However, the excessive use of insecticides may lead to serious problems such as pesticidal pollution, pest resurgence, mortality of natural enemies and pollinators, high cost of production, reduction in nitrogen fixation and biodiversity (Miller, 2004).

Keeping in mind the above mentioned problem, the proposed research work has been planned to understand the effect of botanicals on eggplant lace bug, which are friendly to environment by low cost in Bangladesh that will be helpful for the farmers to take proper management strategies. Conversely, farmers gain the economic sustainability by the quality production.

Botanical extracts are broad spectrum compounds which are essential oils (mono-terpenoids) used in pest control and they are safe to apply, unique in action and non-persistent that can breakdown quickly in the environment. Locally available strategy that derive from plant materials have been widely used in the past to protect the crop plants from damage caused by insects

(Golob and Webly 1980). The main advantage of botanicals is that they are easily produced by farmers, cheaper and hazard free in comparison to chemical insecticides (Saxena *et al.* 1996). Botanical extracts have defensive compounds which make difficult or impossible for pests to consume the plants. Thus, in many countries efforts are being made to minimize the use of harmful chemical insecticides through the use of indigenous plant products and use of bio-degradable products to protect the brinjal plant (Khattach and Hameed 1986). The plant products include extracts of dried leaves, fruits and seeds can play an important role in agriculture that are naturally occurring toxins extracted from plants, and are environmentally friendly. The main advantage to use botanicals rather than synthetic insecticides is unstable in the environment, resulting in little risk of residues on food crops and less risk to beneficial insects. Some materials can be used shortly before harvest. Most botanicals are rapid acting and most, but not all botanicals are of low to moderate toxicity to mammals.

The aim of this research work was to propose an alternative for lace bug control in eggplant and avoid using large amounts of synthetic pesticides. Botanicals can offer a safe and effective alternative of conventional insecticides for controlling whitefly within an integrated pest management program. The proposed study highlights the practical application of botanical insecticides for controlling lace bug of eggplant.

Materials and Methods

Seedling Preparation

The seeds were sown on a nursery bed of size 3m x 2.2m on 20th October 2016 at PSTU farm. Seed bed was used for raising eggplant seedling. A soil mixture of sandy loam was used for preparing the bed. Seeds were sown in drills about 10cm apart at a depth of about 5mm. The distance between two stands was 20cm. A nutrient solution of 25g NPK in 15litres of water was used to water the seedlings a week later (Bonsu, 2002).

Transplanting

28 days aged healthy seedlings with uniform height were transplanted following the single line of planting. A planting distance of 50 cm x 50 cm was employed. The seedlings were irrigated immediately after transplanting.

Insects Rearing in Laboratory

Samples of several adult insect of eggplant lace bug were collected from eggplant at Patuakhali in Bangladesh and some of them were preserved in 99% ethanol (alcohol) for further study. Rest of collected alive samples of them were brought to IPM lab, PSTU (Insect Pest Management Laboratory of Patuakhali Science and Technology University) with their host plant in a rearing chamber for making colony. These colonies were reared in separate insect-rearing chambers under conditions of 25 ± 2°C, 60 ± 5% relative humidity, and a 16 h light/8 h dark (16L:8D) photoperiodic cycle.

Collection and Processing of Plant Materials

Fresh leaves of biskathali (*Polygonum hydropiper* L),

Figure 1. Extracts of different Botanicals after centrifuge (from the left: Leaves of bishkathali, neem flower, garlic bulb, mahagoni flower, and hatishur leaves & flowers)

flowers of neem *(Azadirachta indica)*, flowers of mahogoni (*Swietenia macrophylla* L.), leaves and flowers of hatisur (*Heliotropium indicum*) and bulb of garlic (*Allium sativum* L.) were collected from the surrounding of Patuakhali Science and Technology University. After bringing them to the laboratory, they were washed in running water. After that the plant materials were kept in shade for air-drying and then they were preserved in refrigerator for 7 days at 4 degree Celsius temperature.

