EFFICACY OF IMITAF AND ACMIX TO PREVENT *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)*

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DHAKA -1207

JUNE, 2017

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REGISTRATION NO : 11-04309

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, 2017

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CERTIFICATE

This is to certify that the thesis entitled Efficacy of Imitaf and ACmix to Prevent *Mungbean Yellow Mosaic Virus (MYMV) 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* JESMIN NAHAR JOLY *bearing* REGISTRATION NO. 11-04309 *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:

Dhaka, Bangladesh

Dr. Md. Belal Hossain
Associate professor
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Dedicated

to

my beloved parents

ACKNOWLEDGEMENTS

All praises to the Almighty and Kindful trust on to "Omnipotent Allah" for His never-ending blessing, the author deems it a great pleasure to express her profound gratefulness to her respected parents, who entiled much hardship inspiring for prosecuting her studies, receiving proper education.

The author likes to express her deepest sense of gratitude to her respected Supervisor ***Dr. Md. Belal Hossain****, Associate Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh for his scholastic guidance, support, encouragement, valuable suggestions and constructive criticism throughout the study period and successfully completing the research work and in the preparation of the thesis writing including data analysis.*

The author also expresses her gratefulness to her respected Co-Supervisor ***Dr. Fatema Begum*** *, Associate Professor, Department of Plant Pathology ,Sher-e-Bangla Agricultural University, Dhaka for useful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and in preparation of the thesis.*

The author expresses her sincere gratitude to the sincerity of the Chairman, Khadija Akhter, Professor, Department of Plant Pathology ,Sher-e-Bangla Agricultural University, Dhaka for her valuable suggestions and cooperation during the study period. The author also expresses heartfelt thanks to all the teachers of the Department of Plant Pathology, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the study.

The author is grateful to all the respondents in the study area for their cooperation and help in accomplishing the objectives of this research work. She is grateful to all those people who made a contribution to this research work although it is not possible to mention all by names. The author is also very much grateful to all the staff of the Department of Plant Pathology.

The author expresses her sincere appreciation to her parent, elder brother, sister, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study period.

Date : June,2017
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ABSTRACT

A field experiment was conducted during March to June 2016 in the central farm of Sher-e- Bangla Agricultural University , Dhaka-1207.The main objective was to manage the mungbean yellow mosaic by controlling the insect vector whitefly using two selective insecticides namely Imitaf and ACmix. The experiment was conducted with BARI Mungbean-5.Different growth parameters, yield attributes and physiological features were significantly affected by application of selected insecticides with different number of spray. In case of Imitaf, the lowest disease incidence, per plant (10.12 %) and per plot (3.51%), and disease severity (7.21%) was recorded in four times spray (T4) at 70 DAS. The highest disease incidence, per plant (36.50 %) and per plot (11.37 %), and disease severity (23.33%) was recorded in control treatment at 70 DAS . In case of ACmix, the lowest disease incidence, per plant (12.21 %) and per plot (4.21 %), and disease severity (7.53 %) was also recorded in T4 at 70 DAS. The highest disease incidence, per plant (36.49 %) and per plot (11.37 %), and disease severity (36.67 %) was recorded in control at 70 DAS. The highest number of flower, no of pod and yield was also found in T4 in case of Imitaf and ACmix. But the yield and yield contributing characterswas found to be better in imitaf than ACmixs. The highest chlorophyll content was recorded in four times spray(T4) in both cases Imitaf (49.62µ mol m^{-2} s^{-1}) and ACmix (56.80 µ mol m^{-2} s^{-1}). The lowest chlorophyll content was recorded in T0 in case of both insecticides application. However from the results of the study it was revealed that Imitaf had better efficacy to control the insect vectors (whitefly) of *MYMV* with four times spray.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
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
^{o}C	=	Degree Celceous
%	=	Percentage
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata L.*) is under the family Fabaceae. It is an ancient, cheapest and conventional pulse crop in the world. It is also called the green gram. The crop is Asiatic in origin was introduced at early 18th century in south China, Indo China and Java. It is widely grown in tropical and sub-tropical regions as a monoculture and as a component in cropping systems successfully. Almost 90% of world's mungbean production comes from Asia and India is the world's largest mungbean producer cultivated on 2.84 million ha area with a production of 1.04 million tones and productivity of 386 kg/ha. Mungbean is also widely grown in Bangladesh. At present days major area of mungbean is replaced by cereals (Abedin, 1991). Now a days, it is cultivated after harvesting of *Rabi* crops such as wheat, mustard, lentil, etc. As mungbean is a short duration crop, it can well fit as a cash crop between major cropping season. It is grown three times in a year covering 23264 ha with an average yield of 0.77 t/ha (BBS, 2010). It contains high graded vegetable proteins and satisfactory level of minerals and vitamins. It also contains amino acids specially lysine which is generally deficit in cereal food grains (Elias, 1986).Pulse Bran 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. The pulses area, only 8.10% lands are used for the cultivation of mungbean (Kabir, 2001). According to World Health Organization (WHO), per capita per day requirement of pulse is 45g.But in Bangladesh, only 12g pulse is available per capita per day. About 6.01 million tons of pulse is required to meet the present per capita requirement of our country (BARI, 1998).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 virus, fungus or bacterium of which *Mungbean yellow mosaic virus (MYMV)* is one of the most prevalent and destructive viral pathogen in mungbean. It causes severe yield loss and a reduction in seed quality. *MYMV* produces typical yellow mosaic symptoms. The symptoms appear in the form of small irregular yellow specs and spots along the veins, which enlarge until leaves were completely yellowed. Diseased plants were stunted, with fewer flowers and pods that bear smaller, occasionally shriveled seeds in severe cases, and other plant parts also become completely yellow. *MYMV* belongs to the family Geminiviridae (Fauquet *et al* .,2003).The family Geminiviridae is divided in to four genera, *Mastrevirus , Curtovirus , Topocuvirus and Begomovirus* (Ramos *et al*.,2008). 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). *MYMV* transmitted by white fly(*Bemisia tabaci).*This polyphagous pest can cause extensive damage in more than 500 species of Agriculture and Horticulture crops (Greathead, 1986) through its direct feeding, and its ability to directly transmit Gemini viruses. 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). So to increase the production of this important crop and to decrease the regular disease infestation we should make concentration to this disease. To increase the production it is very important to reduce the virus infection by managing its vectors. The disease can be managed the vector using several measures. We can manage the disease using resistant variety, by practicing crop rotation , implanting slush and burn process , maintain growing time and properly intercultural operation. Besides devastating viral disease can also be managed precisely by applying insecticides properly. The prime aim of this study was to evaluate the selected insecticides for controlling the insect vectors white fly (*Bamisia tabaci)* .

Objectives

- To evaluated the selective insecticides in controlling Mungbean yellow mosaic disease.
- To increase the yield of the Mungbean

CHAPTER II

REVIEW OF LITERATURE

A huge number of research works on mungbean have been performed extensively in several countries especially in the South East Asian countries for the improvement of yield and quality of this crop. In Bangladesh, little attention has so far been given for the improvement of mungbean virus disease management. Currently Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have started extensive research work on the development and improvement of this crop. Findings of various experiments related to the present study in home and abroad have been reviewed and discussed in this chapter.

2.1 Effect of insect and pests on mungbean

Hossain *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 perailing climatic conditions of the cropping season. The early (February 14 to March 06) and late sown (mid April to onward) crops had higher pest infestation than the mid sown (March 13 to April 10) crops.

Islam *et al.* (2008) worked on seven recommend varieties of mungbean viz. BARI mungbean-2, BARI mungbean-3, BARI mungbean-4, BARI mungbean-5, BARI mungbean-6, BARI mungbean-2 and BARI mungbean-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 BARI mungbean-6 as against the highest in BARI mungbean-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 BARI mungbean-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.

Lal (2008) reviewed the studies on 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 of 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.*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).

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, (Hossain *et al.* 2004) aphid and whitefly, thrips and pod borers are important.

Khattak *et al.* (2004) investigated the resistance of mungbean 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.

Sharma *et al.* (2004) studied eighteen promising varieties of mungbean for resistance to whitefly *(Bemisia tabaci)* and yellow mosaic disease and reported that the cultivar IPU-9513 showed high tolerance of yellow mosaic disease. 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 disease.

Massod *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.

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.

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.

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.

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 andGanapathy and Karuppiah (2004) reported that the incidence of MYMV in mungbean was the lowest in crops raised from the seeds treated with thiamethoxam.

2.2 Mosaic disease impact on mungbean

Iqbal *et al.* (2011) observed one hundred genotypes/lines of mungbean germplasm against *MYMV* during summer season under field conditions at NARC, Islamabad.The germplasm were categorized in to resistant and susceptible depending upon severity of disease. Response of mungbean accessions to *MYMV* was determined and none of the genotype/line was found to be highly resistant to disease. Four genotypes/lines i.e. 014043, 014133, 014249, 014250 were found as resistant.Eight were moderately resistant and 30 were moderately susceptible. Remaining 30 accessions were classified as susceptible and 43 as highly susceptible accessions.

Gupta and Pathak (2009) reported that the yellow mosaic virus disease of black gram *[Vigna mungo* (Linn.) Hepper] caused by *Mungbean yellow mosaic Gemini virus* and transmitted by whitefly *(Bemisia tabaci* Genn.) is most serious in northern states of India, particularly, Bundelkhand Zone of Madhya Pradesh. *Mungbean yellow mosaic virus (MYMV)* causes yield loss up to 80 *%* and is becoming problematic in French bean growing areas. Molecular marker linked selection to *MYMV* resistance is helpful in rapid identification of genotypes carrying resistant genes.

