STUDY ON THE BIOLOGY OF MEALYBUG INFESTING BRINJAL AND ITS CHEMICAL CONTROL

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STUDY ON THE BIOLOGY OF MEALYBUG INFESTING BRINJAL AND ITS CHEMICAL CONTROL

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CERTIFICATE

This is to certify that thesis entitled **"STUDY ON THE BIOLOGY OF MEALYBUG INFESTING BRINJAL AND ITS CHEMICAL CONTROL"** submitted to the **Faculty of Agriculture,** Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) IN ENTOMOLOGY**, embodies the result of a piece of bona fide research work carried out by **SWAKKOR SAHA, Registration no. 13-05788** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: DECEMBER, 2014
Place: Dhaka, Bangladesh

Prof. Dr. Mohammed Ali
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LIST OF ABBREVIATIONS AND ACRONYMS

Sl. No.	Abbreviation	Full meaning
1.	AEZ	Agro-Ecological Zone
2.	CV	Coefficient of variation
3.	^{o}C	Degree Celsius
4.	DAE	Department of Agricultural Extension

5.	DAT	Days After Transplanting
6.	*et al.*	and others
7.	etc.	etcetera
8.	EC	Emulsifiable Concentrate
9.	FAO	Food and Agriculture Organization
10.	Fig.	Figure
11.	G	Gram
12.	Ha	Hectare
13.	J.	Journal
14.	Kg	Kilogram
15.	LSD	Least Significant Difference
16.	m	Meter
17.	mm	Millimeter
18.	^{o}N	Degree North
19.	%	Percent
20.	p^{H}	Hydrogen ion concentration
21.	RCBD	Randomized Complete Block Design
22.	^{o}S	Degree South
23.	SAU	Sher-e-Bangla Agricultural University
24.	SRDI	Soil Resource Development Institute
25.	T	Ton

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December, 2014 **The Author**

SAU, Dhaka

STUDY ON THE BIOLOGY OF MEALYBUG INFESTING BRINJAL AND ITS CHEMICAL CONTROL

SWAKKOR SAHA

ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka to evaluate the biology of mealybug and effect of some chemical insecticides on mealybug attacking brinjal in the field during the period from June, 2014 to October, 2014. Mean developmental periods of 1^{st}, 2^{nd}, 3^{rd}, instar nymphs and adults were 5.6, 8.4, 9.8 and 12 days respectively. Six insecticides were applied in replicated brinjal field. The treatments were T_1: T-mectin 1.8 EC (Abamectin) @ 2.0 ml/L of water at 7 days interval; T_2: Fighter 2.5 EC (Lambda cyhalothrin @ 1.0 ml/L of water at 7 days interval); T_3: Voliam flexi (Thiamethoxam + Chlorantraniliprole @ 1.0 ml/L of water at 7 days interval); T_4: Sevin 85 WP (Carbaryl @ 2.0 g/L of water at 7 days interval); T_5: Dursban 20 EC (Chlorpyriphos @ 2.5 ml/L of water at 7 days interval); T_6 : Admire 200SL (Imidachloprid @ 1.0 ml/L of water at 7 days interval); and T_7 (untreated control). The result revealed that treatment T_5 (Dursban @ 2.5ml/L of water) treatment was the most effective for reducing mealybug 90.22, 67.37, 64.22 and 83.84 respectively from leaf, twig, flower and fruits. The treatment T_3 showed 77.17, 56.84, 45.87 and 56.57 respectively for reduction of these insect pests from those plant parts and T_6 had the least performance over control. Dursban was also most effective insecticide for increasing fruit number and weight per fruit 205.83 and 41.23% respectively and in T_6 it was 50 and 11.57% respectively. In terms of yield Dursban treatment was most effective increasing yield (130.23%) followed by T_3(100.2%) and T_1 (63.66%) treated plot. The application of Dursban at 7 days intervals was the best effective treatment for the control of mealybug pests in the brinjal field.

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CHAPTER I

INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. The name brinjal is popular in Indian subcontinent and is derived from Arabic and Sanskrit whereas the name eggplant has been derived from the shape of the fruit of some varieties, which are white and resemble in shape to chicken eggs. It is also called aubergine (French word) in Europe. The brinjal is of much importance in the warm areas of Far East, being grown extensively in India, Bangladesh, Pakistan, China and the Philippines. It is also popular in Egypt, France, Italy and United States. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A number of cultivars are grown in Bangladesh, consumer preference being dependent upon fruit color, size and shape. Asia accounts for about 94 percent of the world eggplant area, with about 92 per cent of world output (Shriwas *et. al*., 2015)

Brinjal fruit (unripe) is primarily consumed as cooked vegetable in various ways and dried shoots are used as fuel in rural areas. It is low in calories and fats, contains mostly water, some protein, fibre and carbohydrates. It is a good source of minerals and vitamins and is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients.

It has been reported that on an average, the oblong-fruited eggplant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of

free reducing sugars, anthocyanin, phenols, glycoalkaloids (such as solasodine), dry matter, and amide proteins (Bajaj *et al*., 1979). A high anthocyanin content and a low glycoalkaloid content are considered essential, regardless of how the fruit is to be used. For processing purposes, the fruit should have a high dry matter content and a low level of phenolics. Bitterness in eggplant is due to the presence of glycoalkaloids which are of wide occurrence in plants of Solanaceae family. The glycoalkaloid contents in the Indian commercial cultivars vary from 0.37 mg/100 g fresh weight to 4.83 mg) (Bajaj *et al*., 1981). Generally, the high content of glycoalkaloids (20 mg/100g fresh weight) produce a bitter taste and off flavor. The discoloration in eggplant fruit is attributed to high polyphenol oxiDASe activity. The cultivars which are least susceptible to discoloration are considered suitable for processing purposes.

Brinjal is known to have ayurvedic medicinal properties and is good for diabetic patients. It has also been recommended as an excellent remedy for those suffering from liver complaints (Shukla and Naik, 1993).

Brinjal consists of almost 95 percent of water and is superior in terms of fiber, folic acid, manganese, thiamin, Vitamin B6, magnesium and potassium contents to that of most other vegetables. It has no fat and supplies 25 calories per serving.

Though Bangladesh produced with 340,000 tons of brinjal only about 1.1 percent of the world's production in 2007, brinjal is one of the most important vegetables like in other South Asian countries. Brinjal is third most important vegetable in Bangladesh, only surpassed by potatoes and onions. In Bangladesh, over64,208 hectare of total cultivable land is devoted to brinjal cultivation.

The main problem with growing brinjal is that the yield of brinjal is decimated by a dozen of insect pest species. Incidence of insect pests is one of the prime factors in

reduction of yield. The major pests include brinjal fruit and shoot borer, leaf hopper, whitefly, thrips, aphid, spotted beetles, leaf roller, stem borer, blister beetle, red spider mite, and disease like little leaf of brinjal. Recently, increased build up of various mealybug species in crop plants and wild species observed is mainly due to certain abiotic changes in environment. Recently, among the mealybug species, the brinjal mealybug *Centrococcus insolitus* (Hemiptera: pseudococcidae) cause damage to brinjal from the early stage of the crop growth to harvest. Both nymphs and adults suck the sap from leaves causing withering and yellowing of leaves and sometimes resulting in sooty mould on the upper surface of the leaves. Fruit may drop prematurely. Heavy infestation can cause defoliation and even death of the plant.

Biological control of mealybugs has been practiced in different parts of the world, particularly on fruits such as citrus and avocado, where certain native and introduced parasitoids have provided good control. However mealybug outbreaks require the use of insecticides due to their rapid growth as compared to the predators and parasitoids (Bartlett 1978; Wysoki *et al*., 1981). Considering the above points in view, present study was undertaken with the following objectives:

Objectives

- To study the biology of mealybug infesting brinjal.
- To identify the mealybug species infesting brinjal.
- To determine the effect of some insecticides against brinjal mealybug.

CHAPTER II

REVIEW OF LITERATURE

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. Brinjal is ranked third important vegetable in Bangladesh, after surpassed by potatoes and onions. Brinjal has a great economic importance in the Bangladesh as a major vegetable.

