MANAGEMENT OF *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)* THROUGH PEAK PERFORMANCE NEUTRIENT (PPN) AND SOME SELECTED INSECTICIDES

MD. SHOHEDUL ISLAM

DEPARTMENT OF PLANT PATHOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA -1207

JUNE, 2016

MANAGEMENT OF *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)* THROUGH PEAK PERFORMANCE NEUTRIENT (PPN) AND SOME SELECTED INSECTICIDES

REGISTRATION NO. 10-03829

A Thesis

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
PLANT PATHOLOGY

SEMESTER: JANUARY - JUNE, 2016

Approved by:

Dr. Md. Belal Hossain
Associate Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University
Supervisor

Dr. Fatema Begum
Associate Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University
Co-supervisor

Dr. Md. Belal Hossain
Chairman
Examination Committee
Department of Plant Pathology
Sher-e-Bangla Agricultural University

DEPARTMENT OF PLANT PATHOLOGY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

Ref. No. : Date:

CERTIFICATE

This is to certify that the thesis entitled **"MANAGEMENT OF *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)* THROUGH PEAK PERFORMANCE NEUTRIENT (PPN) AND SOME SELECTED INSECTICIDES"***submitted to the Department of Plant pathology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in PLANT PATHOLOGY, embodies the result of a piece of bona-fide research work carried out by* **MD. SHOHEDUL ISLAM, REGISTRATION NO. 10-03829** *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, 2016

Dhaka, Bangladesh

Dr. Md. Belal Hossain
Associate professor
Supervisor

Dedicated To

My Beloved Parents

ACKNOWLEDGEMENTS

All praises are due to the "Almighty Allah" who enabled the author to pursue higher education in Plant Pathology and to submit the thesis for the degree of Master of Science (M.S.) in Plant Pathology.

The author wishes to express his profound sense of appreciation and heartiest gratitude to his Supervisor, ***Dr. Md. Belal Hossain,*** *Associate Professorand Chairman, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his help, scholastic supervision, continuous encouragement and constructive suggestion throughout the period of research and for taking immense care in preparing this manuscript. The author expresses his immense gratitude to his Co-supervisor,* ***Dr. Fatema Begum,*** *Associate Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for her valuable advice and constructive criticism during the critic period of research work.*

The author is grateful to all the respectable teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University for giving necessary suggestions. The author would like to extend his appreciation to all the staffs of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for their co-operation and encouragement during the study period.

The author is also thankful to Sher-e-Bangla Agricultural University Research System (SAURES) for providing research support. The author would like to give a thanks to his elder brothers of the Department, Md. Abu sayed, M. Z. Kadir Rony, Amit Partho Sarker, Syed Md. Syduzzaman; junior brothers Md. Shariful Islam, for their cordial help and support in research work thesis writing. The author can never repay the debt of his beloved parents, uncle, aunty, sisters, brothers and well wishers for their inspiration, constant encouragement and sacrifice for his higher education.

The author expresses his immense gratefulness to all of them who assisted and inspired him to achieve higher education and regret for his inability for not to mention every one by name.

The Author

MANAGEMENT OF *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)* THROUGH PEAK PERFORMANCE NEUTRIENT (PPN) AND SOME SELECTED INSECTICIDES

ABSTRACT

An experiment on management of *mungbean yellow mosaic virus* (*MYMV*) was conducted in the field of SAU central Farm of Sher-e-Bangla Agricultural University, Dhaka during April to July, 2015.The prime aim of the study was to manage of *Mungbean yellow mosaic virus (MYMV)* by using one newly release botanical and through insect control. BARI released variety BARI mung-5, and three insecticides (Imidacloprid, Acmix and Sobicron) and one botanical nutrients PPN (Peak performance nutrients) was used in the experiment. The plants were grown for pulse production and natural inoculums were relied upon for the infection of *MYMV*. Growth parameters, yield attributes and physiological features were significantly affected by application of selected insecticides and PPN combinations. Disease incidence and severity of *MYMV* was significantly varied among the treatments. Application of Imidacloprid with PPN combination gave the lowest disease incidence (3.13, 5.24 and 6.24 % per plot and 14.33, 15.49 and 21.87 % per plant) at 30, 40 and 50 DAS, respectively while the highest disease incidence (7.77, 13.70 and 19.24 % per plot and 39.33, 48.20 and 56.63 % per plant) were found in control at 30, 40 and 50 DAS, respectively. Application of Imidacloprid with PPN also gave the lowest disease severity (5.00, 6.00 and 13.33% at 30, 40 and 50 DAS, respectively while the highest disease severity (27.33, 35.00 and 45.00%) at 30, 40 and 50 DAS, respectively were measured in control treatment when no insecticides and PPN was used. The highest chlorophyll content number of flower, pod and yield was also measured in case of combined application of Imidacloprid and PPN (Peak performance nutrients).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
mL	=	Milliliter
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Mungbean *(Vigna radiata* L. Wilczek) belongs to the family Fabaceae and sub-family papilonaceae, is a good source of protein, carbohydrate and vitamin. Being an important short-duration Kharif grain legume, mungbean is grown extensively in major tropical and subtropical countries of the world. Mungbean is the fifth important pulse crop of Bangladesh (Abedin *et al.,* 1991). Bangladesh grows various types of pulse crops among which grass pea, lentil, mungbean, chickpea, field pea and cowpea are important. In Bangladesh, Mungbean is traditionally cultivated in the winter in about 97078 acres of land and about 31610 m tons of grains are produced (BBS 2013-2014) which is very low as compared to other countries of the region. According to World Health Organization (WHO), per capita requirement of pulse is 45 g. but in Bangladesh, only 12 g of pulse is available per capita per day. About 6.01 million metric tons of pulse will be required to meet the present per capita requirement of Bangladesh. Mungbean considered as a poor man's meat. It is an important source of protein and several essential micronutrients. It contains 24.5% protein and 59.9% carbohydrate, 75 mg calcium, 8.5 mg iron and 49 mg B-carotene per 100 gm of split dual (Bakr *et al.,* 2004). The foliage and stem are also a good source of fodder for livestock as well as a green manure. Among pulses, mungbean is favored for children and the elderly people because of its easy digestibility and low production of flatulence. It is a drought tolerant, grown twice a year and fits well in our crop rotation program. This classification is convenient in judging the economic importance of the pest, especially their influence on seed yield, and in devising control measures. Mungbean is attacked by different species of insect pests but sucking insect pests (aphid, jessed, white leaf hopper and whitefly) are of the importance (Islam *et al*, 2008). These insect pests not only reduce the vigor of the plant by sucking the sap but also transmit different diseases particularly viral diseases and affect photosynthesis as well (Sachan *et al.,* 1994). Pest appearance, population fluctuation, infestation rate and crop yield are very much dependent on sowing time. Most of the farmer's usually sown mungbean just after harvesting them rabi crops without considering optimum sowing dates (Hossain *et al.,* 2000).The reasons of low yield of mungbean are numerous but yield losses due to insect pest complex are distinct one. Mungbean is attacked by different species of insect pests. Insect pests that attack mungbean can be classified based on their appearance in the field as it related to the phonology of mungbean plant. They are stem feeders, foliage feeders, pod feeders and storage pests. Mungbean crop is affected by various pathogens among them *Mungbean Yellow Mosaic Virus (MYMV)* is the most important and widely distributed. *MYMV* causes irregular yellow and green patches on older leaves resulting complete yellowing leaves. Affected plants produce less number of flowers, pods and seeds. This disease is seriously, destructive, and widespread heavy loss annually. It was first identified in India in 1955 and is naturally transmitted by whitefly (*Bemisia tabaci Genn*), but not by mechanical inoculation or by seed (Nariani, I960). It infects mungbean, soybean, mothbean, cowpea and some hosts of the family Malvaceae and Solanaceae (Dhingra and Chenulu, 1985). Yellow mosaic is reported to be the most destructive viral disease not only in Bangladesh, but also in India, Pakistan, Sri Lanka and adjacent areas of South East Asia (Bakar, 1981and Malik,1991). *MYMV* belongs to the genus *Begomovirus* of the family *Geminivirideae* (Bos, 1999). The virus has geminate particle morphology (20 × 30 nm) and the coat protein encapsulates circular, single stranded DNA genome of approximately 2.8 kb. In Pakistan, the virus has been partially characterized and identified on the basis of Polymerase Chain Reaction (PCR) and epitope profile and DNA sequence (Hossain *et al.*, 2004; Hamid and Robinson 2004).

Inheritance studies with *MYMV* have also been conducted (Malik 1991; Jayana *et al.*, 1991). Epidemiological factors play crucial role in the development of *MYMV* and white fly population. The proper time of application of insecticides could be helpful not only to manage whitefly and virus minimizing the number of sprays. The study of epidemiological factors determined the most conducive environment for the application of pesticides at right time, enhancing the yield of this crop. The aim of the present study was to evaluate the effect of PPN, newly formed plant nutrients to use some selected insecticides viz. Acmix, sobicron and imidacloprid against to control insect vector (white fly).

Objectives

- To evaluate the efficacy of PPN to manage the *Mungbean yellow mosaic virus (MYMV).*
- To evaluate potentiality of selected insecticides to control insect vectors.
- To manage the *MYMV* by using PPN and insecticides.

CHAPTER II

REVIEW OF LITERATURE

Mungbean (*Vigna radiata* L. Wilczek) suffers from many diseases of which yellow mosaic disease causes severe damage to the crop. Available literatures on various aspects of this disease so far have been presented in this chapter

Mungbean Yellow Mosaic Virus

The *yellow mosaic disease (YMD*) of mungbean was first observed in 1955 at the experimental farm of the Indian Agricultural Research Institute, New Delhi. The causal virus, *mungbean yellow mosaic virus (MYMV)* is transmitted by the whitefly (*Bemisia tabaci)* and by grafting but not by sap inoculation (Nariani I960). Similar *yellow mosaic diseases* were earlier reported on other legume crops like *Phaseolus lunatus* and *Dolichos Iablab* (Capoor and Vamia 1948), but these were considered different isolate of *MYMV* (Nariani 1960). Since then *MYMV* has been found widely distributed in India and other countries of the subcontinent causing enormous losses in the production of several leguminous crops (Chenulu andVanna1988).

Singh and Singh (1979) reported that *MYMV* causes diseases in a variety of leguminous crops, but the most seriously affected crops are black gram, mungbean and soybean in the Indian subcontinent. During a survey in 1973 and 1974, which were favorable years for the spread of *MYMV*, the incidence of yellow mosaic in mungbean was recorded as more than 60% in six districts in Haryana State. *Mungbean yellow mosaic* disease was first reported in Bangladesh by Fakir (l983) with some recommendations for the management of the disease.

Occurrence and symptoms of *MYMV*

Mungbean yellow mosaic is the most destructive disease of mungbean in the Indian subcontinent and adjacent areas of Southeast Asia (Bakar 1991, Benigno and Dolares 1978, Grewal 1978, lwaki and Auzay 1978, Jayasekera and Ariyarantoe 1988, Nariani 1960, Nene *et al.*, 1972, Nene 1973, Poehlman *et al.*, 1976, and Williams *et al*. 1968).