MYMV infects mungbean, soybean, mothbean, cowpea and urdbean (Mash) and some other leguminous hosts (Qazi *et. al.* 2007). Yellow mosaic is reported to be the most destructive viral disease not only in Pakistan, but also in India,Bangladesh, Srilanka and contiguous areas of South East Asia (Biswass *et. al.,*2008. John *et. al.,* 2008). *MYMV* resembling other whitefly-transmitted Gemini viruses has appeared as the disease throughout Pakistan. The virus causes uneven yellow and green specks or patches on the leaves which finally turn entire yellow.Affected plants produce fewer flowers and pods, which also develop mottling and remain small and contain fewer, smaller and shrunken seeds.

Awasthi and Shyam, (2008) The results showed that there were 30 susceptible and 43 highly susceptible genotypes of mungbean. Great variation in genotype response to *MYMV* represents variability in their genetic makeup.

Shad *et al.* (2006) found that there was no resistant line against *MYMV* and identified of seven susceptible and 247 as highly susceptible lines.

Khatri *et al.* (2003) was conducted survey and determined the spread of *yellowmosaic virus (YMV)* disease and extensive damage was caused by the disease on mothbean *(Vigna aconitifolia).* They further observed that *MYMV* was the most important disease of mothbean in the region during both years.

Yaqoob *et al.*(2005) identified some resistance lines of mungbean in available land races.

Sachan *et al.* (1994) found a drastic reduction in the infection of *YMV* when whitefly attack was reasonably controlled. The yellow mosaic virus caused 30-70% yield loss (Marimuthu *et al.*, 1981).

Chamder and Singh (1991) noticed as ignificant reduction in the attack of whitefly and infection of *YMV* in Mungbean when 0.04% monocrotophos, 0.03% dimethoate, and 0.05% chlorvinphos were applied 55 days after sowing.

2.3 Occurrence and symptoms of *MYMV*

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*., (I981). The various biochemical changes clearly indicate the stress exerted by *MYMV* on the physiology of infected plants.

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.

2.4 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.

2.5 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.

2.6 Effect of chemicals on pest, mosaic disease and growth and yield of mungbean

Ganapathy *et al*. (2003) in view of identifying resistance against mungbean yellow mosaic virus, urdbean leaf crinkle virus and leaf curl virus in urdbean, evaluated 71 entries at NPRC, Vamban, Tamil Nadu. They found that RU 2229, VBG 86, 2KU 54, VBG 89, SU16 were highly resistant to *MYMV*.

Jahangir Shah *et al*. (2007) conducted a field study was undertaken at Arid Zone Research Institute (AZRI), Bahawalpur, during Kharif, 2005 to investigate the efficiency of different insecticides, namely Imitaf (Confidor 200SL), acetameprid (Mospilan 20SP), buprofezin (Polo), thiomethoxam (Actara 25WG) along with control on the growth and yield of mungbean. The results revealed that pods/plant and seed yield kg ha-1 varied significantly among different insecticides. Out of all the insecticides used in this study, Imitaf treated plots had significantly the highest yield of (1563 kg ha-1) while the lowest seed yield of (1056 kg/ha) was obtained from the control plots where no insecticide was applied.

Rajnish *et al*. (2006) were investigate on the insecticides *viz.*, dimethoate (0.03%), monocrotophos (0.04%) and carbofuran (0.5 kg a.i./ha) gave better response and were found most effective followed by neem based formulations as moderately effective. The neem based insecticides *viz.*, NSKE (3%). achook (0.3%), neem gold (0.3%) and nimbecidin (0.3%) were found comparable to monocrotophos and dimethoate in all 67 respects. All the insecticides were found economical but two sprays of dimethoate were found most effective and economical.

Sunil and Singh (2010) conducted a field experiment to manage yellow mosaic*(Mungbean yellow mosaic virus)* and cercospora leaf spots (*Cercospora canescens* and *Pseudocercospora cruenta*) of mungbean. Insecticides and fungicides as seed dressings, with or without foliar sprays, were evaluated. Amongst the treatments, a combination of seed treatment with thiamethoxam (Cruiser TM) at 4 g kg-1 and carbendazim (Bavistin TM), TMTD (Thiram TM) at 2.5 g kg-1 (1:1 ratio) followed by foliar applications of thiamethoxam (Actara TM) 0.02% and carbendazim 0.05% at 21 and 35 days, respectively after sowing produced the highest seedling establishment, shoot and root lengths, number of pods, plant biomass, 1000-seed weight, and grain yield in mungbean with the lowest intensity of cercospora leafspots and mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in this treatment during all stages of the crop. This treatment was costeffective, as it provided the highest return per Rupee of input. It was second bestfor the number of Rhizobium root nodules per plant.

Khattak *et al.* (2004) conducted an experiment at Agriculture Research Station,Kalurkot, Bhakkar to evaluate the efficacy of Mospilan 20SP, Actara 25WG, polo 500EC, Tamaron 60SI and confidor 200SL against whitefly, jassids, and thrips on mungbean. All the tested insecticides reduced the mean percent population of whiteflies even at 240 hours after spray. Similar trend of efficacy was also not against thrips, but Atari 25WG lost its efficacy at 240 hours after spray. Against jassids. Misplay 20 SP, Polo 500 EC, and Confider 200SL at 120 hours and 2 hours after spray were completely ineffective. Variation in the mean percent population of the test insects by insecticides, especially, a sudden drop in the efficacy of insecticides at 72 hours after spray almost against the tested insect pests could be because of the special temporary changes in the environmental conditions.

Ganapathy and Karuppiah (2004) recorded a reduction in whitefly population and incidence of *MYMV* in mungbean with the application of thiamethoxam either as a seed treatment or as a spray. Previous workers did not investige combination of seed treatment and foliar spray formulations against *MYMV*. The treatments that had Imitaf either as seed treatment or as spray reduced yellow mosaic disease development. Previous workers also demonstrated the efficacy of Imitaf in reducing the insect pest population and providing protection to the crop from whitefly infestation and minimizing the intensity of yellow mosaic disease.

Ganapathy *et al.* (2003) in view of identifying resistance against *Mungbean yellow mosaic virus*, *Urdbean leaf crinkle virus* and leaf curl virus in urdbean, evaluated 71 entries at NPRC, Vamban, Tamil Nadu. They found that RU 2229, VBG 86,2KU 54, VBG 89, SU16 were highly resistant to *MYMV*.

Chandrasekharan and Balasubramanian (2002) evaluated the efficacy of botanicals and insecticides against sucking pests, viz., aphid, *Aphis craccivora* Koch. And whitefly, *Bemisia tabaci* Genn. on greengram. They reported that among the treatments, acephate 75 SP @ 0.075 percent and TNAU neem oil (C) 60 EC at 3.0 per cent were found significantly superior by recording higher percentage of reduction in aphid population and yellow mosaic virus *(YMV)* incidence due to whitefly and also with grain yield recording 8.5 and 7.4 q ha-1, respectively.

Sucking insects not only reduce the vigor of the plant by sucking the sap but also transmit disease and affect the photosynthetic activity that is the main source of producing more number of pods plant-1 (Sethuraman *et al.*, 2001). He also reportedthat the minimum 1000 seed weight (41.7 gm) was observed in case of plots whereno pesticide was applied to control sucking insect pest complex.

Mustafa (2000) found that Mospilan, polo and confidor resulted almost 72.76% mortality of whitefly. They also investigated the increased susceptibility of whitefly to confidor.

Mohan and Katiyar (2000) stated that confidor was the most effective in suppressing the whitefly population and its continuous use resulted in increased whitefly population. They also showed better control of jassid by Confidor 200 SL.

CHAPTER III

MATERIALS AND METHODS

This chapter includes a short description about the experimental location, experimental duration, soil, climate, seed collection, collection of selected insecticides, Design and layout of experiment, land preparation, Treatments of experiment ,fertilizer application, sowing of seeds, management practices, Intercultural operations, harvesting, parameter assessed , collection of data, Disease incidence, Disease severity, chlorophyll content in leaves per plant, Yield, Statistical analysis.

3.1. Experiment location

The field experiment was conducted at the central Farm under the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka- 1207 .

3.2 Experiment duration

The experiment was carried out during the period from March to June 2016.

3.3. Soil

The soil of the experimental plot belongs to the Tejgaon series under the Agro Ecological Zone, Madhupur Tract (AEZ- 28) and the General Soil.

3.4. Climate

The experimental site has sub-tropical climatic condition characterized by high temperature, heavy rainfall during May to September and scanty rainfall during rest of the year.

3.5. Seed collection

BARI Mungbean-5 a variety of Mungbean were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.6 . Collection of selected insecticides

The selected insecticides namely Imitaf and ACmix were collected from local market named Green nursery from Agargaon .

Figure 1 . ACmix and Imitaf

3.7. Formulation of ACmix and Imitaf

SL No.	Trade name	Active ingredient	Application rate
1	Imitaf	Imidacloprid	0.5 ml/L
2	ACmix	Chloropyriphos(50%) +Cypermethrin (5%)	1.5 ml /L

3.8. Design and layout of experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and two blocks as ‘Imitaf’ and ‘ACmix’. For Imitaf and ACmix there were seven treatment with a control 21 (3 × 7) unit plots. Thus there were 42 (21 +21) unit plots altogether in the experiment. The size of each unit plot was (3m x 1m). Plot to plot distances were 0.5 m. Imitaf block to ACmix block distances 1m. The Replication and treatments of the experiment randomly distributedinto the experimental plot.