2.1 General review on brinjal

The varieties of *Solanum melongena* L. display a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. Most of the commercially important varieties have been selected from the long established types of the tropical India and China. Brinjal fruit (unripe) is primarily consumed as cooked vegetable in various ways and dried shoots are used as fuel in rural areas. It is low in calories and fats, contains mostly water, some protein, fiber and carbohydrates. It is a good source of minerals and vitamins and is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients. It is grown from 58^{o}N to 40^{o}S, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rainfall per year and with a growing cycle ranging from 3 to 6 months (Metcalf and Metcalf, 1993).

2.2 Taxonomy

Brinjal belongs to the family Solanaceae and is known under the botanical name *Solanum melongena* L. The family contains 75 genera and over 2000 species, out of which, about 150-200 are tuber bearing and belong to section Tuberarium. The majority of species (about 1800) are non tuber bearing. Cytological studies have

indicated that basic chromosomal number *2n* = 24 is same in almost all the varieties and species. There are 3 main botanical varieties under the species *melongena* (Choudhury, 1976). The common brinjal, to which large, round or egg shaped fruited forms belong, are grouped under var. *esculentum.* The long, slender types are included under var. *serpentinum* and the dwarf brinjal plants are put under var. *depressum*.

2.3. Geographic origin and distribution of brinjal

Brinjal is considered a native to India where the major domestication of large fruited cultivars occurred. Tokihiro (1886) stated in his "Origin of cultivated plants" that the species *S. melongena* has been known in India from ancient times and regarded it as a native of Asia. Vavilov (1928) opined that its centre of origin was in the Indo-Burma region. Various forms, colors and shapes of brinjal are found throughout South-East Asia, suggesting that this area is an important centre of variation. A centre of diversity is believed to be in the region of Bangladesh and Myanmar (Former India-Burma border). Evidence to this was given by Isshiki *et al*. (1994) based on the iso enzyme and morphological variation noticed in large germplasm collection from India. According to Zeven and Zhukovsky (1975), it originated in India but spread eastward and by the 5^{th}century B.C. was in China, which became a secondary centre of variation. Thus, it has been known for the last 1500 years in China. Arabic traders were responsible for subsequent movement to Africa and Spain. Brinjal cultivation in the Mediterranean region is relatively recent. Portuguese colonies took it to Brazil. It is now widely cultivated for its fruits in the tropical, subtropical and warm temperate zones, especially in Southern Europe and the Southern United States. Sampson (1936), suggested the African origin of this crop, but there is no evidence that *S. melongena* is native there though there are spiny African brinjal plants.

2.4. Variety of brinjal cultivated in Bangladesh

Recently the Bangladesh agriculture research institute developed 5 varieties i.e, *Uttara, Shuktara* (hybrid), *Tarapuri* (hybrid), *Nayantara* and *Kazla* (Bengali name). *Singnath* (Bengali name) is also a popular variety of brinjal in bangladesh.

2.5 General review on brinjal mealybug

The brinjal mealybug, *Centrococcus insolitus* (Hemiptera: Pseudococcidae) is a small polyphagous sucking insect with pest status that attacks several genera of host plants, including economically important tropical fruits, vegetables and ornamentals. Infestation of the mealybug appears as clusters of cotton-like masses on the above-ground portion of plants with long waxy filaments. Immature and adult stages of *C. insolitus* suck the sap of the plant and weaken it. The leaves become crinkled, yellowish and wither. The honeydew excreted by the bug and the associated black sooty mould formation impairs photosynthetic efficiency of the affected plants. Brinjal mealybug has caused havoc in agricultural and horticultural crops ever since its first report from Coimbatore in 2007. According to CAB International (2006) that the insect assumed the status of a major pest in 2009 when it caused severe damage to economically important crops and huge losses to farmers in Coimbatore, Erode, Tirupur and Salem districts of Tamil Nadu. In the same year, standing mulberry crop over 1,500 hectares in Tirupur was destroyed by the pest leading to enormous financial losses to mulberry growers across the district.

2.6. Origin and distribution

According to Williams and Watson (1988) that the brinjal mealybug is believed to be native of Mexico and/or Central America, where it never acquired the status of a serious pest, probably due to the presence of an endemic natural enemy complex. The specimens of the pest were collected first in 1955 in Mexico but it was described in 1992 from the Neo tropical Region in Belize, Costa Rica, Guatemala, and Mexico. Brinjal mealybug became a pest when it invaded the Caribbean region. Since 1994 it has been recorded in 14 Caribbean countries. The pest was recorded in Bradenton, Florida in 1998 on Hibiscus and by January 2002 it spread to 18 different plant species in 30 different cities. The establishment of this mealybug in Guam in 2002 and Palau in 2003 resulted in further spread to neighboring Hawaiian Islands in the Pacific. According to Arif *et. al.* (2009) that it was noticed in South and Southeast Asia during 2008–09. In India it was recorded in July 2007 at Tamil Nadu Agricultural University, Coimbatore and subsequently spread to neighboring countries.

2.7. Morphology

The adult female is yellowish, approximately 2.2 mm long and 1.4 mm wide and is covered with a white waxy coating. A series of short waxy caudal filaments, less than 1/4th the length of the body exists around the margin. Adult males are, yellowish, especially during the pre-pupal and pupal stages, but appear yellow in the first and second instars. Adult males are approximately 1.0 mm long, with an elongate oval body that is widest at the thorax (0.3 mm) (Williams,2004). Adult males have ten-segmented antennae, a distinct aedeagus, lateral pore clusters, a heavily sclerotized thorax and head, and well-developed wings. Two characteristics that are important in distinguishing *C. insolitus* adult females from all other species of *Centrococcus* are:

the presence of oral-rim tubular ducts dorsally restricted to marginal areas of the body, and the absence of pores on the hind tibiae. The female brinjal mealybug can easily be identified by the presence of eight antennal segments, in contrast to nine in pink hibiscus mealybug, (*Maconellicoccus marginatus).* Ovisac is three to four times the body length and develops ventrally beneath the body of the female. When pressed, the body fluid of yellow color comes out.

2.8. Host plants

Heavy attack of brinjal mealybug has been noticed on wider range of cultivated crops and weed hosts belonging to different families of plant kingdom. The following table provides the list of recorded hosts of *C. insolitus*.

Table: List of recorded hosts of brinjal mealybug, *C. insolitus* according to Abbas et. *al.* (2006)

Host category	Botanical name	Common name	Family
Cultivated agricultural and horticultural crops	*Cajanus cajan* L.	Redgram	Leguminaceae
	Carica papaya L.	Papaya	Caricaceae
	Ceiba pentandra (L.) Gaertn.	Silk cotton	Malvaceae
	Jatropha curcus L.	Jatropha	Euphorbiaceae
	Gossypium hirsutum L.	Cotton	Malvaceae
	Hibiscus rosasinensis L.	Shoe flower	Malvaceae
	Lycopersicon esculentum Mill.	Tomato	Solanaceae
	Solanum melongena L.	Brinjal	Solanaceae
	Ocimum sanctum L.	Tulsi	Lamiaceae

2.9. Damage symptoms

Brinjal mealybug infestation appears on above ground parts on leaves, stem and fruits as clusters of cotton-like masses. The insect sucks the sap by inserting its stylets into the epidermis of the leaf, fruit, twig and other plant parts. While feeding, it injects a toxic substance into the leaves, resulting in chlorosis, plant stunting, leaf deformation

or crinkling, early leaf and fruit drop, and death of plants. The honeydew excreted by the bug results in the formation of black sooty mould which interferes in the photosynthesis process and causes further damage to the crops. Heavy infestations are capable of rendering fruit inedible due to the buildup of thick white waxy coating.

2.10. Biology

Brinjal mealybugs are most active in warm, dry weather. Females have no wings, and move by crawling short distances or by being blown in air currents. Females usually lay 100 to 600 eggs. Eggs are greenish yellow and are laid in an ovisac sac that is three to four times the body length and entirely covered with white wax. The ovisac is developed ventrally on the adult female. Egg-laying usually continuous over a period of one to two weeks. Eggs hatch in about 10 days, and nymphs or crawlers begin to actively search for feeding sites. Adult males may be distinguished from other related species by the presence of stout fleshy setae on the antennae and the absence of fleshy setae on the legs. Adult females attract the males with sex pheromones.

