HOST PREFERENCE OF DIFFERENT INSECT PESTS ON DIFFERENT VARIETIES OF MUNGBEAN

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CERTIFICATE

This is to certify that the thesis entitled "HOST PREFERENCE OF DIFFERENT INSECT PESTS ON DIFFERENT VARIETIES OF MUNGBEAN" submitted to the DEPARTMENT OF ENTOMOLOGY, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (M.S.) in ENTOMOLOGY, embodies the results of a piece of bona fide research work carried out by BISHWAJIT ROY, Registration. No. 09-03488, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation has duly been acknowledged.

. . . .

Prof. Dr. Md. Serajul Islam Bhuiyan
Supervisor

Dated:
Dhaka, Bangladesh

DEDICATED TO

MY

BELOVED PARENTS

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Dhaka, Bangladesh
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HOST PREFERENCE OF DIFFERENT INSECT PESTS ON DIFFERENT VARIETIES OF MUNGBEAN

ABSTRACT

To evaluate the varietal preference of mungbean against major insect pests, an experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during March-June, 2015. The experiment consisted of seven mungbean varieties namely BARI Mung-3 (V_1), BARI Mung-4 (V_2), BARI Mung-6 (V_3), BARI Mung-5 (V_4), BINA Mung-5 (V_5), BINA Mung-6 (V_6) and BINA Mung-8 (V_7), which were laid out in Randomized Block Design with three replications. The occurrence and incidence of, whitefly (*Bemisia tabaci*), aphid *(Brevicoryne brassicae)*, bean thrips (*Caliothrips fasciapus*) and bean podborer *(Maruca vitrata)* were observed and recorded in the field of all mungbean varieties. Among seven mungbean varieties BARI Mung-3 (V_1) was found to be the most susceptible host for bean podborer, whitefly, aphid and bean thrips. Conversely, the BARI Mung-6 (V_4) was found to be the least preferred host against most of the insect pests. Considering the yield potential, BARI Mung-6 (V_4) produced the highest yield (1148.89 kg/ha), and the BARI Mung-3 (V_1) produced the lowest yield (857.22 kg/ha).

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LIST OF ABBREVIATIONS

%	=	Percent
@	=	At the rate
°C	=	Degree Celsius
AEZ	=	Agro Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cv.	=	Cultivar (s)
DAS	=	Days After Sowing
DMRT	=	Duncan’s Multiple Range Test
EC	=	Emulsifiable Concentrate
et al.	=	And Others
FAO	=	Food and Agriculture Organization
g	=	Gram
IRRI	=	International Rice Research Institute
LSD	=	Least Significant Difference
MoP		Muriate of Potash
ppm	=	Parts per million
RCBD	=	Randomized Complete Block Design
SAU	=	Sher-e-Bangla Agricultural University
t/ha	=	Ton per Hectare
Tk./ha	=	Taka per Hectare
TSP	=	Triple Super Phosphate

CHAPTER I

INTRODUCTION

Pulses are the most important protein in the diet of the majority of the people in Bangladesh. It contains about twice as much protein as cereals. It also contains amino acid lysine, which is generally deficit in food grains (Elias, 1986). Pulse bran is also used as quality feed for animals. Apart from these, the ability to fix nitrogen and addition of organic matter to the soil are important factors in maintaining soil fertility (Senanayake *et al.*, 1987; Zapata *et al.*, 1987). Pulse fits well in the existing cropping systems, due to its short duration, low input, minimum care required and drought tolerant nature. A large number of pulse crops are grown in Bangladesh in respect of area and production (BBS. 2008). Mungbean (*Vigna radiata*) is one of the most important pulse crops in Bangladesh in both area and production. The mungbean belongs to the family Fabaceae and sub-family Papilionaceae. Much area of mungbean is planted to cereals. It ranks third in acreage, fifth in production and third in protein content among all the pulses grown in Bangladesh (BBS, 2008). Now a days, it is cultivated after harvesting of Rabi crops (i.e., wheat mustard, lentil, etc.). Due to its short duration, mungbean can fit in as a cash crop between major cropping seasons. Mungbean covers an area of 23077 hectares and production was about 20000 metric tons. The average production of mungbean in the country is about 867 kg/ha (BBS, 2010). About 3 tons/ha of seed yield have been reported in a trial in Taiwan but in Bangladesh the average yield is very low. The yield difference indicates the wide scope for increasing yield of mungbean.

Because of more vegetative canopy, large number of insect pests attack mungbean from its seedling to harvest which causes a serious loss to this crop. Since mungbean is grown mainly in the tropical climates, insect pests play important role in the profitable production of the crop. Most of these insects are polyphagous and feed on wide variety of legumes and non-legumes. Lal (1985) reported 64 species of insects that attack mungbean in the field. Among these sucking insect pests whitefly, jassids, and thrips are of the major importance (Khattak *et al*., 2004).

In flowers, both larvae and adults of thrips nourish on pollen and scratch other flower parts and suck the plant sap oozing out from the injured plant parts. As a result of this type of damage, flowers drop off and reduces pods formation. Sometimes these pests cause total yield loss.These insect pests not only reduce the vigor of the plant by sucking the sap but transmit diseases and affect photosynthesis as well. In mungbean crop, whiteflies play a key role in the spread of mungbean yellow mosaic virus which is known as a serious disease of this crop (Akhtar *et al.*, 2011, 2012). Heavy attack of whitefly cause severe loss of cell sap of plants, make plants weakened and sickly black appearance to plants due to injection of body toxins of whitefly. Insect pests that attack mungbean can be classified based on their appearance in the field as it related to the phenology of mungbean plant. They are stem feeders, pod borers and storage pests which cause a heavy loss to crop (Islam *et al.*, 2008). Damage is normally attributed to pod-borers as a complex without an attempt to apportion it to particular species. However, *M. vitrata* is often regarded as a major pest within the group. Karel (1985) described *M. vitrata* larvae in Tanzania as more abundant and injurious to pods than *H. armigera* (causing an average of 31 and 13% damage, respectively).

Variety is the key component to produce higher yield of mungbean depending upon their differences in genotypic characters, input requirements and response, growth process and of course the prevailing environmental conditions during the growing season. The growth process of mungbean plants under a given agro-climatic condition differs with variety. Variety is the most important factor in mungbean production. Selection of potential variety, planting in appropriate method and application of optimum amount of nutrient elements, can play an important role in increasing yield and national income. Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. Yield components are directly related to the variety and neighboring environments in which it grows.

Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have released different varieties of mungbean. No work has been done on the comparative efficacy of those varieties against different insect pests.

Therefore, the present study was undertaken with the following objectives:

i. To study the level of infestation caused by different insect pests in mungbean variety and
ii. To study the comparative performance of those varieties against different insect pests.

CHAPTER II

REVIEW OF LITERATURE

Mungbean (*Vigna radiata*) is one of the most important pulse crops in Bangladesh in both area and production. The mungbean belongs to the familyFabaceae and sub-family Papilionaceae. This crop is infested by large number of insect pests that cause considerable yield damage. Cultivar plays an important role in mungbean production by affecting the growth, yield and yield components of mungbean. Research works related to effect of host preference of different insect pests on different varieties of mungbean have been reviewed in this chapter.

Table 2.1 Insect pests of mungbean

Sl. No.	Common Name	Scientific Name	Reference
1	Bean thrips	*Caliothrips fasciapus*	Persley and Sharman, 2007
2	Whitefly	*Bemisia tabaci*	Bruce *et al.,* 1995
3	Aphid	*Brevicoryne brassicae*	Kazana *et al.,* 2007
4	Bean podborer	*Maruca vitrata*	Adetonah, 2003

Effect of insect and pests on mungbean

Schreinemachers *et al.* (2015) reported that incidence of vector-transmitted virus diseases and the damage caused to vegetable crops by these diseases to be increasing in countries with tropical and subtropical conditions. Virus-resistant crops and an integrated approach to crop management including appropriate control of plant-virus insect-vectors could reduce the problem. However, in developing countries, such a strategy is rarely applied effectively.

We surveyed 800 growers of chili, tomato and mungbean in India, Thailand and Vietnam to understand what farmers know about plant viruses, their perceptions about yield damage, the control methods they choose to apply and the perceived effectiveness of these.

Farmers regarded their economic losses from pests and diseases to be very substantial. Only a minority of them knew that certain disease symptoms were probably being caused by a plant virus and even fewer knew about the role of insect vectors in its spread. Building knowledge among farmers is therefore an important way to address the diseases caused by plant viruses, while the development of virus-resistant varieties and simple and effective methods of vector control offer longer-term solutions.

Nadeem *et al.* (2014) was conducted an experiment to examine the resistance in eight advance mungbean genotypes in comparison with two check varieties against sucking insect pests under natural field conditions at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad. Findings of the trial showed that none of the tested genotypes have complete resistance against sucking pests i.e., whiteflies, thrips and jassids. Comparison of resistance among the tested genotypes against whitefly showed that the lowest number of whiteflies per leaf (3.7±1.20) was observed in MH 3153, lower than those of both checks, whereas, the highest (11±1.53) was observed in MH 34143. Number of thrips per leaf was observed the lowest (4±1.00) and the highest (12.3±0.67) in cultivar MH 3153 and MH 34143, respectively. Among all the tested cultivars, MH 3153 gave the highest yield (438.7 g/plot) with 129 and 161% increase over check 1 and check 2, respectively. Therefore, genotypes which showed the highest resistance against the sucking pests and tied with high grain yield could be used for direct release as variety or may be used in cross breeding programme to get improved resistant germplasm against sucking insects.

Srivastava and Prajapati (2012) were conducted a field surveys to find out the influence of weather factors and their association with white fly population and Mungbean Yellow Mosaic Virus (MYMV) incidence in Black gram during kharif seasons of 2008-2011 in Tikamgarh district of Bundelkhand Agro-climatic zone. Maximum temperature, mean relative humidity and rainfall play an important role in white fly population built-up and significantly related to its peak population.

A regression model was developed utilizing these three variables and it was found that the model explained 65 per cent variability of the MYVY outbreak. MYMV outbreak may be estimated through minimum temperature and white fly population of the 34-37th SMW and rainfall of 37-39th SMW.