3.9. Treatments of experiment

T_0=Control/No spray

T_1=One time spray at 20 DAS

T_2= Two times spray at 20 and 25 DAS

T_3= Three times spray at 20,25 and 30 DAS

T_4= Four times spray at 20,25,30 and 35 DAS

T_5= Five times spray at 20,25,30,35 and 40 DAS

T_6= Six times spray at 20,25, 30, 35, 40and 45DAS

3.10. Land preparation

The selected experimental plot was ploughed by power tiller driven rotavator; afterwards the land was cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and destroyrd . All the large clods were broken into smaller pieces to obtain a desirable tilth condition of field for seed sowing. Finally, the land was leveled and the experimental plot was partitioned equally into the unit plots in accordance with the experimental design mentioned in the following section.

3.11. Fertilizers application

Well decomposed Cowdung was applied during land preparation. One third of required Urea was also applied during land preparation. The Triple super phosphate (TSP) and Muriate of potash (MOP) were also applied during final land preparation. The fertilizers were then applied and mixed well by spading and individual unit plots were leveled properly.

3.12. Sowing of seeds

Seeds were sown in the main field on the 14 March 2016 maintaining line to line distance 30 cm and plant to plant distance 10 cm for better plant growth.

3.13. Management practices

During the whole experiment period several intercultural operations such as thinning of plants, gap filling, weeding, mulching, irrigation and spraying of insecticides were practiced as per necessity to keep the plants healthy and the field weed free. Special care was taken to protect the crop from birds especially after sowing and germination stages. Some special measure also applied to protect the young green fruits from birds .The field was irrigated regularly.

3.14. Intercultural operations

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

3.14.1 Thinning

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

3.14.2. Gap filling

Gap filling was done where necessary.

3.14.3. Irrigation

The plot was regularly irrigated as and when needed.

3.14.4. 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.

3.14.5. Drainage

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

3.14.6 Spraying insecticides

First spray was started 20 DAS and after that other spray was done at 5 days interval.

3.14.7 Protection

Some protective measures were taken to protect the green fruit from bird attack.

3.15. Harvesting

The crop was 1st harvested at maturity on May, 2016.The harvested crop of each plot was bundled separately. Grains were recorded plot wise and the yields were expressed in gram (kg) as per plant and per ha.

3.16. Parameters assessed

The data were recorded on the following parameters-

- ❖ 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 flower per plant
- ❖ Number of pod per plant
- ❖ Chlorophyll content
- ❖ Yield / plot

3.17. Collection of data

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

3.17.1. Number of plants per plot

Number of plants from each plot at 50, 60 and 70 days after sowing (DAS) was recorded.

3.17.2. Number of infected plants per plot

Number of infected plants from each plot at 50, 60 and 70 days after sowing (DAS) was recorded.

3.17.3. Number of leaves per infected plant

Number of leaves of selected infected plants from each plot at 50, 60 and 70 days after sowing (DAS) was recorded. Only the s youngest leaves at the growing point of the plant were excluded from counting. From that data we may Calculate the average number of leaves, and then the average number was recorded.

3.17.4. Number of infected leaves per infected plant

Number of infected leaves of selected infected plants from each plot at 50, 60 and 70 days after sowing (DAS) was recorded. From that data we may Calculate the average number of leaves, and then the average number was recorded .

3.17.5. Percentage of infection per infected leaf

Total percentage of infected area of each infected leaf and thus we may calculate the disease severity.

3.17.6. Number of flower per plant

Total number flower of selected plants were counted and was taken average number from each plot as per treatment was recorded.

3.17.7. Number of pod per plant

Total number of green pods of selected plants were counted and was taken average number from each plot as per treatment was recorded.

3.18. Plant height (cm)

The plant height was measured from the ground level to the top. Heights of 5 plants randomly from each plot were measured. It was done at them at maturing stage of the crop.

3.19. Disease incidence (%)

Disease incidence was defined as the number of plant units sampled that are diseased expressed as a percentage or proportion of the total number of units assessed. Incidence of mosaic diseases were recorded at before and after flowering. For measurement disease incidence per plant Ten plants were randomly selected and then data were collected on the basis of no of leaf infected.

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

Where,

X= Total number of plants assessed

X_1= Number of infected plants

3.20. Disease severity (%)

Disease severity is defined as the 'area of a sampling unit affected by disease, expressed as a percentage or proportion of the total area assessed. 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.

$$\text{Disease Severity(\%)} = \frac{X_1}{X} \times 100$$

Where,

X_1=Leaf area infected

X= Total leaf area assessed

3.21. Chlorophyll content in leaves per plant

Chlorophyll content of leaf was measured by using Spad meter. From each plot five plant was selected and was measured its Chlorophyll content of leaf. In each plant 3 leafs were selected for Chlorophyll content. Lower leaf, middle leaf and top leaf were measured to define the average Chlorophyll content of the leaf. The average chlorophyll content in the leaves of the selected plants was recorded with the help of "S-pad" meter, which is an advanced technology to directly measure the chlorophyll content in plant leaf at 50, 60 and 70 days after sowing (DAS).

3.22. Yield

Yield per plot was calculated and then yield of grain (kg/plot) was calculated by converting the mean grain weight of each plot as per treatment combination.

3.23. Statistical analysis

The collected data were arranged in a excel sheet and then was statistically analyzed by using the computer based software MSTAT-C. The mean data was calculated through ANOVA .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.

CHAPTER IV
RESULT AND DISCUSSION

The experiment was conducted to define the efficacy between two selective insecticides ACmix and Imitaf to prevent the insect vectors whitefly that transmit the devastating disease caused by *Mungbean Yellow Mosaic Virus.* Results were compiled based on disease incidence and severity, morphological and physiological parameters. The experiment was done under the following parameters thus,disease Incidence per plant,disease Incidence per plot,disease Severity per plot,Chlorophyll content,Height,number of flower,number of Pod,yield.The results found after the study was given below.

4.1. Symptoms

Mungbean yellow mosaic is the most destructive disease of legumes . Generally this diseases appear on the leaf. Infected leaf show necrotic symptoms. Irregular chlorotic spots along the veinlets which develop into yellow mosaic. The first emerging trifoliate leaves often show severe downward curling. The infected plants leaf show alternating green and yellow patches as color in figure 2. Leaf size is generally not affected, but sometimes the green areas are slightly raised and the leaves show a slight puckering and reduction in size. The leaves become papery white and thin. The diseases start to show its symptom at the vegetative stage of the plant. Diseased plants are become stunted and mature late. The infected pods become thin and curl upwards. Reduction of pods/plant, seeds /pod and seed weight.

Figure 2 . Severely infected leaves showing *MYMV* symptoms

4.2. Effect of Imitaf and ACmix on disease incidence (%) and severity (%) of *Mungbean Yellow Mosaic Virus (MYMV)*

Disease incidence was recorded per plant and per plot after application of all spraying of two different selective insecticides and disease severity was recorded on the basis of percent leaf area infection of the selected leaves.

4.2.1. Effect of Imitaf in different incidence treatment on disease per plant and per plot and disease *Yellow* Severity of *Mungbean Mosaic Virus (MYMV)* at 50 DAS

After the application of Imitaf up to six times spray , at 50 DAS the lowest disease incidence per plant was found in T_4 (9.32%) followed by T_5 (18.18%).The highest disease incidence per plant was observed in control treatment(T_0 = 33.59%).The moderate disease incidence per plant was observed in T_3 (25.37%) which is statistically similar with T_6 (25.00%).The lowest disease incidence per plot was also found in T_4 (3.34%) and followed by T_5 (6.63%). the highest disease incidence per plot was observed in T_0 (9.72%) which is statistically similar with T_1(9.67%) and T_2(9.62%) and identical with T_6 (15.33%).The moderate disease incidence was found in T_3(27.17%).

In case of disease severity at 50 DAS after the application of Imitaf the lowest disease incidence was measured in T_4 (8.67%) and followed by T_5 (11.67%) and the lowest disease severity was measured in T_0 (23.33%) which is statistically identical with T_1(18.71%).These results are presented on table in. 1.

Table 1. Effect of Imitaf in different treatment on disease incidence (D.I/plant and D.I/plot) and disease Severity at 50 DAS

Treatment	D.I/plant(%)	D.I/plot(%)	Severity(%)
T_0	33.59 a	9.72 a	23.33 a
T_1	27.34 b	9.67 a	18.71 b
T_2	27.17 b	9.62 a	17.71 bc
T3	25.37 c	7.71 bc	17.43 bc
T_4	9.32 e	3.34 d	8.67 e
T_5	18.18 d	6.63 c	11.67 d
T_6	25.00 c	9.09 ab	15.33 c
$LSD_{0.01}$	1.64	1.5	2.96
CV%	2.59	6.22	3.63

4.2.2 Effect of ACmix in different treatment on disease incidence(per plant and per plot) and disease Severity of *MYMV* at 50 DAS

After the application of ACmix up to six times at 50 DAS , the lowest disease incidence per plant was found in T_4 (14.56%) and followed by T_5 (26.44%).The highest disease incidence per plant was recorded in control (T_0= 5.21%) ,which is statistically identical with T_1 (32.015%) .The lowest disease incidence per plot was also observed in T_4(4.78%) and followed by T_5 (6.63 %).The highest disease incidence per plot was observed in case of control (T_0 = 9.78%) which is statistically similar with T_1 (9.68%) and statistically identical with T_6 (9.1%).

In case of disease severity at 50 DAS after application of ACmix the lowest disease severity was found in T_4 (10.34%)and followed by T_6 (17.33%).The highest disease severity was recorded in control (T_0 =21%) ,which is statistically similar with T_1(19.86%)These results are presented in table no 2.

