RESPONSE OF SELECTED MUNGBEAN VARIETIES AGAINST *MUNGBEAN YELLOW MOSAIC VIRUS* AND IT'S MANAGEMENT

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CERTIFICATE

This is to certify that thesis entitled, "**RESPONSE of SELECTED MUNGBEAN VARIETIES AGAINST *MUNGBEAN YELLOW MOSAIC VIRUS* AND ITS MANAGEMENT**" 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 (M. S.) IN PLANT PATHOLOGY**, embodies the result of a piece of bona fide research work carried out by **ILIMA AFRIN KEYA, REGISTRATION NO. 18-09098** 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.

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DEDICATED

TO

BELOVED PARENTS

MY

SISTER

AND

MY HUSBAND

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ABSTRACT

Two split experiments were conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka to evaluate response of selected mungbean varieties against *Mungbean Yellow Mosaic virus (MYMV)* and management of *MYMV* in field condition. The 1st experiment was conducted during the period of July to October, 2019. Three varieties of BARI mungbean namely BARI mung 5, BARI mung 6, BARI mung 7 and one local variety were selected to conduct the experiment and the experiments were designed at Randomized Completely Block Design (RCBD) with three replications. Response against *MYMV* of selected varieties at 30, 40, 50 and 60 DAS was recorded, the lowest disease incidence (17.80%, 25%, 38.67%, and 48.67%) was recorded in BARI mung 7, whereas the highest diseases incidence (24%, 48.67%, 62% and 74%) was recorded in local variety. On the other hand, the lowest disease severity (5.97%, 11.67%, 26.63%, 31.17%) was recorded in BARI mung 7, whereas the highest disease severity (9.63%, 19.17%, 36.47%, 45.10%) was recorded in local variety. The highest healthy yield (0.91 t/ha) and the lowest infected yield (0.22 t/ha) was recorded in BARI mung 7, whereas the lowest healthy yield (0.59 t/ha) and the highest infected yield (0.35 t/ha) was recorded in local variety. Variation of growth and yield parameters were found in selected varieties at different DAS in field condition. The 2nd experiment was conducted during the period of July to October, 2020 and local variety was used as variety which showed susceptible to *MYMV* during 1st experiment. The experiment was conducted to manage the *MYMV* in field condition. Five treatments were namely T_1 = (Netting at seedling stage), T_2 = (Yellow sticky trap), T_3 = (Border crop, maize), T_4 = (One spray of imidacloprid), T_5 = (Two spray of imidacloprid) including T_0 = (Control) used in this experiment and one control without any treatment was used. In management study at 30, 40, 50 and 60 DAS, the lowest disease incidence (4.43%, 13.37%, 25.56%, and 33.32%) was recorded in treatment T_5 = (Two spray of imidacloprid), whereas the highest diseases incidence (23%, 41.10%, 53.32% and 66.67%) was recorded in treatment T_0 = (Control). On the contrary, the lowest disease severity (1.33%, 2.63%, 8.33%, 14.17%) was recorded in treatment T_5 = (Two spray of imidacloprid), the highest disease severity (10.83%, 18.67%, 34.17%, 44.73%) was recorded in treatment T_0 = (Control). The highest healthy yield (1 t/ha) and the lowest infected yield (0.08 t/ha) was recorded in treatment T_5 = (Two spray of imidacloprid), whereas the lowest healthy yield (0.41 t/ha) and the highest infected yield (0.27 t/ha) was recorded in treatment T_0 = (Control). The findings of the experiment revealed that BARI mung 7 showed the best performance among all aspect of incidence, severity, growth and yield contributing parameters whereas local variety was susceptible to *MYMV* disease and two spray of imidacloprid gave better results compared to the other control measures in management study.

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ACRONYMS AND ABBREVIATIONS

ACRONYMS	**ABBREVIATIONS**
AEZ	Agro-Ecological Zone
BBS	Bangladesh Bureau of Statistics
CM	Centimeters
CV	Coefficient of Variation
DAS	Days After Sowing
et al.,	And others
e. g.	exempli gratia (L), for example
etc.	Etcetera
FAO	Food and Agricultural Organization
i. e.	id est (L), that is
Kg	Kilogram (s)
LSD	Least Significant Difference
M. S.	Master of Science
No.	Number
SAU	Sher-e-Bangla Agricultural University
Var.	Variety
^{o}C	Degree Celsius
Entomology	Entomol.
International	Int.
Journal	J.
ANOVA	Analysis of Variance
Agricultural	Agril.
Biology	Biol.
Phytopathology	Phytopathol.
Mycology	Mycol.
Species	Spp.
Science	Sci.
%	Percentage

INTRODUCTION

Mungbean (*Vigna radiata*) belongs to the family Fabaceae and subfamily Papilionoideae, is one of the most important pulse crops in tropical and subtropical region. The crop is Asiatic in origin was introduced at early 18th century in south China, Indo China and Java.