Hossain (2010) was conducted an experiment at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to November, 2011 to manage the sucking insects of mungbean and observe its impact on incidence of mosaic disease and reported that whitefly, jassid, aphid and white leaf hooper were found as sucking insects and whitefly was the most abundant in mungbean field.

Hossain *et al.* (2009) was conducted an experiment at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the insect pests attacking mungbean crop sowing at different dates to determine the optimum date(s) of sowing. It is seen that the incidence and population fluctuation of various insect pests was very much dependent on the prevailed climatic conditions of the cropping season. The early (February 14 to March 06) and late sown (mid April to onward) crops received higher pest infestation than mid sown (March 13 to April 10) crops.

Altaf *et al*. (2009) conducted an experiment was at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the insect pests attacking mungbean crop sowing at different dates to determine the optimum date(s) of sowing. It is seen that the incidence and population fluctuation of various insect pests was very much dependent on the prevailed climatic conditions of the cropping season.
The early (February 14 to March 06) and late sown (mid April to onward) crops received higher pest infestation than the mid sown (March 13 to April 10) crops.

Lal (2008) reviews the studies of various insect pests infesting mungbean or green gram, *Vigna radiate* (L) Wilczeck, in India. A total of 64 species of insects reported to attack mungbean in the field have been tabulated. Information on distribution, biology, ecology, natural enemies, cultural, varietal and chemical methods of control etc. of whitefly, *Bemisia tabaci* Genn, leaf hopper, *Empoasca kerri* Pruthi, black aphid, *Aphis craccivora* Koch, Bihar hairy caterpillar, *Diacrisia obliqua* (WIK), galerucid beetle, *Madurasia obscurella* Jacoby, stem fly, *Ophiomyia (Melanagromyza) phaseoli* (Tryon), lycaenid borer, *Euchrysops cnezus* Fabr, and spotted caterpillar, *Maruca testulalis* Geyer, is included.

Islam *et al*. (2008) were studied on seven recommend varieties of mungbean viz. Barimung 2, Barimung 3, Barimung 4, Barimung 5, Barimung 6, Binamoog 2 and Binamoog 5 were tested to know the population dynamics of whitefly under existing environmental conditions and its impact on incidence of mungbean yellow mosaic virus (MYMV) disease and yield. The experiment was conducted at the farm of Sher-e-Bangla Agricultural University (SAU) Dhaka during the kharif-I season (April to June) in 2006.

The lowest population of whitefly (adult and nymph) was found in Barimung 6 as against the highest in Binamoog 2. The population of whitefly was gradually increased with environmental temperature and relative humidity. However, the peak population was found at 320C and 80% relative humidity. The lowest percent of MYMV infected plant was found in Barimung 6 and a positive relationship was found between whitefly population and incidence of MYMV disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the MYMV infection and yield of mungbean.

MYMV a member of family Geminiviridae, belong to genus Begomovirus was identified in 1955 and it was observed that vector, whitefly (*Bemisia tabaci* Genn) is responsible for its transmission. This virus cannot be transmitted through sap, seed, soil or mechanically but Thailand strain of this virus can be transmitted by mechanical inoculation (Shad *et al.*, 2005).

Thiamethoxam was reported to be the best insecticide for controlling sucking pests such as jassid and aphid in okra and whitefly in mungbean (Ganapathy and Karuppiah 2004). Foliar sprays of carbendazim were effective against cercospora leaf spot of groundnut and greengram (Khunti *et al*. 2002; Chand *et al*. 2003).

Sreekant *et al*. (2004) conducted field experiments in kharif seasons on mungbean cv. K-851 to determine the effect of intercropping on the incidence of thrips. The treatments comprised intercropping mungbean with pigeon pea, maize, sorghum, pearl millet, castor bean and cotton, sole cropping of mungbean. The reduction in thrips was observed with pearl millet intercrop during both the seasons.

Sharma *et al*. (2004) studied eighteen promising varieties of mungbean for resistance to white fly (*Bemisia tabaci*) and yellow mosaic virus and reported that the cultivar IPU-95-13 showed high tolerance of yellow mosaic virus. Among the 4 control cultivars, PU-35 performed well. T-9, a popular cultivar of the area was highly susceptible to whitefly and yellow mosaic virus.

Mungbean (*Vigna radiata* L) is one of the important pulse crops in Bangladesh. Due to its short lifespan gradually farmers are becoming more interested to cultivate this valuable crop after harvesting of rabi crops (kharif-I season). Several insect pests have been reported to infest mungbean damaging the crops during seedlings, leaves, stems, flowers, buds and pods causing considerable losses. More than twelve species of insect pests were found to infest mungbean in Bangladesh, aphid and whitefly, thrips and pod borers (Hossain *et al.,* 2004) are important.

Masood *et al*. (2004) reported that the resistance of mungbean varieties (NM-92, NM-98, NM-121-125, M-1, and NCM-209) was investigated against some sucking insect pests of mungbean at the Gram Research Station Kalurkot, Bhakkar. Mungbean varieties, NM-92 and NM-98 showed significantly low mean whitefly population/leaf as compared to the other three tested varieties. Similar trend was also found among the varieties against jassids and thrips; however, the mean population/leaf of jassids and thrips in NM-98 and NM-121-125 were statistically similar. Yield production of NM-92 and NM-98 was significantly higher than the other tested varieties due to low infestation by sucking insect pests.

Khattak *et al*. (2004) were investigate the resistance of mung bean cultivars (NM-92, NM-98, NM-121-125, M-1 and NCM- 209) against some sucking insect pests was evaluated in Kalurkot, Bhakkar, Pakistan. NM-92 and NM-98 showed significantly low mean whitefly population per leaf than the other cultivars.

A similar trend was observed among the cultivars against jassids (A. devastans [A. biguttula biguttula]) and thrips, except that the mean populations of jassids and thrips per leaf in NM-98 and NM-121-125 did not significantly vary. The yields of NM-92 and NM-98 were significantly higher than the other cultivars due to low infestation by sucking insect pests.

Bakr *et al*. (2004) conducted an experiment in the field against thrips population. They showed that during kharif season, the thrips catching ranged from 21.2-66.5. The white traps caught the highest number of thrips (297.4) followed by blue traps (227.6). In general, thrips infestation appeared from the first week of the crop, which progressively and significantly increased in successive crop stages up to 6 weeks.

Huang-Chichung *et al*. (2003) reported that the bean pod borer infested *Sesbania cannabina* 30-90 days after sowing especially during 48-62 USA. Although bean pod borers are not strong fliers when dispersing, it is recommended that mungbean should be planted 45 m away from *Sesbania cannabina* to minimize infestation by the bean pod borer.

Chi Yuchenque *et al*. (2003) conducted an experiment in Kagoshima, Japan to study the seasonal variation in legume pod borer abundance in four legumes species by cowpea, odzuki, soybean and ned kidney bean. The infestation peaked in mid July, when more than 90% of cowpea and adzuki flowers were infested.

Jost and Pitre (2002) conducted a survey on colonization and abundance of mungbean semilooper pesudoplusia includens and cabbage looper *Thihoplusiani*, was found, adults and larvae in mungbean cropping system in the Delta region of Mississippi, USA for three growing season (1994-96). Adult population of both species remained low in early stage of mungbean. The occurrence of mungbean loopers in Mississippi appears to be similar to patterns of activity recorded for the insects 20 to 40 years ago in other area of the Southern United Stages.

Camargo (2001) were conducted investigation in Balasas, Maranhao State, Brazil during 1996-2000 to study species composition and biodiversities of noctural moth. Mungbean was grown during the first 3 years and light trop were used to collect 22199 insects (993 species, 33 families). Noctuidae and pyralidae were most abundant followed by Geometriadae, Arctitidae and oecophoridae.

Yadav and Dahiya (2000) evaluated 30 genotyeps of mungbean under field conditions for resistance of whitefly *Bemisia tabaci*, jassids *Empoasca kerri* and YMV. There were no significant differences among the genotypes MI-5, ML-803, DP91-249 and PMB-5. However, the genotypes were good sources of resistance against whitefly, jassids and YMV and might be used as donor parents in breeding programme.

Gumber *et al*. (2000) observed sixty two chickpea germplasm accessions and 6 approved cultivars for resistance to *Helicoverpa armigera* and reported that accessions ICC 93512, ICC 93515 and ICC 93212 were the most promising with higher seed yield and low pod borer damage.

Bundy and Mcpherson (2000) observed the dynamics and the relative abundance of phytophagous stingbugs. Within two crops the most abundant pentatomid species in bota crops for all 3 years were *N. viridula, Aorosternum hilane* and *Zuschistus servus*. Sting bugs began arriving in mungbean when plant growth ranged from pod formation to full seed development.

Sharma *et al.* (1999) reported that the legume pod borer, *Maruca* (testulalis) *vitrata* (Geyer) is one of the major limitations to increasing the production and productivity of grain legumes in the tropics. Several natural enemies have been recorded on *M. vitrata,* and pathogens such as *Bacillus thuringiensis*, *Nosema*, and *Aspergillus* play an important role in regulating its populations under field conditions. Cultural practices such as intercropping, time of sowing, density of sowing, and weeding reduce the pod borer damage. Several insecticides have been found to be effective for controlling this insect.

Pal (1996) stated that several factors are responsible for low production of mungbean and blackgram. Among them, insects attack plays an important role. The most important insects observed in the field, in order of their intensity, were caterpillar *(Spodoptera litura)*, white fly *(Bemisia tabaci)*, and pod borer *(Helicoverpa armigera)*. The farmers' perception of losses due to insect infestation matched with higher pesticide use on modern varieties. The perceived losses due to disease were found to be minimal at about 4-6%, depending upon variety.