Table 2. Effect of ACmix in different treatment on disease incidence (D.I/plant and D.I/plot)) and disease Severity at 50 DAS

Treatment	D.I/plant (%)	D.I/plot(%)	Severity (%)
T_0	35.21 A	9.78 a	21 a
T_1	32.01 B	9.68 a	19.86 a
T_2	26.88 C	9.63 a	19.66 a
T_3	26.51 C	7.72 bc	19.40 a
T_4	14.56 D	4.78 d	10.34 c
T_5	26.44 C	6.63 c	18.1 4 a
T_6	26.11 c	9.1 ab	17.33 b
$LSD_{0.01}$	3.01	1.5	10.29
CV%	4.53	6.11	8.83

Figure 3. Disease Incidence at 50 DAS (Control)

Figure 4 .Disease severity at 50 DAS (Control)

Figure 5. Disease incidence at 50 DAS (T_4)

4.2.3 Effect of Imitaf in different treatment on disease incidence (per plant and per plot and disease Severity of *MYMV* at 60 DAS

After the application of Imitaf up to six times at 60 DAS ,the lowest disease incidence per plant was found in T_4 (11.10%) and followed by T_5 (24.11%).The highest disease incidence per plant was recorded in control (T_0 =35.77%),Which is statistically similar with T_6 (25.10%) and T_2(27.93%).The lowest disease incidence per plot was also found in T_4 (3.43%) and followed by T_5 (7.51%).The highest disease incidence per plot was observed in case of control (T_0 = 10.17%) which is statistically similar with T_1 (10.15%), T_2 (9.88%), T_6 (9.14%).

In case of disease severity at 60 DAS after application of Imitaf the lowest disease severity was found in T_4 (7.23%) and following T_5 (16.33%),The highest disease severity was recorded in control (T_0 =26.00%),The moderate disease severity per plant was found in T_2 (19.71%).These informations are presented in table no 3 in below.

Table 3 . Effect of Imitaf in different treatments on disease incidence (D.I/plant and D.I/plot)) and disease Severity at 60 DAS

Treatment	D.I/plant (%)	D.I/plot (%)	Severity (%)
T_0	35.77 A	10.17 a	26.00 a
T_1	29.36 Ab	10.15 a	23.33 ab
T_2	27.93 B	9.88 a	19.71 b
T_3	27.74 B	9.24 a	18.71 b
T_4	11.10 C	3.43 c	7.23 d
T_5	24.11 B	7.51 b	16.33 c
T_6	25.10 B	9.14 a	19.70 b
$LSD_{0.01}$	6.67	1.48	4.85
CV%	9.93	6.03	6.03

4.2.4 . Effect of ACmix in different treatment on disease incidence (per plant and per plot) and disease Severity of *MYMV* at 60 DAS

After the application of ACmix up to six times at 60 DAS ,the lowest disease incidence per plant was found in T_4 (16.82%) and followed by T_5 (26.14%).The highest disease incidence per plant was recorded in control (T_0 =34.59%) , which is statistically similar with T_6 (32.89%) and statistically identical with T_1 (28.24%). The lowest disease incidence per plot was also found in T_4 (4.17%) and followed by T_5 (9.17%) .The highest disease incidence per plot was observed in case of control (T_0 = 10.17%) which is statistically similar with T_1 (10.15%).

In case of disease severity at 60 DAS after application of ACmix the lowest disease severity was found in T_4 (12.12%) and followed by T_5 (24.80%).The highest disease severity was recorded in control (T_0=36.33%) ,The moderate disease severity per plant was found in T_3 (20.00%) which is identical with T_6 (24.57%).

Table 4. Effect of ACmix in different treatment on disease incidence (D.I/plant and D.I/plot)) and disease Severity at 60 DAS

Treatment	D.I/plant(%)	D.I/plot (%)	Severity(%)
T_0	34.59 A	10.17 a	36.33 a
T_1	28.24 B	10.15 a	26. 57 b
T_2	26.38 B	9.88 a	26.33 b
T_3	25.58 B	9.24 b	20.00 c
T_4	16.82 C	4.17 b	12.12 d
T_5	26.14 B	9.17 c	24.80 bc
T_6	32.89 A	10.01 a	24.57 bc
$LSD_{0.01}$	4.50	1.48	4.04
CV%	6.7	8.07	16.29

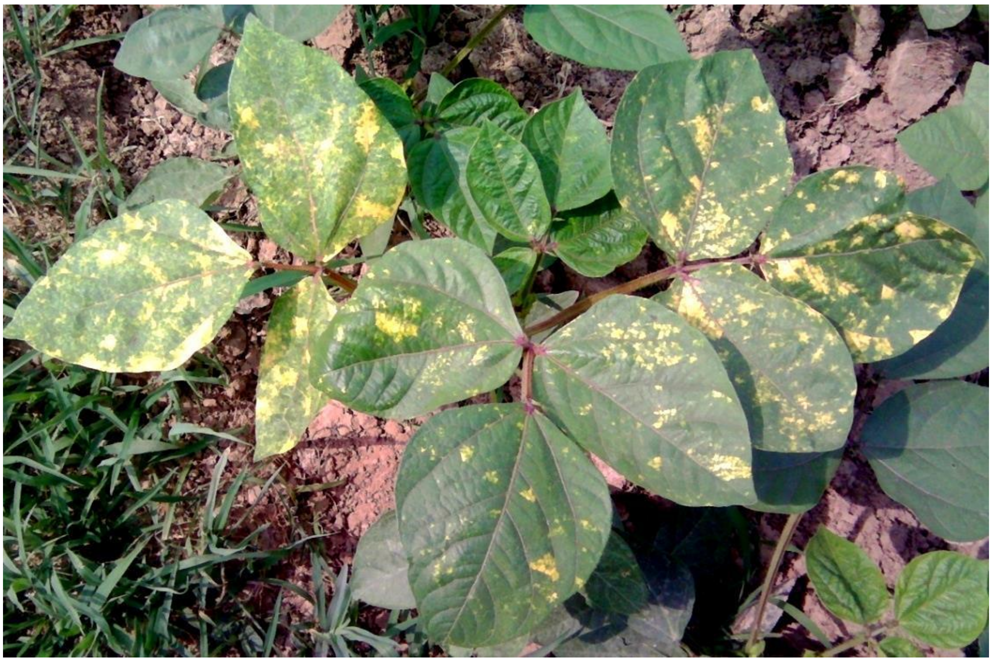

Figure 6. Disease Incidence at 60 DAS (Control)

Figure 7. Disease Severity at 60 DAS (Control)

Figure 8. Disease incidence at 60 DAS (T_4)

4. 2. 5 Effect of Imitaf in different treatment on disease incidence and disease severity (%) of *Mungbean Yellow Mosaic Virus (MYMV)* at 70 DAS

After the application of Imitaf up to six times at 70 DAS ,the lowest disease incidence per plant was found in T_4(10.12%) and followed by T_5(23.33%).The highest disease incidence per plant was recorded in control (T_0=36.50%) ,The moderate disease incidence per plant was found in T_2(28.29%).The lowest disease incidence per plot was also found in T_4 (3.51%) and followed by T_5(7.51%).The highest disease incidence per plot was observed in case of control (T_0=11.37%)and followed by T_1(10.07%) which is statistically similar with T_2(9.52%) and T_3(9.42%).

In case of disease severity at 70 DAS after application of Imitaf the lowest disease severity was found in T_4(7.21%) and followed by T_5 (11.67).The highest disease severity was recorded in control (T_0 =23.33%) . These results present in Table no.5.

Table 5. Effect of Imitaf in different treatment on disease incidence (D.I/plant and D.I/plot) and disease Severity at 70 DAS

Treatment	D.I/plant(%)	D.I/plot(%)	Severity(%)
T_0	36.50 a	11.37 a	23.33 a
T_1	29.78 b	10.07 a	18.71 bc
T_2	28.29 b	9.52 b	17.71 bc
T_3	28.27 b	9.42 ab	17.43 b
T_4	10.12 c	3.51 c	7.21 e
T_5	23.33 b	7.51 b	11.67 d
T_6	25.81 b	9.33 ab	15.33 c
$LSD_{0.01}$	6.36	2.31	2.96
CV%	9.28	9.64	6.62

4.2.6.Effect of ACmix in different treatment on disease incidence and disease severity (%) of *Mungbean yellow mosaic virus (MYMV)* at 70 DAS

After the application of ACmix up to six times at 70 DAS ,the lowest disease incidence per plant was found in T_4 (12.21%) and followed by T_5 (27.79%).The highest disease incidence per plant was recorded in contr(T_0 =34.49%),The moderate disease incidence per plant was found in The lowest disease incidence per plot was also found in T_4 (4.21%) and followed by T_3(7.51%).The highest disease incidence per plot was observed in case of control (T_0 = 11.37%) which is statistically similar with T_1(10.07%), and identical with T_2(9.44%).

In case of disease severity at 70 DAS after application of ACmix the lowest disease severity was measured in T_4(7.53%) and followed by T_6 (25.67).The highest disease severity was recorded in control (T_0 =36.67%) and followed by T_1(30.33%). The results are shown in table no 6.

