HOST PREFERENCES OF EPILACHNA BEETLE ON DIFFERENT VARIETIES OF BRINJAL PLANT

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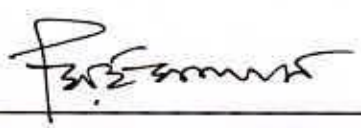

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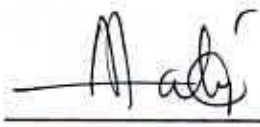

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CERTIFICATE

This is to certify that thesis entitled, **"HOST PREFERENCES OF EPILACHNA BEETLE ON DIFFERENT VARIETIES OF BRINJAL PLANT"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **Master of Science in Entomology**, embodies the result of a piece of bona fide research work carried out by **MEHDI HASAN MILON, Registration No. 06-1925** 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: June 2013

(Prof. Dr. Md. Serajul Islam Bhuiyan)
Supervisor

DEDICATED TO
MY
BELOVED PARENTS

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The author

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ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif* -2 season from June to November, 2012 to study host preferences of *Epilachna* beetle on different varieties of brinjal plant. Each variety was considered as individual treatment. There were ten varieties of brinjal, viz. T_1 = Shamli, T_2 = Muktakeshi, T_3 = Yashaswi, T_4 = Mohini, T_5 = Anondo, T_6 = Sandhya, T_7 = Harshita, T_8 = Dark stallon, T_9 = Shingnath and T_{10} = Islampuri. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Incidence of epilachna beetle showed significant variation on different varieties of brinjal. Among the varieties, Harsitha was found to be the most tolerant against epilachna beetle pest based on the incidence of minimum number of epilachna beetle, number of eggmass and number of grubs per plant was recorded. Varieties of brinjal on epilachna beetle significantly influenced on growth characteristics of rose whereas minimum number of infested plant per plot, minimum number of infested leaf per plant and minimum number of infested fruit per plant were found from Harshita variety. The maximum number of healthy and epilachna free brinjal per plant was found in Harshita variety. Yield per plant was significantly influenced by the different varieties of brinjal on epilachna beetle. The highest yield per plant (1777.00 g) was obtained from Harshita variety of brinjal. On the other hand, the lowest yield per plant (155.2 g) was found from Shamli variety of brinjal. These results indicate that the Harshita variety is tolerant to epilachna beetle of brinjal as well as on growth and yield among all the varietal treatments in this study.

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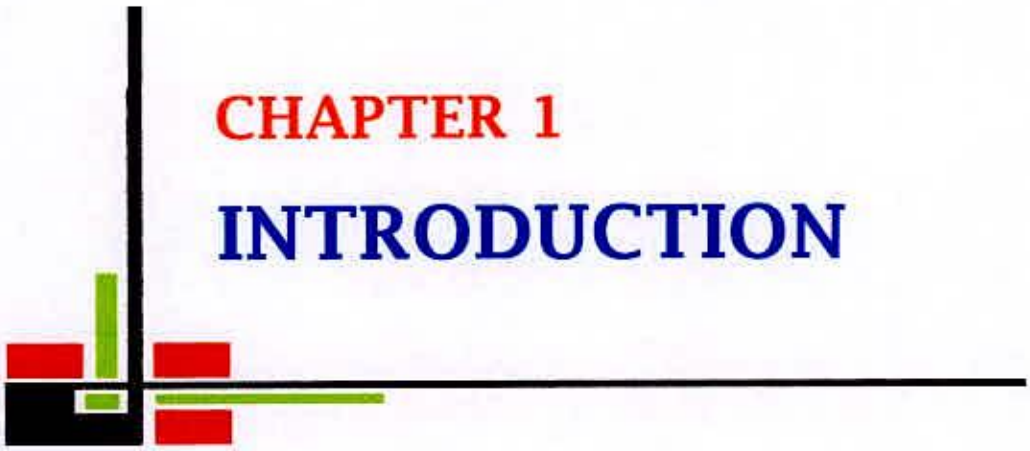
LIST OF ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
Ppm	=	Parts per million
et al.	=	And others
N	=	Nitrogen
TSP	=	Triple Super Phosphate
MP	=	Murate of Potash
RCBD	=	Randomized complete block design
DAS	=	Days after sowing
ha^{-1}	=	Per hectare
G	=	gram (s)
Kg	=	Kilogram
µg	=	Micro gram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
HI	=	Harvest Index
No.	=	Number
Wt.	=	Weight
LSD	=	Least Significant Difference
^0C	=	Degree Celsius
NS	=	Not significant
Mm	=	Millimeter
Max	=	Maximum
Min	=	Minimum
%	=	Percent
cv.	=	Cultivar
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of coefficient of variance
Hr	=	Hour
T	=	Ton
viz.	=	Videlicet (namely)



CHAPTER 1

INTRODUCTION

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INTRODUCTION

Eggplant (*Solanum melongena* L.), also called aubergine or brinjal, is one of the top ten vegetables in the world. It is grown on more than 2 million ha with a production of nearly 33 million ton. China is the world's top egg plant grower, accounting for more than half of world acreage and India is second, with about one quarter of the world total; Indonesia, Egypt, Turkey, Iraq and the Philippines are the other major egg plant producing countries. Asia accounts for about 94 percent of the world egg plant area, with about 92 percent of world output (FAO 2007). India and Indochina are considered the centers of origin for egg-plant (Vavilov, 1951).In Bangladesh rabi 2009-2010 the total area covered by brinjal cultivation was 29.74 thousand hectares with the production of 216 thousand metric tons and in kharif (summer), the area and production was 17.81 thousand hectares and 125 thousand metric tons respectively (BBS, 2011).

Egg plant is well adapted to high rainfall and high temperatures, and is among the few vegetables capable of high yields in hot-wet environments (Hanson *et al.* 2006). Egg plant contains nutrients such as dietary fiber, folate, ascorbic acid, vitamin K, niacin, vitamin B6, pantothenic acid, potassium, iron, magnesium, manganese, phosphorus, and copper (USDA, 2008); the nutrients that it contributes to the diets of the poor are especially important during times when other vegetables are in short supply.