2.11. Factors responsible for high population build up

With rapid development, high survival rate, and enormous reproductive capacity, *C. insolitus* population could potentially reach a high level. Wax layer and waxy fibers over the ovisac and body of mealybug nymphs and adult females protect them from adverse environmental conditions and routine chemical pesticides. Availability of alternate hosts / weeds around fields not cared by cultivators. Movement of crawlers through air, irrigation water or farm equipment helps in fast spread of the mealybug from infested field to healthy fields. Wider acceptability of hosts by brinjal mealybug and its subsequent adaptability on them (Banks, 1998).

2.12. Association with ants

Mealybugs are known to offer ants with their sugary excretion (honeydew) and in return ants help in spreading the mealybugs and provide protection from predator ladybird beetles, parasites and other natural enemies. Ants also keep the brinjal mealybug colony clean from detritus. Association of ant, *Oecophylla smaragdina* with brinjal mealybug on jatropha and custard apple that accumulate in the secreted honeydew, which may be harmful to the colony. Species of ant, *Oecophylla smaragdina* has been found attending brinjal mealybug, feeding on honeydew on jatropha, brinjal and other plants.

2.13. Management strategies

Mealybug control often involves the control of attendant ants that are important for the proper development of mealybugs. Without the ants, mealybug populations are small and slow to invade new areas and the field would be free of a serious mealybug infestation. Therefore, management of mealybugs often includes the control of ant species. For management of mealybugs, it is important to know the species present as management programs for the various mealybugs may differ. Plant protection products are of limited effectiveness against mealybugs because of the presence of waxy covering of its body. Management of mealybug involves the following tactics:

2.14. Cultural and mechanical

Monitoring and scouting to detect early presence of the mealybug. Pruning of infested branches and burning them regularly. Removal of weeds/alternate host plants like *Hibiscus*, *Parthenium* etc. in and nearby crop. Avoiding the movement of planting

material from infested areas to other areas. Avoiding flood irrigation. Prevention of the movement of ants and destruction of already existing ant colonies. Sanitization of farm equipment before moving it to the uninfected crop. Application of sticky bands or alkathene sheet or a band of insecticide on arms or on main stem to prevent movement of crawlers.

2.15. Phytosanitary measures

It is relatively easy to detect mealybugs by inspection, so the basic requirement that imported consignments of plants for planting should be free from the pest can be fulfilled by inspection. Monitoring the movement of fresh farm produce, including flowers, between countries as well as between States of our country is the first step in controlling any spread within the region. This applies to both the import/export trade and to passenger traffic. *M. hirsutus* was added in 2003 to the European and Mediterranean Plant Protection Organization (EPPO) A1 Action List, and endangered EPPO member countries have recommended regulating it as a quarantine pest. Similar case is required for brinjal mealybug.

2.16. Chemical control

Chemical control is only partially effective and requires multiple applications. Locate ant colonies and destroy them with drenching of chlorpyriphos 20 EC @ 2 .0 ml/litre of water. Apply recommended chemical insecticides as the last resort such asprofenophos 50 EC (2 ml/litre), chlorpyriphos 20 EC (2ml/litre), buprofezin 25EC (2 ml/litre), dimethoate 30 EC (2 ml/litre), thiomethoxam 25 WG (0.6 g/litre), imidacloprid 17.8 SL (0.6 ml/litre). Spray profenophos @ 2 ml / litre on stumps immediately after pruning in mulberry followed by second spray, 15 days after pruning, with dichlorvos @2 ml /litre along with azadirachtin (10000 ppm) @ 1 ml/ litre. Stickers should always be added in spray solutions. Avoid repeating the use of

the same chemical insecticide as there are chances for development of resistance in the pest. Drenching soil with chlorpyriphos around the collar region of the plant to prevent movement of crawlers of mealybug and ant activity is useful.

CHAPTER III

METERIELS AND METHODS

This chapter deals with the materials and methods that were used in conducting the experiment. It consists of a short description of location of' the experimental plot, characteristics of soil, climate, material used, treatments, Layout and design of experiment, land preparation and gap filling, after cares, harvesting, and collection of data. These are described below:

3.1 Location of the experimental plot

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from June 2014 to October 2014. The site is 22^0 46' N and $90^0$22'E Latitude and at Altitude of 9m from the sea level.

3.2 Soil

Initial soil samples from 0-15 cm depth were collected from experimental field. The collected samples were analyzed at Soil Resources Development Institute (SRDI), Dhaka, Bangladesh. The soil was silty clay in texture having 26% sand, 45% silt and 29% clay and the pH was 5.6. The physicochemical properties of the soil are presented in Appendix I. The experimental site belongs to the Madhupur Tract Agro Ecological Zone (AEZ-28) as shown in Appendix III. The experimental site was a medium high land.

3.3 Climate

The climate of experimental site was under the subtropical climate; characterized the monsoon period from June to October (Edris *et al*., 1979). The average maximum temperature during the period of experiment was32°C and the average minimum temperature was 27°C. Details of the meteorological data related to the temperature, relative humidity and rainfalls during the period of the experiment was collected from the Bangladesh Meteorological Department, Dhaka and presented in Appendix II.

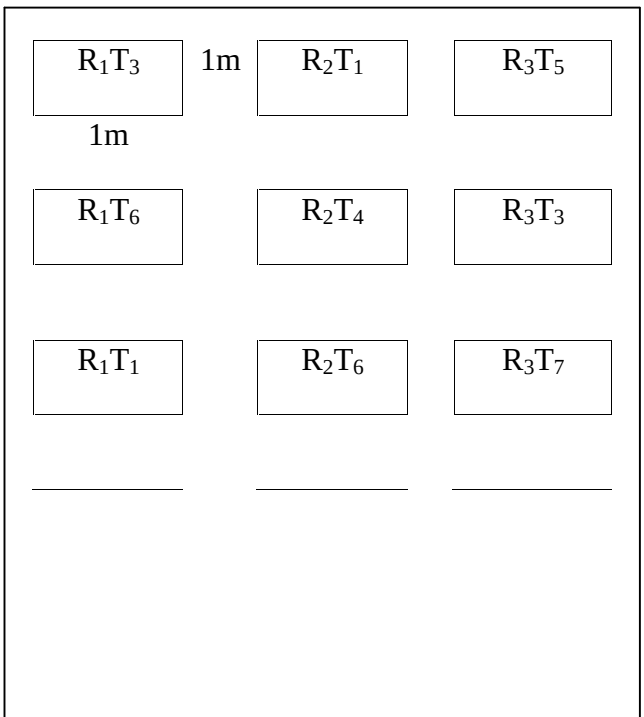
3.4 Transplanting materials used for experiment

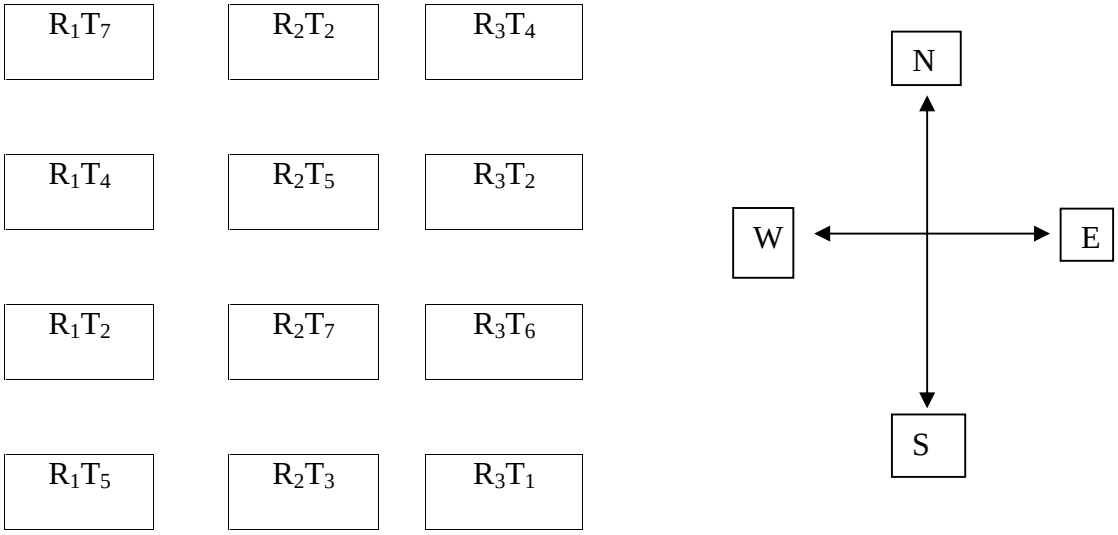
Seeds of brinjal variety *Singnath* (Bengali name) were used as a test crop for the study and the seeds of this variety were collected from department of entomology, Sher-e-Bangla Agricultural University, Dhaka.