Karel, A. K. (1985) stated that the effects of infestations with the pod borers *Maruca testulalis* and *Heliothis armigera* on the flowers, pods and seeds on the dry-seed yield of common beans (*Phaseolus vulgaris*) under various insecticide treatments were determined in field-plot tests in Tanzania in 1981-82. More larvae (52.3%) were found on flowers than on pods (37.8%) or leaves (9.9%). Up to 31% of flowers were damaged by feeding by larvae of the 2 species. *M. testulalis* larvae were more abundant and injurious to pods than *H. armigera* (causing an average of 31 and 13% damage, respectively). Seed damage by larvae of both species averaged 16%. Seed-yield losses caused by the 2 species ranged from 33 to 53%.

CHAPTER III

MATERIALS AND METHODS

Details of the experimental materials and methods followed in the study are presented in this chapter. The experiment was carried out during the period from March-June (kharif-I season) of 2015 for finding out the host preference of different insect pests on different varieties of mungbean.

3.1 Experimental site

The experiment was carried out at the Sher-e-Bangla Agricultural University (SAU) Farm, Dhaka. The experimental site is situated at $23^{o}77'$ North Latitude and $90^{o}30'$ East Longitude. The elevation of the experimental site is 1.0 m above the sea level. The area belongs to the Agro-ecological Zone (AEZ- 28): Madhupur Tract.

3.2 Soil

The soil of the experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. The analysis were done by Soil Resource and Development Institute (SRDI), Dhaka. The morphological, physical and chemical characteristics of the experimental soil are presented in Tables 3.1 and 3.2.

Table 3.1. Morphological characteristics of the experiment field

Characters	SAU farm
Locality	SAU, Dhaka
Geographic position	23^o77'North Latitude 90^o30'East Longitude 1.0 m height above the mean sea level
Agro-ecological zone	Madhupur Tract (AEZ-28)
General soil type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Parent material	Madhupur Terrace
Topography	Fairly level
Drainage	Well drained
Land type	High land

Table 3.2. Physical and chemical characteristics of the soils

Characteristics	SAU farm
Mechanical fractions:	
%Sand (0.2-0.02 mm)	29.93
%Silt (0.02-0.002 mm)	40.27
%Clay (< 0.002 mm)	29.80
Textural class	Silty clay loam
Soil pH	6.9
Organic C (%)	0.61
Organic matter (%)	1.05
Total N (%)	0.08
Available P (ppm)	12.78
Available K (ppm)	43.29
Available S (ppm)	23.74
Available B (ppm)	0.36

3.3 Climate

The climate of the experimental site was sub-tropical characterized by heavy rainfall, high humidity, high temperature and relatively long day during the Kharif season (April to Septamber) and hardly rainfall, low temperature and short period during the Rabi season (October to March).

3.4 Treatments and experimental design

The experiment was laid out in a randomized complete block design with three replications. Each plot was measured 3 m x 2 m. Seven different varieties of mungbean were used for the study. The name and source of availability of them were given below, where each variety was used as individual treatment.

Treatments	Varieties	Sources of availability
V_1	BARI Mung-3	BARI
V_2	BARI Mung-4	BARI
V_3	BARI Mung-5	BARI
V_4	BARI Mung-6	BARI
V_5	BINA Mung-5	BINA
V_6	BINA Mung-6	BINA
V_7	BINA Mung-8	BINA

BARI = Bangladesh Agricultural research Institute and BINA = Bangladesh Institute of Nuclear Agriculture

3.5 Year: Kharif-I, 2015

3.6 Fertilizer application

Organic fertilizers (poultry manure, farm yard manure and vermicompost) were applied along with urea, TSP, MoP, gypsum, zinc sulphate and boric acid as recommended doses during the final land preparation.

a) Urea for nitrogen @ 25 kg ha^{-1}

b) TSP for phosphorous@ 50 kg ha^{-1}

c) MoP for potassium at @ 20 kg ha^{-1}

d) Gypsum for sulphur @30 kg ha^{-1}

e) Zinc sulphate for zinc @ 2.0 kg ha^{-1}

f) Boric acid for boron @ 1.5 kg ha^{-1}

(BARI, 2009)

3.7 Land preparation

The experimental lands were opened with a power tiller and subsequently ploughed twice followed by laddering. Weed stubble and crop residues were removed. Finally, the land was leveled and the experimental plot was partitioned into the unit plots in accordance with the experimental design mentioned in the following section.

3.8 Sowing

Mungbean was sown on 27 February 2015. Healthy seeds of mungbean @ 35 kg ha^{-1} were sown by hand as uniformly as possible in furrows. Seeds were sown in the afternoon and immediately covered with soil to avoid sunlight. Line to line distance was 30 cm.

3.9 Intercultural operation

Weeding was done at 12 and 35 days after sowing. Thinning was done on the same date of 1^{st} weeding to maintain optimum plant density. Plant to plant distance was maintained at 10 cm. A light irrigation was given after sowing for germination of seed.

3.10 Harvesting and sampling

The crops were harvested at a time due to synchronous maturity of pods. At first 50% of early matured pods were harvested by hand picking at 55 days after sowing. Finally 4 days after first harvesting all plants were harvested plot-wise by uprooting and were bundled separately, tagged and brought to the threshing floor of the SAU farm. All of the harvested pods were kept separately in properly tagged gunny bags. Ten plants were randomly selected prior to maturity from each plot for data recording.

3.11 Threshing, drying, cleaning and weighing

The crop bundles were sun dried for two days on threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks. The collected seeds were dried in sun to lower the moisture content to 12% level. The dried and cleaned seed and stover were weighed plot-wise.

3.12 Data collection

i) Number of insect pest plant^{-1}

The data regarding insect population were recorded using sweep net, pitfall trap and direct field observation as needed. The species of different of insect pests were found in the mungbean field. The number of insect pest were recorded in ten plants plot^{-1}.

ii) Percent of plant infestation

The infested plants were calculated using the following formula:

$$\text{\% of infested plant by number} = \frac{\text{Number of infested plants plot}^{-1}}{\text{Total number of plants plot}^{-1}} \times 100$$

iii) Plant height

The plant height was measured from base of the plant to the tip of the main shoot for ten randomly tagged plants with the help of scale at 30 DAS and harvest. The average of ten plants was computed and expressed as the plant height in centimeters.

iv) Number of leaves plant^{-1}

The numbers of green trifoliate leaves present on each plant were counted manually from the ten tagged plants at 30 DAS and harvest. The mean number of leaves per plant was calculated and expressed in number per plant.

v) Number of pods plant^{-1}

The total number of pods from ten randomly selected plants was counted manually from each treatment. Average was worked out and recorded as number of pods per plant.

vi) Number of seeds pod^{-1} and seed yield plant^{-1}(g)

Ten pods were selected at random from the total number of pods harvested from tagged ten plants. The seeds from each pod were separated, counted and average was worked out and expressed as number of seeds pod^{-1}.The yield of seeds from ten randomly selected plants were counted from each treatment. Average was calculated and recorded as seed yield plant^{-1}(g).

vii) Seed yield

The seed yield obtained from the net plot area of each treatment was added with the yield obtained for ten tagged and harvested plants. The seeds were cleaned and dried in shade for five days. After size grading seed weight per plant was recorded in gram. The seed yield per hectare was computed and expressed in kg per hectare.

3.13 Statistical analysis

The collected data on different growth and yield parameters and nutrient contents of mungbean were statistically analyzed. The means for all treatments were calculated and the analyses of variances for all the characters were performed by ‘F’ variance test using MSTAT-C computer package program. The significance of difference between pair of means was performed by the Dancan’s Multiple Range Test (DMRT) (Russel, 1986).

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Occurrence of insect pests in the field of selected mungbean varieties

During the study period of March-June, 2015 the occurrence of four insects were recorded in the field of Mungbean using sevens varieties. Significant population of insect pests viz. Pod borer, Whitefly, Aphid and Thrips were recorded.

Table 4.1 List of insect pests found in the field of mungbean during March-June'2015

Sl. No.	Name of the insect pests	Stage(g) of insects	Site of infestation	Nature of damage
1	Whitefly (*Bemisia tabaci*)	Adult & nymph	Foliage	Feed by sucking the sap from the foliage
2	Aphid *(Brevicoryne brassicae)*	Adult & nymph	Tended leaves	Sucking cell sap from the tended leaves
3	Bean thrips (*Caliothrips fasciapus*)	Adult and nymph	Flower and Pod	Feed in growing points and inside flowers
4	Bean podborer *(Maruca vitrata)*	Larvae	Flowers and developing pods	Feeds inside the flowers before moving to developing pods

The occurrence of insect pests in the present study were recorded by observing the incidence of the respective insect pests and their nature of damage of different mungbean varieties during data recording time and identification of insects were made by visual observation with the help of field guidance by Hossain *et al.* (2009). For the identification of similar pests and insects on mungben field were conducted by Khattak *et al.* (2004) and Iqbal *et al.* (2013).

4.1.1 Occurrence of mungbean Whitefly

Pictorial view of white fly

Whitefly at its adult & nymphal stages attacked mungbean leaves and feed by sucking the sap from the foliage resulted weaken of the plants. Sharma *et al.* (2011) reported that whitefly (*Bemisia tabaci*) nymphs and adults suck sap from leaves. The infested plants become very weak showing downward cupping of the leaves giving a sickly look and the plant may die due to severe attack of the pest.

4.1.2 Occurrence of mungbean Aphid

Pictorial view of aphid

Aphid at its adult and nymphal stage attacked mungbean tender leaves and damage caused by sucking cell sap from the tended leaves resulted weaken of the plants. Sharma *et al.* (2011) reported that aphids attack adult and nymphal stage on mungbean. Nymphs are covered with waxy coating that makes them grey and dull. Nymphs and adults are seen in large numbers on young plants, leaflets, stem and pods. Young leaves of seedlings become twisted.

4.1.3 Occurrence of mungbean Thrips

Pictorial view of mungbean thrips

Among identified insect pests bean thrips attack at adult and nymphal stage. It attacked in flowering and podset condition of mungbean. Thrips feeds in growing points and inside flowers of mungbean. Chabra *et al.* (1985) reported that thrips is associated mostly with the damage of tender buds and flowers of mungbean.