Table .6. Effect of ACmix in different treatment on disease incidence (D.I/plant and D.I/plot) and disease Severity at 70 DAS

Treatment	D.I/plant(%)	D.I/plot (%)	Severity(%)
T_0	36.49 a	11.37 a	36.67 a
T_1	28.94 Ab	10.07 a	30.33 b
T_2	28.04 B	9.44 ab	29.29 b
T_3	27.66 b	7.51 b	28.14 b
T_4	12.21 C	4.21 c	7.53 c
T_5	27.79 B	9.33 ab	27.71 b
T_6	34.20 A	9.52 ab	25.67 b
$LSD_{0.01}$	1.41	2.31	5.78
CV%	2.01	5.30	5.70

Figure 9. Disease Incidence at 70 DAS (Control)

Figure 10. Disease Severity at 70 DAS (Control)

Figure 11. Disease incidence at 70 DAS (T_4)

4.3 Yield contributing characters in different treatment

In different treatment for both the insecticides Imitaf and ACmix ,they shown different effect on plants for their yield and yield contributing characters.

4. 3. 1 Effect of Imitaf in different treatment on yield contributing characters

In case of Imitaf it found that highest height was observed in case of T_4 treatment (20.63 cm) and lowest height was observed in T_0 (11.32 cm) in control and followed by T_1(18.86 cm) ,T_2 (19.43 cm) in this case the lowest number of flower fruit and yield also found in control. Highest flower (14.34) Fruit (11.28) and Yield (678g) was found in T_4.

Table 7: Effect of Imitaf in different treatment on yield contributing characters

Treatment	Plant Height (cm)	Number of Flower	Number of pod	Yield (g/plot)
T_0	11.32 c	8.34 d	7.89 d	342 d
T_1	18.86 a	11.79 b	10.44 b	478 c
T_2	19.43 a	11.92 b	10.69 ab	537 ab
T_3	19.73 a	12.03 b	10.76 ab	596 b
T_4	20.63 a	14.34 a	11.28 a	678 a
T_5	18.64 a	11.62 b	9.33 c	547ab
T_6	15.74 b	10.53 c	8.67 c	473c
$LSD_{0.01}$	2.15	1.06	1.03	7.9
CV%	4.54	3.52	2.89	5.69

4.3.2. Effect of ACmix in different treatment on yield contributing characters

In case of Imitaf it found that highest height was observed in case of T_4 treatment (24.85 cm) and preceding T_3 (24.17 cm) and lowest height was observed in T_0 (18.54 cm) in control and following T_1(22.43 cm) ,T_5 (22.35 cm) in this case the lowest number of flower fruit and yield also found in control. The Highest flower (14.13) and preceded by T_3(14.00)T_2 (13.26), the highest number of Fruit in T_4(9.19) and preceded by T_3(9.11) and Yield (637g) was found in T_4 preceded by T_3 (607 g) , T_2 (600 g) .

Table 8: Effect of ACmix in different treatment on yield contributing characters

Treatment	Plant Height (cm)	Number of Flower	Number of pod	Yield (g/plot)
T_0	18.54 d	10.21 c	5.34 c	205 d
T_1	22.43 c	12.85 ab	7.81 b	600 ab
T_2	22.57 bc	13.26 ab	8.56 a	602 ab
T_3	24.17 ab	14.00 a	9.11 a	607 ab
T_4	24.85 a	14.13 a	9.19 a	637 a
T_5	22.35 c	12.56 b	7.66 b	497 bc
T_6	21.33 c	12.13 b	7.62 b	470 c
$LSD_{0.01}$	1.64	1.23	1.92	0.11
CV%	3.33	5.08	5.98	14.47

4.4.Chlorophyll Content in different treatment for both Imitaf and ACmix

Chlorophyll content in different treatment for both the insecticides are presented in table number 9.The lowest amount of chlorophyll content was found for both the insecticides for the control in case of Imitaf it is (42.01 µ mol m^{-2} s^{-1}) and for the ACmix it is (48.34 µ mol m^{-2} s^{-1}).The highest amount of chlorophyll content was found for the Imitaf in T4 (49.62 µ mol m^{-2} s^{-1}) and thus for the ACmix in T4 (56.80 µ mol m^{-2} s^{-1}).

Table 9: Chlorophyll Content in different treatmrnt for both Imitaf and ACmix

Treatment	Chlorophyll Content(Imitaf)	Chlorophyll Content(ACmix)
T_0	42.01 c	48.34 d
T_1	47.32 ab	52.98 c
T_2	47.48 ab	53.78 bc
T_3	47.76 ab	55.08 ab
T_4	49.62 a	56.80 a
T_5	47.23 ab	52.90 c
T_6	46.39 b	52.72 c
$LSD_{0.01}$	2.48	1.83
CV%	2.10	4.39

4.5. Relationship between chlorophyll content in Imitaf treated plants and disease incidence at 70 DAS

Two selective insecticide with different number of spray in different plot 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 observed in T_4 (49.67 μ mol m^{-2} s^{-1}) followed by T_3 (47.76 μ mol m^{-2} s^{-1}) and T_2(46.48 μ mol m^{-2} s^{-1}) where control treatment showed the lowest chlorophyll content with the highest disease incidence. The relation of chlorophyll content with the disease incidence at 70 DAS per plot was shown below by the graph.

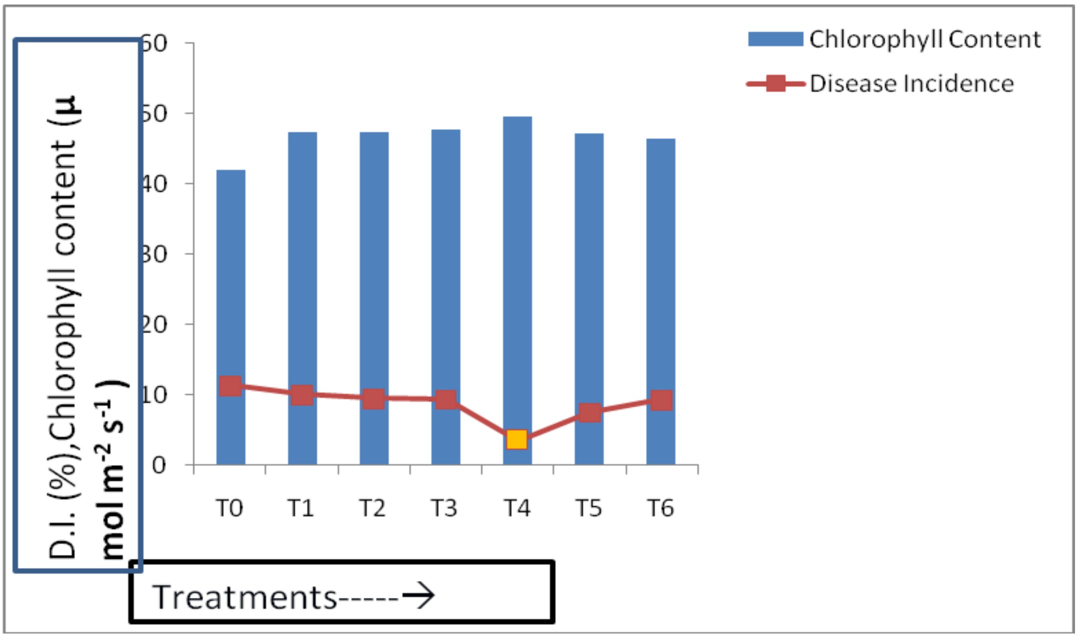

Figure 12. Relationship between chlorophyll content in Imitaf treated plants and disease incidence at 70 DAS

4.6. Relationship between chlorophyll content in ACmix treated plants and disease incidence at 70 DAS

Two selective insecticide with different number of spray in different plot 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 observed in T_4 (56.80 µ mol m^{-2} s^{-1}) followed by T_3 (55.08 µ mol m^{-2} s^{-1}) and T_2(53.78 µ mol m^{-2} s^{-1}) where control treatment showed the lowest chlorophyll content with the highest disease incidence .The relation of chlorophyll content with the disease incidence at 70 DAS per plot was shown below by the graph.

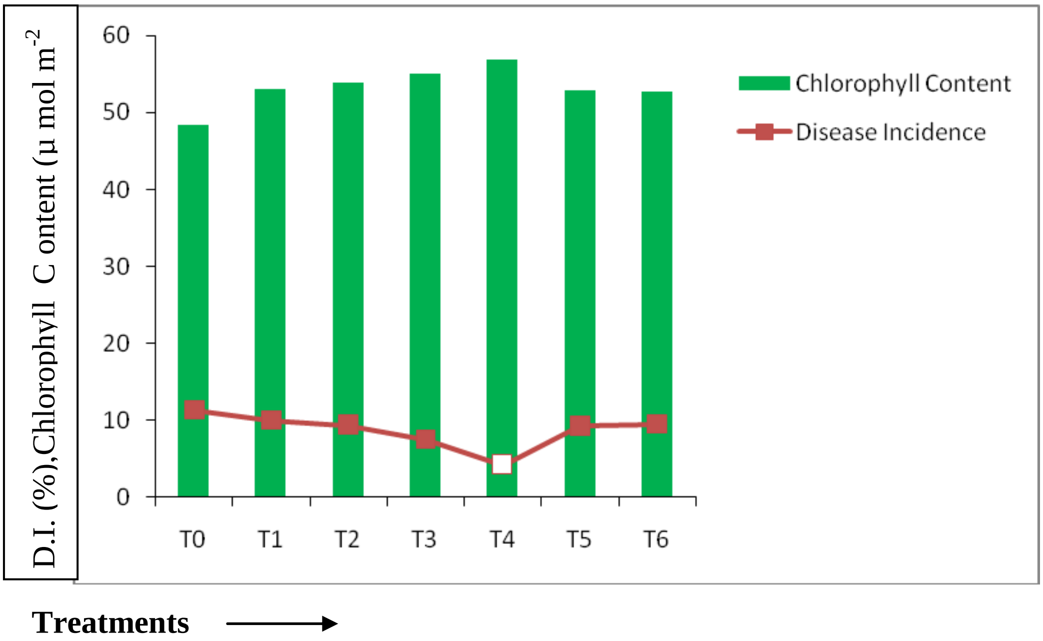

Figure 13. Relationship between chlorophyll content in ACmix treated plants and disease incidence at 70 DAS

4.7. Relationship between chlorophyll content in Imitaf treated plants and disease severity at 70 DAS

Two selective insecticide with different number of spray in different plot 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 observed in T_4 (49.67 µ mol m^{-2} s^{-1}) followed by T_3 (47.76 µ mol m^{-2} s^{-1}) and T_2(46.48 µ mol m^{-2} s^{-1}) where control treatment showed the lowest chlorophyll content with the highest disease severity. The relation of chlorophyll content with the disease incidence at 70 DAS per plot was shown below by the graph.