In Bangladesh, mungbean is traditionally cultivated in the rabi season in about 41322.04 ha of land and about 33915 m tons of grains are produced (BBS, 2020) which is very low as compared to other countries of the region. In Bangladesh per capita consumption of pulses is only 14.72 g per day (BBS, 2012) as against 45.0 g recommended by World Health Organization (WHO). Among pulses, mungbean is favored for children and the elder 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.

Mungbean is 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). Mungbean is the fifth important pulse crop of Bangladesh (Abedin *et al*., 1991).

Mungbean is affected with different fungal, bacterial and viral diseases (Singh, 1981). Among them, the viral diseases of mungbean are *Mungbean yellow mosaic virus (MYMV)*, *Leaf crinkle virus (ULCV)*, *Mungbean leaf curl virus (MLCV)* and *Mosaic mottle virus (BCMV)* (Singh *et al*., 2018) are important. Among the viral diseases *(MYMV)* is the most damaging one and is prevalent in all growing areas (Sudha *et al*., 2013; Mohan *et al*., 2014). Mungbean is attacked by different species of insect pests but sucking insect pests (aphid, jessed, white leaf hopper and whitefly) are 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 of plant as well (Sachan *et al*., 1994).

The *MYMV*, a member of the family Geminiviridae (William *et al*., 1968), genus begomovirus (Bos, 1999) has long been a great threat to legume crops. The virus represents geminate particles 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).

This disease is destructive and widespread causing heavy loss annually. It was first identified in India in 1955.The virus is naturally transmitted by whitefly (*Bemisia tabaci Genn*), but not by mechanical inoculation or by seed (Nariani, 1960). 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.

MYMV is characterized by small irregular yellow specks and spots along the veins which enlarge until leaves completely become yellow. Affected plants show stunted growth and produce a fewer flowers and pods with smaller and shriveled seeds (Habib *et al*., 2007; Sudha *et al*., 2013). Breakdown of chlorophyll content is caused by the *MYMV* which results in yellowing of leaves. In addition, majority of the cultivars in the field are susceptible to *MYMV* which is mainly responsible for poor production and productivity in mungbean growing countries. (Singh, 1980 and Marimuthu *et al*., 1981) reported that yield loss due to *MYMV* disease in mungbean was about 76 to 100 percent.

MYMV 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, 1991 and Malik, 1991). The incidence and severity of *MYMV* are directly related with the availability and abundance of insect vector.

To overcome this vector borne viral disease different strategies are formed but no breakthrough is found for cost effective management.

Numerous sprays of insecticides are required to control whitefly. Recurrent sprayings also lead to health hazard and ecological imbalance of living organisms. Management through chemical control is difficult for complete destruction of vectors.

On the contrary, use of virus resistant varieties, if available, is the best approach to reduce the occurrence of *MYMV* in areas where the infection is recurring constraint. Use of resistant crop varieties is considered as the reasonable, robust and perfect method of controlling viral diseases. A good quality research is directed towards screening mungbean cultivars against *MYMV* for the identification of resistant sources under diverse environmental conditions.

The yellow traps are used to supplement weekly monitoring of plants for green house white flies (Ekbom, 1980). Yellow sticky traps to be effective for quantitative surveillance of green house white flies but found them effective for determining general population trends (Yano and Koshihara, 1984). Netting is considered as an important management tools for controlling white flies' abundance at seedling stage. If possible, borders of crops like sorghum, pearl millet or maize may be planted around mungbean (Akram and Sing, 2016).

Current management of *MYMV* includes planting resistant varieties, vector management, alternate hosts of mungbean and modifying the cultural practices of the crop which are not effective in managing the disease remarkably. Therefore, there was needed to develop a better management practice. In this context, the present study was undertaken to screen out the resistant mungbean varieties against *MYMV* and using different chemicals, yellow sticky trap, netting and border crop for the management of *yellow mosaic virus* disease.

Viewing the above facts, the following objectives are considered for this research experiment-

1. To screen out the resistant varieties against *Mungbean yellow mosaic virus*;

2. To assess the effect of *MYMV* infection on growth and yield of mungbean at different days after sowing and

3. To see the effect of selected treatment for controlling *MYMV* in field condition.

REVIEW OF LITERATURE

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. some of the important and informative works and research findings related to the resistance response and management of *Mungbean yellow mosaic virus* at home and abroad have been reviewed in this chapter.

Origin and Distribution of mungbean

The mungbean is thought to have originated from the Indian subcontinent where it was domesticated as early as 1500 BC. Cultivated mungbean were introduced to Southern and Eastern Asia, Africa, Austronesia, the Americas and the West Indies. It is now widespread throughout the Tropics and is found from sea level up to an altitude of 1850 m in the Himalayas (Lambrides *et al*., 2006; Mogotsi, 2006).