Preparation of Plant Extracts

The collected fresh leaf, flower and bulb were used for preparation of plant paste. 250 g of each category was cut into small pieces and separately blended in a blender with little distilled water to prepare paste. Then the paste was taken into container for mixed thoroughly with water by vortex mixture with equal ratio to water. Then the mixer was centrifuged at 10000 rpm for 20 minutes to obtain aqueous plant extract and that operation was repeated for 3 times consequently (Figure 1)

Experimental Design

There were six (6) treatments with three (3) replications for each. The treatments were as follows:

T_0: Control (100% water)

T_1: 10% of aqueous biskathali (*Polygonum hydropiper* L.) leaves extract

T_2: 10% of aqueous neem (*Azadirachta indica*) flowers extract

T_3: 10% of aqueous mahogoni (*Swietenia mahagoni* L.) flowers extract

T_4: 10% of aqueous hatisur (*Heliotropium indicum*) leaves and flowers extract

T_5: 10% of aqueous garlic (*Allium sativum* L.) bulb extract

The effects of the above listed treatments were studied against eggplant lace bug (*Gargaphia solani*) in the field and laboratory environment. The field was designed following by Randomized Complete Block Design (RCBD). Six small plots were considered at a replication for individual crop. Each plot and replication were separated from each other by using insect proofed fine mesh and polythene supported by steel made rectangle structure. Certain number of insects was released from the colony to the each plot.

Cultural Practices

The normal agronomic practices (e. g. watering, weeding, mulching, fertilization, sticking and pruning) recommended for growing vegetables in an experimental farm were followed.

Spraying Method

The botanical extracts of 10% concentrations were sprayed on experimental field with 3 days interval. Both upper and lower surfaces of plant leaves were sprayed with botanicals.

Data collection

Sweetpotato whitefly and lace bug were released from their mother stock plant to the selected experimental plots one day before of spraying for their settlement. After spraying, number of dead insects were counted and recorded after 24 hours, 48 hours and 72 hours followed by the next two sprayings, and finally mortality percentages (%) of these insects were calculated.

Justification the toxicity of botanicals

Toxicity of different botanicals was justified using mosquito larvae by an experiment. 5%, 10% and 15% concentrations of all the treatments with 3 replications were made in small plastic pot (125ml). Five larvae were released in each treatment to test the toxicity on larvae. The number of dead mosquito larvae were counted and recorded at every hour after releasing the mosquito larvae in the botanical solutions having different concentration up to 4 hours (Figure 2 & 3).

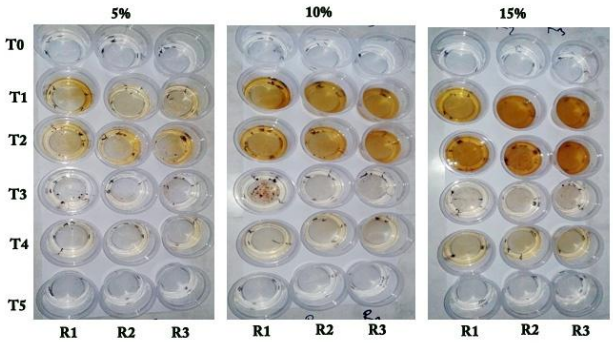

Figure 2. Justification of toxicity at 5%, 10% and 15% concentration of different botanicals.

Figure 3. Dead larvae represent the toxic effect of botanicals

Statistical Analysis

Data were expressed in three individual replicates, and mean values ± standard error were plotted using Sigma plot 8.0 (Systat software, Inc., Point Richmond, CA, USA). Analysis of variance (ANOVA) was carried out in order to analyze the means by using PROC General Linear Model (GLM) with the Statistical Analysis System (SAS, 2002-2003 SAS Institute Inc., Cary, NC, USA) version 9.1 program. Significant differences among mean values were determined using Duncan's Multiple Range Tests (DMRT) at 1% and 5% level of significance.

Results and Discussion

Performance of Botanicals on Eggplant Lace bug

Eggplant lace bugs were released from the mother stock plant to the eggplant one day before of spraying for their settlement. After spraying, number of dead lace bug were counted and recorded after 24 hours, 48 hours and 72 hours followed by the next two sprayings, and finally mortality percentages (%) of lace bug were calculated. The mortality percentages were presented graphically in figure 21 that showed 8.66%, 59.00%, 63.00%, 46.00%, 39.00% and 41.00% as per treatment T_0, T_1, T_2, T_3, T_4 and T_5 respectively. The highest mortality rate of lace bug was observed in T_2 (63.00%), followed by T_1 (59.00%) and lowest mortality rate was observed in T_0 (8.66%) followed by T_4 (39.00%).