In the tropics, egg plant production is severely constrained by several insect and mite pests. The major pests include egg plant fruit and shoot borer, leafhopper, whitefly, thrips, aphid, spotted beetles, leaf roller, stem borer, blister beetle, red spider mite, and little leaf disease. Growers rely heavily on chemical pesticides to protect their egg plant crop. For instance, farmers in certain areas of Philippines spray chemical insecticides up to 56 times during a cropping season; the total quantity of pesticide used per hectare of egg plant was about 41 liters of different brands belonging to the four major pesticide groups (Gapud and Canapi, 1994; Orden *et al.* 1994). In Bangladesh, some farmers spray about 180 times during a cropping season (SUSVEG-Asia, 2007). Pesticide misuse has adverse effects on the environment and human health and also increases the cost of production. The share of the cost of pesticide to total material input cost was 55% for eggplant compared with cabbage (49%) and tomato (31%) in the Philippines (Orden *et al.* 1994), and accounted for 40–50 percent in Bangladesh (SUSVEG-Asia 2007). Many farmers refrain from growing eggplant due to the cost of pesticides (Gapud and Canapi, 1994).

Brinjal plants are affected by different insect pests both at the seedling and mature stages. Among the insect pests of brinjal under field conditions, aphid, whitefly, epilachna beetle and brinjal shoot and fruit borer cause much damage. Among the many pest species, Epilachna beetles, *Epilachna dodecastigma* (12-spotted), *Epilachna vigintioctopunctata* (28-spotted), is the most destructive pest. It has chewing mouthparts. Adults and the young (larvae) are often seen living together. Adults are familiar and look like common lady beetles. They are oval-shaped,

brownish with wavy black spots on their backs. The young are pale yellow and have branched spines covering their backs and sides. Leaf tissue is eaten between the veins. The leaves may be completely stripped to the mid-vein and small areas eaten out and/or shallow holes may be present on the fruit surface. More severe economical damage caused by the adult to feeding leaf tissue and the fruit surface, which make damaged the fruit and unfit for human consumption. The yield loss varies different environment conditions but can exceed 35% in Bangladesh (BARI, 1999). Now, the word ladybird applies to a whole family of beetles, Coccinellidae or ladybirds, not just *Coccinella septempunctata*. We can but hope that newspaper writers will desist from generalizing them all as "the ladybird" and thus deluding the public into believing that there is only one species. There are many species of ladybirds, just as there are of birds, and the word "variety" (frequently use by newspaper writers) is not an appropriate substitute for the word "species." Many ladybird species are considered beneficial to humans because they eat phytophagous insects ("pests of plants", sometimes called "plant pests"), but not all eat pests of plants, and a few are themselves pests.

Farmers always desire quick curative action for controlling pests. Since no other control measure against epilachna beetle pests is available, chemical insecticides have remained as the most powerful tools for controlling this pest. Insecticides are highly effective, rapid in curative action, adaptable to most situations and relatively economical. Insecticides are the only tool for pest management which is reliable for emergency action when insect pest population approach or exceed the economic threshold level. But this is not environment friendly. This is also

harmful for human consumption. For that reason, by using resistant variety of brinjal against epilachna beetles would be more economical and eco-friendly.

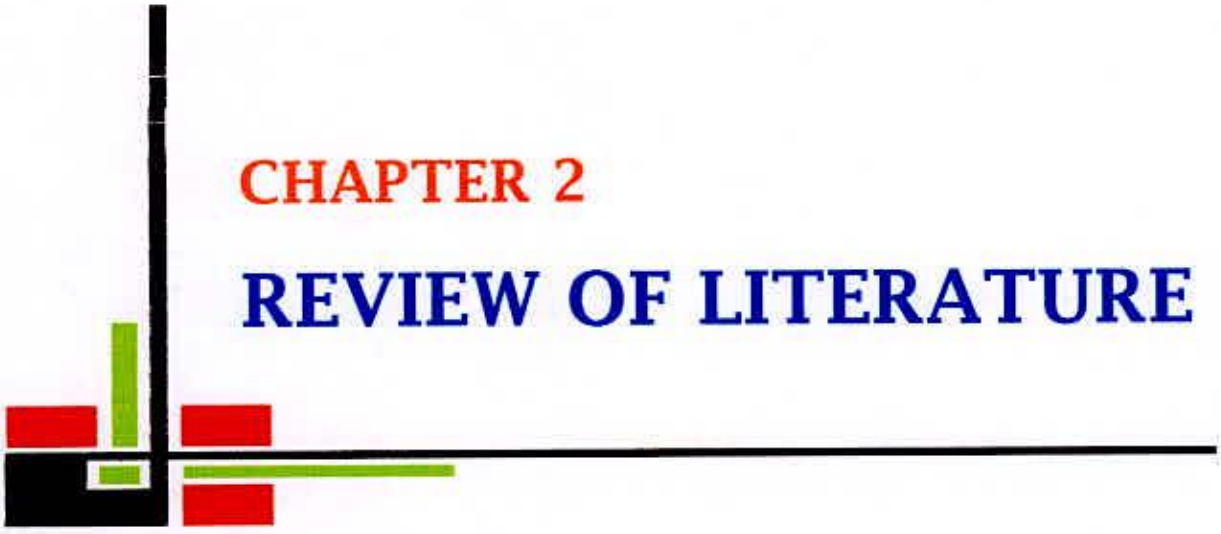
Considering the above facts, the present study was undertaken to determine host preferences of *Epilachna* beetle on different varieties of brinjal plant.

Objectives of the present study were:

i. To know the infestation status of epilachna beetles on brinjal plant.

ii. To evaluate the performance of some brinjal varieties against the epilachna beetles.

iii. To identify the effective brinjal variety against the epilachna beetles.



CHAPTER 2

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

General review of epilachna beetle

Epilachnabeetle, *Epilachna dodecastigma* Muls. belongs to the order Coleoptera and family Coccinellidae. A review of literature on the biology,host- range and nature of damage due to epilachna beetle is presented below:

Biology

Nakano and Katakura (1999) observed that *Epilachna pusilanima* is externally similar to another cucurbit feeder, *Epilachna boisduvali*. In that both have 12 spots on the elytra and similar body size, but the two species are easily distinguished by the structure of the genitalia of both sex, the colour and maculation of pre pupae and diet.

Ohgushi (1996) reported that large adults of *Epilachna nipanica* had higher survival from emergence to the reproductive season. Size was dependent of adult survival and was most apparent during hibernation. Adult survival during pre-hybernation period contributed little to size-dependent overall survival. Neither reproductive lifespan nor lifetime fecundity was a function of adult size, though large females produced larger egg fatches.