According to Nariani (1960) the first symptom on mungbean appears on young leaves in the form of mild yellow specks or spots. The next leaf emerging from the growing apex shows irregular bright yellow and green patches. The green areas may be slightly raised and leaves may be slightly puckered and reduced in size. Yellow areas increase and apical leaves turn into completely yellow. Nene (1969) reported that diseased plants usually mature late and produce fewer number of flowers and pods. Pods are small, sometimes curled and contain few seeds. In case of severe infection very few pods are produced. Chlorosis, stunting, fewer branches and premature shedding of leaves have also been reported by Singh et al., (1982). ‘In mungbean, *MYMV* infection results considerable decrease in chlorophyll and DNA contents and increase in RNA, phenols, free amino acids, sugars and enzymes, was reported by Chhabra *et al*., (1981). The various biochemical changes clearly indicate the stress exerted by *MYMV* on the physiology of infected plants. Nene *et al.* (1974) observed that due to this disease a necrotic centre might develop in the yellow spots in some cultivars. In these cultivars, they observed no reduction in number and size of pods. It seems that the necrotic- mottle appeared as a type of resistant reaction to *MYMV* in this cultivar.

Nene (1974) in their experiment found that *MYMV* causes irregular yellow and green patches on older leaves and yellowing of young leaves of susceptible varieties of black gram, mungbean and soybean. Affected plants produce fewer flowers and pods; pods often develop mottling, remain small and contain fewer and smaller seeds.

Ahmed (1985) described the chronological development of symptoms of the disease as appearance of scattered yellow spots in young leaves which eventually turn to large irregular green and yellow mosaic with slight stunting of emerging trifoliate leaves associated with occasional puckering. Finally leaves completely turned into yellow mosaic. The symptom bearing plants mature late with flowers and pods. Pods were stunted, curled and frequently contained small, shriveled immature seeds.

According to Bakar (1991) the symptoms of the disease appear on the leaves as minute yellow specks that may expand and cover the entire area. Mixture of irregular yellow green patches could be observed on the leaves. Pods were reduced in size and borne small-shriveled seeds.

Poehlman (1991) observed the yellow patches on mungbean leaves, which coalesced to form larger patches that developed into a yellow mottle; eventually the entire leaf could turn yellow. Maturity was delayed in the diseased plants and flowers and pod production were severely reduced. Seeds that developed on severely infected plants were small and immature.

Transmission

Nene (1973) reported that whitefly is acquiring and inoculating the virus in certain hosts within 10-15 min and ten viruliferous whiteflies/plant are required for 100% transmission.

In 1960, Nariani reported that *MYMV* was transmitted by the whitefly (*Bemisia tabaci* Genn). The virus was neither seed nor soil borne or sap transmissible

Honda *et al*., (1983) reported that many isolates of *MYMV* have been obtained from different hosts and regions in India which were transmitted by *(Bemisia tabaci)* but not by sap inoculation or through seeds. Isolates from Bangladesh, Pakistan and Srilanka have similar transmission characteristics. However, a isolate from Thailand was found sap-transmissible.

Brunt *et al.* (1990) reported that *MYMV* was observed to be transmitted nature by an insect vector belonging to the Aleyrodidae: *Bemisia tabaci* in a non-persistent manner. Helper virus was not apparently required for transmission. Non-vector transmission was apparently absent by mechanical inoculation, not by seed or pollen.

Vector (s)

According to Basu (1986) *Bemisia tabaci* Gen. is an efficient vector of *MYMV*. So far, no intraspecific diversity has been identifying. Nene (1972) observed that *MYMV* could be acquired and transmitted to *phaseolus mungo* by *Bemisia tabaci* adults after l5 of acquisition period.

Nariani (1960) reported that MYM is transmitted by the whitefly *(Bemisia tabaci* Genn). Nene (1972) and Butter (1977) studied the life history of the vector (*Bemisia tabaci),* its maintenance, multiplication and dispersal on *Vigna radiata* and cotton, respectively. They found that the females laid 38-106 eggs in their total life span on the lower surface of leaves. The hatching “period was between 24 and 48 hours. The total life cycle from egg to adult stage ranged from 13 to 72 days.

Murugesan and Chelliah (1977) reported that *mungbean yellow mosaic virus* could be transmitted successfully by a single infectious *Bemisia tabaci* but maximum infection was given by 10 flies /plant. Infection was ensured when vector had a pre-acquisition starvation period of 24 hours.

According to Chenulu *et al*., (1979) *MYMV* is transmitted by the whitefly in a circulatory manner. Pre-acquisition and pre-inoculation starvation either increase the efficiency of transmission or have no effect.

Aftab *et al*., (1992) observed that *MYMV* disease spread rapidly with increase in the whitefly *(Bemisia tabaci)* population.

Dhingra (1993) also studied on the efficiency of *Bemisia tabaci* in transmission of *MYMV* in reciprocal inoculation tests of five different hosts. They reported that the maximum percentage of virus transmission occurred when the test and source plants were of the same species. Mungbean and Urdbean were better test and source plants than French bean (*Phaseolus*) and pigeonpea for the virus and /or the vector. They also described that the virus transmission percentage increased with the increase in the number of adult whitefly and that the nymphs were less efficient vectors than the adults.

Nath (I994) studied the relationship between disease incidence and population size of *Bemisia tabaci* in the crop sown. He observed a positive correlation between *MYMV* incidence and population size of *B. tabaci.*

Dantre *et al.,* (1996) studied on a yellow mosaic virus disease of soybean and mungbean and reported that the *mungbean yellow mosaic* Gemini virus was transmitted by whitefly (*Bemisia tabaci*) but not through sap or seed.

Environmental effects on vector population and spread of *MYMV*

Subrahmanynm *et al*., (1986) reported that environmental factors also influence the spread of *MYMV*. In northern India, the virus starts spreading with the onset of the monsoon and progresses fast in susceptible varieties of black gram and mungbean. Rapid spread of the virus also coincides with the vector population. Before the monsoon, the *B. tabaci* population is nonviruliferous whereas during the monsoon nearly 75% of the *B. tabaci* collected from the black gram canopy are found to be viruliferous.

According to Varma (1986) *B. tabaci* thrives best under hot and humid conditions. In subtropical areas, it survives in small number on bushy perennial plants like *Lanrana camara* during unfavorable winter and dry summer months. In tropical areas population of *B. tabaci* varies throughout the year by weather conditions. Pimple and Summanwar (1986) reported that in northern India (semitropical) with minimum temperature and minimum relative humidity are the most important factors whereas in southern India with low rainfall, low humidity and high temperatures are more favorable (Sastry *et al.,* 1978, Murugesan *et al*., 1977) for whitefly population.

The whitefly population on plants varies significantly at different periods of the day. In black gram, the lowest number of *B. tabaci* are found at noon when the light intensity is maximum, and the highest number during early morning or late evening hours as reported by Subrahmanyan *et al* (1986).

Whitefly population build up maximum from April to October when the average maximum temperature ranged from 21 to 35°C reported by Nene (1972) and Butter (1977).

Effect of *Yellow mosaic virus* on yield and yield components of mungbean

Reduction in yield in legumes due to *MYMV* depends on the time of infection and severity of the disease. If highly susceptible varieties of black gram or soybean are infected within three weeks of sowing, no yield is obtained. Infection of these species during the fourth, fifth, sixth, seventh and eighth week results in yield reductions up to 85, 60, 44, 28 and less than 10%, respectively. Yield is significant by decreased when infection occurs up to 50 days after sowing. Reduction in the number of pods plant, seeds/ pod and seed weight is the main contributing factors for the decrease in yield (Nene 1973, Suteri *et al.,*1979 and Vohra *et al*., 1979). Vohra and Beniwal observed that *MYMV* infection affects grain yield when the plant having infection up to 50 days after planting. The color, texture, size and germination of the seeds were found to be affected. Marimuthu *et al.,* (1981) found that healthy mungbean cultivars Mung and B-105 gave yield 6.5 and 5.14 g seed/plant, respectively, while yields were decreased to 4.4 and 2.03 g in severely infected plants due to *MYMV*.

Babu *et al*. (1984) reported that infection of (*Vigna radiata)* plants by *MYMV* caused significant reduction in number of pods/plant, seed yield and 100-seed wt. When healthy and infected leaves were compared a reduction in the contents of chlorophyll and functional chloroplast cells was evident in the latter. Soluble N and reducing sugars accumulated to a greater extent in infected leaves and the rate of photosynthesis was reduced.

Singh *et al*. (1982) observed that early infected plants had more severe symptoms than the late infected ones. They also established that chlorosis, stunting and reduced branching contributed to yield loss.

Ahmad (1991) observed that *mungbean yellow mosaic*Gemini virus infection causes maximum growth reduction (62.94%) and yield loss (83.9%) for (*vignaradiata cv Pusa Baisakhi)* on which symptoms appeared 20 days after sowing (DAS). For plants on which symptoms appeared 30 or 40 DAS growth parameters and yield were less affected. It is concluded that early crop infection reduced yield more than late infection.Chanda and Varma (1983) observed that plant height and fresh weight reduced upto 38.2% and 28.5% respectively for *MYMV* infection on mungbean and Urbean. The shape, size and appearance of pods and seeds of plants were considerably distorted although seed germ inability was found to be unaffected.

Yellow mosaic caused 16% yield loss in mungbean and 10% yield loss (Fakir 1983b). Reduced plant height and fresh shoot weight were reported along with yield loss up to 66% (Chanda *et al*., 1983). Ahmed (1985) observed 85% *MYMV* incidence both in summer and winter pulse verities.

Krishnareddy (1989) studied that yield loss models based on components like number of pods per plant, severity of disease and stage of infection by *MYMV* could predict yield loss very close to the actual loss in black gram. These of such a model would provide better estimates of losses due to the virus in different crops.

Bisht *et al*., (1988) observed variations in reduction of growth components and subsequent yield loss by *MYMV* among the cultivars under natural condition.

Bakar (1991) described *yellow mosaic virus* as the most serious limiting factor in mungbean and black gram cultivation and can attack the crop at any stage of growth, however, losses are severe when it attacks at an early stage. ‘Total loss had been reported when the crop was infected by *MYMV* within 1-2 weeks after germination. 63% and 20-30% losses were recorded 3 and 4-7 weeks of age.

Jain *et al.,* (1995) reported that the reduction in grain yield by *MYMV* ranged from 39.9 to 51.5% in black gram varieties. They also observed that reduction in plant height, pods/plant, 100-seed weight and crop growth rate contributed to decreased grain yield.

Gill (1999) reported that *MYMV* infection in the early growth stages of mungbean reduced yields significantly more than that of infection at the flowering stage.

Host and Source plant

The host range of most of the isolates of *MYMV* has been restricted to leguminous species, except for an isolate studied by Rathi and Nene (1976) which could also infect four nonleguminous common weeds, viz. *Brachiariaramosa*, *Cosmosbipinnatus*, *Ecllpta alba* and *Xanthium strumarium*..