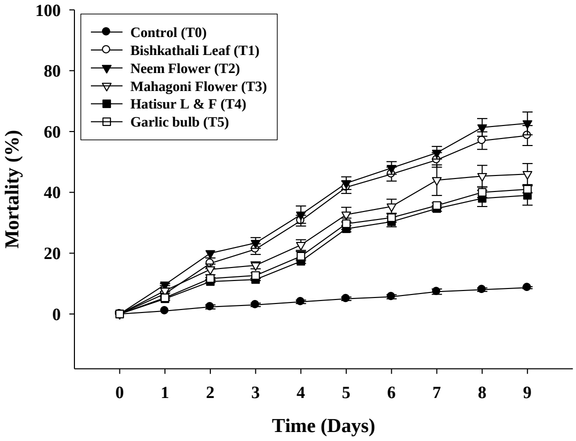

Figure 4. Performance of botanicals on eggplant lace bug.

The main compounds of plant extracts are essential oils (mono-terpenoids). These botanical compounds offer promising alternatives to chemical insecticides. These compounds may act as effective insecticides against vegetables pests (Cork *et al.* 2005; Muyinza *et al.* 2010), contact insecticides (Kim *et al*. 2004; Tapondjou *et al*. 2005), repellents (Hori, 2003) and antifeedants (Park *et al*. 2003).

This study was carried out through a field experiment conducted at PSTU farm, Patuakhali in Bangladesh. The performance of different botanicals to reduce the number of eggplant lace bug were evaluated on eggplant crops. Six treatments such as T_0 (control; 100% water), T_1 (10% of aqueous bishkathali leaves extract), T_2 (10% of aqueous neem flower extract), T_3 (10% of aqueous mahagoni flowers extract), T_4 (10% of aqueous hatishur leaves & flowers extract) and T_5 (10% of aqueous garlic bulb extract) were sprayed on eggplant lace bug and all these treatments were compared with each other.

The T_2 (flowers of neem) treatment resulted highest mortality percentages (63.00%) which was significant both 1% and 5% level of significance (Figure 4) followed by T_1 (leaves of bishkathali) treatment (59.00%). T_3 (flowers of mahagoni), T_5 (bulb of garlic) and T_4 (leaves & flowers of hatishur) resulted almost similar result in mean comparison was 46.00%, 41.00% and 39% respectively (Figure 4). So, there was significant different among the treatments.

The review of literature on performance of any botanicals on eggplant lace bug was not available to support the current research work.

Botanical's Toxicity Justification by Mosquito Larvae at Different Concentration

Toxicity of different botanicals was justified using mosquito larvae by a bioassay experiment. Five larvae were released in each treatment to test the toxicity on larvae. The number of dead mosquito larvae were counted and recorded at every hour after releasing the mosquito larvae in the botanical solutions having different concentrations.

The mean numbers of dead larvae at 5% concentration of different treatments after one hour observation were 0%, 13.2%, 6.6%, 6.6%, 0% and 0% but after 4 hours results were shown 20%, 72.2%, 53.2%, 40%, 26.6% and 20% as per treatment T_0, T_1, T_2, T_3, T_4 and $T_{5,}$ respectively (Figure 5).

The number of dead larvae at 10% concentration of different treatments after one hour observation were 0%, 26.6%, 6.6%, 6.6%, 0% and 6.6% but after 4 hours results were 20%, 100%, 93.2%, 73.2%, 66.6% and 53.2% as per treatment T_0, T_1, T_2, T_3, T_4 and $T_{5,}$ respectively (Figure 6). After 3 hoursT_1 treatment at 10% concentration yielded almost similar result which found after 4 hours at 5% concentration.

The number of dead larvae at 15% concentration of different treatments after one hour observation were 0%, 33.2%, 20%, 6.6%, 13.2% and 6.6% as per treatment T_0, T_1, T_2, T_3, T_4 and $T_{5,}$ respectively but after 4 hours results were 20%, 100%, 86.6%, 73.2%, 66.6% and 53.2% as per treatment T_0, T_1, T_2, T_3, T_4 and $T_{5,}$ respectively (Figure 7). After 3 hoursT_1 treatment at 15% concentration yielded almost similar result which found after 4 hours at 5% concentration. But after 3 hours both 10% and 15% concentration yielded almost similar results.