Hirano (1993) observed that the female lays up to 450 eggs in batches on the underside of the leaves. The eggs are yellow, cigar shaped which are very prominent on the green leaves. Datta (1966) also observed that the incubation

period of *Epilachna dodecastigma* was 3-5 days in summer and 6-8 days in winter.

Tripathi and Mishra (1990) found that weight loss of pupal of *Epilachna dodecastigma* (Weid) did not differ among host plants on which larvae were reared. However, the rate of weight loss differed from host to host due to differences in durtion of pupae between hosts. Rate of weight loss/day was inversely proportional to the subsequent hatching of eggs.

The hatched larvae have characteristic shape, the body being broad in front and narrow behind and covered with spiny structure all over. They confined their feeding activities generally to the under surface of the leaves. The larval period varies from 12-18 days with 3 larval instars. The full-grown larvae are 6-8 mm in length. Ahmed and Khatun (1996) found the larval duration of *Epilachna dodecastigma* were 10-15 days.

Datta (1966) observed that the pupation takes place on the leaf surface. At that time the full-grown larva attaches the last segment of its abdomen to the leaf surface by means of its sticky secretion and the pupa is formed within the last larval skin which splits on the dorsal side. The pupal period lasts for 4-8 days. The life cycle is completed in 2-3 weeks during the summer but it extends up to 2 months during the winter.

Pradhan (1969) stated that *Epilachna vigintioctopanctata* Fab. is a serious pest of brinjal, potato and other solanaceous plants. Both grubs and adults cause damage,

the grubs confining their attack on the lower surface of the leaves and adults usually feeding on the upper surface of the leaves.

Nature of damage

Many grubs and adults can be seen on the ventral surface of the leaves. Both the adult and grub stages feed on the leaf surface and skeletonize the leaves which present a lace like appearance as the green matter in-between the veins is eaten away leaving the skeleton of anastomizing veins. The attacked leaves turn brown, dry up and fall off. In case of severe infestation the crop presents a very unhealthy look. The vigour of the plant and thereby its yield is adversely affected.

Seasonal abundance

Thebeetle appear on the plants from March to April. The pest remains active from April to October, but the greatest damage is caused during April- May. The adults hibernate under straw, creepers or in cracks and crevices in soil in the winter (Alam, 1969).

Ghosh and Senapati (2001) observed the seasonal incidence, population fluctuation and biology of *Henosepilachna vigintioctopunctata* (*Epilachna vigintioctopunctata*)on brinjal cv. Pusa Purple Long in west Bengal, India. The beetles were recorded from April to October, and the highest abundance (8.14 beetles/plant) was observed in mid-September. Beetle population showed significant positive correlation with average temperature, relative humidity and rainfall.

Rajagopal and Trivedi (1989) reported that *Epilachna dodecastigma, Epilachna vigintioctopunctata, Epilachna ocellata* and *Epilachna sparsa* commonly attack solanaceous plants. The peak period of infestation varied with season, but the peak was generally in July-August. The pest also fed on tobacco, pumpkin and bitter gourd. The larvae and adults scraped the green matter from leaves and damaged up to 80% of plants.

Host range and food habit

Imura and Ninomiya (1998) reported that the leaf is of a solanaceous weed, *Solanum carolinense*, consumed by larvae and adults of a leaf scraping coccinellid beetle, *Epilachna vigintioctopunctata* Fab., was measured by the Image Processing System (IPS). On average beetle consumed 1429.25 mm^2 of leaves of complete its larval development and consumed 2510.9 mm^2 of leaves during the first 10 days of its adult stage.

Gannon and Bach (1996) studied the effect of rachoma density of development of *Epilachna varivestis*, using larvae reared on 3 soybean (*Glycine max*)isolines isogenic excepts for trichome density, glabrous, normal and dense. Feeding performance, as determined by choice tests, also significantly varied among development stages. First instar larvae caused 6-8 times more feeding damage on the pubescent isolines, while third and fourth instars caused 3-13 times more damage on the glabrous isolines than on the normal and dense isolines. Adult did not show a significant feeding preference.

Shukla and Upadhyay (1987) investigated the effect of light on the feeding preference of adults of *Epilachna dodecastigma* for different parts of cylindrica.

Prasad *et al.* (2008) conducted in the University farm to explore economically viable IPM module for managing one of the most injurious defoliating insect pest, epilachna beetle (*Henosepilachna vigintioctopunctata* Fab.) infesting brinjal (Var. Muktakeshi) through intercropping (crop association) and judicious application of granular insecticides @ 1.0 kg ai/ha incorporated around the root zone of plants at 30 DAT (days after transplanting). The efficacy of intercropping was in the order: brinjal+marigold > brinjal+French bean > sole crop of brinjal. The efficacy of the insecticides was in the order: phorate > carbofuran > quinalphos. The interactive impact of crop association and soil application of insecticide @ 1.0 kg ai/ha coupled with need based spray of chlorpyriphos 20 EC @ 1000 ml/ha was significantly effective in suppressing the incidence of the insect pest and enhancing the yield of marketable fruits of brinjal.

Rahman *et al.* (2009) conducted a set of experiment to study the biology and food consumption of epilachna beetle, *Epilachna dodecastigma* (Wied.) on three different host plants viz. ridged gourd, bitter gourd and brinjal. The larval period was significantly influenced by the type of the host plants. The highest larval period was observed on brinjal (29.88±0.78 days) and the lowest (17.40±1.02 days) on ridged gourd. The highest pupal duration (7.5±0.7 days) was observed on brinjal and lowest (6.0±0.63 days) on ridged gourd. Adult longevity was longest on ridged gourd (26±1.67 days) and shortest on bitter gourd (15.29±1.39 days). Mean food consumption by a single larva during its whole larval period was the

highest on bitter gourd (921.14±671.70 mm^2) and the lowest on ridged gourd (609.6±178.74 mm^2). The mean food consumption by a single adult beetle during its whole adult life was highest on ridged gourd (4981.0±430.13 mm^2) and lowest on bitter gourd (2578.57±793.56mm^2).