3.5 Experimental Design

The experiment was conducted considering seven treatments and laid out in a Randomized Complete Block Design (RCBD). Each treatment was allocated randomly in three replications.

Field Layout





The unit plot size was 3 m × 2m and 1m between the plots. Each plot contains four rows having 75cm distance between the row and that between plants was 25 cm. The above table shows the design of the experimental plot.

3.6 Recommended fertilizer dose

Manure/fertilizer	Dose (Kg/ha)	Dose/unit plot $6m^2$ (3m × 2m)
Urea	150kg	0.4Kg
TSP	90kg	0.2 kg
MP	80kg	0.2 kg
Zypsum	200g	13g

3.7 Treatments of the experiment

Treatment	Common name	Trade name	Dose

T_1	Abamectin	T-mectin 1.8 EC	@ 2.0 ml/L of water at 7 days interval
T_2	Lambda-cyhalothrin	Fighter 2.5 EC	@ 1.0 ml/L of water at 7 days interval
T_3	Thiamethoxam + Chlorantraniliprole	Voliam flexi 300 SC	@ 1.0 ml/L of water at 7 days interval
T_4	Carbaryl	Sevin 85 WP	@ 2.0 g/L of water at 7 days interval
T_5	Chlorpyriphos	Dursban 20 EC	@ 2.5 ml/L of water at 7 days interval
T_6	Imidacloprid	Admire 200 SL	@ 1.0 ml/L of water at 7 days interval
T_7	untreated control		

3.8 Seed processing and treatment

The seeds of *Singnath* variety of Brinjal were collected from department of Sher-e-Bangla Agricultural University. Germination test was done before sowing. The rate of germination was found to be more than 95%. The seeds were treated with Vitavax 200 at the rate of 2 g per kg seed to protect seedlings against different diseases.

3.9 Land preparation

The experimental field was first opened on June 3, 2014 with the help of a power tiller and prepared by three successive ploughing and cross-ploughings. Each ploughing was followed by laddering to have a desirable fine tilth. The visible larger clods were hammered to break into small pieces. All kinds of weeds and residues of previous crop were removed from the field. Individual plots were cleaned and finally leveled with the help of wooden plank.

Transplanting of seeds**:** The seeds of brinjal were transplanted on 14June 2014.

3.10 Intercultural operations

Intercultural operations like thinning, weeding and earthen up were done as and when necessary for proper growth and development of the crop.

3.10.1 Drainage

Stagnant water effectively drained out at the time of heavy rains.

3.10.2 Irrigation

Five irrigations were given throughout the growing period. The first irrigation was given at 7 days after planting followed by irrigation 15 days after the first irrigation and the other were done in the same way. Earthen up was also done by raising the soil.

Plate 1: Leaf infestation by mealybug at experimental plot

Plate 2: Mealybug association with ant

Plate 3: Flower & twig infestation by mealybug at experimental plot

Plate 4: Fruit infestation by mealybug at experimental plot

3.11 Harvesting

The matured vegetables were harvested and separated under plot wise. The yield obtained from each plot was converted into yield per hectare.

3.12 Biology of the brinjal mealybug

To determine the duration of different stages/ instars of brinjal mealybug, 5 infested leaves were randomly selected from control plot and were covered by fine-meshed net separately. The netted leaves were observed daily at 10.00 am. The duration of each stage were counted independently. To detect each instar, few mealybugs were collected daily from each sample by using camel hair brush and were examined under stereo-microscope.

3.13 Data collection

The data on the following parameters were recorded at different time intervals as given below:

- Number of infested leaf/plant

For the estimation of no. of infested leaf/Plant, 5 plants were randomly selected from each plot, each time. The number of infested leaf/plant on each plant was counted and recorded. The means of infested leaf per plant was calculated for the determination of no. of infested leaf/Plant.

- Number of healthy leaf/plant

For the estimation of no. of healthy leaf/Plant, 5 plants were randomly selected from each plot, each time. The number of healthy leaf/plant on each plant was counted and recorded. The means of healthy leaf per plant was calculated for the determination of no. of healthy leaf/Plant.

- Number of infested fruits/plant

For the estimation of no. of infested fruits/plant, 5 plants were randomly selected from each plot, each time. The number of infested fruits/plant on each plant was counted and recorded. The means of infested fruits per plant was calculated for the determination of no. of infested fruits/plant.

- Number of Mealybug/plant

For the estimation of no. of Mealybug/plant, 5 plants were randomly selected from each plot, each time. The number of mealybug/plant on each plant was counted and recorded. The means of mealybug per plant was calculated for the determination of no. of mealybug /Plant.

- Number of infested twigs/plant

For the estimation of no. of infested twigs/plant, 5 plants were randomly selected from each plot, each time. The number of twigs/plant on each plant was counted and

recorded. The means of infested twigs per plant was calculated for the determination of no. of twigs /Plant.

- Number of healthy fruits/plant

For the estimation of no. of healthy fruits/plant, 5 plants were randomly selected from each plot, each time. The number of healthy fruits /plant on each plant was counted and recorded. The means of healthy fruits per plant was calculated for the determination of no. of healthy fruits/Plant.

- Percent leaf infestation
- Percent shoot infestation
- Percent fruit infestation
- Single fruit weight

For the estimation of single fruit weight, 5 plants were randomly selected from each plot, each time. The weight of single fruit on each plot was counted and recorded. The means of single fruit weight per plot was calculated for the determination of single fruit weight.

- Yield data

For the estimation of yield weight, 5 plants were randomly selected from each plot, each time. The weight of each fruit on each plot was counted and recorded. The means of each fruit weight per plot was calculated for the determination of yield weight.

3.14 Calculation of the recorded data

The data recorded on different parameters were calculated using the following formula:

$$\% \text{ fruit infestation} = \frac{\text{No. of infested fruit}}{\text{Total no. fruit}} \times 100$$

% increase or decrease over control

$$= \frac{\text{Mean value of treated plot} - \text{Mean value of untreated plot}}{\text{Mean value of untreated plot}} \times 100$$

3.15Statistical Analysis

The collected data on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-C computer package program developed by Russell (1986). The mean differences among the treatments were adjusted by using Least Significant Difference (LSD) test at 0.05 level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and explanation of the results obtained from the experiment on biology and chemical control of brinjal mealybug. The data have been presented and discussed and possible interpretations are made under the following headings:

4.1 Duration of different life stages of brinjal mealybug (*C. insolitus*) on brinjal plant in the field

The adult females produced white foam like egg sac within this ovisac. Each female produced one ovisac. The 1st instar nymph moulted to 2nd instar. After that 2nd instar nymph moulted to 3rd instar and 3rd instar moulted to adult brinjal mealybug (*C.insolitus*). After moulting, the adult casted and exuvae and started to feed. Newly moulted nymphs were yellowish but after one day they became whitish in color. Mean developmental periods of 1st instar, 2nd instar, 3rd instar and adult were 5.6, 8.4, 9.8, and 12 days respectively. The modes of reproduction were parthenogenesis and amphimictic. The life span of brinjal mealybug ranged 31-36 days. The average life

span of brinjal mealybug were 34 days. Length of different instars (days), mean, standard deviations are given table.