The mungbean is a fast-growing, warm-season legume. It reaches maturity very quickly under tropical and subtropical conditions where optimal temperatures are about 28-30°C and always above 15°C. It can be sown during summer and autumn. It does not require large amounts of water (600-1000 mm rainfall/year) and is tolerant to drought. It is sensitive to water logging. High moisture at maturity tends to spoil the seeds that may sprout before being harvested. The mungbean grows on a wide range of soils but prefers well-drained loams or sandy loams, with a pH ranging from 5 to 8. It is somewhat tolerant to saline soils (Mogotsi, 2006).

Mungbean production is mainly (90%) situated in Asia: India is the largest producer with more than 50% of world production but consumes almost its entire production. China produces large amounts of mungbeans, which represents 19% of its legume production. Thailand is the main exporter and its production increased by 22% per year between 1980 and 2000 (Lambrides *et al*., 2006). Though it is produced in many African countries, the mungbean is not a major crop there (Mogotsi, 2006).

Nutritional value of mungbean

The mungbean contains balanced nutrients, including protein, dietary fiber, minerals, vitamins, and significant amounts of bioactive compounds (Gan, 2017). For those individuals who cannot afford animal proteins or those who are vegetarian, the mungbean is of a comparatively low-cost and has a good source of protein for them. Furthermore, mungbean protein is easily digestible, as compared to protein in other legumes (Mubarak, 2005; Yi-shen *et al*., 2018).

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 and Vanna, 1988).

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.

Symptoms of *MYMV*

Green (1999) in a survey (by AVRDC) to determine the occurrence of Gemini viruses in mungbean collected samples of which 30 of black gram, 2 of soybean collected from India (west), 24 mungbean varieties from Bangladesh, 14 from Sri Lanka and none of the samples of mungbean collected from Vietnam, Thailand and Tanzania those were positive (MYMV) by nucleic acid hybridization and PCR based techniques.

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.

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.

Singh *et al*. (1982) reported that the symptoms of *MYMV* is Chlorosis, stunting, fewer branches resulting premature shedding of leaves.

Chhabra *et al*. (1981) reported in mungbean, *MYMV* infection results considerable decrease in chlorophyll and DNA contents and increase in RNA, phenols, free amino acids, sugars and enzymes.

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 Nariani 1960, Nene *et al*., 1972, Nene 1973, Poehlman *et al.*, 1976, and Williams *et al*., 1968).

Nene (1974) 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.

Nene *et al.* (1973) observed that due to this disease a necrotic center 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 (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.

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.

Transmission of *MYMV*

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.

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 nonpersistent manner. Helper virus was not apparently required for transmission. Non-vector transmission was apparently absent by mechanical inoculation, not by seed or pollen.

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, an isolate from Thailand was found sap-transmissible.

Muniyappa (1980) reported that yellow mosaic of mungbean, yellow mosaic of limabean, yellow mosaic of soybean, yellow mosaic of groundnut, dolichos yellow vein mosaic, abutilon infectious variegation, yellow mosaic of croton, yellow vein mosaic *of Eclipta alba*, mosaic of *Jatropa gossypifolia*, yellow vein mosaic of *Malvastrum coromandalianum* were transmitted by grafting successfully.

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.

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

Vector (s) of *Mungbean Yellow Mosaic Virus (MYMV)*

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.

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*.

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.

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

According to Basu (1986) *Bemisia tabaci* Gen. is an efficient vector of *MYMV*. So far, no intraspecific diversity has been identifying.

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.

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.

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 *MYMV* is transmitted by the whitefly *(Bemisia tabaci* Genn).

Varietal resistance

Sudha *et al.* (2013) reported that the intraspecific hybridization is used for the improvement of resistance to *MYMV* in mungbean. Resistance to *MYMV* has also been recognized in the wild species (*V. umbellata and V. sublobata*) of mungbean and may consent the introduction of such resistance by means of interspecific hybridization.

Iqbal *et al*. (2011) evaluated one hundred genotypes/lines of mungbean germplasm were screened against *MYMV* during summer season under field conditions at NARC, Islamabad. The germplasm was categorized in to resistant and susceptible depending upon severity of disease. The differential 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.

Ravishankar *et al*. (2009) reported that *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. Hence, the present study was undertaken to identify the RAPD marker associated with *MYMV* resistance in French bean (*Phaseolus vulgaris* L.). Bulk segregant analysis (BSA) was used to identify RAPD marker linked to *MYMV* resistance.

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

Awasthi and Shyam (2008) observed that nine resistant lines field conditions from 83 lines against *MYMV*. 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.