Jamwal *et al.* (2013) conducted an experiment at Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu during 2008 and 2009 which revealed that 16 cultivated and 3 wild plants grown in the vicinity of the brinjal and bitter gourd crop fields offered shelter to the pest and maintain its population throughout the year. Effect of eight major hostplants on all the biological parameters of the test insect included in the study revealed that grub and pupal development, survival, longevity and fecundity of *Epilachna vigintioctopunctata* (F.) (Coleoptera: Coccinellidae) adults on given host plants under laboratory conditions (29±1°C, 60-70% RH) differ significantly. In a choice test *E. Vigintioctopunctata* females oviposited most on *Solanum nigrum*(286.80 ± 19.86 eggs), least on *Luffa acutangula* (164.90 ± 26.24 eggs). The incubation period was shortest on *S. nigrum*(3.25 ± 0.97 days) and longest on *Datura stromonium* (5.40 ± 0.75 days) whereas per cent egg hatchability was highest on *Solanum tuberosum* (91.75 ± 3.73%) and lowest on *L. acutangula* (82.00 ± 5.94%). *E. vigintioctopunctata* grubs developed differently on eight host plants, shortest on *S. nigrum*(13.25 ± 1.12 days) and longest on *D. stromonium*(21.55± 1.70 days) and survived best on *S. nigrum*and *P. minima* (92.00±1.22 and 91.25±0.88%) and worst on *L. acutangula* (45.25±2.45%). More females than males were found among emerged adults and females lived longer than males.

Pupal development was shortest on *S. nigrum* (3.85 ± 0.67 days) and longest on *M. charantia*(6.10 ± 0.72 days), wherein, adult emergence rate was highest on *S. nigrum* (94.25±0.98%) and lowest on *L. acutangula* (53.25±2.18%). Further on the basis of growth index, fecundity, survival and adult emergence, *S. nigrum* and *P. minima* were recorded to be the most suitable host plants followed by *S. melongena*, *S. tuberosum*, *S. esculentum*, *M. charantia* and *D. stromonium*. *L. acutangula* was the least preferred host plant by the test insectfor overall growth and development.

Brinjal (*Solanum melongena* L.) is one among the vegetables grown in Jaffna Peninsula of Sri Lanka. It has been extensively cultivated throughout the country due to its high demand among the consumers. The productivity of brinjal depends on the intensity of the attack of pests throughout the year. Among the pests epilachna beetle, *Epilachna vigintioctopunctata* (Coleoptera: Coccinellidae) emerged as the key pest and caused serious damage on the foliage. This damage affected the flowering and fruiting ability of the crop and as a result few malformed fruits were produced. This enforced the farmers to frequently spray huge amount of insecticides, but the beetle was not controlled successfully. Farmers invested 50% of the cost of production for spraying insecticides thus, frequent spraying of toxic chemicals cause health hazards to the consumers. Considering the biosafety of the environment and effective management of the pest using mycopathogen, *Beauveria bassiana* was evaluated. Pathogenicity tests were conducted in vitro and followed by field evaluation. Concentrations of 1 x 10(9), 10(8), 10(7), 10(6) and 10(5) spores/ml in vitro and in the field, 1 x 10(7)

spores/ml of *B. bassiana* was used for evaluation. The mortality of the beetles was recorded daily and dead beetles were removed and kept in humid chambers for incubation to enhance mycelial development. Mortality of *E. vigintioctopunctata* was apparent at 18 hours after application of *B. bassiana* at the concentration of 1 x 10(8) spores/ml under the laboratory condition (30 +/- 2 degrees C, 80 +/- 2% RH) and 72 hours after application in the field, the mortality of *E. vigintioctopunctata* was achieved even the first day itself at the concentration of 1 x 10(7) spores/ml. These results are helpful to develop an eco-friendly management of the beetle, *E. vigintioctopunctata* and would help immensely to reduce the spray load of insecticides on brinjal and to minimize the pesticide hazards to the consumers(Thurkathipana and Mikunthan, 2008).

Among the major insect pests that attack potato, the Epilachna beetle, *Epilachna vigintioctopunctata* is very important in Asia. It is widely distributed in South and East Asia, Australia, America, and the East Indies. Commonly 12*stigma* and *E.* 28 *punctata, E. ocellata* and *Henosepilachna sparsa* attack solanaceous plants. The peak period of infestation varies with' the region, but the peak is in July-August. The pest also feeds on brinjal (egg plant), tomato, tobacco, pumpkin and bitter gourd. The larvae and adults scrape the green matter from leaves and cause damage up to 80%. The morphology and biology are described. Among the various components of management, the predator reduviid bug, *Rhinocoris fuscipes* (Fab.) is recorded and seven larval parasites have been found, with 53–5–77–5% parasitization. *Aspergillus flavus* and *Bacillus thuringiensis* are effective

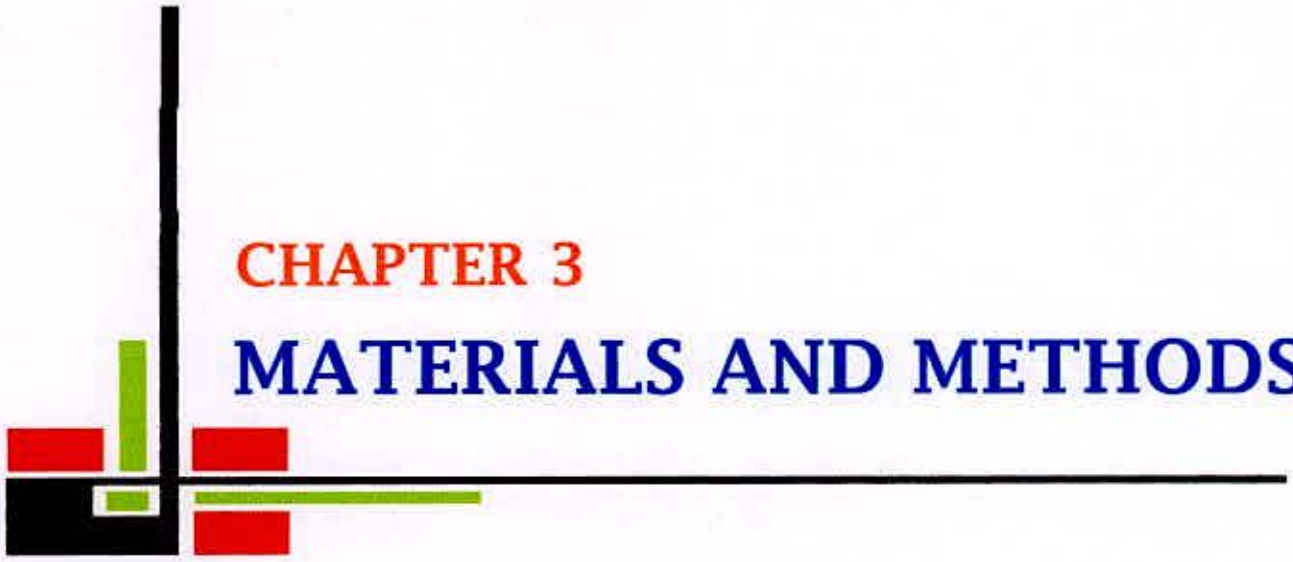
against different stages of the pest. Various chemicals including plant products have been evaluated and sprays of 0–5% carbaryl + molasses and quinalphos were found to be effective for 20 days. The repellent and anti feedant properties of neem, mahua and groundnut cakes have also been established. Varying degrees of malformation were observed after radiation by a 60 cobalt source (Rajagopal & Trivedi , 2008).