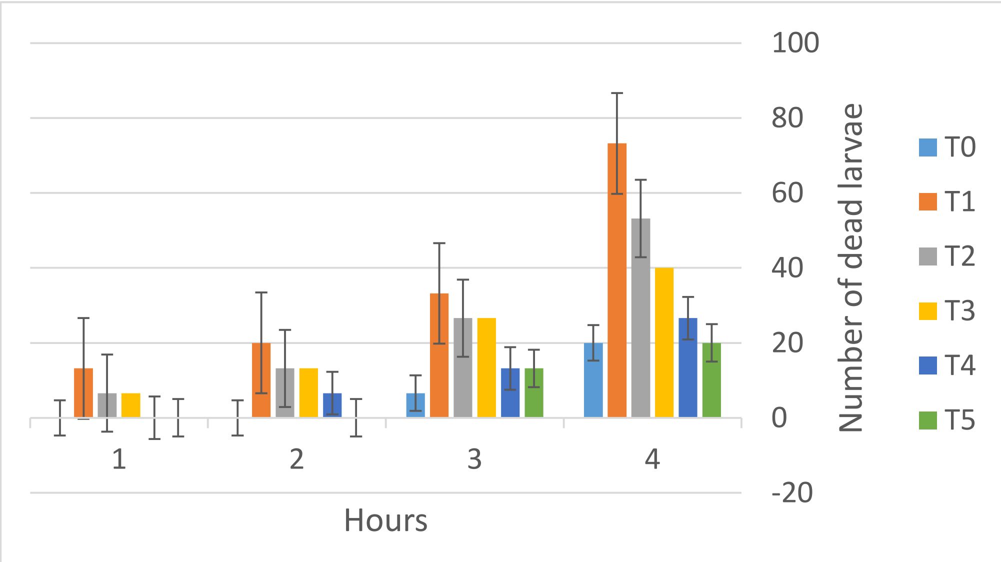

Figure 5. Justification of Toxicity at 5% Concentration.

Toxicity of different botanicals was justified at different concentrations. The highest number of dead larvae at 5% concentration was found at T_1 treatment (72.2%) after four hour. The treatments were found significant at 1% and 5% level of significance (Figure 5). But rest of the treatments showed very poor result.

At 10% concentration 100% larvae were died after 4 hours and the trend of mean value was $T_1>T_2>T_3>T_4>T_5>T_{0.}$ The treatments were found significant at 1% and 5% level of significance (Figure 6). Both T_1 and T_2 treatments were found significantly different comparison with other treatments. After 3 hoursT_1 treatment at 10% concentration yielded almost similar result which found after 4 hours at 5% concentration. So, 10% concentration gives rapid results. The farmer in our country desire rapid results hence, 10% concentration recommendable.

After four hour at 15% concentration the trend of mean value was $T_1>T_2>T_3>T_4>T_5>T_0$ and the treatments were found significant at 1% and 5% level of significance (Figure 7). T1, T_2 and T_3 treatments were found significantly different comparison with other treatments. But the mean value and calculated F value of all treatments both in 10% concentration and 15% concentration were more or less same. After 3 hoursT_1 treatment at 15% concentration gives almost similar result which found after 4 hours at 5% concentration. But after 3 hours both 10% and 15% concentration