4.1.4 Occurrence of mungbean podborer

Among identified insect pests, bean podborer only at its larvae stage attacked mungbean flowers and developing pods and caused damage by feed inside the flowers before moving to developing pods. Gentry (2010) reported that the bean podborer infests crops from early budding onwards, eggs are laid on or in the flowers (inserted between the petals), young larvae feed inside the flowers before pods becoming mid-sized, seeds in damaged pods are eaten out by larvae, entry holes also let in water, which stains the remaining seeds.

4.2 Incidence of insect pests in the field of mungbean

Significant variations on the incedence of bean podborer, whitefly, Aphid and bean thrips were observed in the field of different mungbean varieties, which are interpreted and discussed on the following sub-heading:

4.2.1 Incidence of whitefly on different mungbean varieties

Significant variations on the incidence of whitefly were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 1). At 15 DAS the highest (12.10 whitefly/10 plants) whitefly incidence was observed in V_1 which was statistically similar with V_3 (11.10 whitefly/10 plants) and the lowest whitefly incidence was recorded in V_4 (3.75 whitefly/10 plants). At 30 DAS the highest (10.21 whitefly/10 plants) whitefly incidence was recorded in V_1 whereas the lowest whitefly incidence was recorded in V_7 (4.10 whitefly/10 plants). At 45 DAS the maximum (3.45 whitefly/10 plants) whitefly prefered V_1 as host plant of mungbean which is statistically similar with V_3 and V_6 (3.12 and 3.11 whitefly/10 plants respectively). On the other hand the V_4 variety was not infested by whitefly. Whitefly incidence was not observed in mungbean varieties at 55 DAS. But the rate of whitefly incidence was decreasing with the increasing of mungbean plant age.

Table 1: Incidence of whitefly by number on different mungbean varieties

Varieties	Incidence of whitefly (No./10 plants)			
	15 DAS	30 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	12.10 a	10.21 a	3.45 a	0
V_2 = BARI Mung-4	8.41 bc	6. 20 d	2.45 bc	0
V_3 = BARI Mung-5	11.10 a	9.23 b	3.12 ab	0
V_4 = BARI Mung-6	3.75 e	3.21 g	0.00 d	0
V_5 = BINA Mung-5	9.10 b	5.10 e	2.45 bc	0
V_6 = BINA Mung-6	7.40 c	7.20 c	3.11 ab	0
V_7 = BINA Mung-8	5.71 d	4.10 f	2.43 bc	0
LSD $_{(0.01)}$	1.20	0.40	0.69	0
CV (%)	6.14	3.20	21.68	0

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

4.2.1.a Incidence of whitefly infested plant on different mungbean varieties

The percentage of incidence of whitefly infestation plot^{-1} were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 2). At 15 DAS the highest whitefly infested plant plot^{-1} was observed in V_1 (41.00%) variety. Where V_2 (34.10%), V_3 (33.15%), V_5 (31.40%), V_6 (30.60%) and V_7 (28.57%) varieties were statistically similar with each other. On the other hand the lowest whitefly infested plant plot^{-1} was observed in V_4 (24.00%) variety. At 30 DAS, among seven mungbean varieties, the highest incidence (30.21%) of whitefly infested plant plot^{-1} was recorded in V_1. On the other hand the lowest incidence (13.00%) of whitefly infested plant $plot^{-1}$ was recorded in V_4 which is statistically similar with V_7 (16.33%). At 45 DAS, the maximum incidence (18.00%) of whitefly infested plant $plot^{-1}$ was recorded in V_1 and no incidence of whitefly infested $plot^{-1}$ was recorded in V_4 which is statistically similar with V_3 (5.00%), V_6 (3.00%) and V_7 (1.00%). On the other hand whitefly incidence of infested plant was not observed of mungbean varieties at 55 DAS. But the rate of whitefly incidence was decreasing with the increasing of mungbean plant age.

Table 2: Incidence of whitefly infested plants on different mungbean varieties

Varieties	Percent plant infestation by whitefly $plot^{-1}$			
	15 DAS	30 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	41.00 a	30.21 a	18.00 a	0
V_2 = BARI Mung-4	34.10 b	23.30 b	12.65 b	0
V_3 = BARI Mung-5	33.15 b	23.31 b	5.00 c	0
V_4 = BARI Mung-6	24.00 c	13.00 c	0.00 c	0
V_5 = BINA Mung-5	31.40 b	22.30 b	11.63 b	0
V_6 = BINA Mung-6	30.60 b	21.23 b	3.00 c	0
V_7 = BINA Mung-8	28.57 b	16.33 c	1.00 c	0
LSD $_{(0.01)}$	3.22	2.88	4.01	0
CV (%)	14.50	6.54	28.13	0

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

From the above findings it was revealed that whitefly caused significant damage on plant of seven mungbean varieties. Among seven varieties, V_1 (BARI Mung-3) was the most suitable host for whitefly in respect of incidence of whitefly by number and infested plant. Conversely, V_4 (BARI Mung-6) was the least preferred host for whitefly in respect of incidence of whitefly by number and infested plant. The rate of incidence of whitefly and infested plants was decreased with the age of the mungbean plants and no incidence of whitefly and infested plants was observed at the later stage (55 DAS) of the growth of mungbean plants. Lal (1985) reported 64 species of insects that attack mungbean in the field. Among these sucking insect pests whitefly, jassids, and thrips are of the major importance (Khattak *et al.*, 2004). Mungbean Yellow Mosaic Begomovirus (MYMV) is very important and serious disease which is transmitted by the white fly (Honda and Ikegami, 1986, Sachan *et al.*, 1994). Heavily infested crop by white fly exhibits a sickly black appearance. Bashir *et al.* (1991) and Sharma *et al.* (1991). Sucking pests are the major cause of yield loss in mung bean, Direct damage by large population of whiteflies, *Bemisia tabaci* (Genn.) is common in India (Sehgal and Ujagir, 1987).

4.2.2 Incidence of aphid on different mungbean varieties

Incidence of aphid was significantly influenced by seven mungbean varieties at different growth stages that was evaluated in natural field condition (Table 3). At 15 DAS the highest V_1 (14.00 aphid/10 plants) aphid incidence was found in V_1 which was statistically similar with V_3 (13.00 aphid/10 plants) while the lowest aphid incidence was recorded in V_4 (5.65 aphid/10 plants). At 30 DAS the maximum (12.31 aphid/10 plants) aphid incidence was recorded in V_1. The minimum (5.31 aphid/10 plants) aphid incidence was observed in V_4. At 45 DAS the highest (2.65 aphid/10 plants) aphid incidence was found in V_1 which was statistically similar with V_3 (2.32 aphid/5 plants) and V_6 (2.31 aphid/10 plants) on the other hand V_4 variety had no incidence of aphid. But the rate of aphid incidence was decreasing with the increasing of mungbean plant age. Aphid incidence was not found of mungbean varieties at 55 DAS.

Table 3: Incidence of aphid by number on different mungbean varieties

Varieties	**Incidence of aphid (No./ 10 plants)**			
	15 DAS	30 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	14.00 a	12.31 a	2.65 a	0
V_2 = BARI Mung-4	10.31 bc	8. 30 d	1.65 bc	0
V_3 = BARI Mung-5	13.00 a	11.33 b	2.32 ab	0
V_4 = BARI Mung-6	5.65 e	5.31 g	0.00 d	0
V_5 = BINA Mung-5	11.00 b	7.00 e	1.65 bc	0
V_6 = BINA Mung-6	9.30 c	9.30 c	2.31 ab	0
V_7 = BINA Mung-8	7.61 d	6.00 f	1.63 bc	0
LSD $_{(0.01)}$	1.27	0.50	0.79	0
CV (%)	7.03	3.31	20.79	0

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

4.2.2.a Incidence of aphid infested plant on different mungbean varieties

The significant percentage of incidence of the aphid infested plant plot^{-1} were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 4). At 15 DAS the highest aphid infested plant plot^{-1} was observed in V_1 (56.56%) variety which is statistically similar with V_2 (50.00%). On the other hand the lowest aphid infested plant plot^{-1} was observed in V_4 (33.22%) variety which is statistically similar with V_7 (36.65%). At 30 DAS, among seven mungbean varieties, the maximum preference of infested plant plot^{-1} by aphid was recorded in V_1 (32.10%) and the minimum preference of infested plant plot^{-1} by aphid was recorded in V_4 (15.00%). On the other hand V_2 (25.00%), V_3 (24.26%), V_5 (22.40%), V_6 (22.30%) and V_7 (19.56%) is statistically similar with each other. At 45 DAS, the maximum infested plant plot^{-1} by aphid was recorded in V_1 (21.00%) and no incidence of aphid infested plant plot^{-1} was recorded in V_4. On the other hand the percentage of aphid infested plant was not observed of mungbean varieties at 55 DAS. But the rate of aphid incidence was decreasing with the increasing of mungbean plant age.

Table 4: Incidence of aphid infested plant on different mungbean varieties

Varieties	Percent plant infestation by aphid plot^{-1}			
	15 DAS	30 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	56.56 a	32.10 a	21.00 a	0
V_2 = BARI Mung-4	50.00 ab	25.00 b	15.36 b	0
V_3 = BARI Mung-5	43.30 b	24.26 b	8.00 c	0
V_4 = BARI Mung-6	33.22 c	15.00 c	0.00 d	0
V_5 = BINA Mung-5	43.23 b	22.40 b	14.47 b	0
V_6 = BINA Mung-6	43.21 b	22.30 b	6.00 c	0
V_7 = BINA Mung-8	36.65 bc	19.56 b	4.00 c	0
$LSD_{(0.01)}$	8.67	2.30	6.00	0
CV (%)	9.11	12.40	32.12	0

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

From the above findings it was revealed that aphid caused significant damage on plant of seven mungbean varieties. Among seven varieties, V_1 (BARI Mung-3) was the most suitable host for aphid in respect of incidence of aphid by number and infested plant. Conversely, V_4 (BARI Mung-6) was the least preferred host for aphid in respect of incidence of aphid by number and infested plant. The rate of incidence of aphid and infested plants was decreased with the age of the mungbean plants and no incidence of aphid and infested plants was observed at the later stage (55 DAS) of the growth of mungbean plants. Mungbean is attacked by different species of insect pests but sucking insect pests (aphid, jassids, leaf hopper and whitefly) are of the major importance (Islam *et al*., 2008). These insect pests not only reduce the vigor of the plant by sucking the sap but also transmit diseases and affect photosynthesis as well (Sachan *et al*., 1994) and ultimately yield losses. Despite its importance, mungbean yields are greatly depressed by a complex of biotic and abiotic factors of which insect pests are the most important. Mungbean is attacked by a number of insect pests which cause a heavy loss to crop. Major insect pests are aphid, stemfly, thrips, whitefly, jassid and pod borer.