Choose resistant or moderately resistant cultivars available in the region. Varieties from India such as Arka Shirish, Hissar Selection 14, and Shankar Vijay have been reported to be tolerant or resistant to Epilachna beetle, especially *E. vigintioctopunctata* (Parker *et al.* 1995). Consult the local extension agency for the availability of resistant or moderately resistant varieties.

Sharma and Ranjana(2012)conducted to find out natural and cheaper source for the control of brinjal pest, *Henosepilachna vigintioctopunctata,* by the extraction of locally available plants. All the extracts prepared from different parts of the plants proved efficacious when first instar larvae were fed on leaves treated with 1.0% concentration and gave 80.0 to 93.3% larval mortality as against 6.7 ± 6.7% in control set. Flower extract of *Eucalyptus globulus*at 0.5% and seed extract of *Nerium indicum* at 0.2% increased total developmental period to 22.5 ± 1.5 and 22.7 ± 0.6 days respectively as compared to control in which larvae took 20.2 days to complete their development. The highest concentration (1.0%) of all the extracts also showed drastic effect on adult emergence while some abnormal adults with deformed wings, elytra and appendages were also observed in lower concentrations of *N. indicum*and *E. globules* extracts. The LC_{50} values of these

plant extracts also been calculated to compare their efficacy. The results show the insecticidal potentiality of *N. indicum* and *E. globulus*in the control of brinjal pest.

Henosepilachna beetle causes considerable economic losses to many crops including brinjal depending on place and season for variations of prevailing environmental conditions (Rajgopal and Trivedi, 1989; Bhagat and Munshi, 2004; Islam *et al.*, 2011). It is highly destructive at both adult and larval stages which feed on the epidermal tissues of leaves, flowers, and fruits by scrapping the chlorophyll content and cause a big yield loss (Imura and Ninomiya, 1978; Srivastava and Butani, 1998; Ghosh and Senapati, 2001) skeletonized, gradually dry and drop down. The larvae confine their attack to the lower surface while adult beetles usually feed on the upper surface of the leaves (Prodhan *et al.*, 1990; Khan *et al.*, 2000). The management of *Henosepilachna* beetle was based on synthetic pesticides due to their quick and knock down action (Jagan Mohan, 1985; Ghosh, 1986; Samanta *et al.*, 1999; Das *et al.*, 2002; Liu *et al.*, 2003). The frequent and indiscriminate application of these pesticides in the vegetable fields has resulted into widespread development of resistance, undesirable effects on non-target organisms, presence of toxic residues in food, environmental and health hazards (Subramanyam and Hagstrum, 1995; Kranthi *et al.*, 2002). These problems have highlighted the need for development of new, safer and eco-friendly pest control measures.



CHAPTER 3

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif* -2 season from June to November, 2012 to study host preferences of *Epilachna* beetle on different varieties of brinjal plant. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Description of the experimental site

3.1.1 Site and soil

Geographically the experimental field was located at 23^0 77' latitude and 90^0 33' E longitudes at an altitude of 9 m above the mean sea level. The soil belongs to the Agro-Ecological Zone – Modhupur Tract (AEZ 28). The land topography is medium high and soil texture is silt clay with pH 8.0. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix I.

3.1.2 Climate and weather

The climate of the locality is subtropical, which is characterized by high temperature and heavy rainfall during *kharif* season (April-September) and scanty rainfall during *rabi* season (October-March) associated with moderately low temperature. The prevailing weather conditions during the study period have been presented in Appendix II

3.2 Planting material

The seeds of brinjal variety were collected from the Horticultural Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Before sowing, the seeds were tested for germination in the laboratory and the percentage of germination was found to be over 90%.

3.3 Raising of seedlings

Brinjal seedlings were raised in two seed beds situated on a relatively high land adjacent to the farm office. The size of each seed bed was 3 m × 1 m. The soil was well prepared and converted into loose, friable and dried mass by spading. All weeds and stubbles were removed and the soil was mixed with 5 kg well rotten cowdung. The seeds were sown on the seed bed. After sowing the seeds were covered with light soil. Complete germination of the seed took place within 10 days after sowing seeds in the beds. Necessary shading by bamboo mat (chatai) was provided over the seedbed to protect the young seedlings from scorching sunshine and heavy rain. Weeding, mulching and irrigation were done from time to time as and when needed.

3.4 Treatments of the experiment

Ten brinjal varieties were considered as treatments in this experiment. These are as follows:

T_1 = Shamli.

T_2 = Muktakeshi.

T_3 = Yashaswi.

T_4 = Mohini.

T_5 = Anondo.

T_6 = Sandhya.

T_7 = Harshita.

T_8 = Dark stallon.

T_9 = Shingnath.

T_{10} = Islampuri

3.5 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD). Each treatment was replicated for three times. The size of each plot was 2.25 m × 3.0 m. The distance between two adjacent replications (block) was 1.0 meter and plot to plot distance was 0.5 meter. The intra block and plot spaces were used as irrigation and drainage channels.

3.6 Cultivation procedure

3.6.1 Land preparation

The land was irrigated before ploughing. After having "zoe" condition the land was first opened with the tractor drawn disc plough. Ploughed soil was then brought into desirable tilth by six operations of ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done. Experimental land was divided into unit plots following the design of experiment. The plots were spaded one day before planting and the basal dose of fertilizers were incorporated thoroughly.