Table 1:Duration of different life stages of brinjal mealybug (*C. insolitus*) on brinjal plant in the field

Length of different instars (Days)	Range	Mean	Standard deviation	No. of observation
1st instar	5-7	5.6	±0.89	5
2nd instar	7-9	8.4	±0.89	5
3rd instar	9-12	9.8	±1.30	5
Adult	11-14	12	±1.41	5
Life span	31-36	34	±1.92	5

4.2Effect of insecticidal treatment on the leaf infestation by mealybug in the brinjal field at different days after transplanting

The effect of different insecticides on the leaf infestation by brinjal mealybug are shown in Table 2. Percentage of leaf infestation (0.85) and (0.72) were found in T_6 (7.61) and T_2 (21.74) respectively. Lowest leaf infestation was observed in T_5 (90.22) treatment which was statistically different from other treatments.

In terms of percent leaf infestation reduction over control all treatment reduced considerable amount of leaf damage by mealybug over control as shown in the Table 2.The highest percent reduction of leaf infestation (90.22%) was recorded in T_5 treated plots followed by T_3 (77.17%) treated plots during cropping season.

Table 2: Effect of insecticidal treatment on the leaf infestation by mealybug in the brinjal field

Treatments	Infestation of mealybug (no.of infested leaf/plant) throughout the growing period				
	30 DAT	**37 DAT**	**44 DAT**	**Mean**	**% reduction over control**
T_1	0.59 d	0.49 d	0.60 c	0.56 e	39.13
T_2	0.73 c	0.70 bc	0.73 b	0.72 c	21.74
T_3	0.23 e	0.19 e	0.23 d	0.21 f	77.17
T_4	0.71 c	0.57 cd	0.64 bc	0.64 d	30.43
T_5	0.08 f	0.08 e	0.12 d	0.09 g	90.22
T_6	0.84 b	0.81 ab	0.91 a	0.85 b	7.61
T_7	0.95 a	0.91 a	0.91 a	0.92 a	-
$LSD_{(0.05)}$	0.10	0.14	0.13	0.056	-
CV (%)	9.59	14.16	12.23	5.18	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment in decreasing leaf infestation (90.22%) during the management of mealybug followed by Voliam flexi (T_3) (77.17%). In case of other treatments in decreasing leaf infestation during the management of mealybug were 39.13%, 30.43%, 21.74% and 7.61% in T-mectin (T_1), Sevin (T_4), Lambda cyhalothrin (T_2) and Admire (T_6), respectively. As a result, the order of efficacy in terms of decreasing the percent leaf infestation is $T_5>T_3>T_1>T_4>T_2>T_6$.

4.3 Effect of insecticidal treatment on the twig infestation by mealybug in the brinjal field at different days after transplanting(DAT)

The data on the effect of different treatments on the twig infestation by mealybug in the brinjal field is shown in Table 3. The data indicate that the highest (0.95) twig infestation was found in T_7 untreated control plot which was statistically similar to T_6 (0.89). The lowest (0.31) infestation was found in T_5 treated plot followed by T_3 (0.41), T_1 (0.60), T_4 (0.73) and T_2 (0.85) respectively has significant difference among different treatment.

In terms of percent twig infestation reduction over control all treatment reduced considerable amount of twig damage over control as shown in the Table 3.The highest percent reduction of twig infestation (67.37%) was recorded in T_5 treated plots followed by T_3 (56.84%), T_1 (36.84%), T_4 (23.16%), T_2(10.53%) and T_6 (6.32%) treated plots, respectively during cropping season.

Table 3: Effect of insecticides treatments on the twig infestation by mealybug in the brinjal field at different days after transplanting (DAT)

Treatments	Infestation of mealybug (no.infested twig/plant) throughout the growing period				
	30 DAT	**37 DAT**	**44 DAT**	**Mean**	**% reduction over control**
T_1	0.60c	0.59b	0.61c	0.60d	36.84
T_2	0.84b	0.87a	0.85ab	0.85b	10.53
T_3	0.51cd	0.29c	0.44d	0.41e	56.84
T_4	0.75b	0.71b	0.75b	0.73c	23.16
T_5	0.40d	0.28c	0.24e	0.31f	67.37
T_6	0.88ab	0.91a	0.89a	0.89ab	6.32
T_7	1.01a	1.00a	0.83ab	0.95a	-
$LSD_{(0.05)}$	0.14	0.15	0.13	0.06	-
CV (%)	10.53	12.16	10.65	4.14	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (67.37%) in decreasing twig infestation during the management of mealybug followed by Voliam flexi (T_3) (56.84%). In case of other treatments in decreasing twig infestation were 36.84%, 23.16%, 10.53% and 6.32% in T-mectin (T_1), Sevin (T_4), Lambda cyhalothrin (T_2) and Admire (T_6), respectively. . As a result, the order of efficacy in terms of decreasing the percent twig infestation is $T_5>T_3>T_1>T_4>T_2>T_6$.

4.4 Effect of insecticidal treatment on the flower infestation by mealybug in the brinjal field at different days after transplanting (DAT)

The data on the effect of different treatments on the flower infestation by mealybug in the brinjal field at different days after transplanting (DAT) are shown in Table 4. The data indicate that the highest (1.09) flower infestation was found in T_7 untreated control plot followed by T_6 (0.97). Statistically similar result was found in T_4 (0.84) and T_2 (0.83) treatments. The lowest (0.39) infestation was found in T_5 treated plot.

In terms of percent flower infestation reduction over control all treatment reduced considerable amount of flower damage over control as shown in the Table 4. The highest percent reduction of flower infestation (64.22%) was recorded in T_5 treated plots followed by T_3 (45.87%), T_1 (33.03%), T_2 (23.85%), T_4(22.94%) and T_6 (11.01%) treated plots, respectively during cropping season.

Table 4: Effect of insecticidal treatment on the flower infestation by mealybug in the brinjal field at different days after transplanting (DAT)

Treatments	infestation of mealybug (no. of flower/plant) throughout the growing period				
	30 DAT	**37 DAT**	**44 DAT**	**Mean**	**%reduction over control**
T_1	0.80d	0.71d	0.69c	0.73d	33.03
T_2	0.91c	0.86bc	0.73bc	0.83c	23.85
T_3	0.69e	0.52e	0.55d	0.59e	45.87
T_4	0.92c	0.79cd	0.81b	0.84c	22.94
T_5	0.47f	0.39f	0.31e	0.39f	64.22
T_6	1.02b	0.93ab	0.96a	0.97b	11.01
T_7	1.21a	1.04a	1.03a	1.09a	-
$LSD_{(0.05)}$	0.10	0.13	0.11	0.06	-
CV (%)	6.10	9.14	8.33	3.82	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (64.22%) in decreasing flower infestation during the management of mealybug followed by Voliam flexi (T_3) (45.87%). In case of other treatments in decreasing leaf infestation were 33.03%, 23.85%, 22.94% and 11.01% in T-mectin (T_1) ,lambda cyhalothrin (T_2), Sevin (T_4) and Admire (T_6), respectively. As a result, the order of efficacy in terms of decreasing the percent flower infestation is $T_5>T_3>T_1>T_2>T_4>T_6$

4.5 Effect of insecticidal treatment on the fruit infestation by mealybug in the brinjal field at different days after transplanting (DAT)

The data on the effect of different treatments on the twig infestation by mealybug in the brinjal field at different days after transplanting(DAT)are shown in Table 5.The data indicate that the highest (0.99) fruit infestation was found in T_7 untreated control plot followed by T_6 (0.91), T_2 (0.83) and T_4 (0.75) respectively. The lowest (0.16) infestation was found in T_5 treated plot followed by T_3 (0.43) and T_1 (0.55) respectively has significant difference among different treatments.

In terms of percent fruit infestation reduction over control all treatment reduced considerable amount of fruit damage over control as shown in the Table 5.The highest percent reduction of fruit infestation (83.84%) was recorded in T_5 treated plots followed by T_3 (56.57%) treated plot during cropping season.