Sana Habib *et al*. (2007) reported that the absence of resistance/tolerance against diseases and insect pests in mungbean [*Vigna radiata* (L.) Wilczek] varieties, is one of the main reasons for their low yield in Pakistan. During the summer (Kharif) season, yellow mosaic epidemic damages the crop in most of the mungbean growing areas of Pakistan. For the purpose of identifying resistance/tolerance in mungbean germplasm, a disease screening nursery, comprising of 108 test entries, was developed. Screening was done under natural environmental conditions in 2007 at University of the Punjab, Lahore, Pakistan against *Yellow mosaic disease (YM*D). All the test entries showed a highly susceptible response. Despite being highly susceptible, some test entries produced good yield and showed tolerance to *YMD.* Tolerance against *YMD* is a considerable factor to be included in breeding program to develop high yielding varieties of *V. radiata.*

Yaqoob *et al*. (2007) were investigating on mungbean which was severely attacked by *Yellow mosaic virus* (*YMV*) disease. The virus is considered to be transmitted through vector whiteflies (*Bemisia tabaci* Genn) a sucking insect of Vigna group. The only way to overcome this problem is development of disease resistant varieties. The local land races are highly susceptible to this dread disease. To purify the available germ plasms accessions a country-wide survey was conducted and some 66 lines of mungbean including the accession from PGRI, NARC, Islamabad were collected for screening against YMV. All the 66 germs plasm accession were planted at Agricultural Research Institute, D.I. Khan during 2004. Most of the lines were totally destroyed by *YMV*. Some desirable tolerant, moderately tolerant, resistant and highly resistant plant were selected. The seed thus obtained was again planted during next year 2005 along with susceptible checks for confirmation of host plant resistance and study of selection response of mungbean against *YMV*. The disease data were recorded on 1-9 rating scale. The observations revealed that there exists greater genetic variability in mungbean lines against their response to *Yellow mosaic virus*. The results further revealed that selection response was quite positive. The lines showing resistance in previous year had again shown the resistance and vice versa.

Shad *et al*. (2006) found that there was no resistant line against *MYMV* and identification of seven susceptible and 247 as highly susceptible lines exhibited meager resistance in mungbean.

Bashir (2003) screened 276 lines of mungbean and out of which 10 show resistance.

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

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*.

Pathak and Jhamaria (2004) from ARS, Durgapura (Jaipur) reported *MYMV* incidence which ranged from 2.22 in variety ML-5 to 100 per cent in K-8512 (check variety) during evaluation programmed against *MYMV*.

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.

Peerajade *et al*. (2004) tested 85 genotypes against *MYMV* at MARS, Dharwad. Among them, GG 41 and GG 42 were found resistant and GG 52 showed moderate resistance.

Khattak *et al*. (2004) were investigated the resistance of mung bean cultivars (NM-92, NM98, 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.

Marappa *et al*. (2003) evaluated mungbean genotypes for resistance against powdery mildew, *Yellow mosaic* and bacterial blight at Bangalore, and they found that the genotypes AKM-9911, AKM-8803, Co-4, KM-2194, KM-188-3, MIVT-842, MIVT-854, MIVT-867, ML-173, ML-1380, DBGG-11, PMB-43, PS-16, SML-151, UPM-99-3, V-2964 and LM-56 were free from *MYMV* incidence.

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*.

Khatri (2003) was conducted survey and determined the spread of *Yellow mosaic virus* (*YMV*) disease and extent to damage caused by the disease on mungbean (Vigna aconitifolia). They further observed that *YMV* was the most important disease of mothbean in the region during both years.

Raje and Rao (2002) found that the genotypes, PLM 19, PLM 25, PLM 32, PLM 42, PLM 113, PLM 122, PLM 618, IC-1396-3, IC-2153, IC-43591, EL-3902-A-EC-5551 and J-45 were resistant to *Yellow mosaic virus*, Cercospora leaf spot and powdery mildew under field conditions.

Singh *et al*. (2000) from Uttar Pradesh reported an incidence ranging from 0 to 58.5 per cent among various varieties during their evaluation programme for resistance against *MYMV*.

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.

The lowest population of whitefly (adult and nymph) was found in Barimung 6 as against the highest in Binamoog 2. The population of whitefly was gradually increased with environmental temperature and relative humidity. However, the peak population was found at 32^0C and 80% relative humidity. The lowest percent of *MYMV* infected plant was found in Barimung 6 and a positive relationship was found between whitefly population and incidence of *MYMV* disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the *MYMV* infection and yield of mungbean.

Siddiqui *et al*. (1999) evaluated some indigenous soybean lines for resistance against *Mungbean yellow mosaic bigemini virus*, transmitted by *Bemisia tabaci* at IARI, New Delhi and found PK-1189, PK-1180, SL-443 and SL-444 were consistent and most promising sources of resistance.

Basandrai *et al*. (1999) evaluated one hundred diverse stocks of blackgram (*Phaseolus mungo* L.) for resistance against five different diseases widely prevalent in Himachal Pradesh. They found HPBU 38, HPBU 153, LBG 626 and UG 367 were resistant against mung bean *Yellow mosaic* and web blight. WVG 108 was found resistant against *Cercospora* leaf spot and *MYMV* and UG 407 was resistant against *Cercospora* leaf spot, *MYMV* and powdery mildew.

Asthana (1998) from Indian Institute of Pulses Research, Kanpur reported PDM-11, PDM-54, PDM-84-139, PDM-84-143 varieties as yellow mosaic resistant and can be utilized in breeding programmes.