3.6.2 Manuring and Fertilization

The entire quantity of cowdung (15 ton/ha) was applied just after opening the land. Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) were used as a source of nitrogen, phosphorous and potassium, respectively. TSP was applied in the experiment as per treatment. Urea and MP were applied at the rate of 370 kg and 250 kg per hectare respectively following the BARI recommendation (Sattar *et al.,* 2005).

3.6.3 Transplantation and after care

Healthy and uniform sized seedlings of 45 days were taken separately from the seedbed and were transplanted in the experimental plots in the afternoon maintaining different as per treatment between the rows and plants. The seed bed was watered before uprooting the seedlings from the seedbed to minimize damage of the roots. The seedlings were watered after transplanting and continued for several days for their early establishment. Seedlings were also transplanted around the border of the experimental plots for gap filling.

3.6.4 Intercultural operations

After transplanting the seedlings, different intercultural operations were accomplished for better growth and development of the plants.

3.6.4.1 Gap filling

When the seedlings were established, the soil around the base of each seedling was pulverized. A few gap filling was done by healthy seedlings of the same stock previously planted in bordered area on the same date of transplanting.

3.6.4.2 Weeding

Weeding was done at every 15 days interval after planting and followed up to peak flowering stage. As the land was covered by plant canopy by that time weeding was discontinued.

3.6.4.3 Irrigation

Irrigations were given twice throughout the growing period. The first irrigation was given at 40 days after planting followed by another irrigation at 20 days after the first irrigation.

3.7 Harvest

Fruits were harvested when they attained full maturity indicating deep violet in color and hard in consistency.

3.8 Data collection

The following data were recorded.

3.8.1 Counting epilachna beetle population

To estimate the population of adult, larvae and egg masses per plant, five plants were randomly selected from each plot by tagging. Ten leaves of each plant were selected randomly and observed visually at early in the morning. The number of adults, larvae and egg masses of epilachna was counted carefully.

3.8.2 Number of infested plants per plot

Number of infested plant per plot was counted from the 15 selected plant sample.

3.8.3 Number of infested leaves per plant

The infested leaves were counted from ten plants at the time of harvesting. The average numbers of leaves per plant were determined.

3.8.4 Number of infested fruits per plant

Numbers of infested fruits per plant were counted from the 10 selected plant sample and then the average fruit number was calculated.

3.8.5 Number of healthy fruits per plant

Number of healthy fruits per plant was counted from the 10 selected plant sample and then the average fruit number was calculated.

3.8.6 Yield of fruits per plant

A per scale balance was used to take the weight of fruits per plant. It was measured by totaling the fruit yield of each plant separately during the period from fruiting to final harvest and was recorded in gram (g).

It was calculated by the following formula

$$\text{Weight of fruits per plant (g)} = \frac{\text{Total wt. of fruits from ten sample plant}}{10}$$

3.9 Statistical analysis

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-computer package program developed by Russell (1986). The means were separated following Duncan's Multiple Range Test (DMRT) at 0.05 level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

The experimental results were studied on host preferences of epilachna beetle on different varieties of brinjal plant. Beside different crop characters, yields and yield contributing characters have also been presented and discussed in this chapter with some tables as follows:

4.1 Incidence of epilachna beetle of brinjal

The effect of varieties of brinjal plant showed significantly variations due to on incidence of Epilachna beetle. Among the varieties on host preferences of Epilachna beetle, the variety "Harshita" showed tolerance against Epilachna beetle and the variety "Yashaswi" was susceptible to the attack of the Epilachna beetle. Though Epilachna beetle is a major limiting factor of brinjal production. The variety Harshita offerred the maximum protection against the attack of Epilachna beetle(1.33).Thus it is expected that this variety will ensure more yield of brinjal. In contrast, the variety "Yashaswi" showed least protection against Epilachna beetle showing the maximum number of Epilachna beetle per plant (8.00) in the research field (Table 1 and plate 1).

It is evident from the above results that the variety "Harshita" is more effective than other varieties to manage the epilachna beetle. The results also indicate that the variety "Yashaswi" performs the lowest on the management of epilachna beetle. So, "Harshita" was more tolerant to control epilachna beetle than other varieties of brinjal plant.

Plate 1: Larva and adults of epilachna beetle are feeding on brinjal leaf.

Table 1. The number of epilachna beetle, number of eggmass and numberof grubs per plant on different varieties of brinjal

Varieties	Number of epilachnabeetles per plant	Number of eggmass per plant	Number of grubs per plant
Shamli	4.33 B	9.00 cd	14.67 Abc
Muktakeshi	3.33 bc	*10.00* cd	*12.00* Bcd
Yashaswi	8.00 A	24.00 a	20.67 A
Mohini	2.67 bcd	15.33 bc	17.33 Ab
Anondo	3.33 bc	13.00 bcd	13.67 Bc
Sandhya	2.33 cd	13.33 bcd	9.33 Cd
Harshita	1.33 D	8.33 d	5.67 D
Dark stallon	2.67 bcd	18.00 ab	10.67 Bcd
Shingnath	1.83 D	14.67 bcd	9.67 Cd
Islampuri	2.33 cd	14.33 bcd	15.00 Abc
$LSD_{(0.05)}$	1.54	6.09	6.01
CV (%)	8.38	5.34	7.25

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

4.2 Number of egg mass per plant of brinjal

Number of egg mass per plant of brinjal showed significant difference. These results are also presented in Table 1. Different varieties were used to suppress the number of egg mass and to test their tolerance against epilachna beetle. The maximum incidence of egg mass (24.00) was found in Yashaswi on brinjal. The brinjal variety "Harshita" showed the lowest incidence of egg mass (8.33) than other varieties evaluated.

The lowest incidence of egg mass, in the brinjal variety "Harshita" indicates that this variety is more effective to manage the egg mass on brinjal research field. The variety of "Harshita" showed the superior performance against egg mass whereas the variety of "Yashaswi" showed the inferior performance to manage the egg mass of epilachna beetle. The results obtained from another varieties showed intermediate incidence of eggmass compared to highest and lowest incidence. So, Harshita was more effective to reduce the egg mass of epilachna beetle than other varieties.