Peak Performance Nutrients (PPN)

Heng (2013) defined Peak Performance Nutrients (PPN) is a liquid formulated from various botanies extract which include vegetable oil extracts, plant extracts and seed extracts etc. It is eco-friendly, non residue and non toxic, increases yield, shorter harvest cycle, increases plant vitality and robustness, improves soil condition, drought resistance, prevent virus attack and has inane insect repellent properties. He alluded some benefits of Peak Performance Nutrients-

- Enhances plant root system for better nutrition absorptions and deeper roots
- Increase of chlorophyll production resulting in healthier, high quality and full bodied and therefore “sweeter” crops

- Increases period of flowering for higher pollination yield.
- Natural repellant for birds, insect and larva – no pesticide or fungicide needed
- Expedite seed germination with seeds soaked with concentration mix of 1:500
- Reduction of harvest cycle duration.
- Soil rejuvenation and revitalization of fatigued soils.
- Harmless to human and animals
- Can improve crops quality with stronger natural flavor and glossier leaves
- Crops enhancement for resistance ability to natural disaster and quick restoration growth effects.

CHAPTER III

MATERIALS AND METHODS

This chapter includes a brief description of the experimental site, experimental period, climatic condition, crop or planting materials, land preparation, experimental design and layout, crop growing procedure, treatments, intercultural operations, data collection and plant samples along with statistical analysis.

3.1. Location and research period

The field experiment was conducted at the Sher-e-Bangla Agricultural University central Farm under the Department of Plant Pathology, Dhaka- 1207 during the period from April, 2015 to July, 2015. The location of the experimental site was at $23^{0}46^{1}$ N latitude and $90^{0}24^{1}$ E longitude with elevation of 9 meters above the sea level and have been presented in Appendix 1and 2.

3.2. Climate and Soil

The experimental site was under the sub-tropical monsoon climatic condition, which is characterized by heavy rainfall during kharif season (May-September) and scanty in the rabi season (October-March). There was very low or no rainfall during the month of December, January and February. The average maximum temperature during the period of investigation was 35.10^{0}c and the average minimum temperature was 26.60^{0}c. Details of the metrological data in respect of temperature, rainfall and relative humidity the period of experiment were collected from Bangladesh Metrological Department, Agargaon, Dhaka and have been presented in Appendix 3.

The soil of the experimental site was carried out in a medium high land belonging to the modhupur tract under the agro ecological zone (AEZ) 28. The soil texture was silty loam, non-calcarious, dark grey soil of Tejgaon soil series with a p^{H} 6.7. Soil samples of the experimental site were collected from a depth of a 0 to 30 cm before conducting the experiment and analyzed in the Soil Resources Development Institute (SRDI), Farmgate, Dhaka and have been presented in Appendix 4.

3.3. Planting materials used for the experiment

Mungbean variety namely, BARI mung-5, was used in the experiment. Seeds of BARI mungbean-5 were collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur. BARI mung-5, a high yielding variety of mungbean was released by BARI, in 1997. It is photo insensitive, short lifespan 55 to 65 days and bold seeded crop. The special characteristic of this variety is its synchronized maturity. It was developed from the NM-92 line introduced by AVRDC in 1992. Its yield potentiality is about 1.2 to 1.5 ton ha^{-1}.

3.4. Collection of selected insecticides

The selected insecticides namely Imidacloprid, Acmix and Sobicron were collected from local market and PPN was collected from China through representative country dealers of Bangladesh.

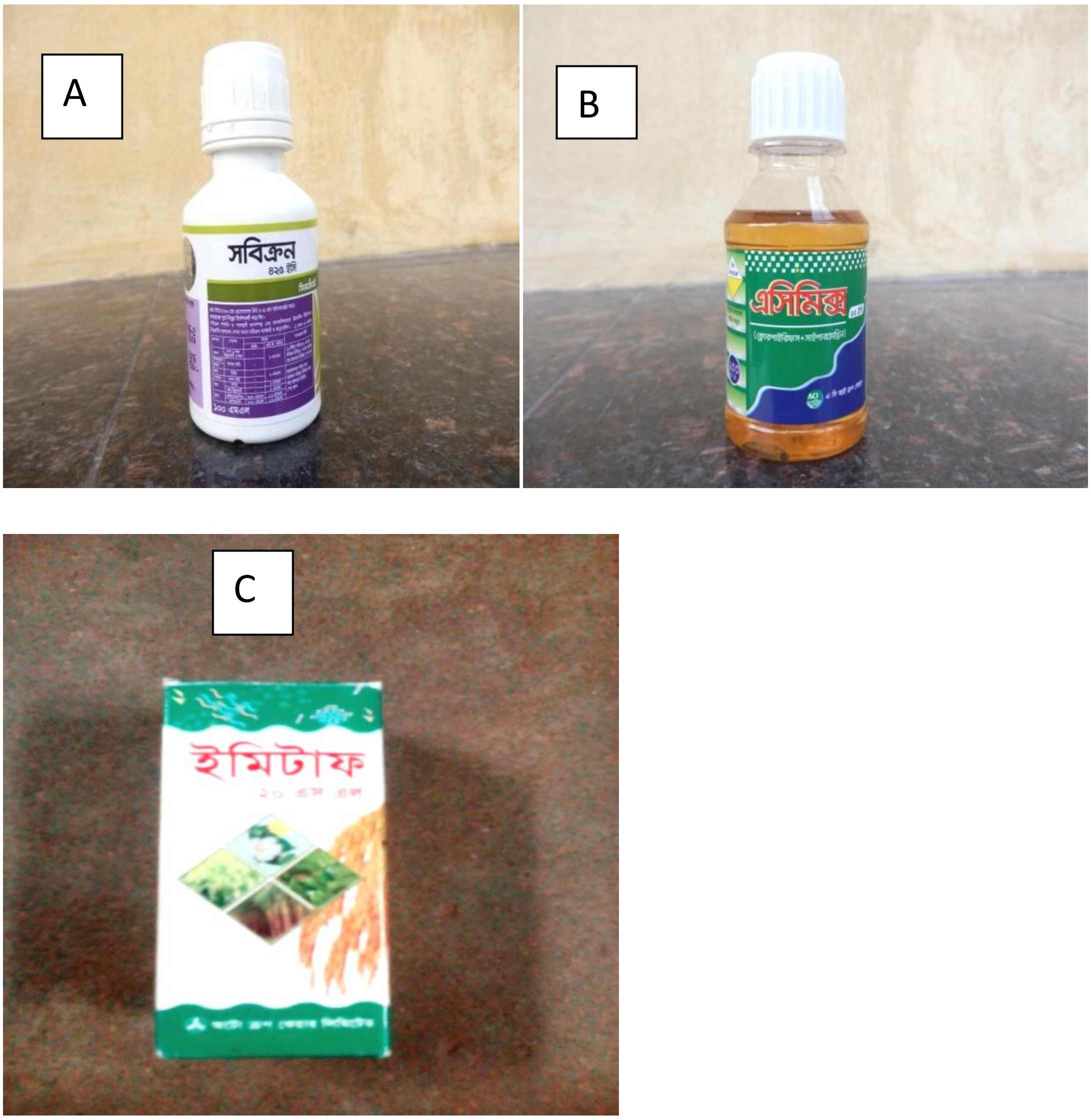


Figure 1. Different insecticides used in this study A) Sobicron, B) Acmix and C) Imitaf

3.5. Collection of peak performance nutrients (PPN)

Figure 2. PPN used in the study as experimental materials; A) PPN in powder form. B) PPN solution

3.6. Specification of PPN

Table 1. Specification of peak performance nutrient (PPN)

Typical	**Specification**
Visual appearance	Beige color (or other color as requested)
Ph	8-10
Density	1.0-1.05 g/l
Nitrogen	4.0-7.0%
K_2O	1.0-2.5%
P_2O_5	1.0-2.0%
Ca	800 ppm-1.4%
MgO	700-4000 ppm
Na	3800-8000 ppm
Cu	20-300 ppm
Mn	150-1500 ppm
Zn	100-1000 ppm

3.7. Design and layout of experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and eight treatments include a control, there were 24(3 × 8) unit plots. The size of each unit plot was (3m × 2m). Plot to plot distances were 1 m. The treatments of the experiment randomly distributed into the experimental plot.

3.8. Experimental Treatments

Considering insecticides and PPN the treatments are

T_1= Peak Performance Nutrients (PPN) at the rate of 2 g/l water

T_2= Imidacloprid (1 ml/l water) + PPN (2 g/l water)

T_3= Imidacloprid (1 ml/l water)

T_4= Sobicron (1 ml/l water) + PPN (2 g/l water)

T_5= Sobicron (1 ml/l water)

$T_{6=}$ Acmix(1 ml/l water) + PPN (2 g/l water)

$T_{7=}$ Acmix(1 ml/l water)

T_8= Control, i.e. without using of insecticides and PPN

3.9. Land preparation

The selected land for the experiment was first opened on 11 April 2015 by disc plough. After opening the land with a tractor it was ploughed and cross-ploughed six times with a power tiller and each ploughing was followed by laddering to break the clods to obtain good tilth and to level the land. All weeds and stubbles and dead roots were removed. After final land preparation, the experimental plot was laid out.

3.10. Manure and fertilizer application

The sources of N, P_2O_5, K_2O were urea, triple superphosphate (TSP), murate of potash (MOP), were applied, respectively. Whole amount of urea, the entire amounts of TSP, MOP were applied during the final land preparation respectively. Well rotten cow dung (10 t ha^{-1}) was also applied during final land preparation. The fertilizers were then mixed well with the soil by spading and individual unit plots were leveled.

3.11. Seeds sowing

Seeds were sown in the main field on the 15 April, 2015 having line to line distance of 30 cm and plant to plant distance of 10 cm.

3.11.1. Intercultural operation

The seedlings were always kept under careful observation. Necessary intercultural operations were done through the cropping season for proper growth and development of the experimental plants.

3.11.2. Thinning

The seedlings were thinned out from the plot at 10 DAS keeping.

3.11.3. Irrigation

The plot was irrigated as and when needed.

3.11.4. Weeding and mulching

Weeding and mulching were necessary to keep the plots free from weeds for ease aeration and to conserve soil moisture. Total five weeding were done to keep the plots free from weeds.

3.11.5. Drainage

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

3.12. Harvesting

The crop was 1st harvested at maturity on 18 June, 2015. The harvested crop of each plot was bundled separately. Grains were recorded plot wise and the yields were expressed in kilogram (kg) as per plot.

3.13. Identification of Disease incidence of *Mungbean Yellow Mosaic Virus (MYMV)*

Based on studying typical symptoms of *MYMV* were observed. The Mungbean plants were inspected every day until harvest and the symptoms appeared in the mungbean plants was noted. The growth stage of the plants were categorized as follows-

1) Early stage- 3weeks after seed sowing
2) Mid stage- 2 weeks after early stage, and
3) Late stage- after mid stage up to harvest.
4) The disease incidence was expressed in percentage on the basis of stage as well as total i.e., average of three stages. The percent disease incidence was calculated using the following formula:

$$\% \text{ Disease incidence} = \frac{X_1}{X} \times 100$$

Where,

X= Total number of plants

X_1= Number of infected plants

3.14. Parameters assessed

10 plants were selected for each plot, from the total experimental site carefully and mean data on the following parameters were recorded-

- Number of plants per plot
- Number of infected plants per plot
- Number of leaves per infected plant
- Number of infected leaves per infected plant
- Disease incidence (%) per plot and per plant
- Disease severity (%)
- Number of pod per plant
- Chlorophyll content in healthy plant
- Chlorophyll content in infected plant
- Yield / ha

3.15. Collection of data

For data collection on different physiological and morphological parameters from the selected plants, different measures were taken. Data over the parameters were taken in the following ways-

3.15.1. Number of plants per plot

Number of plants from each plot at 30, 40 and 50 days after sowing (DAS) was recorded.