4.2.3 Incidence of bean thrips on different mungbean varieties

Significant variations of the incidence of bean thrips were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 5). At 25 DAS there was no incidence of bean thrips of seven mungbean varieties. At 35 DAS the V_1 variety showed the highest (3.43 bean thrips/10 plants) bean thrips incidence whereas there was no bean thrips incidence of $V_{2,}$ $V_{4,}$ V_5 and V_7. At 45 DAS the maximum (4.15 bean thrips/10 plants) bean thrips incidence was recorded in V_1 which was statistically similar with V_3 (3.48 bean thrips/10 plants), V_5 (3.16 bean thrips/10 plants) and V_6 (4.12 bean thrips/10 plants) while BARI Mung-6 (V_4) had no bean thrips incidence. At 55 DAS the highest (5.65 bean thrips/10 plants) bean thrips incidence was found in V_1 which was statistically similar with V_3 (5.31 bean thrips/10 plants) and V_6 (3.00 bean thrips/10 plants) whereas the V_4 variety had no infestation by bean thrips.

Table 5: Incidence of bean thrips by number on different mungbean varieties

Varieties	Incidence of bean thrips (No./ 10 plants)			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	0	3.43 a	4.15 a	5.65 a
V_2 = BARI Mung-4	0	0.00 c	3.10 bc	4.63 b
V_3 = BARI Mung-5	0	2.63 ab	3.48 ab	5.31 ab
V_4 = BARI Mung-6	0	0.00 c	0.00 d	0.00 d
V_5 = BINA Mung-5	0	0.00 c	3.16 ab	3.32 c
V_6 = BINA Mung-6	0	2.00 b	4.12 a	3.00 ab
V_7 = BINA Mung-8	0	0.00 c	2.16 c	3.64 c
$LSD_{(0.01)}$	0	0.48	0.96	0.93
CV (%)	0	31.64	22.3	14.21

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

4.2.3.a Incidence of bean thrips infested plant on different mungbean varieties

The significant percentage of incidence of bean thrips infested plant $plot^{-1}$ were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 6). It was observed that at 25 DAS there was no incidence of bean thrips on mungbean varieties. With the increasing of days the incidence of bean thrips on mungbean varieties had increased. At 35 DAS, among seven mungbean varieties, the maximum preference of infested plant $plot^{-1}$ by bean thrips was recorded in V_1 (18.20%) and there were no preference of V_4, V_6 and V_7 varieties by bean thrips. At 45 DAS, the maximum percent of infested plant $plot^{-1}$ by bean thrips was recorded in V_1 (40.13%) and the minimum percent of infested plant $plot^{-1}$ by bean thrips was recorded in V_7 (7.10%) which is statistically similar with V_3 (7.20%). On the other hand no incidence of bean thrips was recorded in V_4 variety. At 45 DAS, the maximum infested plant $plot^{-1}$ by bean thrips was recorded in V_1 (43.67%) which is statistically similar with V_2 (37.00%) and the minimum infested plant $plot^{-1}$ by bean thrips was recorded in V_4 (7.00%).

Table 6: Incidence of bean thrips infested plant on different mungbean varieties

Varieties	Percent plant infestation by bean thrips plot^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	0	18.20 a	40.13 a	43.67 a
V_2 = BARI Mung-4	0	13.88 b	33.34 b	37.00 ab
V_3 = BARI Mung-5	0	1.70 d	7.20 e	30.33 bc
V_4 = BARI Mung-6	0	0.00 e	0.00 f	7.00 e
V_5 = BINA Mung-5	0	5.70 c	23.75 c	33.67 b
V_6 = BINA Mung-6	0	0.00 e	17.00 d	23.67 cd
V_7 = BINA Mung-8	0	0.00 e	7.10 e	17.00 d
LSD $_{(0.01)}$	0	2.88	5.45	7.22
CV (%)	0	29.63	15.43	11.21

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

From the above findings it was revealed that bean thrips caused significant damage on plant of seven mungbean varieties. Among seven varieties, V_1 (BARI Mung-3) was the most susceptible host for bean thrips in respect of incidence of bean thrips by number and infested plant. Conversely, V_4 (BARI Mung-6) was the least preferred host for bean thrips in respect of incidence of bean thrips by number and infested plant. The rate of incidence of bean thrips and infested plants was increased with the age of the mungbean plants and no incidence of bean thrips and infested plants was observed at the early stage (25 DAS) of the growth of mungbean plants. Several insect pests have been reported to infest mungbean and damage the seedlings, leaves, stems, flowers, buds, pods causing considerable losses (Sehgal and Ujagir 1988, Rahman 1988, Husain 1993). The most damaging insect pests of mungbean recorded so far is thrips (Rahman *et al.* 1981). Thrips is associated mostly with the damage of tender buds and flowers of mungbean (Chabra and Kooner 1985, Lal 1985). Several factors are responsible for low production of mungbean and blackgram. Among them, insects attack plays an important role (Nine, 1980; Pal, 1996).

Losses due to insect infestation are important problem in mungbean cultivation. According to farmers, insects caused more losses in modern varieties (about 14% yield losses) than in traditional varieties (about 9% yield losses).

4.2.4 Incidence of bean podborer on different mungbean varieties

Significant variations of the incidence of bean podborer were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 1). At 25 DAS there was no incidence of bean podborer of seven mungbean varieties. At 35 DAS the highest (2.63 larvae/10 plants) bean podborer incidence was recorded in V_1 whereas the lowest bean podborer incidence was recorded in V_4 (0.00 larvae/10 plants) which was statistically similar with all varieties except V_1 (0.00 larvae/10 plants) and V_3 (0.00 larvae/10 plants). At 45 DAS the maximum (3.34 larvae/10 plants) bean podborer incidence was recorded in V_1 which was statistically similar with V_3 (2.67 larvae/10 plants), V_5 (2.34 larvae/10 plants) and V_6 (3.33 larvae/10 plants) whereas the lowest bean podborer incidence was observed in V_4 (0.00 larvae/10 plants). At 55 DAS the highest (4.65 larvae/10 plants) bean podborer incidence was found in V_1 which was statistically similar with V_3 (4.31 larvae/10 plants) and V_4 (4.00 larvae/10 plants) whereas the lowest bean podborer incidence was found in V_4 (0.00 larvae/10 plants). But the rate of bean podborer incidence was increasing with the increase of the age of the mungbean plant.

Table 7: Incidence of bean podborer by number on different mungbean varieties

Varieties	Incidence of bean podborer (No./ 10 plants)			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	0	2.63 a	3.34 a	4.65 a
V_2 = BARI Mung-4	0	0.00 c	2.00 bc	3.63 b
V_3 = BARI Mung-5	0	2.00 b	2.67 ab	4.31 ab
V_4 = BARI Mung-6	0	0.00 c	0.00 d	0.00 d
V_5 = BINA Mung-5	0	0.00 c	2.34 ab	2.32 c
V_6 = BINA Mung-6	0	0.00 c	3.33 a	4.00 ab
V_7 = BINA Mung-8	0	0.00 c	1.35 c	2.64 c
$LSD_{(0.01)}$	0	0.39	0.94	0.84
CV (%)	0	32.73	24.6	15.23

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

4.2.4.a Incidence of bean podborer infested plant on different mungbean varieties

Significant variations of the incidence of bean podborer infested plants were recorded at different growth stages of seven mungbean varieties evaluated in natural field condition (Table 2). At 25 DAS no bean podborer infested plants was observed because of bean podborer incidence occur at flowering and pod forming stage. At 35 DAS, among seven mungbean varieties, the highest incidence (21.00%) of bean podborer infested plants was recorded in V_1. On the other hand, no incidence (0.00%) of bean podborer infested plants was recorded in V_4 which is statistically similar with V_3 (0.00%) and V_7 (0.00%). At 45 DAS, the maximum incidence (42.68%) of bean podborer infested plants was recorded in V_1 which is statistically similar with V_2 (36.10%) and the minimum incidence (6.10%) of bean podborer infested plants was recorded in V_4. At 55 DAS, V_1 gave the highest incidence (56.57%) of bean podborer infested plants whereas no incidence (0.00%) of bean podborer infested plants was recorded in V_4.

Table 8: Incidence of bean podborer infested plants on different mungbean varieties

Varieties	Percent infested by bean podborer plot^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1 = BARI Mung-3	0	21.00 a	42.68 a	56.57 a
V_2 = BARI Mung-4	0	4.40 d	36.10 ab	43.23 b
V_3 = BARI Mung-5	0	0.00 e	29.43 bc	36.57 b
V_4 = BARI Mung-6	0	0.00 e	6.10 e	0.00 d
V_5 = BINA Mung-5	0	8.40 c	22.77 cd	26.57 c
V_6 = BINA Mung-6	0	16.57 b	32.67 b	43.23 b
V_7 = BINA Mung-8	0	0.00 e	16.20 d	20.00 c
LSD $_{(0.01)}$	0	4.88	6.24	7.39
CV (%)	0	32.73	11.19	10.51

In a column, means followed by same letter (s) do not differ significantly at 1% level by DMRT

DAS – Days After Sowing

From the above findings it was revealed that bean podborer caused significant damage on plant of seven mungbean varieties. Among seven varieties, V_1 (BARI Mung-3) was the most suitable host for bean podborer in respect of incidence of bean pod borer by number and infested plant. Conversely, V_4 (BARI Mung-6) was the least preferred host for bean podborer in respect of incidence of bean pod borer by number and infested plant. The rate of incidence of bean podborer and infested plants was increased with the age of the mungbean plants and no incidence of bean podborer and infested plants was observed at the early stage (25 DAS) of the growth of mungbean plants. Damage is normally attributed to pod-borers as a complex without an attempt to apportion it to particular species. However, *M. vitrata* is often regarded as a major pest within the group. Karel (1985) described *M. vitrata* larvae in Tanzania as more abundant and injurious to pods than *H. armigera* (causing an average of 31 and 13% damage, respectively).