Table 5: Effect of insecticidal treatment on the fruit infestation by mealybug in the brinjal field at different days after transplanting (DAT)

Treatments	Infestation of mealybug (no. of fruit/plant) throughout the growing period				
	30DAT	**37 DAT**	**44 DAT**	**Mean**	**% reduction over control**
T_1	0.56d	0.52c	0.56c	0.55e	44.44

T_2	0.91b	0.79b	0.79b	0.83c	16.16
T_3	0.47e	0.41d	0.40d	0.43f	56.57
T_4	0.77c	0.80b	0.67bc	0.75d	24.24
T_5	0.17f	0.19e	0.12e	0.16g	83.84
T_6	0.88b	0.88ab	0.96a	0.91b	8.08
T_7	1.05a	0.97a	0.93a	0.99a	-
$LSD_{(0.05)}$	0.08	0.10	0.14	0.21	-
CV (%)	6.91	8.39	12.02	4.41	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (83.84%) in decreasing fruit infestation during the management of mealybug followed by Voliam flexi (T_3) (56.57%). In case of other treatments in decreasing fruit infestation during the management were T-mectin (T_1) (44.44%), Sevin (T_4) (24.24%), Lambda cyhalothrin (T_2) (16.16%) and Admire (T_6) (8.08%) respectively. As a result, the order of efficacy in terms of decreasing the percent fruit infestation is $T_5>T_3>T_1>T_4>T_2>T_6$.

4.6 Effect of insecticidal treatment on the number of leaf per brinjal plant at 40 DAT

The comparative effectiveness of various treatments on the number of leaf per brinjal plant has been evaluated as well as percent (%) increase over control is presented in Table 6. The data indicated that highest (13.77 %) no. of leaf was obtained in T_4 treatment plot followed by T_6 (13.44%), T_1 (12.89%), T_3 (12.89%) andT_5 (12.56%) treated plots, respectively having no significance difference. However, the lowest (11.55%) no. of leaf was obtained in T_7 untreated control plot followed by T_2 (12.11%)treated plot having no significant difference.

In terms of percent increase of no. of leaf over control, all treatments increased considerable amount of leaf over control as shown in the Table 6.The highest (19.22%) percent increase of leaf was recorded in T_4 treated plots followed by T_6 (16.36%), T_1 (11.60%), T_3 (11.60%), T_5(8.75%) and T_2 (4.85%) treated plots, respectively during cropping season.

Table 6: Effect of insecticidal treatment on the number of leaf per brinjal plant at 40 DAT

Treatments	Number of leaf per plant	% increase (+) or decrease (-) over control
T_1	12.89 abc	11.60
T_2	12.11 bc	4.85
T_3	12.89 abc	11.60
T_4	13.77 a	19.22
T_5	12.56 abc	8.75
T_6	13.44 ab	16.36

T_7	11.55 c	-
$LSD_{(0.05)}$	1.33	-
CV (%)	5.85	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).
[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Sevin (T_4) performed as the best treatment (19.22%) in increasing leaf number followed by Admire (T_6) (16.36%). In case of other treatments in increasing leaf number during the management were T-mectin (T_1) (11.60%), Voliam flexi (T_3) (11.60%) respectively. As a result, the order of efficacy in terms of increasing the percent of leaf is $T_4>T_6>T_1>T_3>T_5>T_2$.

4.7 Effect of insecticidal treatment on the number of fruits per plant

The comparative effectiveness of various treatments on the number of fruits per brinjal plant has been evaluated as well as percent (%) increase over control is presented in Table 7.The data indicated that highest (3.67%) no. of fruit was obtained in T_5 treatment plot followed by T_3 (3.13%) and T_1 (2.80)treated plots, respectively having significance difference. However, the lowest (1.20%) no. of fruit was obtained in T_7 untreated control plot followed by T_6 (1.80%) treated plot having significant difference and T_4 (2.47%), T_2(2.20 %) treated plot having no significant difference.

In terms of percent increase of no. of fruit over control, all treatments increased considerable amount of fruit over control as shown in the Table 7.The highest (205.83%) percent increase of fruit was recorded in T_5 treated plots followed by T_3 (160.83%), T_1 (133.33%), T_4 (105.83%), T_2(83.33%) and T_6 (50%) treated plots, respectively during cropping season.

Table 7: Effect of insecticidal treatment on the number of fruit per plant

Treatments	Number of fruit per plant	% increase (+) or decrease (-) over control
T_1	2.80 c	133.33
T_2	2.20 d	83.33
T_3	3.13 b	160.83
T_4	2.47 d	105.83
T_5	3.67 a	205.83

T_6	1.80 e	50
T_7	1.20 f	-
$LSD_{(0.05)}$	0.66	-
CV (%)	7.37	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).
[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (205.83%) in increasing fruit number followed by Voliamflexi (T_3) (160.83%), T-mectin (T_1) (133.33%), Sevin (T_4)(105.83%), Lambda cyhalothrin (T_2) (83.33%) and Admire(T_6) (50%). As a result, the trend of results in terms of increasing the percent of fruit number is $T_5>T_3>T_1>T_4>T_2>T_6$.

4.8 Effect of insecticidal treatment on the weight per fruit

The comparative effectiveness of various treatments on weight per fruit has been evaluated as well as percent (%) increase over control is presented in Table 8. The data indicated that highest (186.7 g/fruit) weight per fruit was recorded in T_5 treated plot followed by T_3 (177.9 g/fruit) and T_1 (172.9 g/fruit) treated plots, respectively having significant difference among them. On the other hand lowest fruit weight per plant (132.2 g/fruit) was recorded in T_7 untreated control plot followed by T_6 (147.5 g/fruit), T_2 (153.1 g/fruit) and T_4 (163.1 g/fruit) treated plots, respectively having significant different among them.

In terms of percent increase of weight per fruit over control, all treatments increased considerable amount of fruit weight over control as shown in the Table 8.The highest (41.23%) percent increase of fruit weight was recorded in T_5 treated plots followed by

T_3 (34.57%), T_1 (30.79%), T_4 (23.37%), T_2 (15.81%) and T_6 (11.57%) treated plots, respectively during cropping season.

Table 8: Effect of insecticidal treatment on the weight per fruit

Treatments	Fruit weight (g/ fruit)	% increase (+) or decrease (-) over control
T_1	172.9b	30.79
T_2	153.1d	15.81
T_3	177.9b	34.57
T_4	163.1c	23.37
T_5	186.7a	41.23
T_6	147.5e	11.57
T_7	132.2f	-
$LSD_{(0.05)}$	5.51	-
CV (%)	1.91	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).
[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (41.23%) in increasing fruit weight per plant followed by Voliam flexi (T_3) (34.57%). In case of other treatments in increasing fruit weight during the management were T-mectin (T_1) (30.79%), Sevin(T_4) (23.37%), Lambda cyhalothrin (T_2) (15.81%) and Admire (T_6) (11.57%) respectively. As a result, the trend of results in terms of increasing the percent of weight per fruitis $T_5>T_3>T_1>T_4>T_2>T_6$.

4.9 Effect of insecticidal treatment on the yield of brinjal

The comparative effectiveness of various treatments on yield of brinjal has been evaluated as well as percent (%) increase over control is presented in Table 9. The

data indicated that highest (7.67 ton/ha) yield was recorded in T_5 treated plot followed by T_3 (6.67 ton/ha) respectively having significant different among them treated plots, and T_1 (5.45 ton/ha), T_4 (5.22 ton/ha) treated plots, respectively having no significant difference among them. On the other hand lowest yield (3.33 ton/ha) was recorded in T_7 untreated control plot followed by T_6 (3.67 ton/ha) treated plots, respectively having no significant different among them, and T_2 (4.12 ton/ha) treated plots, respectively having significant different among them.

In terms of percent increase of yield over control, all treatments increased considerable amount of yield over control as shown in the Table 9. The highest (130.23%) percent increase of yield was recorded in T_5 treated plots followed by T_3 (100.2%), T_1 (63.66%), T_4 (56.66%), T_2 (23.62%) and T_6 (10.21%) treated plots, respectively during cropping season.