3.15.2. Number of infected plants per plot

Number of infected plants from each plot at 30, 40 and 50 days after sowing (DAS) was recorded.

3.15.3. Number of leaves per infected plant

Number of leaves of selected infected plants from each plot at 30, 40 and 50 days after sowing (DAS) was recorded. Only the smallest young leaves at the growing point of the plant were excluded from counting. Calculating the average number of leaves, the average number was recorded.

3.15.4. Number of infected leaves per infected plant

Number of infected leaves of selected infected plants from each plot at 30, 40 and 50 days after sowing (DAS) was recorded. Calculating the average number of infected leaves, the average number was recorded

3.15.5. Number of flower per plant

Mean number of flower of selected plants from each plot as per treatment combination was recorded.

3.15.6. Number of pod per plant

Mean number of green pods of selected plants from each plot as per treatment combination was recorded.

3.15.7. Disease incidence (%) per plot

Incidence of mosaic diseases were recorded at before and after flowering.Ten plants were randomly selected from each plot and the mosaic symptoms were observed carefully for the collection of data. Data on mosaic disease incidence were recorded at an interval of 10 days commencing from first incidence and continued up to 3 times.

3.15.8. Disease severity (%) per plot

Severity of mosaic diseases were recorded from ten plants were randomly selected in each plot and observed carefully for the collection of data. Data on mosaic disease severity were recorded at an interval of 10 days commencing from first severity and continued up to 3 times.

3.15.9. Chlorophyll content in leaves per plant

The average chlorophyll content in the leaves of the selected plants was recorded with the help of "S-pad", which is an advanced technology to directly measure the chlorophyll content in plant leaf at 30, 40 and 50 days after sowing (DAS). In each reading single leaf was held by the machine three times at three location of the leaf then the machine automatically average the data and gave the value.

Figure 3. Recording net chlorophyll content in plant leaf by "S-PAD" meter

3.15.10. Yield

Yield of grain (t/ha) was calculated by converting the mean grain weight of each plot as per treatment combination.

3.16. Statistical analysis

The collected data were statistically analyzed by using the ANOVA technique. The test of significance of all parameters was done. The Duncan's Multiple Range Test (DMRT) with Least Significant Difference value was determined with appropriate levels of significance and the means were tabulated. The mean comparison was carried out by DMRT technique. The statistical package MSTAT-C was used for this purpose.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to manage a mungbean cultivar against *Mungbean yellow mosaic virus (MYMV)* using Peak Performance Nutrients (PPN), Imidacloprid , Acmix and Sobicron under field condition. Results were compiled based on disease incidence, severity, morphological and physiological parameters at 30, 40, and 50 days after sowing (DAS) are presented in this chapter.

4.1. Effect of insecticides and PPN on disease incidence (%) of *Mungbean yellow mosaic virus (MYMV)* at 30 DAS.

Disease incidence was recorded per plot and per plant after application of different treatments *viz.*, T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARI mung-5 against *Mungbean yellow mosaic virus*.The highest disease incidence was found in T_8 ((7.77%) and T_1 (7.33%), which were statistically identical, followed by T_6 (6.63%) and T_3 (6.06%) which were also statistically identical. The moderate disease incidence was found in T_5 (4.36%), T_7 (5.03%) and T_4 (5.63%) which were statistically similar with each other. The lowest disease incidence was found in T_2 (3.13%), which was statistically different from the others. In case of disease incidence per plant at 30 DAS, the highest disease incidence was found in T_8 (39.33%) and T_1 (37.67), which were statistically similar. The lowest disease incidence was found in T_2 (14.33%) preceded by T_5 (18.27%), T_7 (22.87%), T_4 (28.51%), T_3 (31.73%) and T_6 (34.83), which are statistically different with each other. (Table 2 and Figure 4)

4.2. Effect of insecticides and PPN on disease severity (%) of *Mungbean yellow mosaic virus (MYMV)* at 30 DAS.

Disease severity was measured after application of different treatments *viz.*, T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARI mung-5 against *Mungbean yellow mosaic virus*. The highest disease severity was found in T_8 (27.33%), followed by T_1 (26.33%) and T_6 (24.67%) which are statistically similar with each other. The lowest disease severity was found in T_2 (5.00%) preceded by T_5 (10.00%), T_7 (15.33%), T_4 (19.00%),T_3 (21.33%), all of them are statistically different with each other. (Table 2 Figure. 5)

Table 2. Effect of treatment on disease incidence per plot (D.I/plot) per plant (D.I/plant) and disease severity at 30 DAS.

Treatment	**%D.I/plot**	**%D.I/plant**	**%Severity**
T_1	7.33 ab	37.67 a	26.33 ab
T_2	3.13 g	14.33 g	5.00 g
T_3	6.06 cd	31.73 c	21.33 c
T_4	5.63 de	28.51 d	19.00 d
T_5	4.36 f	18.27 f	10.00 f
T_6	6.63 bc	34.83 b	24.67 b
T_7	5.03 ef	22.87 e	15.33 e
T_8	7.77 a	39.33 a	27.33 a
$LSD_{0.01}$	0.764	1.774	1.666
CV%	5.49	2.57	3.66

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).


Figure 4. Disease incidence at 30 DAS


Figure 5. Disease severity at 30DAS

4.3. Effect of insecticides and PPN on disease incidence (%) of *Mungbean yellow mosaic virus (MYMV)* at 40 DAS.

Disease incidence was recorded per plot and per plant after application of different treatments *viz*., T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARI mung-5 against *Mungbean yellow mosaic virus*. In case of disease incidence per plot**,** the highest disease incidence was found in T_8 ((13.70%) followed by T_1 (12.83%), T_6 (12.13%), T_3 (11.33%) and T_4 (10.27%), which are statistically different with each other. The moderate disease incidence was found inT_5 (8.50%), and T_7 (9.43%), both are also statistically different. The lowest disease incidence was found in T_2 (5.24%), which is statistically different from the others. In case of disease incidence per plant**,** the highest disease incidence per plant was found in T_8 (48.20%) and The lowest disease incidence was found in T_2 (15.49%) preceded by T_5 (26.70%), T_7 (30.44%), T_4 (35.12%), T_3 (37.77%), T_6 (41.00%), and T_1 (43.90%) all of them are statistically different with each other. (Table 3 and Figure 6.)

4.4. Effect of insecticides and PPN on disease severity (%) of *Mungbean yellow mosaic virus (MYMV)* at 40 DAS.

Disease severity was measured after application of different treatments *viz*., T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARImung-5 against *Mungbean yellow mosaic virus*.The highest disease severity was found in T_8 (35.00%), followed by T_1 (33.00%) and T_6 (31.67%), which are statistically similar with each other. The lowest disease severity was found in T_2 (6.00%) preceded by T_5 (17.33%), T_7 (21.00%), T_4 (24.33%),T_3 (28.67%), all of them are statistically different with each other. The results are presented in (Table 3 Figure. 7)

Table 3. Effect of treatment on disease incidence per plot (D.I/plot) per plant (D.I/plant) and disease severity at 40 DAS.

Treatment	%D.I/plot	%D.I/plant	%Severity
T_1	12.83 b	43.90 b	33.00 b
T_2	5.24 h	15.49 h	6.00 g
T_3	11.33 d	37.77 d	28.67 c
T_4	10.27 e	35.12 e	24.33 d
T_5	8.50 g	26.70 g	17.33 f
T_6	12.13 c	41.00 c	31.67 b
T_7	9.43 f	30.44 f	21.00 e
T_8	13.70 a	48.20 a	35.00 a
$LSD_{0.01}$	0.352	1.853	1.415
CV%	1.38	2.14	2.28

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).

Figure 6: Disease incidence at 40 DAS

Figure 7: Disease severity at 40 DAS

4.5. Effect of insecticides and PPN on disease incidence (%) of *Mungbean yellow mosaic virus (MYMV)* at 50 DAS

Disease incidence was recorded per plot and per plant after application of different treatments *viz*., T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARI mung-5 against *Mungbean yellow mosaic virus*. In case of disease incidence per plot**,** the highest disease incidence was found in T_8 ((19.24%) followed by T_1 (17.90%), T_6 (16.60%), T_3 (14.83%) and T_4 (13.40%), which are statistically different with each other. The moderate disease incidence was found in T_5 (8.51%), and T_7 (11.97%), both are also statistically different. The lowest disease incidence was found in T_2 (6.24%), which is statistically different from the others. In case of disease incidence per plant at 50 DAS**,** the highest disease incidence was found in T_8 (56.63%) and the lowest disease incidence was found in T_2 (21.87%) preceded by T_5 (38.93%), T_7 (35.10%), T_4 (38.50%), T_3 (43.20%), T_6 (48.23%), and T_1 (52.53%), all of them are statistically different with each other. The results are presented in Table 4.

4.6. Effect of insecticides and PPN on disease severity (%) of *Mungbean yellow mosaic virus (MYMV)* at 50 DAS

Disease severity was measured after application of different treatments *viz*., T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control) in BARI mungbean-5 against *Mungbean yellow mosaic virus*.The highest disease severity was found in T_8 (45.00%), and The lowest disease severity was found in T_2 (13.33%) preceded by T_5 (23.67%), T_7 (25.12%), T_4 (27.00%),T_3 (33.33%), T_6(37.67%) and T_1 (41.33%), all of them are statistically different with each other. The results are presented in Table 4.

Table 4. Effect of treatment on disease incidence per plot (D.I/plot) per plant (D.I/plant) and disease severity at 50 DAS.

Treatment	%D.I/plot	%D.I/plant	%Severity
T_1	17.90 b	52.73 b	41.33 b
T_2	6.24 g	21.87 h	13.33 h
T_3	14.83 c	43.20 d	33.33 d
T_4	13.40 d	38.50 e	27.00 e
T_5	8.51 f	38.93 g	23.67 g
T_6	16.60 b	48.23 c	37.67 c
T_7	11.97 e	35.10 f	25.12 f
T_8	19.24 a	56.63 a	45.00 a
$LSD_{0.01}$	1.340	1.938	2.097
CV%	4.09	2.11	3.17

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).

4.7. Effect of insecticides and PPN on Net chlorophyll content(μ mol m^{-2} s^{-1}) of healthy plant and infected plant.

In healthy plant, the highest net chlorophyll content was found in T_2 (56.30) followed by T_5 (54.20), T_7 (52.23), T_4 (50.40), T_3 (48.17), and T_6 (46.23), which are statistically different with each others. The lowest net chlorophyll content was recorded in T_8 (41.80), which are statistically different from others. In infected plant, the highest net chlorophyll content was found in T_2 (28.90), followed by T_5 (27.43) and T_7 (26.37), which is statistically identical with each other. The moderate chlorophyll content was found in T_6 (21.53), T_3 (22.83), and T_4 (24.43), which are statistically identical with each other. The lowest net chlorophyll content was recorded in T_8 (18.23) preceded by T_1 (19.63), both are statistically similar. These results are clearly shown in Figure 8.