Patnaik *et al.* (1986) stated that *M. vitrata* was the dominant pest in Orissa, India; however, Okeyo-Owour and Khamala (1980) did not list *M. vitrata* among the more important pod-borer pests in Kenya.

Loss of yield (of seed) due to the complex of pod-borer larvae was measured as 3.69-8.89% for pigeon pea in Orissa, India (Patnaik *et al.*, 1986); 33-53% for beans in Tanzania (Karel, 1985); 25.7-62.7% for pigeon pea in Kenya (Okeyo-Owour and Khamala, 1980). Yadava *et al.* (1988) in Uttar Pradesh, India, found a difference between early varieties of pigeon pea, where *M. vitrata* was an important member of the complex of species, and late varieties where it was not. The respective yield losses for early and late varieties were 13-13.6% and 26.7-34.8%.

4.3 Performance of seven varieties on growth and yield attributes

4.3.1 Plant Height (cm)

The data on plant height (cm) of mungbean at different growth stages as influenced by different varieties are presented in Table 9. Among the seven varieties, it was found that both at 30 DAS and at harvest the highest plant height was obtained from V_4 variety (30.25cm and 44.81 cm respectively) that is BARI Mung-6 and the lowest plant height was obtained from V_1 variety (21.13 cm and 33.11 cm respectively).

4.3.2 Number of leaves plant^{-1}

The data on number of leaves plant^{-1} of mungbean at different growth stages as influenced by different varieties are presented in Table 9. Among the seven varieties, it was found that both at 30 DAS and at harvest the highest number of leaves was obtained from V_4 variety (13.88 and 21.72 respectively) which is statistically similar with all vatieties except V_1 (9.90) and V_2 (10.10) at 30 DAS and V_5 (21.63) at harvest. The lowest number of leaves was obtained from V_0 treatment (9.90 and 14.17 respectively).

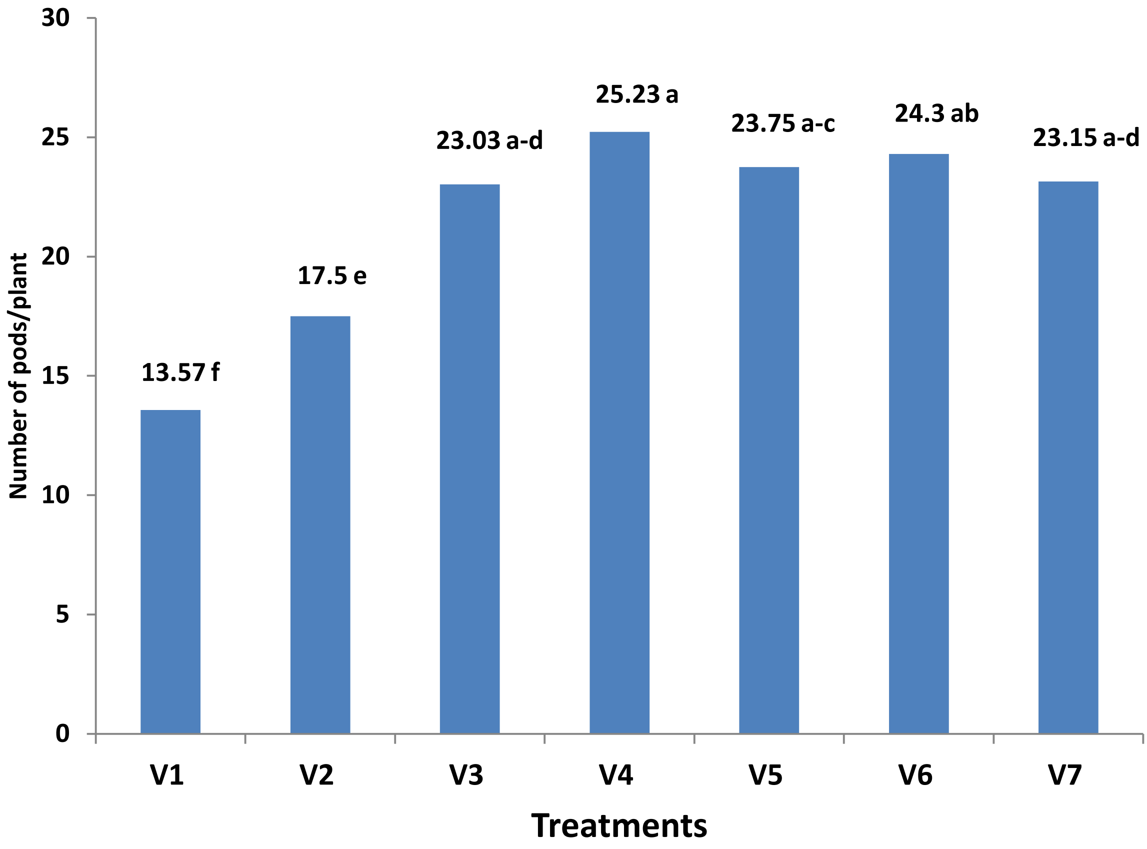
Table 9. Effect of mungbean varieties on plant height and number of leaves plant^{-1} (at 30 DAS and at harvest)

Treatment	Plant height (cm)		Number of leaves plant^{-1}	
	30 DAS	At harvest	30 DAS	At harvest
V_1 = BARI Mung-3	21.13 f	33.11 e	9.90c	14.17e
V_2 = BARI Mung-4	22.63 e	37.17 d	10.10 bc	17.03 cd
V_3 = BARI Mung-5	28.45 b	39.57 c	11.68 a-c	17.30 cd
V_4 = BARI Mung-6	30.25 a	44.81 a	13.88 a	21.72 a
V_5 = BINA Mung-5	29.05 b	40.67 b	13.77 a	21.63 a
V_6 = BINA Mung-6	23.57 d	39.13 c	11.57 a-c	18.97 bc
V_7 = BINA Mung-8	25.28 c	37.83 d	11.96 a-c	18.99 bc
LSD	0.846	0.846	2.622	1.916
CV (%)	3.37	2.71	4.00	6.92
Level of Significance	**	**	*	**

** = Significant at 1% level, * = Significant at 5% level

4.3.3 Number of pods plant^{-1}

The data on number of pods plant^{-1} of mungbean as influenced by different varieties are presented in Figure 1. The average values of the varieties were observed; it was found that the highest number of pods plant^{-1} was obtained from V_4 variety (25.23) which is statistically similar with V_3 (23.03), V_5 (23.75), V_6 (24.30) and V_7 (23.15) and the lowest number of pods plant^{-1} was obtained from V_1 treatment (13.57).

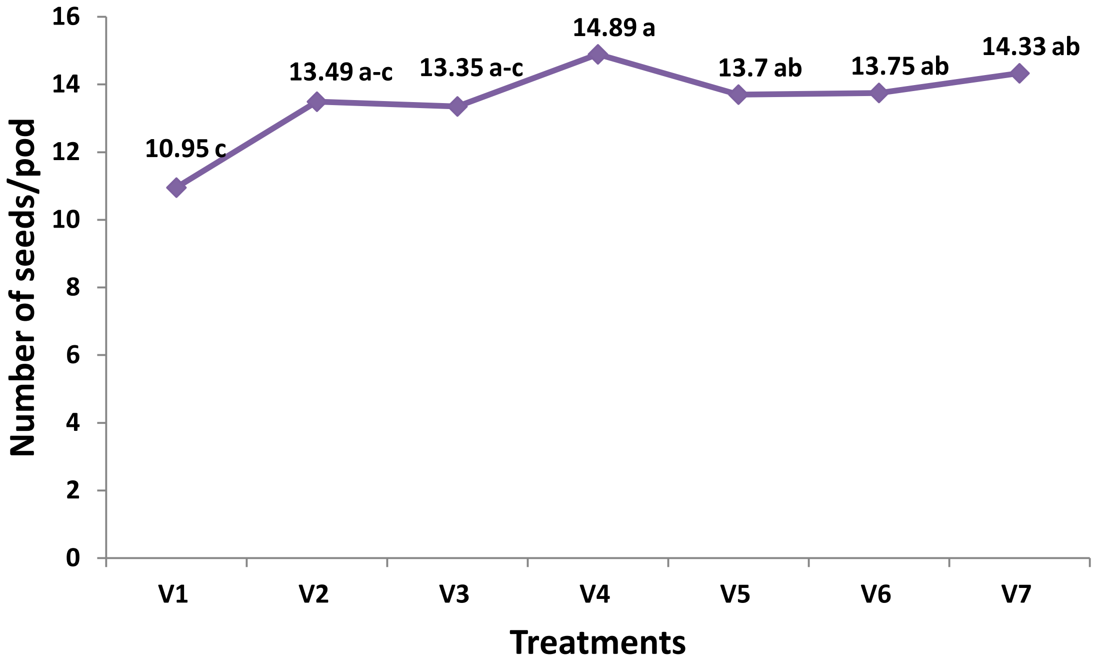


V_1 = BARI Mung-3, V_2 = BARI Mung-4, V_3 = BARI Mung-5, V_4 = BARI Mung-6, V_5 = BINA Mung-5, V_6 = BINA Mung-6, V_7 = BINA Mung-8

Figure 1. Effect of mungbean varieties on number of pods plant^{-1}

4.3.4 Number of seeds pod^{-1}

The data on number of seeds pod^{-1} of mungbean as influenced by different varieties are presented in Figure 2. The average values of the varieties were observed; it was found that the maximum number of seeds pod^{-1} was obtained from V_4 variety (14.89) which is statistically similar with all variety except V_1 (10.95) whereas the minimum number of seeds pod^{-1} was obtained from V_1 variety (10.95).