Table 9: Effect of insecticidal treatment on the fruit weight of brinjal per ha

Treatments	Yield of brinjal(kg/plot)	Yield of brinjal(ton/ha)	% increase (+) or decrease (-) over control
T_1	3.27c	5.45 c	63.66
T_2	2.47d	4.12 d	23.62
T_3	4.00b	6.67 b	100.2
T_4	3.13c	5.22 c	56.66
T_5	4.60a	7.67 a	130.23
T_6	2.20 de	3.67 de	10.21

T_7	2.00 e	3.33 e	-
$LSD_{(0.05)}$	0.31	0.52	-
CV (%)	5.70	5.70	-

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

[T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1 ml/Lof water at 7 days intervals, T_3= Voliam flexi 300 SC @ 1 ml/L in the water at 7 days intervals, T_4= Sevin 85 WP @ 2 g/L of water at 7 days intervals, T_5= Dursban 20 EC @ 2.5 ml/Lof water at 7 days intervals, T_6= Admire 200 SL @ 1 ml/L of water at 7 days intervals and T_7 =Control.]

From the above findings it was revealed that Dursban (T_5) performed as the best treatment (130.23%) in increasing yield followed by Voliam flexi (T_3) (130.23%), T-mectin (T_1) (63.66%), Sevin (T_4) (56.66%),Lambda cyhalothrin (T_2) (23.62%) and Admire (T_6) (10.21%). As a result, the order of efficacy in terms of increasing the percent of yield is $T_5>T_3>T_1>T_4>T_2>T_6$.

4.10 Relationship between incidence of mealybug and weight per fruit

Correlation study was done to establish a relationship between incidence of mealybug and weight per fruit. From the study it was revealed that significant correlation existed between the characters (Fig.1). The regression equation [y = -56.82 x +194.3] gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.879). From this it can be concluded that the weight per fruit decreased with the increase of number of mealybug.

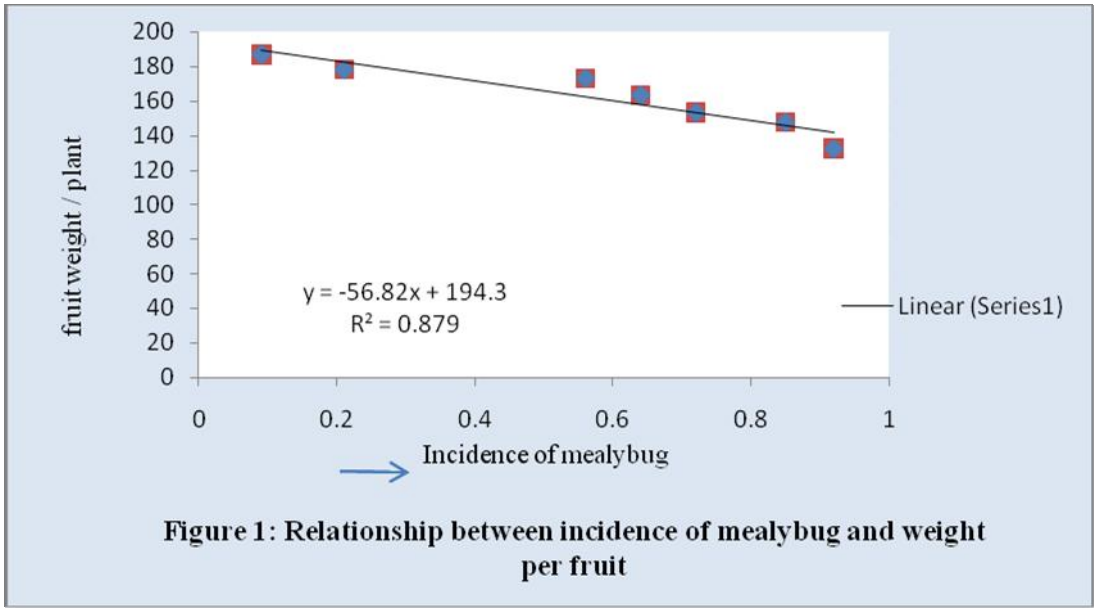


Figure 1: Relationship between incidence of mealybug and weight per fruit

4.11 Relationship between incidence of mealybug and yield (ton/ha)

Correlation study was done to establish a relationship between incidence of mealybug and yield (ton/ha). Negative correlation existed between incidence of brinjal mealybug and yield (Fig.2). The regression equation y = [-5.032 x +8.029] gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.972). From this it can be concluded that the yield weight decreased with the increase of number of mealybug.

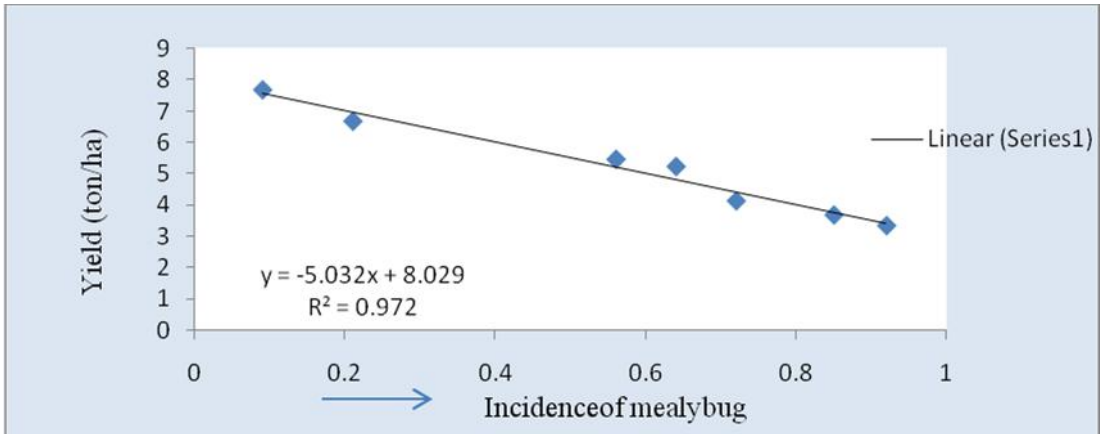


Figure 2 : Relationship between incidence of mealybug and yield (ton/ha)

CHAPTER V

SUMMARY

The adult females produced white foam like egg sac (ovisac) and laid eggs within the ovisac. Mean developmental periods of 1st, 2nd, 3rd, instar nymph and adult were 5.6, 8.4, 9.8 and 12 days. The total life span of brinjal mealybug (*C.insolitus*) was 31-36

days.

Incidence of mealybug in brinjal and their control were investigated at the farm of the Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from June, 2014 to October, 2014. The treatments comprised with six insecticides with a control. These were T_1= T-mectin 1.8 EC @ 2.0 ml/L of water at 7 days intervals, T_2= Fighter 2.5 EC @ 1.0ml/L of water at 7 days intervals, T_3= Voliam flexi @ 1.0 ml/L of water at 7 days intervals, T_4= Sevin @ 2.0 g/L of water at 7 days intervals, T_5= Dursban @ 2.5 ml/L of water at 7 days intervals, T_6= Admire @ 1.0 ml/L of water at 7 days intervals and T_7 =Control.

In terms of percent brinjal leaf infestation reduction over control all chemical treatment reduced considerable amount of leaf damage by mealybug. The highest percent reduction of leaf infestation (90.22%) and (67.37%) were recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such asT_3 (77.17%), T_1 (39.13%), T_4 (30.43%), T_2 (21.74%) and T_6 (7.61%) treated plots, respectively during cropping season. As a result, order of efficacy in terms of decreasing the percent leaf infestation was $T_5>T_3>T_1>T_4>T_2>T_6$.

In terms of percent brinjal twig infestation reduction over control all applied treatment reduced considerable amount of twig damage by mealybug over control. The highest percent reduction of twig infestation (67.37%) was recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such asT_3 (56.84%), T_1 (36.84%), T_4 (23.16%), T_2 (10.53%) and T_6 (6.32%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of decreasing the percent twig infestation is $T_5>T_3>T_1>T_4>T_2>T_6$.

In terms of percent brinjal flower infestation by mealybug reduction over control all applied treatment reduced considerable amount of flower damage over control. The highest percent reduction of flower infestation (64.22%) was recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such as T_3 (45.87%), T_1 (33.03%), T_2 (23.85%), T_4 (22.94%) and T_6 (11.01%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of decreasing the percent flower infestation is $T_5>T_3>T_1>T_2>T_4>T_6$.