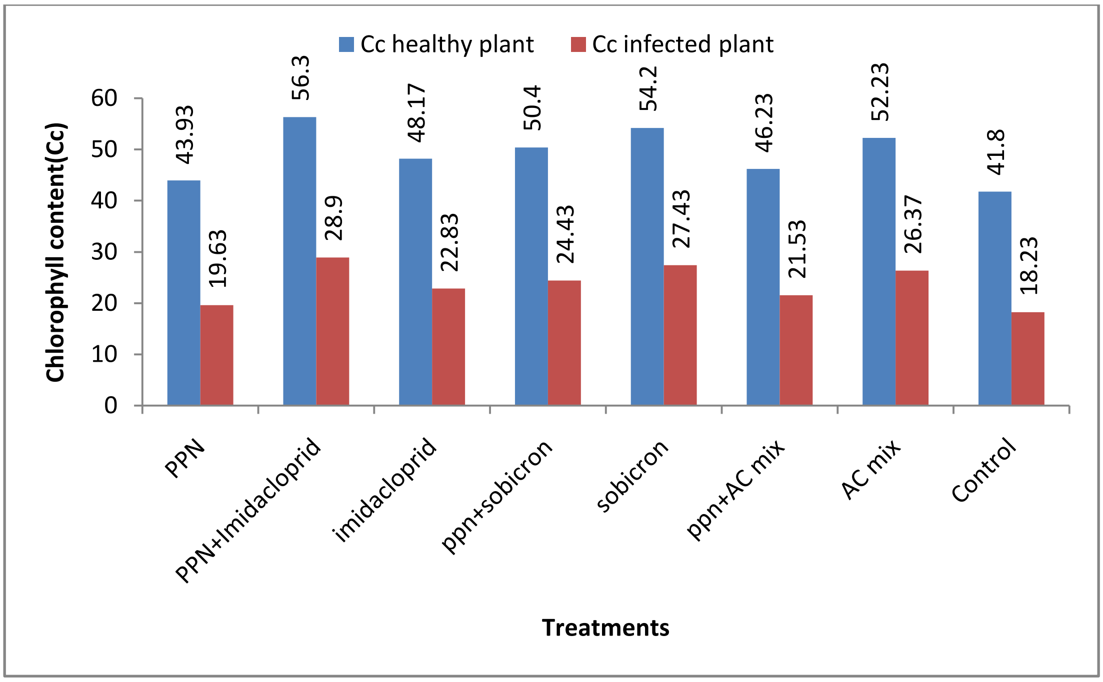


Figure 8. Graphical presentation of chlorophyll content healthy plant and infected plant.

4.8. Effect of insecticides and PPN on the number of flower, number of pod and yield (kg)

The maximum number of flower per plant was found in T_2 (13.27), which is statistically different from T_5 (12.53), T_7 (11.83), T_4 (11.27), T_3 (10.57), T_6 (10.10) and T_1 (9.33). The minimum number of flower per plant was found in T_8 (8.33), which is statistically different from others. The highest number of pod was found in T_2 (34.50), which is statistically similar with T_5 (33.83), followed by T_7 (32.37) and T_4 (31.33), both are also statistically similar with each other.The Lowest number of pod was found in T_8 (24.33), preceded by T_1 (26.70), T_6 (28.53), and T_3 (30.17), which is statistically different from others. The highest fruit yield was found in T_2 (3.16 kg), followed by T_5 (2.73) and T_7 (2.53), which is statistically identical with each other. The lowest fruit yield was found in T_8 (0.82 kg), followed by T_6 (1.33) and T_1 (1.06), both are statistically similar with each others. Result are shown in figure 9.

.

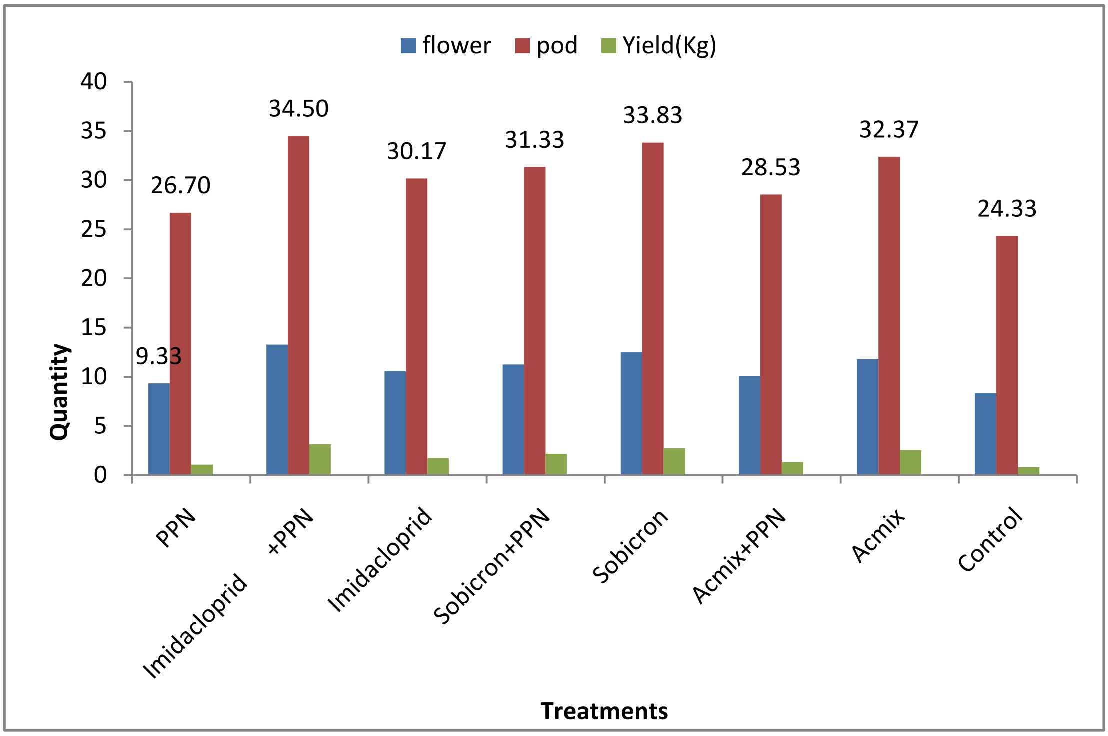


Figure 9. Graphical presentation of flower, number of pod and yield (kg)

4.9. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) and Disease Incidence (%) per Plant

Different treatments that were used in the present study regarding chlorophyll content (µ mol m^{-2} s^{-1}) and disease incidence **(%)**, it is revealed that increased chlorophyll content was observed with decreased disease incidence. The highest chlorophyll content was found in T_2 (28.90) followed by T_5 (27.43) and T_7 (26.37) where control treatment showed the lowest chlorophyll content because of the highest disease incidence. As depicted in the figure 10.

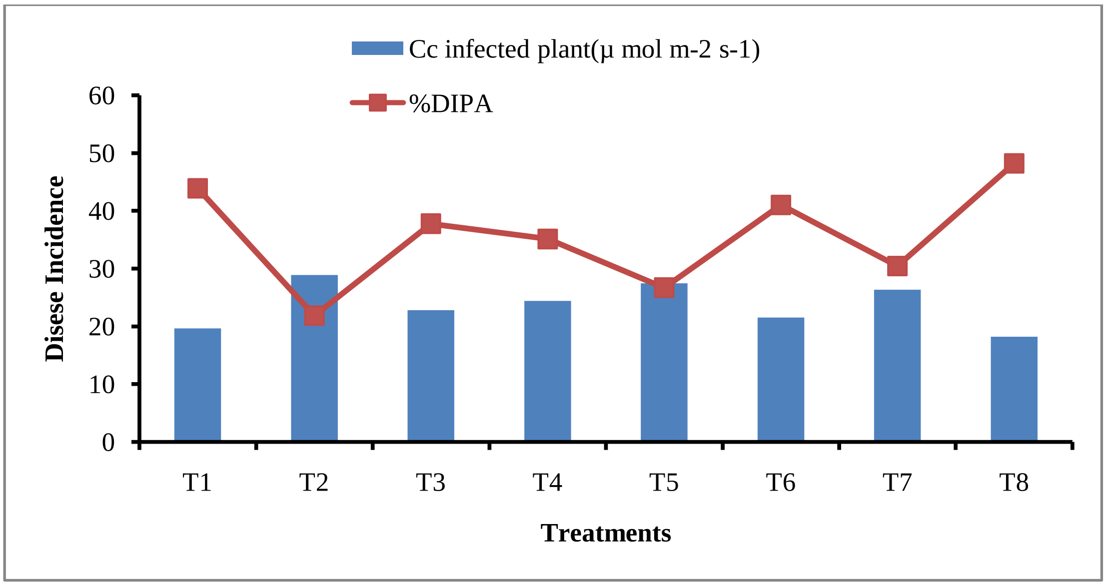


Figure 10. Relationship between Chlorophyll content and Disease incidence (%) per Plant.

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).

4.10. Relationship between chlorophyll content (μ mol m^{-2} s^{-1}) and Disease severity (%)

Different treatments that were used in the present study regarding chlorophyll content (μ mol m^{-2} s^{-1}) and disease severity **(%)**, it is revealed that increased chlorophyll content was observed with decreased disease severity. The highest chlorophyll content was found in T_2 (28.90) followed by T_5 (27.43) and T_7 (26.37) where control treatment showed lowest chlorophyll content because of highest disease severity. As depicted in the figure 11.

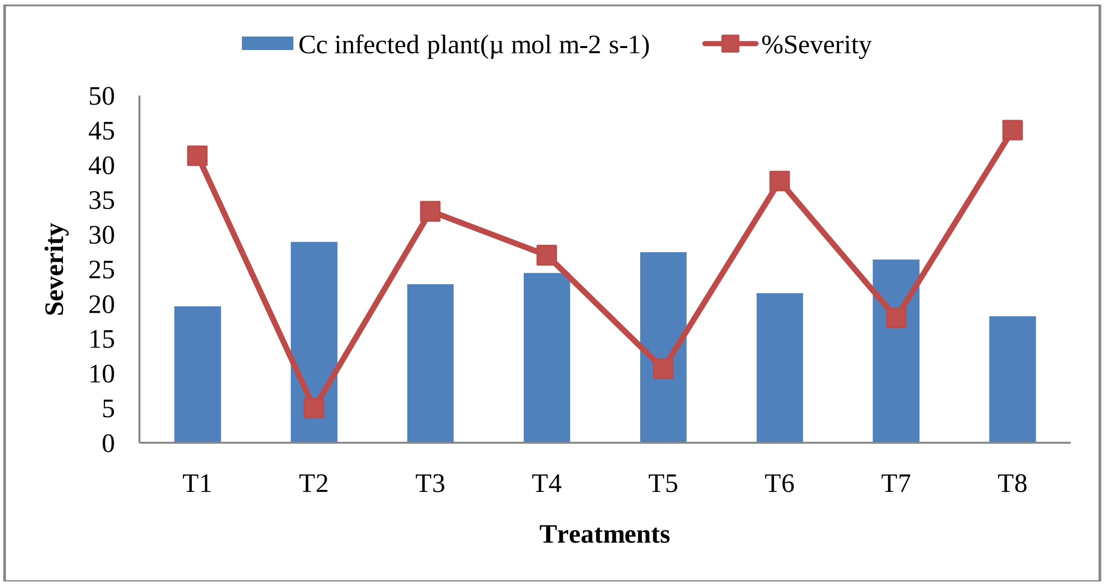


Figure 11. Relationship between Chlorophyll content and Disease severity (%)

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).