Kuldip Singh *et al*. (1996) screened 126 mungbean germplasm lines for resistance against *MYMV*. They found ML 267, ML 337, ML 393, ML 395, ML 409, ML 443, ML 591, ML 593, ML 605, MUG 225, PDM 84-143, PDM 219 and Pusa 8731 germplasms were resistant against *MYMV*.

Premchand and Varma (1983) screened the mung and urd bean cultivars for growth components and yield against *Yellow mosaic disease* incidence. There was a reduction of 9.6 to 38.2 per cent in height, 7 to 28.5 per cent in fresh weight of shoot and 4.3 to 22.1 per cent in dry weight, 25.7 per cent in 1000 seed weight of susceptible cultivar. However, the germinability of seeds was apparently unaffected due to yellow mosaic.

Singh *et al*. (1980) reported that mungbean, Hyb-4-3 A and Hyb-12-4, remained free from disease at Ludhiana. Mungbean selections 15229, L 24-2 in Punjab, ML-220, PLS 274 in Tamil Nadu and L 80, ML 326, PDM 54 and PDM 62 in UP were also reported to be resistant to yellow mosaic

Chenulu *et al*. (1979) taken up varietal screening for resistance against *MYMV* at IARI, New Delhi and reported that Jalgaon-781, T-2, Khargaon and Mung local showed cent per cent infection, however, Pusabaisakhi showed least infection.

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

Islam *et al*. (2008) conducted an experiment on seven recommend varieties of mungbean 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 peak population was found at 32^0 C and 80% relative humidity. The lowest percent of *MYMV* infected plant was found in Barimung 6 and a positive relationship was found between whitefly population and incidence of *MYMV* disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the *MYMV* infection and yield of mungbean.

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 imidacloprid (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, imidacloprid 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.

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.

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. 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 a*l. 1981).

Aftab *et al*. (1993) reported *MYMV* infection on Vigna (*Ungiliculata* sub sp. *Sesquipedalis*) at Islamabad, Pakistan. The disease spread rapidly with increase in whitefly population. Plant height, number of pods, seeds and yield/plant were reduced by 10.3, 50.5, 44.7 and 49.2 per cent, respectively.

Quaiser Ahmed (1991) reported a yield loss of 83.9 per cent and a maximum growth reduction of 62.94 per cent in Vigna radiata cv. Pusabaisakhi due to *Mungbean yellow mosaic gemini virus* infection and he also concluded that early crop infection reduced yield more than late infection.

Chamder *et al*. (1991) noticed a significant reduction in the attack of whitefly and infection of *YMV* in mungbean when 0.04% monocrotophos, 0.03% dimethoate, and 0.05% chlorvinphos 55 days after sowing were applied.

Ahmad (1991) observed that *Mungbean yellow mosaic gemini virus* infection causes maximum growth reduction (62.94%) and yield loss (83.9%) for (*vigna radiata 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. 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.

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.

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.

Chanda and Varma (1983) observed that plant height and fresh weight reduced up to 38.2% and 28.5%, respectively for *MYMV* infection on mungbean and Urdbean. The shape, size and appearance of pods and seeds of plants were considerably distorted although seed germ inability was found to be unaffected.

Fakir (1983) reported the yellow mosaic caused 16% yield loss in mungbean and 10% yield loss reduced plant height and fresh shoot weight were reported along with yield loss up to 66%.

Chanda *et al*. (1983) and Ahmed (1985) observed 85% *MYMV* incidence both in summer and winter pulse verities.

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.

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*.

Vohra and Beniwal (1979) 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.

Suteri *et al* and Vohra *et al*. (1979) observed that 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.

Management of *MYMV*

Cultural practices

Yellow sticky traps

Idris *et al*. (2012) reported that both vertical and cylindrical traps were the most effective traps as significantly higher numbers of alate white flies caught on these traps than on traps of other designs. yellow was the most attractive color to alate white flies of mungbean, regardless of the trap design as it had the highest number of alates caught compared to the other colors. Comparatively, the vertical yellow trap was the most attractive and efficient trap to use in monitoring white flies.

Uthamasamy (1989) studied the effectiveness of yellow sticky traps in cotton for monitoring the whitefly population. He reported that the traps set up at a height of 30 cm over the ground level in the cotton crop attracted most of the adult flies over that kept at 60, 90 and 120 cm height.

Webb *et al*. (1985) reported that the depending on trap density, yellow sticky traps can remove substantial proportions of a GHWF adult population.

Gerling and Horowitz (1984) found that a high number of *B. tabaci* was captured in a horizontally placed trap compared to the cross-shaped vertical trap of similar size, and the catches were greater at the ground level.

Yano and Koshihara (1984) did not consider yellow sticky traps to be effective for quantitative surveillance of greenhouse white flies but found them effective for determining general population trends.

Ekbom (1980) proposed the use of yellow traps to supplement weekly monitoring of plants for green house white flies.