In case of percent fruit infestation by mealybug reduction over control all applied treatment reduced considerable amount of fruit damage over control. The highest percent reduction of fruit infestation (83.84%) was recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such as T_3 (56.57%), T_1 (44.44%), T_4 (24.24%), T_2 (16.16%) and T_6 (8.08%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of decreasing the percent fruit infestation is $T_5>T_3>T_1>T_4>T_2>T_6$.

In terms of percent increase of no. of leaf over control, all applied treatments increased considerable amount of leaf over control as shown in the Table 5.The highest (19.22%) percent increase of leaf was recorded in T_4 treated plots and showed decreasing trend in other insecticide treatments such as T_6 (16.36%), T_1 (11.60%), T_3 (11.60%), T_5 (8.75%) and T_2 (4.85%) treated plots, respectively during cropping season. As a result, the trend of results in terms of increasing the percent of leaf is $T_4>T_6>T_1>T_3>T_5>T_2$.

In case of percent increase of fruit over control, all applied treatments increased significantly the amount of fruit over control. The highest (205.83%) percent increase of fruit was recorded in T_5 treated plots and showed decreasing trend in other

insecticide treatments such as T_3 (160.83%), T_1 (133.33%), T_4 (105.83%), T_2(83.33%) and T_6 (50%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of increasing the percent of fruit number is $T_5>T_3>T_1>T_4>T_2>T_6$.

In terms of percent increase of weight per fruit over control, all chemical treatments increased considerable amount of fruit weight over control. The highest (41.23%) percent increase of fruit weight was recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such as T_3 (34.57%), T_1 (30.79%), T_4 (23.37%), T_2 (15.81%) and T_6 (11.57%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of increasing the percent of weight per fruit is $T_5>T_3>T_1>T_4>T_2>T_6$.

In terms of percent increase of yield over control, all applied treatments increased considerable amount of yield over control. The highest (130.23%) percent increase of yield was recorded in T_5 treated plots and showed decreasing trend in other insecticide treatments such asT_3 (100.2%), T_1 (63.66%), T_4 (56.66%), T_2(23.62%) and T_6 (10.21%) treated plots, respectively during cropping season. As a result, the order of efficacy in terms of increasing the percent of yield is $T_5>T_3>T_1>T_4>T_2>T_6$.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

Based on the above findings of the study it can be concluded that the total life span of brinjal mealybug (*C.insolitus*) was 31-36 days and recommended dose of Dursban @ 2.5 ml/Lof water at 7 days intervals was the best effective treatment for the Control of

mealybug insect pests of brinjal. It might increase fruit number, fruit weight, single fruit weight and yield. It also reduced fruit infestation and leaf infestation. Only number of leaf were increased in recommended dose of Sevin @ 2.0 g/L of water at 7 days intervals.

Considering the findings of the study the following recommendations can be drawn:

1. Recommended dose of Dursban @ 2.5ml/L might be suggested for the best effective treatment for control of mealybug in brinjal.
2. Further study can be conducted with different doses of other insecticides.
3. Further intensive studies based on different management practice could be done.

CHAPTER VII

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APPENDICES

Appendix I. The physical and chemical characteristics of soil the experimental site as observed prior to experimentation (0-15 cm depth)

Mechanical composition:

Soil parameters	Observed values
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.07
Phosphorus	22.08 µg/g soil
Sulphur	25.98 µg/g soil
Magnesium	1.00 mcq/100 g soil
Boron	0.48 µg/g soil
Copper	3.54 µg/g soil
Zinc	3.32 µg/g soil

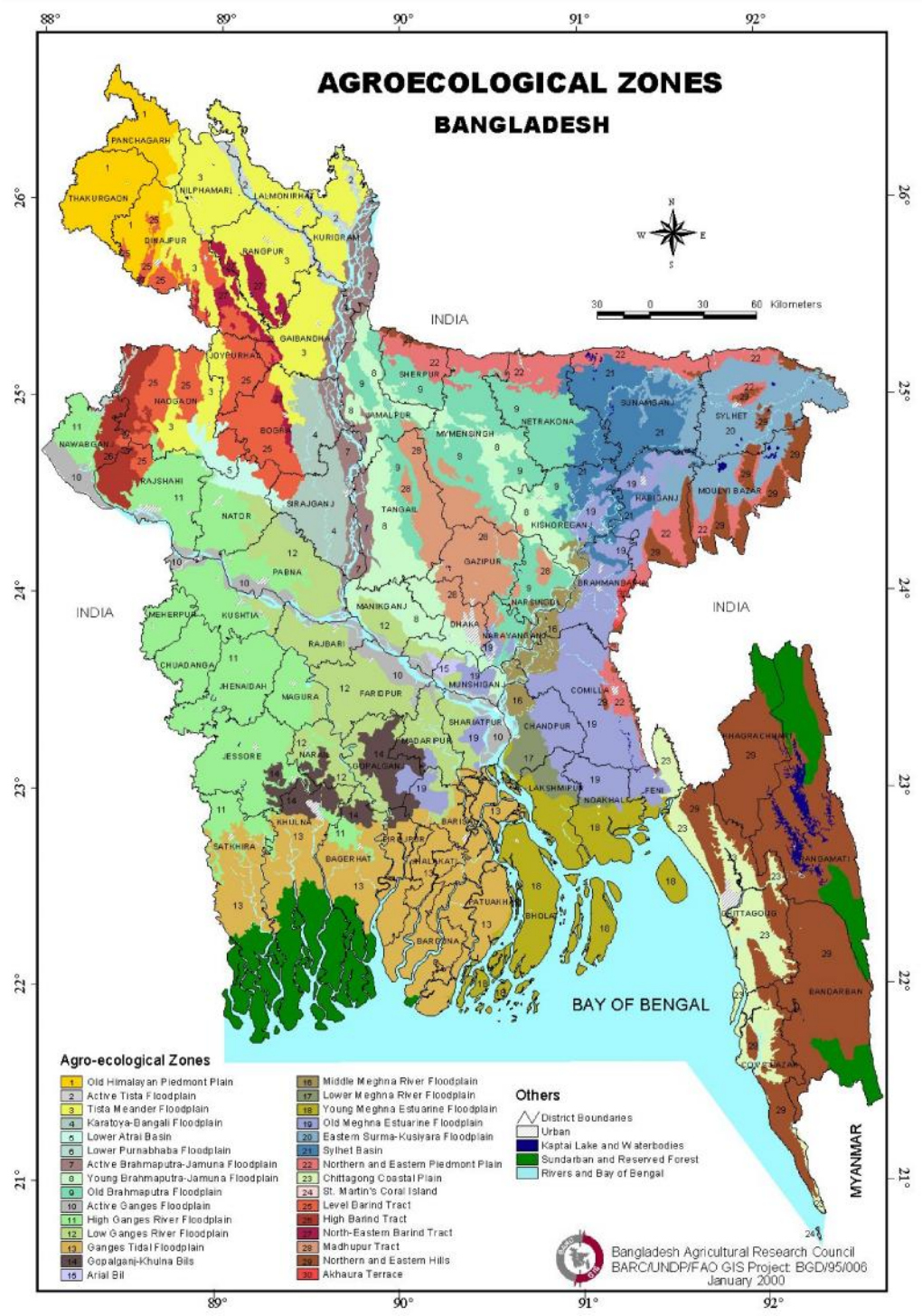
Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka.

Appendix II: Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from June 2014 to October 2014

Date/Week	Temperature		Relative humidity (%)	Rainfall (mm) (Total)
	Maximum	**Minimum**		
June	34.6	26.2	73.1	3.89
July	32.2	26.3	74.4	3.53
August	32.3	26.5	79.4	2.5
September	32.8	25.9	80.1	2.7
October	32.2	24.5	70.1	2.08

Source: Bangladesh Meteorological Department (Climate and Weather Division), Agargoan, Dhaka- 1207

Appendix III. Experimental location on the map of Agro-ecological Zones of Bangladesh.



Source: Bangladesh Agricultural Research Council, Khamarbari, Dhaka.