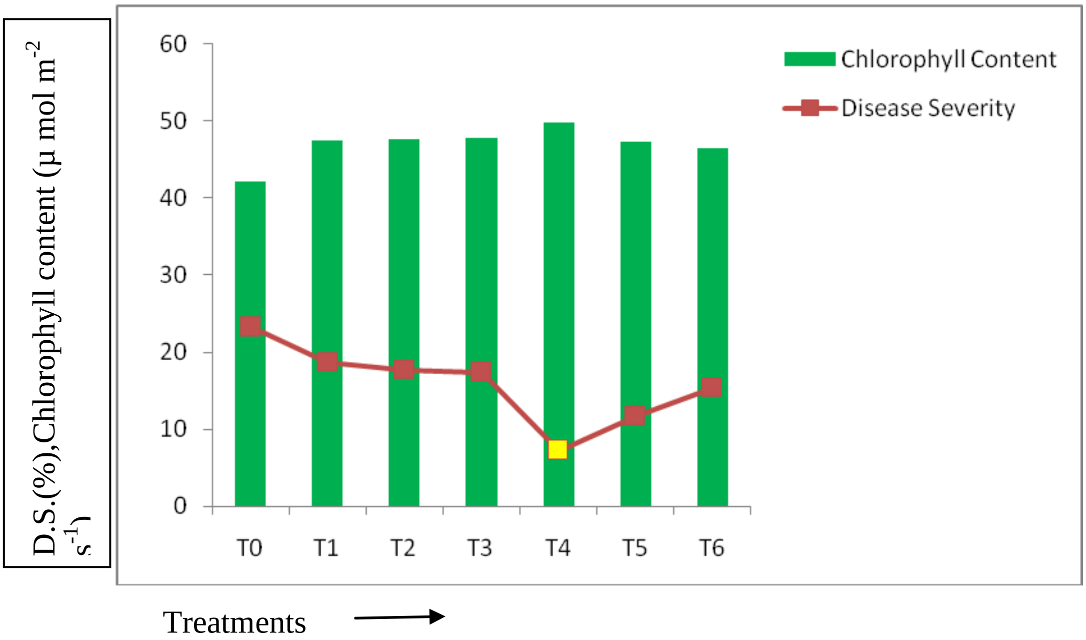

Figure 14 . Relationship between chlorophyll content in Imitaf treated plants and disease severity at 70 DAS

4.8. Relationship between chlorophyll content in ACmix treated plants and disease severity at 70 DAS

Two selective insecticide with different number of spray in different plot 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 observed in T_4 (56.80 µ mol m^{-2} s^{-1}) followed by T_3 (55.08 µ mol m^{-2} s^{-1}) and T_2(53.78 µ mol m^{-2} s^{-1}) where control treatment showed the lowest chlorophyll content with the highest disease severity. The relation of chlorophyll content with the disease incidence 70 DAS per plot was shown below by the graph in figure no 19.

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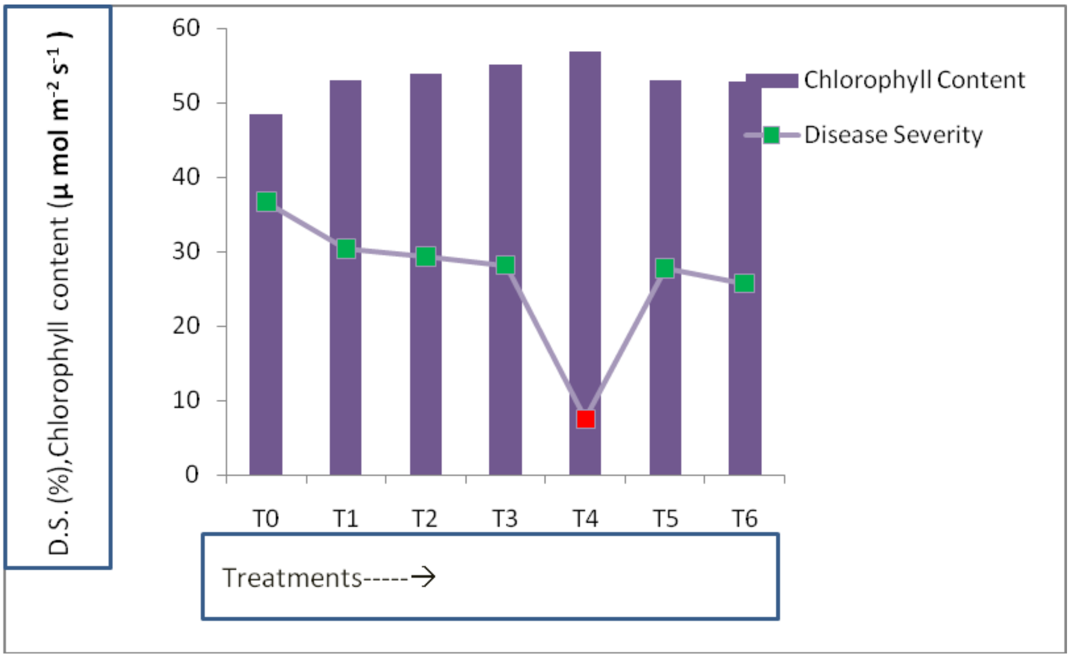
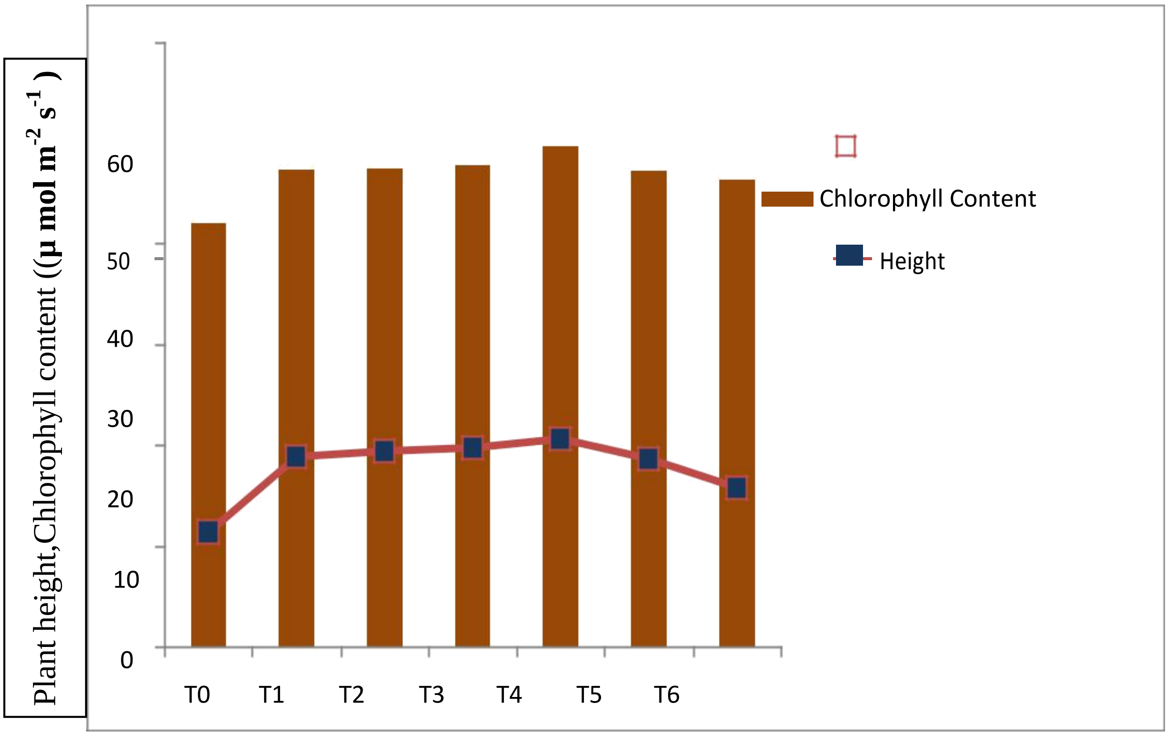


Figure 15 . Relationship between chlorophyll content in ACmix treated plants and disease severity at 70 DAS

4.9. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) and Plant Height of Imitaf treated plants

In this experiment after different treatment on different plot the height was measured. With the value of Chlorophyll content it found that the highest plant height was recorded in T_4 (20.63 cm) with the highest chlorophyll content and the lowest height was observed in T_1(11.32 cm) with the lowest chlorophyll content.