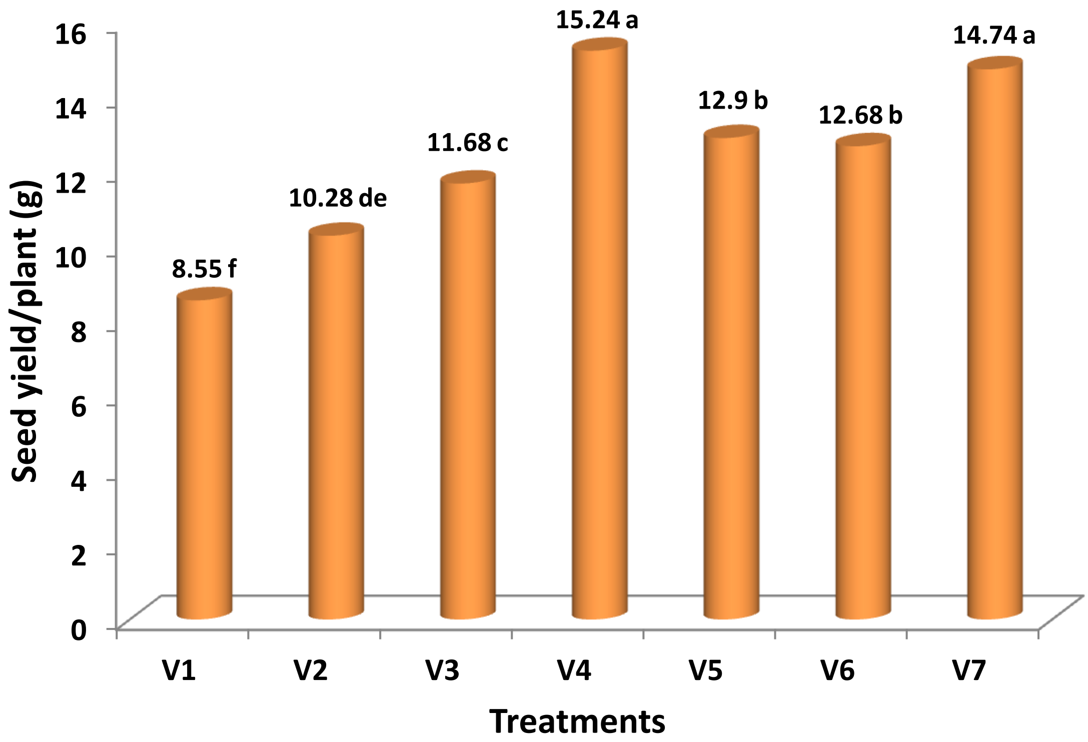


V_1 = BARI Mung-3, V_2 = BARI Mung-4, V_3 = BARI Mung-5, V_4 = BARI Mung-6, V_5 = BINA Mung-5, V_6 = BINA Mung-6, V_7 = BINA Mung-8

Figure 2. Effect of mungbean varieties on number of seeds pod^{-1}

4.3.5 Seeds yield plant^{-1} (g)

The data on seed yield plant^{-1}(g) of mungbean as influenced by different varieties are presented in Figure 3. The highest seed yield plant^{-1} was obtained from V_4 variety (15.24 g) which is statistically similar with V_7 (14.74 g) and the lowest number of seeds plant^{-1} was obtained from V_1 variety (8.55 g).

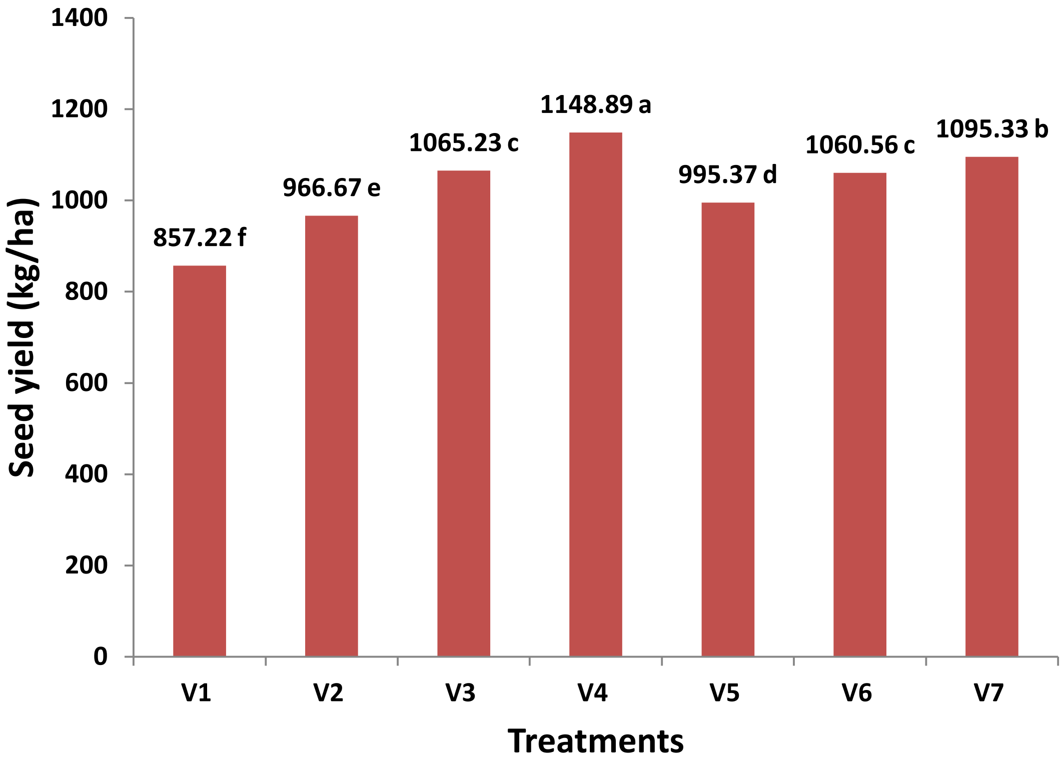


V_1 = BARI Mung-3, V_2 = BARI Mung-4, V_3 = BARI Mung-5, V_4 = BARI Mung-6, V_5 = BINA Mung-5, V_6 = BINA Mung-6, V_7 = BINA Mung-8

Figure 3. Effect of mungbean varieties on seed yield plant^{-1}

4.3.6 Seed yield (kg ha^{-1})

The data on seed yield kg ha^{-1} of mungbean as influenced by different varieties are presented in Figure 4. The average values of the varieties were observed; it was found that the highest seed yield was obtained from V_4 variety (1148.89 kg ha^{-1}) whereas the lowest seed yield was obtained from V_1 variety (857.22 kg ha^{-1}) that is control.



V_1 = BARI Mung-3, V_2 = BARI Mung-4, V_3 = BARI Mung-5, V_4 = BARI Mung-6, V_5 = BINA Mung-5, V_6 = BINA Mung-6, V_7 = BINA Mung-8

Figure 4. Effect of mungbean varieties on number seed yield (kg ha^{-1})

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was carried out at the experimental farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from March-June, 2015 to evaluate performance of seven mungbean varieties against the different insect pest over a cropping season.

The soil of the experimental field initially had a pH of 6.9, organic carbon 1.05%, total N 0.08%, available P 12.78 ppm, exchangeable K 43.29 ppm, available S 23.74 ppm, available B 0.36 ppm. The experiment was designed with 8 treatments, laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 3 m x 2 m.

There were four insect pests viz., whitefly, aphid, bean thrips and bean podborer identified in the field of seven mungbean varieties and caused considerable damage on them. In case of whitefly among seven mungbean varieties, V_1 (BARI Mung-3) was the most suitable host for whitefly. Conversely, V_4 (BARI Mung-6) was the least preferred host for whitefly in respect of incidence of whitefly by number and infested plants. The rate of incidence of whitefly and infested plants were decreased with the age of the mungbean plants and no incidence of whitefly and infested plants was observed at the later stage (55 DAS) of the plant growth.

Among seven mungbean varieties, V_1 (BARI Mung-3) was the most suitable host for aphid and V_4 (BARI Mung-6) was the least preferred host for aphid in respect of incidence of aphid by number and infested plants plot^{-1}. The rate of incidence of aphid and infested plants were decreased with the age of the mungbean plants and no incidence of aphid and infested plants was observed at the later stage (55 DAS) of the plant growth.

Out of seven mungbean varieties, V_1 (BARI Mung-3) was the most suitable host for bean thrips whereas V_4 (BARI Mung-6) was the least preferred host for bean thrips in respect of incidence of bean thrips by number and infested plants plot^{-1}. The rate of incidence of bean thrips and infested plants were increased with the age of the mungbean plants and no incidence of bean thrips and infested plants was observed at the early stage (25 DAS) of the plant growth.

It was observed that among seven mungbean varieties, V_1 (BARI Mung-3) was the most suitable host for bean bean podbored while V_4 (BARI Mung-6) was the least preferred host for bean podborer in respect of incidence of bean podborer by number and infested plants plot^{-1}. The rate of incidence of bean podborer and infested plants were increased with the age of the mungbean plants and no incidence of bean podborer and infested plants was observed at the early stage (25 DAS) of the plant growth.

Significant variation was found in plant height, number of leaves and branches plant^{-1} of different mungbean varieties at 30 DAS and at harvest. At 30 DAS and at harvest highest (30.25cm and 44.81 cm respectively) plant height were observed in V_4 (BARI Mung-6). The lowest (21.13 cm and 33.11 cm respectively) plant height at 30 DAS and at harvest was found from the V_1 variety. Numbers of leaves plant^{-1} (both at 30 DAS and at harvest) were also the highest (13.88 and 21.72 respectively) inV_4 whereas the lowest (9.90 and 14.17 respectively) number of leaves plant^{-1} at 30 DAS and at harvest was found from the V_1 variety. Numbers of branches plant^{-1} (both at 30 DAS and at harvest) were also the highest (2.67 and 4.97 respectively) inV_4 and it was closely followed by V_7 (2.61 and 4.90 respectively). The lowest (1.95 and 3.50 respectively) numbers of branches plant^{-1} at 30 DAS and at harvest were found from the variety V_1. For the above parameters; V_4 (BARI Mung-6) showed better results than other varieties. Number of pods plant^{-1}, seeds pod^{-1} and seed yield plant^{-1} showed significant variation due to the different varieties of mungbean. Maximum numbers of pods plant^{-1} (25.23), seeds pod^{-1} (14.89) and seed yield plant^{-1} (15.24 g) were recorded in V_4. Minimum numbers of pods plant^{-1}(13.57), seeds pod^{-1} (10.95) and seed yield plant^{-1} (8.55 g) was found from the variety V_1. It was observed that, for the above parameters; V_4 (BARI Mung-6) showed better results than other varieties. This improvement in seed yield components may be due to improved vegetative growth.