4.11. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) and yield /kg

Different treatments that were used in the present study regarding chlorophyll content (µ mol m^{-2} s^{-1}) and yield. It is revealed that increase chlorophyll content was observed with increase yield. The highest chlorophyll content was found in T_2 (28.90) followed by T_5 (27.43) and T_7 (26.37) where control treatment showed lowest chlorophyll content because of lowest yield. As depicted in the figure 12.

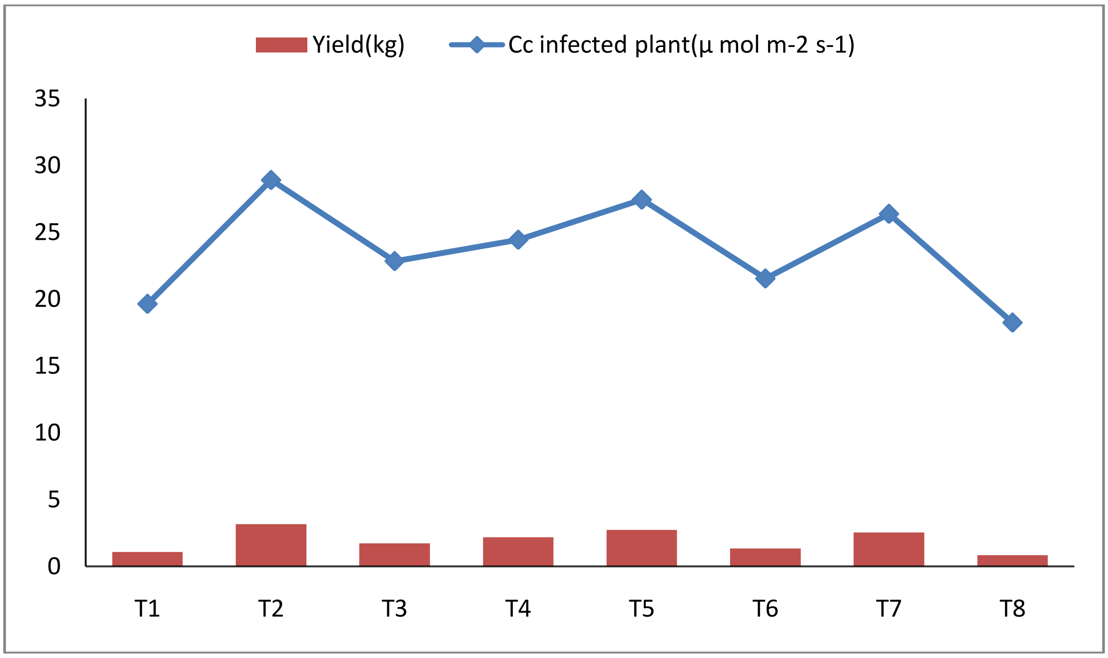


Figure 12. Relationship between Chlorophyll content and Disease severity (%)

T_1 (PPN), T_2 (Imidacloprid with PPN), T_3 (Imidacloprid), T_4 (Sobicron with PPN), T_5 (Sobicron), T_6 (Acmix with PPN), T_7 (Acmix) and T_8 (Control).

DISCUSSION

Mungbean *(Vigna radiata* L. Wilczek) is a good source of protein, carbohydrates, vitamin for mankind all over the world. It contains high graded plant proteins and satisfactory level of minerals and vitamins. It also contains amino acid, lysine which is generally deficit in food grains (Elias, 1986). Pulse of mungbean is also used as quality feed for animals. It contains 19.5% to 28.5% protein (AVRDC, 1988). It provides grain for human consumption and the plant fix nitrogen to the soil. It is an excellent component of human diet particularly for peasants of under developed countries where, animal protein is not easily available and affordable. Mungbean considered as a poor man's meat. But the mungbean production has not considerably increased yet. The main cause for the low yield is the susceptibility of the crop to insects, weeds and diseases caused by fungus, virus or bacterium, of which *Mungbean yellow mosaic virus (MYMV)* is one of the most prevalent and destructive viral pathogens . *Mungbean yellow mosaic virus (MYMV)* causes yield loss up to 80 *%* and is becoming problematic in French bean growing areas. Gupta and Pathak (2009) reported that the yellow mosaic virus disease of black gram (*Vigna mungo* L.) caused by *Mungbean yellow mosaic Gemini virus* transmitted by whitefly *(Bemisia tabaci* Genn.) is most serious in northern states of India. *MYMV* infects mungbean and some other leguminous hosts (Qazi *et. al.,* 2007). Yellow mosaic is reported to be the most destructive viral disease in Bangladesh (Biswass *et. al.,* 2008. John *et. al.,* 2008).The virus causes uneven yellow and green patches on the leaves which finally turn entire yellow. Affected plants generate fewer flowers and pods, which also develop mottling and remain small and contain fewer, smaller and shrunken seeds. Islam *et al.* (2008) observed population dynamics of whitefly under existing environmental conditions and its impact on incidence of *Mungbean yellow mosaic virus (MYMV)* disease and yield. The objectives of the present study was to manage *Mungbean yellow mosaic virus (MYMV)* through selected three insecticides and one botanical nutrient namely Peak Performance Nutrients

(PPN). The experiment was conducted in the Sher-e-Bangla Agricultural University farm during April to July, 2015

5.1. Disease Incidence and Severity

The disease incidence due to *Mungbean yellow mosaic virus (MYMV*) as affected by spraying chemical and botanical (PPN) were estimated. The highest disease incidence was found when no insecticides and PPN was applied followed by only PPN application and the lowest disease incidence was found when Imidacloprid with PPN was applied, which found in both observation, (per plot and per plant) at 30, 40 and 50 (DAS). In case of disease severity, the highest disease severity was found when no insecticides and PPN is used followed by only PPN was used, and the lowest disease severity was found when Imidacloprid with PPN was used that was found in all observation. Sunil and Singh (2010) observed that the foliar applications of Imidacloprid (Imitaf) 0.02% and carbendazim 0.05% at 21 and 35 DAS, respectively produced the highest seedling establishment, number of pods, plant biomass and grain yield in mungbean with the lowest intensity of mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in those treatment during all stages of the crop.

5.2. Morphological features

The maximum number of flower, pod and yield per plant was found when Imidacloprid was used with PPN and the lowest in control. The maximum number of flower, pod and yield per plot was also found when Imidacloprid was used with PPN and the lowest when no insecticides and PPN is used. Almost similar findings were reported in the previous works has done by Suteri *et, al*., 2008 and Vohra *et, al*., 2008).

5.3. Physiological features

From this study it was revealed that the minimum chlorophyll content per plant was recorded in control and the maximum chlorophyll content per plant was recorded when Imidacloprid used with PPN combination. Babu *et al.* (1984) reported that infection of Vigna radiata plants by *MYMV* caused significant reduction in number of pods/plant, seed yield and 100-seed weight. When healthy and infected leaves were compared a reduction in the contents of chlorophyll and functional chloroplast cells was evident in the latter.

5.4. Relationship of Chlorophyll content with Disease incidence and severity (%) per plot and plant and Yield.

In the present study regarding chlorophyll content (μ mol m^{-2} s^{-1}) and disease incidence **(%)**, it is revealed that increased chlorophyll content was observed with decreased disease incidence. The highest chlorophyll content was found in Imidacloprid with PPN where control treatment showed the lowest chlorophyll content because of the highest disease incidence. Relationship between chlorophyll content (μ mol m^{-2} s^{-1}) and disease severity **(%)**, it is revealed that increased chlorophyll content was observed with decreased disease severity. The highest chlorophyll content was found in Imidacloprid with PPN where control treatment showed lowest chlorophyll content because of highest disease severity. In relationship between chlorophyll content (μ mol m^{-2} s^{-1}) and yield, it is revealed that increase of chlorophyll content increase yield. The highest chlorophyll content was found in Imidacloprid with PPN where control treatment showed lowest chlorophyll content that was responsible for the lowest yield.

CHAPTER V

SUMMARY AND CONCLUSION

The present piece of research work was carried out in the field allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, during the period from April to July, 2015.The study was conducted to evaluate the effect of Three selected insecticides and Peak Performance Nutrients (PPN) on disease incidence and severity of *MYMV*. Yield and yield contributing characters and physiological features of mungbean plant that changes due to the disease infection which cause serious damages of mungbean production was also the part of this study. One mungbean varieties namely BARI mung-5, was grown in the field of SAU farm with normal agronomic practices. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

From the present study it has been observed that, the highest disease incidence was found when no insecticides and PPN is used followed by PPN and the lowest disease incidence was found when Imidacloprid with PPN is used, which found in both observations, per plot and per plant at 30, 40 and 50 (DAS).

In case of insecticidal and PPN effect, highly resistant at 30, and 40 DAS and resistant at 50 DAS, when Imidacloprid with PPN used in per plot. Tolerant at 30, and 40 DAS and susceptible at 50 DAS when no insecticides and PPN used in per plot.

From this study it has been found that, effect of insecticidal and PPN, on net chlorophyll content showed highest when Imidacloprid with PPN used and the lowest when no insecticide and PPN used. It has been also observed that, disease incidence per plot and plant was negatively correlated with the chlorophyll content of mungbean plant. On the other hand the chlorophyll content was positively correlated with the yield of mungbean plant. Thus low chlorophyll content increases disease incidence per plot and plant and highest yield induced by highest chlorophyll content.

From this study it may be conducted that the application of insecticides Imidachloprid (Imitaf) in combination with PPN (Peak Performance Nutrients) showed promising performance in management of *mungbean yellow mosaic virus (MYMV)* contributing yield contributing attributes and yield. Thus the farmer may be suggested to used this combination of treatments for the management of *MYMV*. However, further study need to be carried out for a consecutive years including more options as management practices in different Agro-ecological zones (AEZs) of the country.

REFERENCES

Abedin, M. Z. and Anwarul, M., (1991). Prospects of Increasing Pulse Production Through Improved Cropping Systems. In: Proceedings of the 2nd National Workshop on Pulse. BARI, Joydebpur, Gazipur. P 65-73.

Ahmad, Q. l991. Growth attributes and grain yield of mungbean plants affected by mungbean yellow mosaic virus in field. *Indian Phytopathology*. 43(4): 559-560.

Ahmad, H. U. 1985. Disease problem of pulse and oilseed crops in Bangladesh. Presented at the First Biennial Conference of the Bangladesh Phytopathological Society, 13-14 April 1985. BARI, Joydebpur, Gazipur, Bangladesh.

Akhtar, K. P. and Haq, M. A. 2003. Standardization of a graft inoculation method for the screening of mungbean germplasm against Mungbean yellow mosaic virus (MYMV). Plant Pathology.19:257-259.

Akhtar. K. P. and Khan, M. S. l. 2002. Modified scale for the assessment of cotton leaf curl virus (CL('uV). Indian Phytopathology. 14:88-90.