Byrne and Bishop (1979) reported that the number of *Myzus persicae* (Sulzer) caught in the yellow water pan trap was correlated with the number of potato leaves from the adjacent potato fields.

Mound (1962) found that *B. tabaci* was attracted to the blue-ultra violet and yellow part of the light spectrum.

Border crops

Sreekant *et al*. (2004) conducted field experiments in kharif seasons on mungbean cv. K851 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.

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

Raghupathi and Sabitha (1994) investigated the effect of different barrier crops on the incidence of soybean *Yellow mosaic virus* and whitefly population. Maize and pearl millet as barrier crops for soybean reduced the incidence of yellow mosaic by 9.88 and 9.81 per cent respectively. The population of whitefly per plant was also less in soybean grown as border crop with maize (2.36) and pearl millet (2.46) as compared to control (8.62). The yellow sticky traps reduced whitefly population but not disease incidence.

Ravindrababu (1987) reported that maize, sorghum and pearl millet barrier crops, sprayed with endosulfan were effective in reducing the incidence of mungbean mosaic as compared to barrier crops, which were not sprayed.

Sridhar (1986) reported that sunflower, sorghum and maize barriers reduced the incidence of CMV in chillies and increased the yield.

Singh (1985) studied the effect of barrier crops in managing viral diseases of vegetable crops and he reported that maximum protection by barriers depended on many factors such as vigour, thickness and height of barriers, environmental factors like the wind velocity and wind direction and growth of the crop. These barriers were fast growing and taller than mungbean and thus acted as hindrance in movement of whiteflies.

Vaishampayan *et al*. (1975) and Southwood (1978) reported that yellow was found to be an efficient color used in trapping insects such as Homopteran, Hymenopterans, Dipteran, and Thysanoptera compared to other colors.

Cohen and Marco (1973) studied the efficacy of yellow sticky traps in reducing aphid transmitted viruses. They achieved an obvious reduction in spread of cucumber mosaic virus and potato virus in treated plots than in untreated plots. They obtained 60, 38, 77, 80 and 51 per cent protection, respectively at 53, 72, 87, 90 and 114 days after planting in yellow sticky traps used plots. They insisted for further investigation in order to determine whether yellow polyethylene sheets act as mechanical barrier or the actively attracted vectors lose their virus charge in attempts to feed on it.

Chemical

Jayappa *et al*. (2017) observed that seed treatment with imidacloprid at 5 ml/Kg seed plus two sprays of neemazal at 3ml/l was also effective in management of *MYMV*

(45.20%) ant its vector (3.7 per plant). Compare to this treatments, maximum percent incidence and whitefly population was recorded in control.

Sunil and Singh (2010) were conducted a field experiment to management of 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 kg71 and carbendazim (Bavistin TM) þ TMTD (Thiram TM) at 2.5 g kg71 (1:1 ratio) followed by foliar applications of thiamethoxam (Actara TM) 0.02% and carbendazim 0.05% at 21 and 35 d, 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* leaf spots and mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in this treatment during all stages of the crop. This treatment was cost-effective, as it provided the highest return per Rupee of input. It was second best for the number of Rhizobium root nodules per plant.

Wang *et al*. (2009) reported that systemic chemical insecticides viz., acetamiprid, ethion, imidachlorpid, triazophos, provide better control of white flies they also kill on contact, but are also taken inside the plant where they go onto protect against further attack for more than a few weeks.

Ghosh (2008) showed that imidacloprid reduced the whitefly populations to significant levels, if the insecticidal treatments are directed on the underside of the leaves, preventing the spread of *MYMV* and achieved more seed yield.

Prodhan *et al*. (2008) found that the highest yield was obtained from the treatment T_3= Seed treatment with Imidachlorpid (5g/kg seeds) (1316 kg/ha) which was statistically similar to T_2= Seed treatment with Imidachlorpid (5g/kg seeds) + Poultry manure (3t/ha) + Sequential release of biocontrol agent (Trichograma chilonis +

Braconhabetor) +Neem seed karnel extract @ 50gm/lof water (1316 kg/ha) and T_1= Seed treatment with Imidachlorpid (5g/kg seeds) + Poultry manure (3t/ha) + Sequential release of bio-control agent (Trichograma chilonis + Braconhabetor) + Detergent @ 2g/l of water (1283 kg/ha). In case of Benefit Cost Ratio (BCR), the highest value was obtained from the treatment T_3 (1.84), which was followed by T_1 (1.55) and T_2 (1.31).

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

Ahmed (2001) reported that soil application of carbofuran 3G (15 kg/ha) twice (once at sowing and 20 days after sowing) + 5 sprays of metasystox (0.2%) at 15 days interval recorded least (29.33%) incidence of bhendi yellow vein mosaic as against 91.26 per cent incidence in control plots.

Cahill *et al*. (1995) reported that Imidachloprid (a systemic chloronicotinyl insecticide) gained major importance Chemicals applied on Mungbean for control of *Bemisia tabaci* in both field and protected crops, in view of extensive resistance to organophosphorus, pyrethroid and cyclodiene insecticides.