4.3 Number of grubs of epilachna beetle per plant

Number of grubs on brinjal showed significant difference. Grubs of epilachna beetle were significant affected on brinjal which are presented in Table 2. From the observation in Table 2, it was found that the variety Yashaswi of brinjal hosted maximum number of grubs (20.67). Among the rest varieties, Harshita was more effective against the grub of epilachna beetle which showed the lowest grub number (5.67) on brinjal research field.

From the above results on number of grubs per plant, it was found that the variety of Harshita on brinjal research field decreased the number of grub. Whereas, Harshita showed highest tolerance against the grubs of epilachna beetle. The results obtained from other varieties showed intermediate number of grubs compared to those of Harshita (highest) and Yashaswi (lowest).

4.4 Number of infested plant per plot

The effect of some varieties on infestation of brinjal plants by epilachna beetle has been presented in Table 2. The data indicate that the lowest number of infested plant (10.67) was found in the brinjal variety of Harshita (T_7) which was significantly higher than the variety of Yashaswi. However, significant difference was observed among the variety of brinjal. It was also observed that Harshita showed the best performance by reducing plant infestation over variety of Yashaswi. The order of tolerance of ten varieties used in this experiment for brinjal plant infestation from epilachna beetle was: Harshita > Muktakeshi > Shamli > Mohini/Dark stallon > Anondo/Sandhya/Shingnath >Islampuri. This result indicates that Harshita was the most effective varietyas it showed intermediate level of prevention of plant from epilachna beetle infestation. Although other varieties reduced brinjal plant infestation their effectiveness was unsatisfactory.

Table 2. Effect of varieties on the incidence of number of infested plant per plot and number of infested leaf per plant of brinjal

Varieties	Number of infested plant per plot	Number of infested leaves per plant
Shamli	14.33 a	24.67 Cd
Muktakeshi	14.00 a	27.00 Bcd
Yashaswi	15.00 a	36.67 A
Mohini	14.67 a	22.33 De
Anondo	15.00 a	26.33 Bcd
Sandhya	15.00 a	25.67 Bcd
Harshita	10.67 b	17.33 E
Dark stallon	14.67 a	27.67 Bcd
Shingnath	15.00 a	29.33 Bc
Islampuri	15.00 a	32.00 Ab
$LSD_{(0.05)}$	1.05	6.18
CV (%)	4.19	13.40

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

4.5 Number of infested leaf per plant

A significant variation was also observed due to the effect of different variety in the management of epilachna beetle on brinjal plant in respect of number of infested leaf per plant (Table 1 and Plate 2). The minimum number of infested leaf per plant (17.33) was observed in Harshita (T_7) variety and the maximum number of infested leaf plant (36.67) was observed from Yashaswi (T_3) variety. Harshita provided more than 52.74% reduction of leaf infestation of brinjal by epilachna beetle over Yashaswi variety. This result indicates that Harshita was the most effective and Yashaswi was the least effective based on the incidence of epilachna beetle in field conditions.

4.6 Number of infested fruit per plant

A significant variation was also observed due to the effect of different variety in the management of epilachna beetle on brinjal plant in respect of number of infested fruit per plant. The minimum number of infested fruit per plant (2.67) was found from variety of Harshita where the epilachna beetle tolerant was obtained by Yashaswi. However, Yashaswi showed the maximum number of infestedfruit (7.33) was recorded (Table 3).

Plate 2. Epilachna beetle infested on brinjal leaf.

Table 3. Effect of varieties on thenumber of infested fruit per plant, number of healthy fruit per plant and yield of fruit per plant *of brinjal*

Varieties	Number of infested fruit	Number of healthy fruits per plant	Yield of fruit per plant (g)
Shamli	4.17 bc	8.67 bc	155.20 E
Muktakeshi	4.17 bc	9.67 bc	497.80 Cde
Yashaswi	7.33 a	7.00 C	340.00 De
Mohini	4.17 bc	9.33 bc	409.20 Cde
Anondo	3.83 bc	10.33 B	791.70 Bc
Sandhya	4.67 b	10.67 B	816.10 Bc
Harshita	2.67 c	15.00 A	1777.00 A
Dark stallon	4.50 b	9.33 bc	670.30 Bcd
Shingnath	4.67 b	11.00 B	779.90 Bcd
Islampuri	4.33 bc	9.67 bc	955.30 B
$LSD_{(0.05)}$	1.62	2.91	402.20
CV (%)	5.47	6.85	12.60

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

4.7 Number of healthy fruit per plant

A significant variation was found due to the effect of different varietiesused as control agent against epilachna beetle on brinjal in respect of number of healthy fruit per plant (Table 3).The maximum number of healthy and epilachna free brinjal fruits were 15.00 per plant was found in Harshita variety, which was significantly higher than those of all other varieties. On the other hand, Yashaswi produced the minimum (7.00) healthy and insect free fruits.

4.8 Yield per plant

Yield per plant was significantly influenced by the different varieties of brinjal on epilachna beetle (Table 3). Various varieties were used to manage the epilachna beetle in this study. As a result, Harshita of brinjal showed the highest yield per plant (1777.00 g) where the maximum reduction was found in epilachna beetle. On the other hand, the lowest yield per plant (155.2 g) was found Shamli variety of brinjal.

From the above results investigated, it was found that among all the varieties in this study, Harshita showed the superior performance on tolerant the epilachna beetle pest as well as on growth and yield.

Plate 3. Healthy fruit per plant.

CHAPTER 5

SUMMARY AND CONCLUSION

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif*-2 seasons from June to November, 2012 to study host preferences of *Epilachna* beetle on different varieties of brinjal plant. Each variety was considered as individual treatment. There were ten varieties of brinjal, viz. T_1 = Shamli, T_2 = Muktakeshi, T_3 = Yashaswi, T_4 = Mohini, T_5 = Anondo, T_6 = Sandhya, T_7 = Harshita, T_8 = Dark stallon, T_9 = Shingnath and T_{10} = Islampuri. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications.

Incidence of epilachna beetle showed significant variation on different varieties of brinjal. Among the varieties, Harshita was tolerant of pests with the minimum number of epilachna beetle per plant (1.33). Similarly, the maximum number of epilachna beetle per plant (8.00) was obtained from Yashaswi. Number of egg mass per plant of brinjal showed significant difference. The maximum incidence of egg mass (24.00) was found in Yashaswi on brinjal. Harshita of variety of brinjal supported the lowest number of egg mass (8.33). The maximum number of grubs per plant (20.67) was found in Yashaswi of brinjal. Harshita was more effective against the grub of epilachna beetle showing the lowest number (5.67) on brinjal.