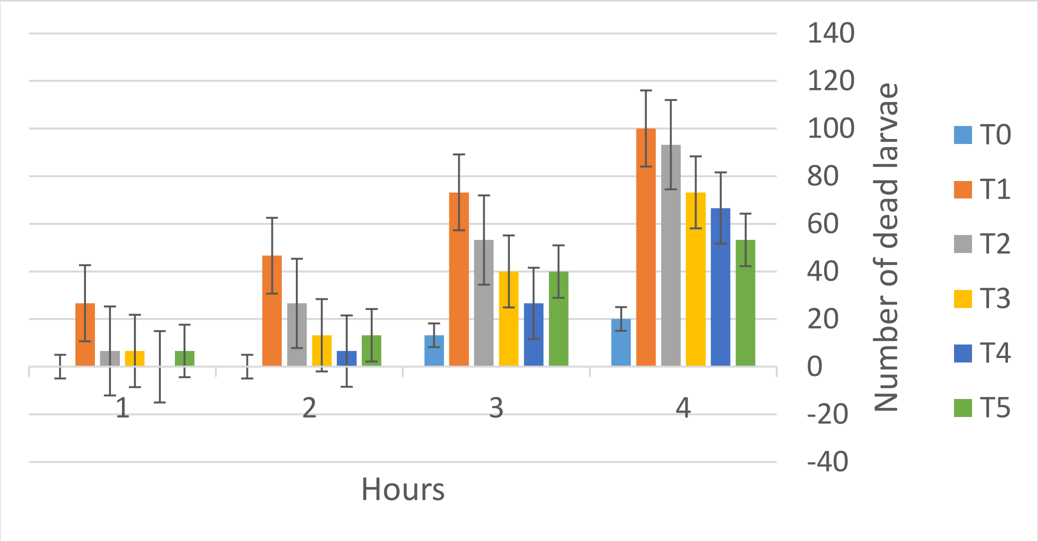

Figure 6. Justification of toxicity of different treatments at 10% Concentration.

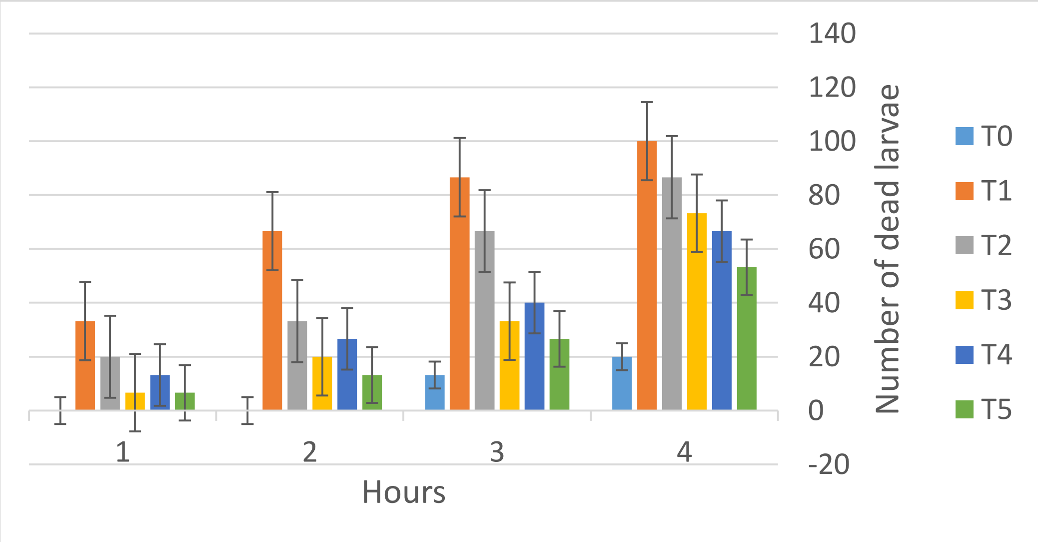

Figure 7. Justification of toxicity of different treatments at 15% Concentration.

yielded almost similar results. Wasting of any properties is not desirable so, 10% concentration suggested.

In the above discussion, it was clear that tested botanicals have toxicity at different level but T_1(leaves of bishkathali) performed the highest toxicity to the larvae after 4 hours treatment and 10% concentration of each extract found more effective than 5% concentration.

Conclusion

Use of synthetic insecticides is costly and very much harmful not only for crops and beneficial insects in the field but also for both mammal and the environment where as botanicals are cheaper, locally available and hazard free as compared to the synthetic insecticides. Therefore among all treated botanicals in this experiment biskathali leaf extract (10% of aqueous *Polygonum hydropiper* L. leaves extract) and neem flower extract (10% of aqueous *Azadirachta indica* flowers extract) can be the right choice considering all aspects of life for controlling sweetpotato whitefly and brinjal lace bug in the field of tomato and brinjal, respectively.

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