Saran and Giri (1990) suggested that Admire (imidacloprid) might have great impact in reducing disease incidence and severity of yellow mosaic disease and producing disease free plants.

Singh *et al*. (1982) observed that application of chemicals resulted more vigorous vegetative growth allowing the plants to escape viral infections and effect of infection.

Mote (1976) reported that among different systemic insecticides evaluated, three applications of dimethoate or monocrotophos at 0.05 per cent at fortnightly intervals starting from 2 weeks after transplanting were found promising in controlling whitefly and also increased the yield to 307.48 and 265.19 per cent respectively.

Sastry and Singh (1974) conducted experiments to restrict the spread of *MYMV* by controlling its vector population. They reported that four sprays, each of parathion

(0.02%), oxydematon methyl (0.02%) and dimethoate (0.05%) at 10day intervals starting from the germination of okra seeds or only one application of phorate 10G (15 kg/ha) at the time of sowing the seeds not only reduced the vector, whitefly (*Bemisia tabaci*) but also restricted the spread of virus to a greater extent.

Works done in Bangladesh

Joly (2017) conducted the experiment with BARI Mungbean-5. Different growth yield parameters and physiological features were significantly affected by application of selected insecticides with different number of sprays. 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 flowers, no of pod and yield was also found in T4 in case of Imitaf and ACmix. But the yield and yield contributing characters was found to be better in imitaf than ACmixs.

Islam (2016) conducted an experiment 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. Growth parameters, yield attributes and physiological features were significantly affected by application of selected insecticides and PPN combinations. 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.

Haque (2012) reported that at 50 DAS, aall the chemicals decreased *MYMV*incidence but Admire (imidachloprid) performed the best results which reduced disease incidence by 30.86% and the seed yield increase by 20.06% over control.

Hossain (2010) carried an experiment to evaluate the potentiality of some selected plant extracts, insecticides and cultural practices in reducing severity of mungbean yellow mosaic virus. The lowest (15.85%) disease symptoms expressed in true leaves was recorded from Admire treated plot compare to the control at 50 DAS. The insecticide, admire 200SL treated plot gave the lowest disease severity (3.95) and the tallest (46.52 cm) plant compare to control. The higher number of pods per plant was recorded where Admire was sprayed (23.50) and lower in Reflective tape treated plot. The maximum pod length also increased by Admire treated plot while Reflective tape treated pod length was minimum.

Hossain (2010) resulted that the Marshal 20EC was the most effective treatment against sucking insects and mosaic infection of mungbean.

Islam *et al*. (2009) reported that Mungbean variety BARI Mung-5 was used in the experiment. Four polyethylene mulch viz. white, black, yellow and blue sheet, two insect trap namely yellow pot trap and yellow cloth trap and reflective tapes were applied in the investigation. It was observed that all the treatments significantly reduced the incidence and severity of mungbean yellow mosaic disease and increased growth characters (Plant height, number of pods/plant, pod length and number of seeds/pod) and yield of mungbean. Among the different cultural practices yellow polyethylene mulch followed by yellow pot trap and yellow cloth trap performed better in respect of growth characters and yield. Yellow polyethylene mulch increased 25.84% yield of mungbean over untreated control.

MATERIALS AND METHODS

3.1. Experimental Site

The experiment was conducted at Central Farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka- 1207. The location of the experimental site was at 23^0 46' N latitude and 90^0 22'E longitudes with an elevation of 8.24 meter from sea level details are given in Appendix I.

3.2. Experimental Period

The field experiment was conducted in kharif 2 season of 2019 (Mid July to Mid December).

3.3. Soil Characteristics

The experimental plot was 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 pH 6.7. The characteristics of soil is given in Appendix II.

3.4. Climatic condition

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 29.9^0 c and the average minimum temperature was 19.3^0 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 III.

3.5. Experiment

For achieving the objectives of the research two split works were conducted in fields they were-

Experiment-I: Response of selected mungbean varieties against *Mungbean Yellow Mosaic Virus* under natural condition

Experiment-II: Management of *Mungbean Yellow Mosaic Virus* in field condition

3.6. Details of Experiment-I: Response of selected mungbean varieties against *Mungbean Yellow Mosaic Virus* under natural condition

3.6.1. Experimental period

The first experiment was conducted during the period of July to September, 2019

3.6.2. Planting materials

Mungbean variety namely, BARI mung-5, BARI mung-6, BARI mung-7 was used as planting material in the experiment. Seeds were collected from BARI. All the selected varieties susceptible to *MYMV* disease.

3.6.3. Treatments(varieties)

The following varieties were used for the treatment:

V_1 = BARI mung-5 (83.3gm/Plot)

V_2 = BARI mung-6 (83.3gm/Plot)

V_3 = BARI mung-7 (83.3gm/Plo

V_4 = Local mung variety (83.3gm/Plot)

3.6.4. Design and layout of the Experiment

The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the variety combinations in each plot in each block. There were 12 units plot in the experiment. The total area was 250 m^2. The size of the plot was 2.5 m ×2.5 m. The distance between two blocks and two plots were 0.75 m and 0.5 m, respectively.