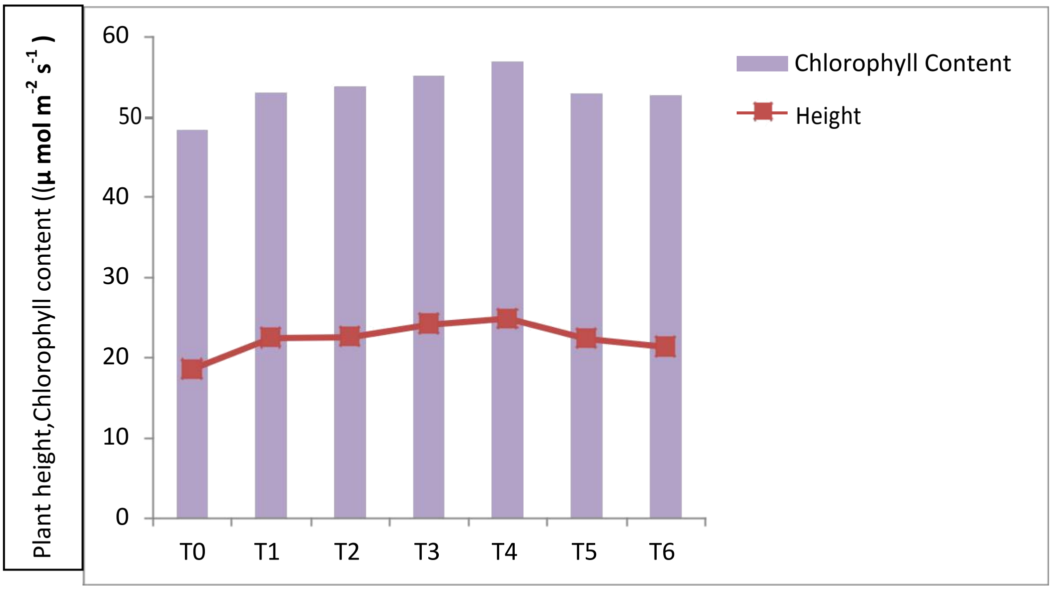


Treatments ⟶

Figure 16. Relationship between chlorophyll content in Imitaf treated plants and Plant height

4.10. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) of ACmix treated plants and Plant Height

In this experiment after different treatment on different plot the height was measured.With the value of Chlorophyll content it found that the highest height was in T_4 (28.45 cm) with the highest chlorophyll content and the lowest height was observed in T_1(18.54 cm) with the lowest chlorophyll content.

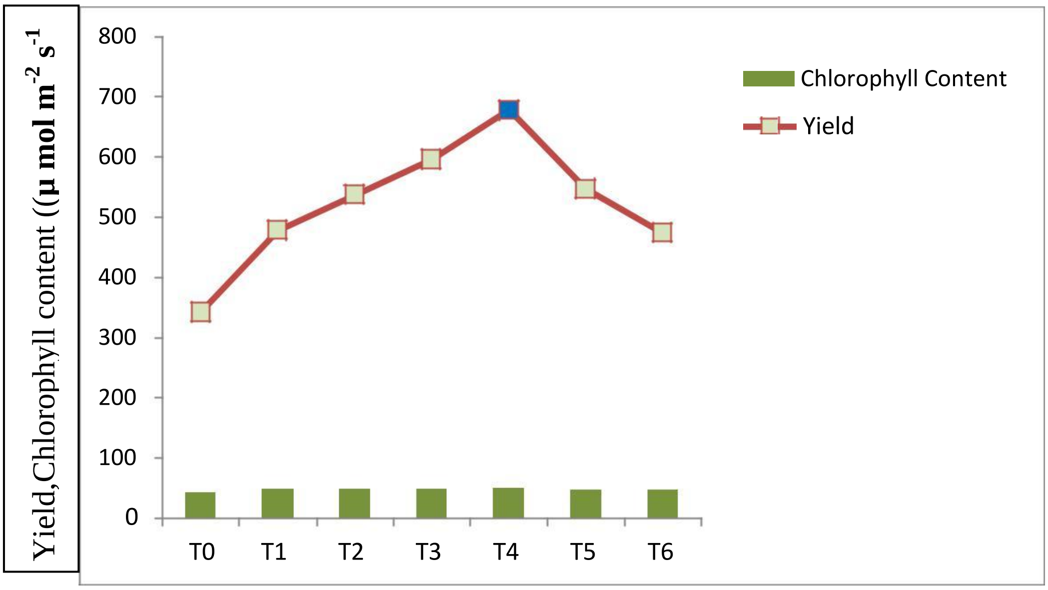


Treatments →

Figure 17. Relationship between chlorophyll content in ACmix treated plants and Plant height

4.11. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) of Imitaf treated plants and Yield(g/plot)

Different treatments were used in this study regarding chlorophyll content (µ mol m^{-2} s^{-1}) and yield. It is found that increase chlorophyll content was observed with increase yield. The highest chlorophyll content was found in T_4 (49.62 µ mol m^{-2} s^{-1}) followed by T_3 (47.76 µ mol m^{-2} s^{-1}) and T_2 (47.48 µ mol m^{-2} s^{-1}) where control treatment showed lowest chlorophyll content because of lowest yield T_0 (342 g/plot). As depicted in the following figure no. 18.



Treatments →

Figure 18 . Relationship between chlorophyll content in Imitaf treated plants and Yield

4.12. Relationship between chlorophyll content (µ mol m^{-2} s^{-1}) of ACmix treated plants and Yield(g/plot)

Different treatments were used in this study regarding chlorophyll content (µ mol m^{-2} s^{-1}) and yield. It is found that increase chlorophyll content was observed with increase yield. The highest chlorophyll content was found in T_4 (56.80 µ mol m^{-2} s^{-1}) followed by T_3 (55.08 µ mol m^{-2} s^{-1}) and T_2 (53.78 µ mol m^{-2} s^{-1}) where control treatment showed lowest chlorophyll content because of lowest yield T_0(205g/plot). As depicted in the following figure no 19.

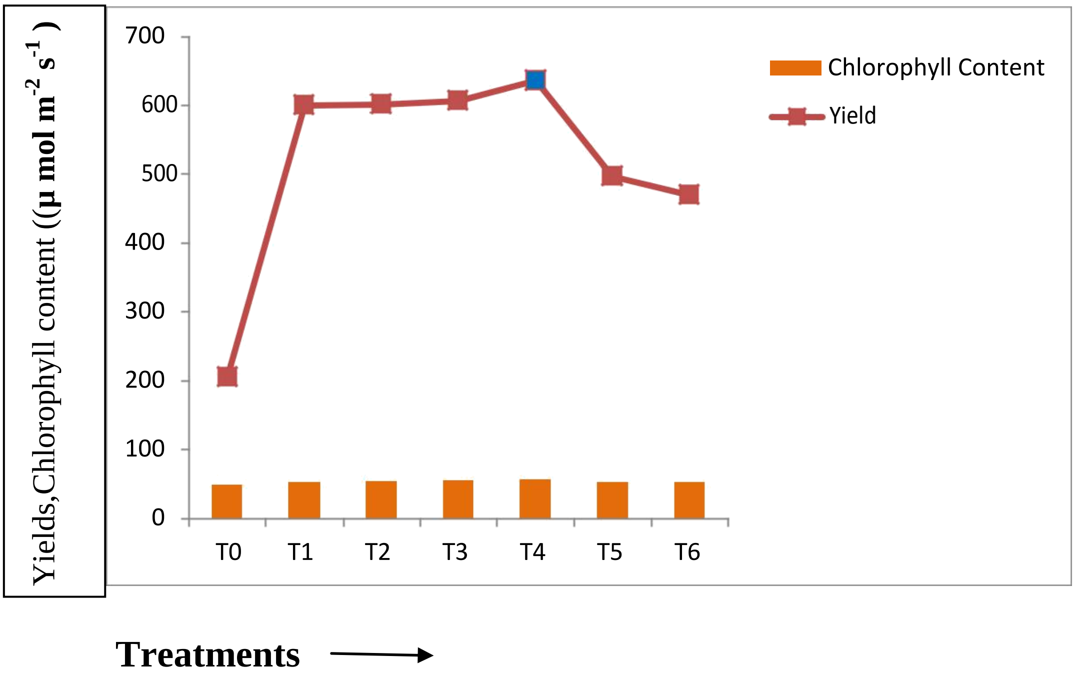


Figure 19 . Relationship between chlorophyll content in ACmix treated plants and Yield

DISCUSSION

This experiment was conducted to manage *Mungbean Yellow Mosaic Virus* with proper management pracices. The main objective was to find out effective management practice to minimize the devastating disease. In this experiment two selective insecticides was used with different number of spray. Pluses play an equally important role in rainfed and irrigated agriculture by improving physical, chemical and biological properties of soil and are considered excellent crops for natural resource management, environmental security, crop diversification and consequently for viable agriculture. Mungbean (*Vigna radiata* L.) is a good source of protein and satisfactory level of minerals and vitamins all over the world. It also contain some essential amino acid which is unavailable in food grain. Yield loss due to *MYMV* in mungbean was recorded as 63% (Anon., 1984). Winter mungbean genotypes are highly susceptible to yellow mosaic virus and showed (67-100)% loss of grain yield in the field where no control measures were taken (Jalaluddin and Shaikh, 1981). *MYMV* has not been reported to be transmitted through soil, seed and sap or by any insect vector other than white fly (*Bemisia tabaci*). Developing resistant variety is the best way to manage yellow mosaic of mungbean but high and fairly stable resistant varieties of mungbean against *MYMV* infections are not available in Bangladesh. Some resistant and tolerant cultivars have been released by Bangladesh Agricultural Research Institute (BARI) which depends on cultural and environmental factors to remain healthy. Reports on management of mungbean yellow mosaic are scanty. Generally chemical insecticides are used to manage the disease.