The overall improvement in growth and yield components may be due to synergistic effect of different varieties. From the present study, the variety V_4 (BARI Mung-6) was the best variety against insect pest in respect of yield performance.

The following recommendations can be made:

1. Research works may be initiated on the effect of different insect pests on growth and yield of mungbean.

2. Other improved cultivars may be tested under such insect pest and

3. Such studies should be conducted under different AEZs.

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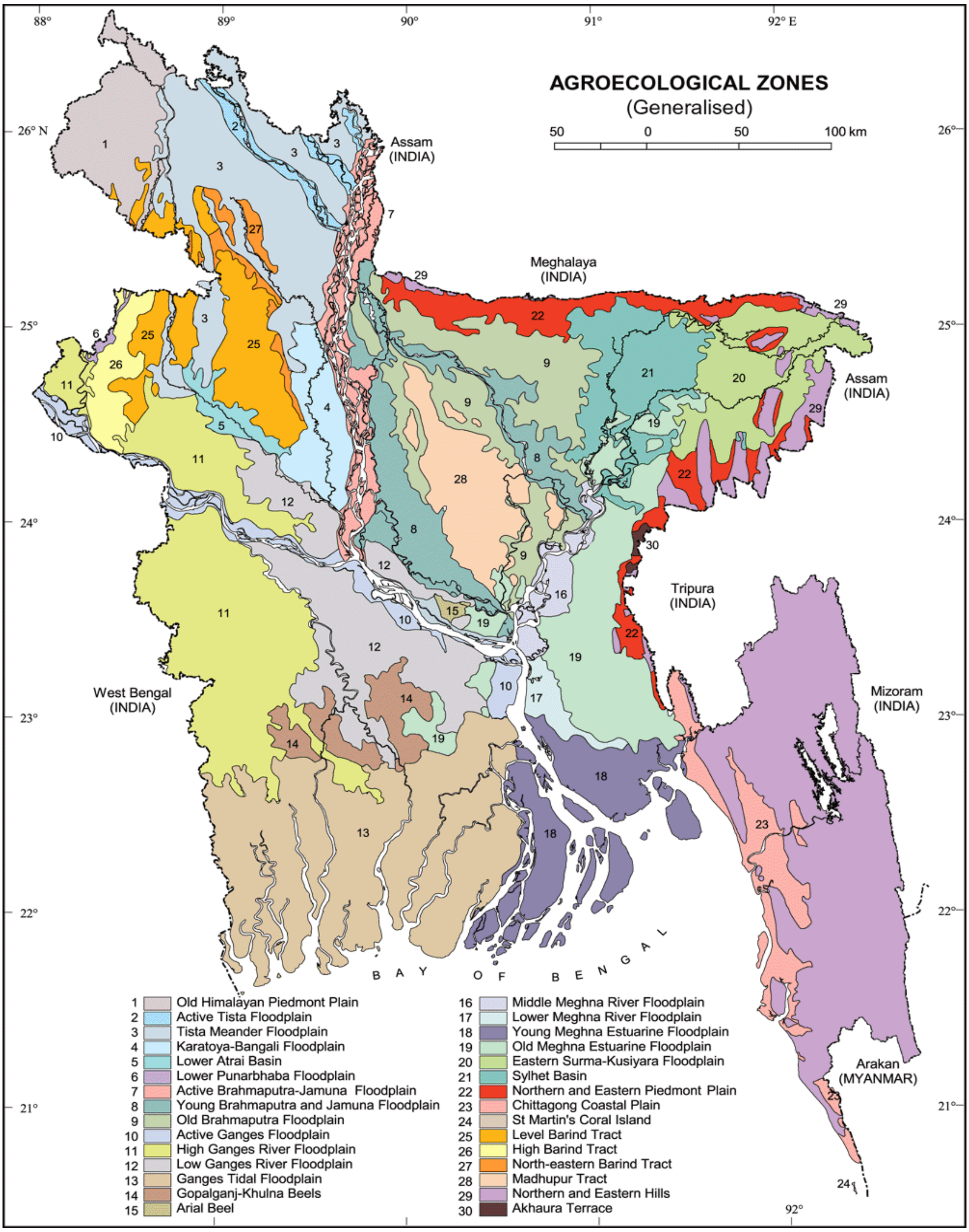
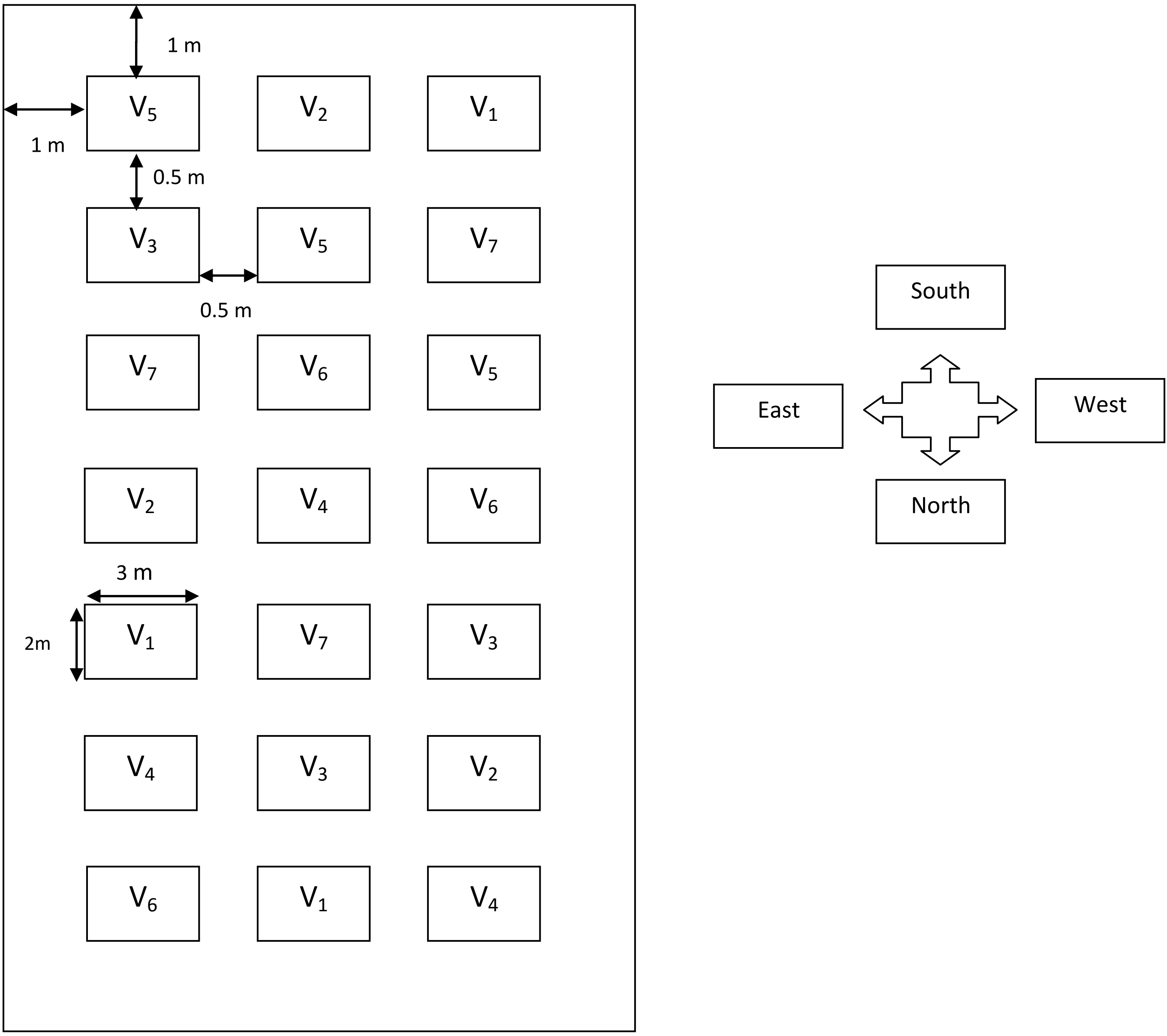
APPENDICES

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



Appendix II : Layout of the experimental field



Appendix III. Effect of mungbean varieties on number of pods plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1} and seed yield (kg ha^{-1})

Treatment	Number of pods plant^{-1}	Number of seeds pod^{-1}	Seed yield plant^{-1}(g)	Seed yield (kg ha^{-1})
V_1 = BARI Mung-3	13.57 f	10.95c	8.55f	857.22 f
V_2 = BARI Mung-4	17.50 e	13.49 a-c	10.28 de	966.67 e
V_3 = BARI Mung-5	23.03 a-d	13.35 a-c	11.68 c	1065.23 c
V_4 = BARI Mung-6	25.23 a	14.89 a	15.24 a	1148.89 a
V_5 = BINA Mung-5	23.75 a-c	13.70 ab	12.90 b	995.37 d
V_6 = BINA Mung-6	24.30 ab	13.75 ab	12.68 b	1060.56 c
V_7 = BINA Mung-8	23.15 a-d	14.33 ab	14.74 a	1095.33 b
LSD	2.503	2.684	0.7869	18.42
CV (%)	9.82	6.55	2.89	5.98
Level of Significance	**	*	**	**

** = Significant at 1% level, * = Significant at 5% level

Appendix IV. Plate 1: Experimental plot of mungbean field

Appendix V. Plate 2: Experimental plot of mungbean

Appendix VI. Plate 3: Experimental plot of mungbean field