Aftab, M., Asad, S., Khokong, K.M., Ayub, M.A. and Butt. 1992. Effect of mungbean yellow mosaic virus on yield and growth components *Vigna radita*. *Pakistan Journal of Phytopathology*. 5(l-2): 58-61.

Bakar, A.K. (1991). Pest and disease problems of mungbean in West Malaysia. *Malaysian Agriculture Journal*., 53: 29-33.

Bakr, M.A., Afzal, M.A., Hamid, A., Haque, M.M. and. Aktar, M.S. (2004). Blackgram in Bangladesh. Lentil Blackgram and Mungbean Development Pilot Project, Publication No.25, Pulses Research Centre, BARI, Gazipur, Babu, R.C., Rathinaswamy, R. and Srinivasan, P.S. 1984. Certain physiological changes in green gram plants infected by mungbean yellow mosaic virus. *Madras Agricultural Journal.* 71(12): 795-798.

Basu, A.N. 1986. Biology of the whitefly *Bemisia tabaci* Genn. p. In: National seminar on whitefly Transmitted Plant Virus Disease, IARI. New Delhi.

BBS (Bangladesh Bureau of Statistics). (2013). Statistics Pocket Book of Bangladesh (2012-2013). Bangladesh Bureau of Statistics Division, Govt. of the People's Republic of Bangladesh. pp.38.

Benigno, D.R.A. and Dolares, A.C. 1978. Virus diseases of mungbean in the Philippines. Proceeding 15' Inteational Mungbean Symposium. *Asian Vegetable Research and Development Centre*, Shanhua, Taiwan.

Biswas, P.K. (1987). A study on the relative merits of mixed cropping under two levels of irrigations. MS Thesis, Dept. Agron. Bangladesh Agricultural University. Mymensingh. p.38-40.

Biswass, K.K., Malathi, V.G. and Varma, A. (2008). Diagnosis of symptom less yellow mosaic begomo virus infection in pigeon pea by using cloned mungbean yellow mosaic India virus a problem. *Journal of. Plant Biochemistry and Biotechnology.*17(1): 9-14.

Bos, L. (1999). Plant Viruses: Unique and Intriguing Pathogens: A Text Book of Plant Virology, Backhuys Publishers, the Netherlands. Pp. 305-306.

Bos, L. (1999). Plant Viruses: Unique and Intriguing Pathogens: Text Book of Plant Virology. Backhuys publishers, The Netherlands pp: 305-306.

Bisht, I.S., Shamsher, S., Dabas, B.S. and Sing, S. 1988. Effect of yellow mosaic virus on growth components and yield of four promising cultivars of mungbean. *Indian Journal of Mycology and Plant pathology*. 18(2): 204-205.

Brunt, A., Crabtree, K. and Gibbs, A. 1990. Viruses of Tropical Plants. CAB International , Wallingford. UK. p355.

Butter, N.S. 1977. Whitefly as a carrier of plant viruses. Everyday Science. 22:27-29.

Chhabra, K.S. and Kooner, B.S. 1981. Reaction of some promising mungbean genotypes towards whitefly, jassid and yellow mosaic virus. Pest Management and Economic Zoology. 2(1): 11-14.

Capoor, S.P., and Varma P.M. 1948. Yellow mosaic of Phaseolus lunatus L. Current Science. 17: 152-153.

Chenulu, V.V. and Vanna, A. 1988. Virus and virus like diseases of pulse crops commonly grown in India. p.338-370. In: Baldev, B., Ramajunam, S.and Jain, I-I.K. Pulse Crops, New Delhi, Oxford & IBH.

Chanda, P. and Verma, J.P. 1983. Effect of yellow mosaic on growth components and yield of mungbean . Haryana Agriculture University. 1983. 63(4): 141.

Dhingra, K.L., and V.V. Chenulu. (1985). Effect of yellow mosaic on yield and nodulalion of soybean. *Indian Phytopathology*, 38(2): 248-251.

Dantre, R.K., Keshwal, R.l. and Khare, M.N. 1996. Studies on a yellow mosaic virus disease of soybean and mungbean. Annals of Plant Protection Sciences. 4(1): 67-70. Npningra, (.L. and Ghosh, D.K. 1993. Efficiency of whitefly vector (*Bemisia tabaci* Genn.) in transmission of mungbean yellow mosaic virus in different source test plant combination. *Intemational Joumal of Tropical Agriculture.* 11(2): 149-152.

Fakir, G.A. 1983a. Status of research on pulse diseases at the BAU, Mymensingh, Bangladesh. Bangladesh Agricultural University.p. 14

Fakir, G.A. 1983b. Status of research on pulse diseases at the BAU, Mymensingh, Bangladesh. Bangladesh Agricultural University. p. 20.

Grewal, J.S. 1978. Diseases of mungbean in India. Proceeding 1“ Intemational Mungbean Sympksium. *Asian Vegetable Research and Development Centre, Shanhua,* Taiwan.

Gupta, M.P. and Pathak, R.K. (2009). Bioefficacy of neem products and insecticides against the incidence of whitefly, yellow mosaic virus and pod borer in Black gram. Natural product radiance**,** 8(2): 133-136.

Gill, E.Z. 1999. Effect of mungbean yellow mosaic virus on yield components in mungbean cultivar. Insect Environment. 5(3): 112-113.

Hamid, S. and D.J. Robinson. (2004). Begomoviruses from mungbeans in Pakistan: Epitope profiles, DNA A sequences and phytogentic relationships. Archives of Virology, 149: 809-819.

Heng, T. S. (2013). Peak performance nutrients. pp 6.

Honda, Y., Iwaki., Saito, Y., Thongmeearkom, P., Kittisak, K. and Deema, N.1983. Mechanical transmission, purification and some properties of whitefly-bome mungbean yellow mosaic virus in Thailand. Plant Dis. 67: 801-804.

Hossain, M.A., Ferdous, J., Sarkar, M.A. and Rahman, M.A. (2004). Insecticidal management of thrips and pod borer in mungbean. *Bangladesh Journal of Agriculture Research institute*. 29(3): 347-356.

Hossain, M.A., Islam, K.M.S. and Mondal, A.T.M.A.I. (2000). Effect of sowing date on lentil aphid, aphis craccivora koch infestation and yield contributing characters of lentil *(Lens culinaris* Medik).p.8: 115-117.

Hossain, M.A., Prodhan, M.Z.H. and Sarkar, M.A. (2009). Sowing Dates: A Major Factor on the Incidence of Major Insect Pests and Yield of Mungbean. *Journal of Agricultural Rural Development.***p**: 127-133.

Hussain, M., J. Qazi, S. Mansoor, S. Irum, M. Bashir and Y. Zafar. (2004). First report of mungbean yellow mosaic virus on mungbean in Pakistan. Plant Pathology, 53(4): 518.

Islam, B.N. (2004). Use of some extract from meliaceae and annonaceae for control of rice hispa, *Dicladispa armigera* and the pulse beetle, *Callosobruchus chinensis.* In: proc. 3rd International Neem Conference. Nirobi, 1986. pp. 217-242.

Islam, M.S., Latif, M.A., Ali, M. and Hossain, M.S. (2008). Population dynamics of white fly on some recommended mungbean varieties in Bangladesh and its impact on incidence of mungbean yellow mosaic virus disease and yield. *International Journal of Sustain Agriculture. Technology* .pp.**5**(4):41-46.

Iwaki, M. and Auzay, H. 1978. Virus disease of mungbean in Indonesia Proceeding lst International Mungbean Symposium. *Asian Vegetable Research and Development Centre,* Shanhua, Taiwan.

Jayasekera, S.J.B.A. and Ariyarate, H.P. 1988. Current status of mungbean improvement for the farming systems in Sri Lanka. Mungbean: Proceedings of the Second lntemational Mungbean Symposium. *Asian Vegetable Research and Development Centre*, Shanhua, Taiwan.

Jain, A.K., Yadava, H.S. and Gupta, J.C. 1995. Grain yield its components as affected by yellow mosaic virus in blackgram (Vigna mungo (L.) Hepper. 16(3): 364-366.

Jayana, M.K., T. Rangaswamy, T.R. Kumar and K.C. Shambulingappa. (1991). Resistance to yellow mosaic virus in mungbean genotypes. Plant Protection Bulletin, 43: 9-10.

Krishnareddy, M. 1989. Studies on yellow mosaic and leaf crinkle disease of blackgram. Ph.D.Thesis_Post Gradute School, IARI, Delhi. P. 263.

Malik, J.A. (1991). Breeding for resistance to MYMV and its vector in Pakistan.Pp: 41-53. Mungbean Yellow Mosaic Disease.Proceedings of an International Workshop. Bangkok, Thailand, 23 July, 1991. AVRDC. (Eds.): S.K. Green and D. Kim.

Marimuthu, T., Subramanian, C.L. and Mohan. (1981). Assessment of yield losses due to yellow mosaic virus in mungbean. Pulse Crop News 1: 104.

Murugesan, S. and Chelliah, S. 1977. Transmission of gram yellow mosaic virus by the whitefly. *Bemisia tabaci(Genn.). Madras Agricultural Joumal.* 64: 437-441.

Nariani, T.K. (1960). Yellow mosaic of mungbean. Indian. Phytopathology.,13: 24-29.

Nair, N.G. and Nene, Y.L. 1974. Studies on the yellow mosaic of bean (*Phaseolus mungo* L.) caused by mungbean yellow mosaic. 3. Factors influencing transmission and symptom expression. *Indian Journal of Science.* 2: 42-47.

Nair, N.G., Nene, Y.L. and Naresh, J.S. 1974. Reaction of certain urdbean varieties to yellow mosaic virus of mungbean. Indian Phytology. 27:256-257.

Nariani, T.K. 1960. Yellow mosaic of mung (Phaseolus aureus L.). Indian Phytopathology. 13: 24-29

Nath, P.D. 1994. Effect of time on the incidence of yellow mosaic virus disease and whitefly population on green gram. *Annals of Agricultural Research.*15(2); 174-177.

Nene, Y.L. 1969. A survey of viral diseases of pulse crops in Uttar Pradesh.Second Annual Report, Uttar Pradesh Agricultural University. p. 25.

Nene, Y.L. 1972. A survey of virual diseases of pulse crops in Uttar Pradesh Research Bulletin No. 4, G. B. Plant University of Agriculture and Technology, Pantnagar, U. P. 95p. Proceedings 1" International Mungbean Symposium. *Asian Vegetable Research and Development Centre*, Shanhua, Taiwan.

Nene, Y.L. 1973. Viral diseases of some warm weather pulse crops in India. Plant Dis. 57(5): 463-467.

Pathak, A.K. and Jhamaria, S.L. (2004). Evaluation of mungbean *(Vigna radiata* L.) varieties to yellow mosaic virus. *Journal of Mycology and Plant Pathology***.** 34(1): 64-65.

Poehlman, J.M. Sechler, D.T., Swindell, R.E. and Sittyos, P. 1976. Performance of the Forth Intemational Mungbean Nursery. Missouri Agricultural Experiment Station Special Report.191.

Poehlman, J.M. 1991. The mungbean. Westview Press. BOULDER. pp.169-274.

Qazi, J., Ilyas, M., Mansoor, S. and Briddon, R.W. (2007). Legume yellow mosaic viruses: genetically isolated begomoviruses. *Molicular Plant Pathology*.8(4): 343-348.