Effect of varieties of brinjal on epilachna beetle was significantly influenced on number of infested plant and number of infested leaf and number of fruits of brinjal. The lowest number of infested plant (10.67) was found in the brinjal variety of Harshita. The minimum number of infested leaf per plant (17.33) was observed in Harshita. The minimum number of infested leaf per plant (17.33) was observed in the Harshita variety. Besides, the minimum number of infested fruit per plant (2.67) was also found in the Harshita variety.

A significant variation was found due to the effect of different varieties control agent against epilachna beetle on brinjal in respect of number of healthy fruit per plant (Table 3). The maximum number of healthy and epilachna free brinjal fruits were 15.00 per plant was found in Harshita variety. Yield per plant was significantly influenced by the different varieties of brinjal on epilachna beetle. The highest yield per plant (1777.00 g) was obtained from Harshita of brinjal. On the other hand, the lowest yield per plant (155.2 g) was found in the Shamli variety of brinjal.

Conclusion

From the above results, it could be concluded that among all the varieties evaluated in this study, Harsita showed best performance towards managing the epilachna beetle of brinjal as well as producing better growth and yield characteristics of brinjal. It also showed superior performance on growth and yield of brinjal whereas the variety of Yashaswi showed the lowest performance on the incidence of epilachna beetle over and above growth and yield. Among

the varieties on management of epilachna beetle, the variety of Harshita showed higher tolerance against epilachna beetle and the variety Yashaswi showed higher susceptibility to epilachna beetle infestation.

The following recommendations may be made from this present study-

1. Harshita may be cultivated as a tolerant variety against epilachna beetle .
2. More varieties may be considered for future study to validate the superior performance of Harshita, observed from the present study.

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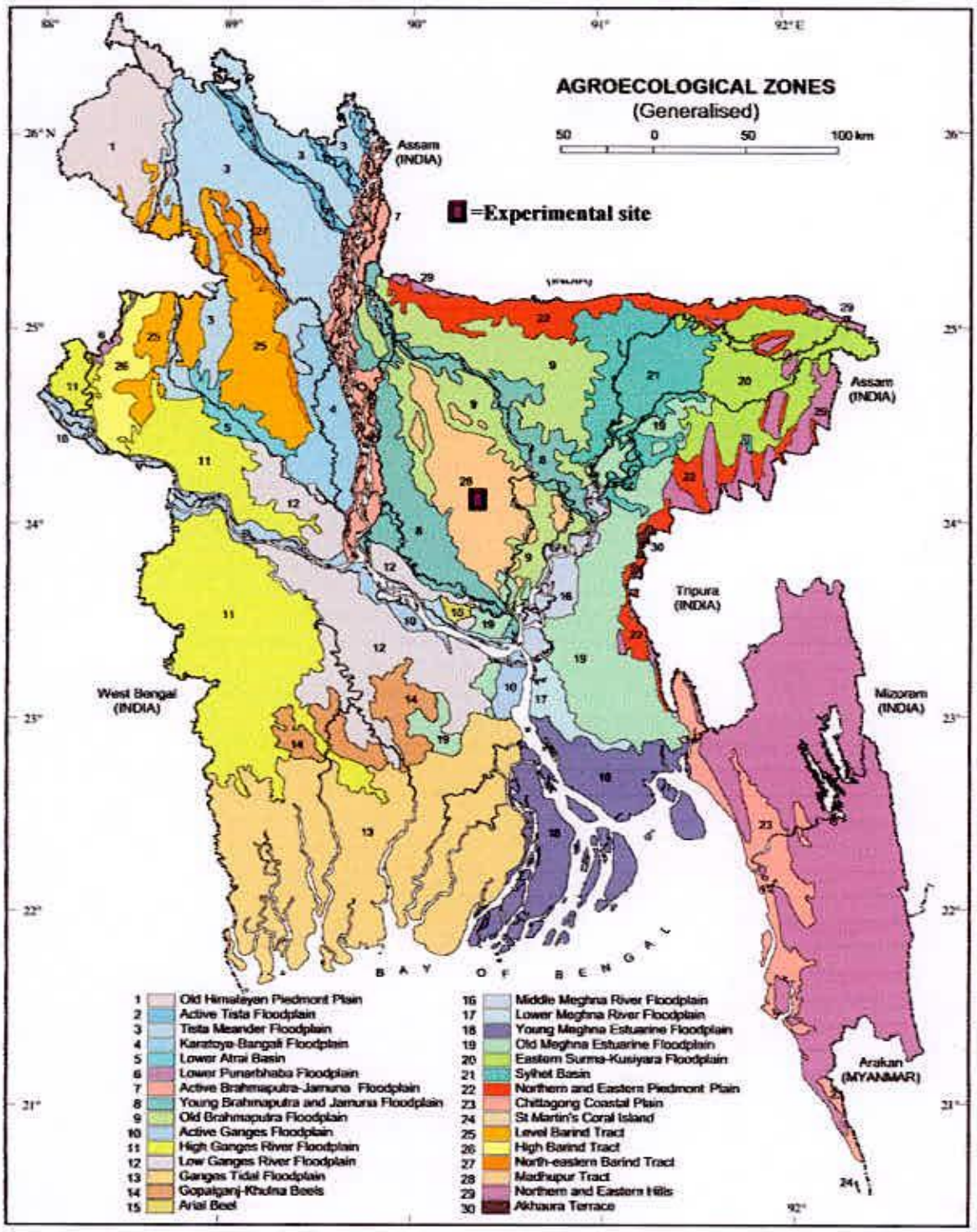
APPENDICES

APPENDICES

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



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

Constituents	Percent
Sand	26
Silt	45
Clay	29
Textural class	Silty clay

Chemical composition:

Soil characters	Value
Organic carbon	0.45%
Organic matter	0.78%
Total nitrogen	0.07%
Phosphorus	22.08 µg/g soil
Sulphur	25.98 µg/g soil
Magnesium	1.00 meq/100 g soil
Boron	0.48 µg/g soil
Copper	3.54 µg/g soil
Zinc	3.32 µg/g soil
Potassium	0.30 µg/g soil

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