Disease incidence for both per plant and per plot was recorded the lowest in case of insecticide Imitaf in T_4 and similarly for the ACmix in T_4 .The highest disease incidence was recorded in T_0 or in no spray for both insecticides. In case of disease severity for both Imitaf and ACmix was recorded the lowest in T_4 and the highest in control T_0.. Almost same result was found in the previous work was done by Islam,.M.S. and Hossain , M.B. 2016 , Madhuban *et al*. (1997) also found better result while used Imitaf against *MYMV* in their study.

The maximum number of flower, pod and yield per plant was found when Imitaf was used than using ACmix and the lowest in control. In case of spraying Imitaf four time spraying gave best result than any other number of spraying or control. Almost similar findings were reported in the previous works has done by Suteri *et, al*., 2008 and Vohra *et, al*., 2008.

From this study it was cleared that the minimum chlorophyll content per plant was recorded in control and the maximum chlorophyll content per plant was recorded when Imitaf was sprayed four times than spraying ACmix. Babu *et al.* (1984) reported through his experiment that infection of Vigna radiata plants by *MYMV* caused significant reduction in number of pods/plant, seed yield and 100-seed weight.

In this study regarding chlorophyll content (μ mol m^{-2} s^{-1}) and disease incidence **(%)**, it is found that increased chlorophyll content was observed with decreased disease incidence. The highest chlorophyll content was found in T_4 and control treatment showed the lowest chlorophyll content because of the highest disease incidence. Here the Relationship between chlorophyll content (μ mol m^{-2} s^{-1}) and disease severity **(%)** is revealed that increased chlorophyll content was observed with decreased disease severity. The highest chlorophyll content was found in T_4 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 T4 with highest yield and control treatment showed lowest chlorophyll content with lowest yield. Almost similar result was found in previous work has done by Islam ,M. S. and Hossain ,M.B. 2016.

SUMMARY AND CONCLUSION

This experiment was performed in the distributed field for the Plant Pathology department of the farm of Sher-e-Bangla Agricultural University,Dhaka. The experiment was carried out during the period of march to june 2016.The experiment was ensued to evaluate the efficiency between two selective insecticides ACmix and Imitaf on disease incidence and severity of Mungbean Yellow Mosaic Virus. Yield and yield contributing characters and physiological characters of mungbean plant that changes due to the disease infection which cause serious damages of mungbean production was also the part of the study. BARI Mungbean-5 was grown in SAU farm under the normal agronomical practices .The experimental plot was designed RCBD (Randomized Complete Block Design) with three (3) replication and seven (7) treatment where T_0 was controlled. Treatments were T_0 (control / No spray),T_1(No of spray 1),T_2(No of spray 2),T_3(No of spray 3),T_4(No of spray 4),T_5(No of spray 5), T_6 (No of spray 6). In this experiment the highest disease incidence was found in control at 50 DAS, 60 DAS and thus in case of 70 DAS for both of the insecticides Imitaf (33.59%, 35.77%, 36.50%) per plant as well (9.72%, 10.17%, 11.37%) per plot and ACmix (35.21%, 34.59%, 36.49%) per plant as well (9.78%, 10.17%, 11.37%) per plot. The lowest disease incidence and disease severity was found in T_4 at 50 DAS,60 DAS and 70 DAS for both of the insecticides Imitaf (23.33%, 26.00%, 23.33%) and ACmix (21%, 36.33%, 36.67%). In case of chlorophyll content the lowest amount of chlorophyll was observed in control Imitaf (42.01 μ mol m^{-2} s^{-1}) and ACmix (48.34 μ mol m^{-2} s^{-1}) with the highest disease incidence and disease severity and the highest amount of chlorophyll was found in T_4 Imitaf (49.62 μ mol m^{-2} s^{-1}) and ACmix (56.80 μ mol m^{-2} s^{-1}) with the lowest amount of disease incidence and disease severity for both the insecticides. In this experiment different yield contributing characters vary with different treatments. The highest plant height was measured in T_4 Imitaf (20.63) and ACmix (24.85) and the lowest in T_0 control Imitaf (11.35 cm) and ACmix (18.54 cm) with lower flower Imitaf (8.34) and ACmix (10.21) and pod Imitaf (7.89) and ACmix (5.34) also. In this experiment the highest yield was found in T_4 Imitaf (678 g/plot) and ACmix (637 g/plot) and lowest in control both insecticides Imitaf (342 g/plot) and ACmix (205 g/plot) and the ultimate yield is higher for Imitaf than ACmix.

From this experiment it may be conducted that the application of insecticides Imidachloprid with 4 time spraying showed promising performance in management of *Mungbean Yellow Mosaic Virus (MYMV)* contributing yield contributing attributes and yield. Thus the farmer may be suggested to use this insecticide with 4 time spraying for the management of *MYMV*. However, further study need to be carried out for a consecutive years with more options as management practices in different Agro-ecological zones (AEZs) of the country.

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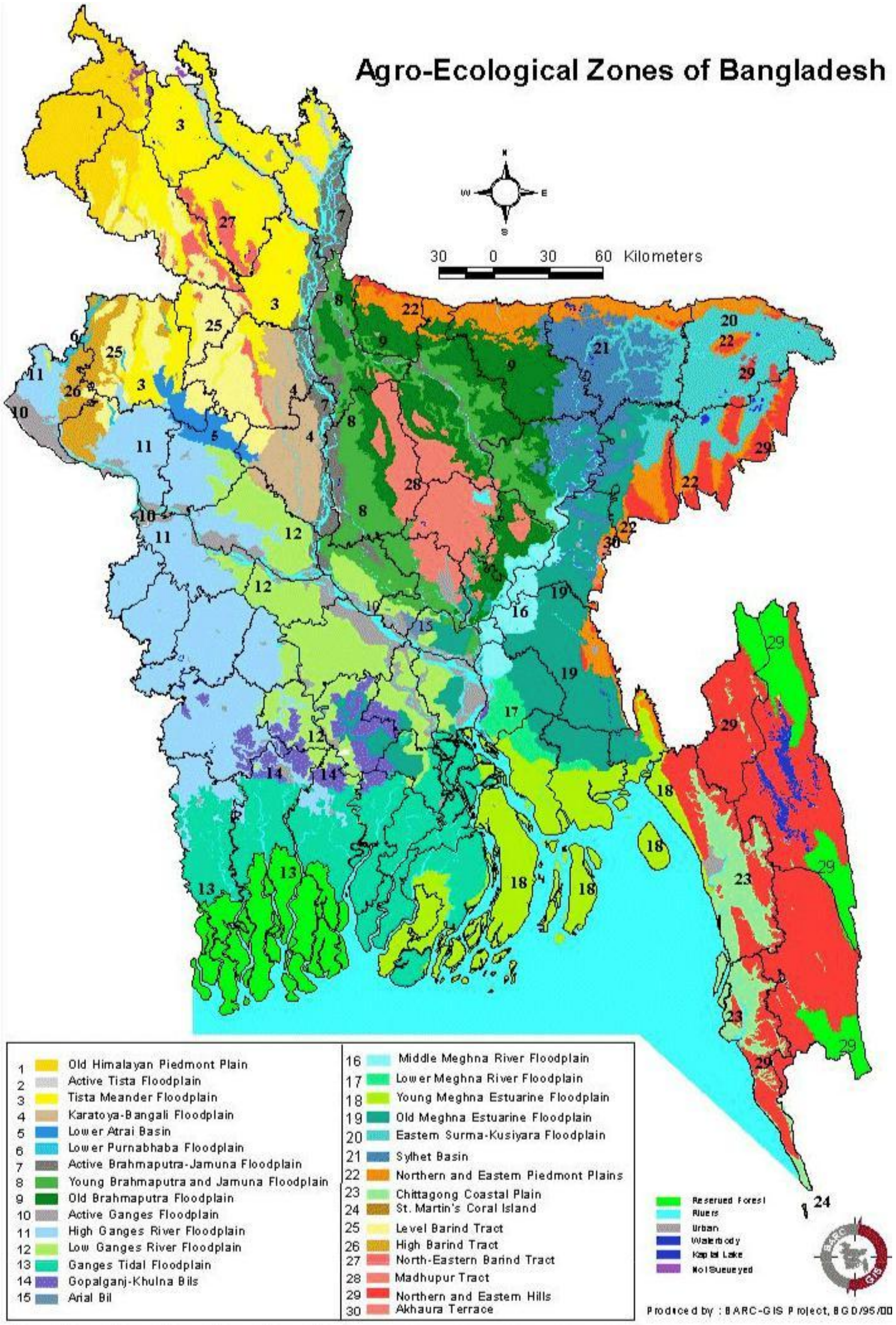
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Physical characteristics of field soil analyzed in Soil Resources Development Institute (SRDI) laboratory, Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Laboratory field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level

Appendix III. Monthly record of air temperature, relative humidity, rainfall, and sunshine of the experimental site during the period from March to June 2016

Months	*Air temperature (ºc)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine	*Relative Humidity (%)
	Maximum	Minimum				
March	31.4	19.6	19.6	54	11	8.2
April	34.2	23.4	23.4	61	112	8.1
May	34.7	25.9	25.9	70	185	7.8
June	35.4	28.6	28.6	75	242	7.5

* Monthly average

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka-1212

Appendix IV: The experimental site under study early stage

Appendix V: The experimental site under study later stage

Appendix VI: Severely infected mungbean plant by *Mungbean Yellow Mosaic virus* (*MYMV*)

Appendix VII : Healthy mungbean plants