Rathi, Y.P.S. and Nene, Y.L. 1976. Influence of different host combinations on virus vector relation to mungbean yellow mosaic virus. *Pantnagar Journal of Research.* 1: 107-111.

Sachan. J.N., Yadava, C.P., Ahmad, R. and Katti, G. (1994). Insect Pest Management in Pulse Crop. In: Dhaliwal, G.S. and Arora, R. (eds.) Agricultural Insect Pest Management. Common Wealth Publishers, New Delhi, India. pp. 45-48

Sastry, K.S.M. and Singh, S.J. 1978. Studies on epidemiology of tomato leaf curl virus. *Indian Journal of Horticulture*. 35: 269-277.

Shad, N., Mughal, S.M. and Bashir, M. (2005). Transmission of mungbean yellow mosaic Begomovirus (MYMV). *Pakistan J. Phytopathol.* **17**(2): 141-143.

Shad, N., Mughal, S.M., Farooq, K. and Bashir, M. (2006). Evaluation of mungbean germplasm for resistance against mungbean yellow mosaic begomovirus. *Pakistan Journal of Botany* **38**(2): 449-457.

Shah, J.M., Ahmad, A., Hussain, M., Malik, M. Yousaf and Ahmad, B. (2007). Efficiency of different insecticides against sucking insect-pest complex and effect on the growth and yield of mungbean *(Vigna radiata* L.). *Pakistan journal of Entomology*.**29**(2): 83-86

Singh, B.R., Singh, M., Yadav, M.D. and Diangar, S.M. 1982. Yield loss in mungbean due to yellow mosaic. Science and Culture, C.S. Azad Agriculture University .and Technology., Kanpur, India. 48(12): 435-436.

Singh, J.P. and Singh, D.P. 1979. Recent advances in urdbean and mungbean production. Indian Farming. 24: 8-20.

Subramanyam, K. and Varma, A. 1986. Management of yellow mosaic disease of blackgram through cultural practices and chemical treament. In:National Seminar on whitefly Transmitted Plant Vims Diseases. IAR1,New Delhi. p.43.

Suteri, B.D. and Srivastava, S.B. 1979. Effect of soybean yellow mosaic on growth and yield of soybean. Plant Dis. Rep. 63: 151-I53.

Subrahmanym, K. 1986. Epideomology of Mungbean Yellow Mosaic Virus in Vigna radiala. In. National Seminar on Whitefly Transmitted Plant Virus Disease. IARI, New Delhi. P. 46.

Sunil, C.D. and Singh, B. (2010). Seed treatment and foliar application of insecticides and fungicides for management of cercospora leaf spots and yellow mosaic of mungbean *(Vigna radiata*). *International Journal of Pest Management.* **56**(4): 309-314.

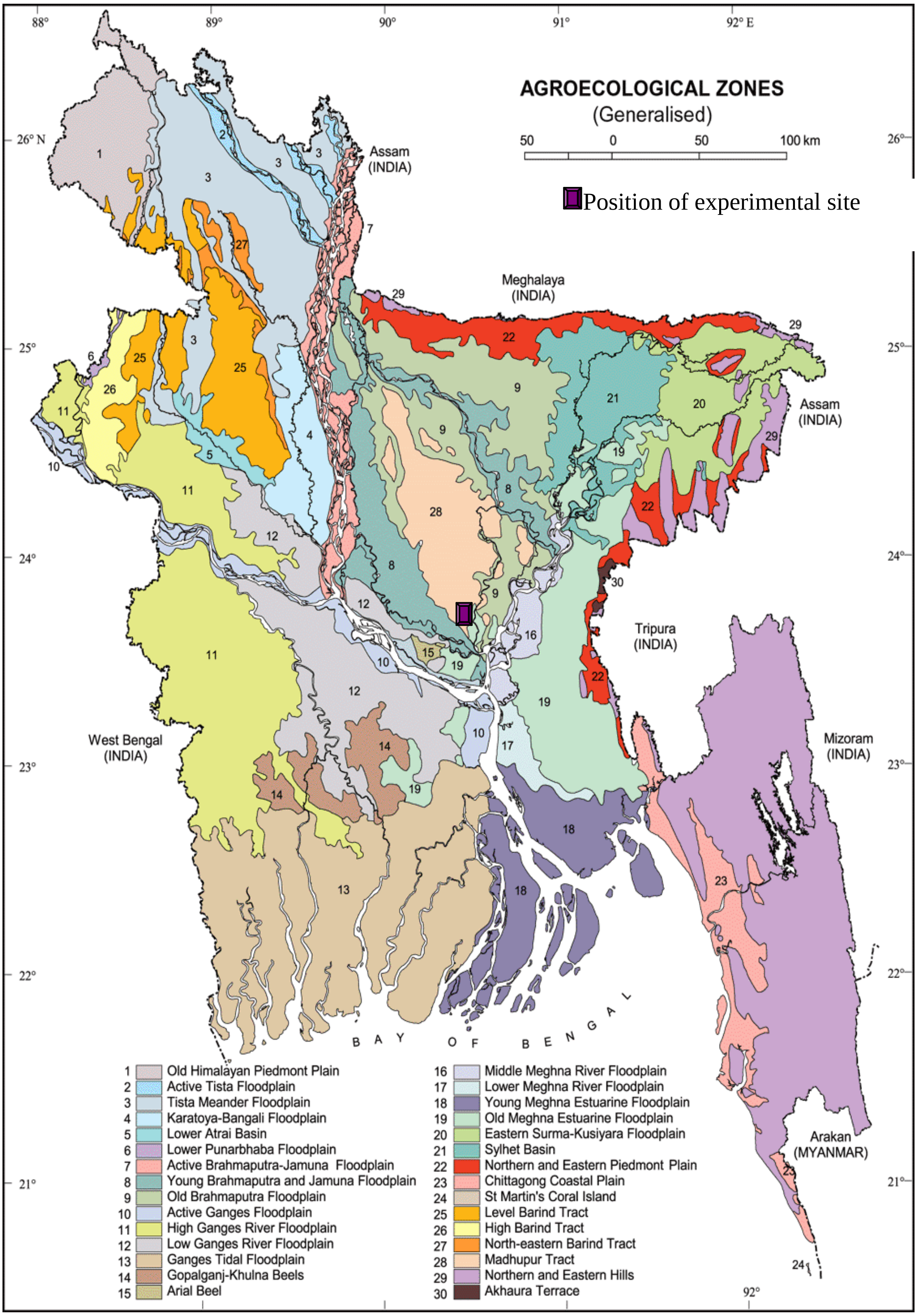
Varma, M.M. and Sandhu, S.S. 1992. Mungbean yellow mosaic disease: Proceeding of an International Workshop, Bankok, thailand, 2-3 July 1991. pp. 28-37.

Vohra, K. and Beniwal, S.P.S. 1979. Effect of mungbean yellow mosaic virus on yield and seed quality of bean (Vigna mungo). Seed Research.7(2): 168-I74.

Williams, F.J., Grewal, J.S. and Amin, K.S. 1968. Serious and new diseases of pulse crops in India in 1966. Plant Disease Report. 52: 300-304.

APPENDICES

Appendix I. Map showing the experimental site under study.



Appendix II. The experimental site under study.

Morphological Features	Characteristics
Location	Sher-e-Bangla Agricultural University Farm, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Appendix III. Monthly average relative humidity, maximum and minimum temperature, rainfall and sunshine hour of the experimental period (April 2015 to July 2015).

Month	Average RH (%)	Average Temperature (°C)		Total Rainfall (mm)	Average Sunshine Hours
		Minimum	Maximum		
April	68	23.6	34.1	165.8	4.8
May	82	24.7	33.3	325.3	4.6
June	84	25.1	35.2	414.4	4.8
July	86	26.9	34.6	500.6	4.7

Source : Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka-1207.

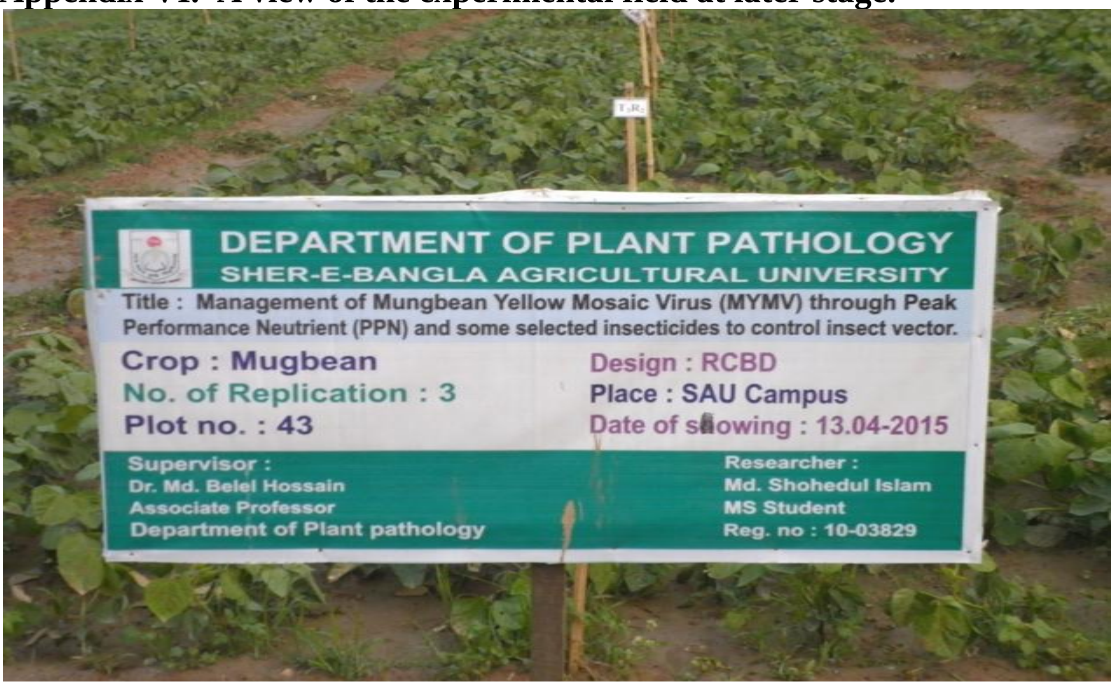
Appendix IV. Physiochemical properties of soil, used in the experimental location.

Characteristics	Value
Particle size analysis	
% Sand	25.68
% Silt	53.85
% Clay	20.47
Textural class	Silt-loam
pH	5.8-7.1
Organic carbon (%)	0.31
Organic matter (%)	0.54
Total N (%)	0.027
Phosphorus(µg/g soil)	23.66
Exchangeable K (me/100 g soil)	0.60
Sulphur (µg/g soil)	28.43
Boron (µg/g soil)	0.05
Zinc (µg/g soil)	2.31

Source: Soil Resources Development Institute (SRDI), Dhaka-1207.

Appendix V. A view of the experimental field at early stage.

Appendix VI. A view of the experimental field at later stage.



Appendix VII. A view of severely infected mungbean plant by*Mungbean Yellow Mosaic virus*(*MYMV)*

Appendix VIII. A view of healthy mungbean plants

Appendix IX. Existence of white fly (*Bemesia tabaci)* in the lower surface of infected leaf.