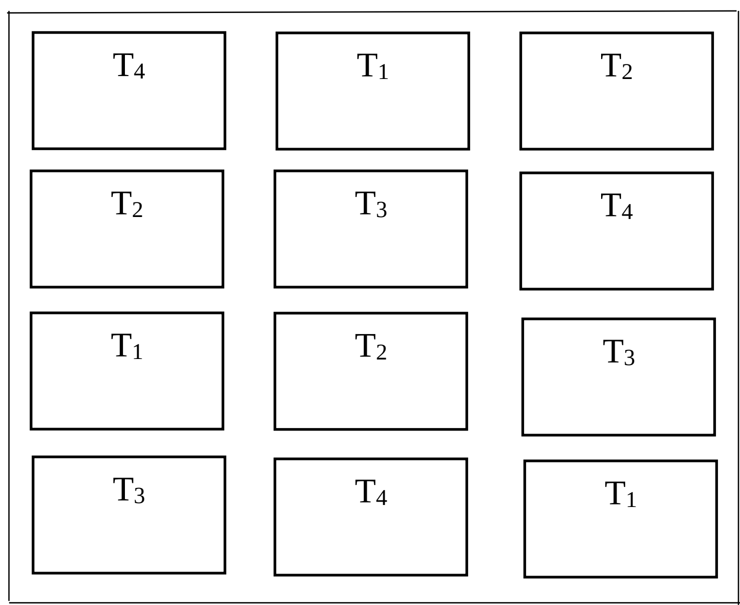


Figure 1. Layout of the experimental plot

Legend:

1. Width of the plot = 2.5 m	
2. Length of the plot = 2.5 m	
3. Space around the land = 75 cm	
4. Space between the block =75 cm	
5. Space between the plot =50 cm	

3.6.5. Land Preparation

The selected land for the first experiment was opened on 16 July 2019 by disc plough. Then it was exposed to the sunshine for 7 days prior to the next ploughing. Thereafter, the land was ploughed and cross-ploughed to obtain good tilth. Deep ploughing was done to produce a good tilth, which was necessary to get better yield of this crop. Laddering was done in order to break the soil clods into small pieces followed by each ploughing. All the weeds and stubbles were removed from the experimental field.

3.6.6. Application of manure and fertilizer

The sources of urea, triple superphosphate (TSP), muriate of potash (MOP), gypsum, boron was applied at 1.5 kg, 2.5 kg, 1kg, 1.5 kg, 200 gm 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.

3.6.7. Seed sowing

Seeds were sown in the main field on the 16 July' 2019 having line to line distance of 30 cm and plant to plant distance of 10 cm.

3.6.8. 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.

3.6.8.1. Thinning

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

3.6.8.2. Irrigation

Light over-head irrigation was provided with a watering can to the plots at 4 and 7 weeks after the seed sowing respectively. Irrigation also applied twice considering the moisture status.

3.6.8.3. Weeding

Weeding was done two times in the experimental plot. First weeding was done one month after sowing followed by another with 20 days interval.

3.6.8.4. Drainage

Stagnant water was effectively drained out after heavy rains.

3.6.9. Harvesting

The crop was 1st harvested at maturity on 16 august, 2019. 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.

3.6.10. Crop sampling and data collection

During the growing period the plots of mungbean were inspected regularly to record the yellow mosaic virus and to measure different parameter. Dead plants were removed from the field after counting. Number of infected leaves was obtained from randomly selected five plants and marked with sample sticks and following data were recorded.

3.6.10.1. Number of healthy plants

Number of healthy plants from each plot was recorded at 30, 40, 50 and 60 days after sowing (DAS).

3.6.10.2. Number of infected plants

Number of Infected plants was counted by visual observation and data were recorded from each plot at 30, 40, 50 and 60 days after sowing (DAS).

3.6.10.3. Plant height (cm)

Plant height was measured from five randomly selected plants using meter scale in centimeter from the ground level to the tip of the longest leaf at 10 days interval starting from 30 days after sowing (DAS) and continued up to 60 DAS and their mean value was calculated.

3.6.10.4. Number of healthy leaves

Number of healthy leaves of selected infected plants from each plot was recorded at 30, 40, 50 and 60 days after sowing (DAS). The data was recorded calculating the average number of leaves.

3.6.10.5. Number of infected leaves

Number of infected leaves of selected infected plants from each plot at 30, 40,50 and 60 days after sowing (DAS) was recorded. The data was recorded calculating the average number of infected leaves.

3.6.10.6. Number of healthy pods per plant

Average number of healthy green pods of selected plants from each plot as per treatment combination was recorded at 40, 50 and 60 days after sowing (DAS).

3.6.10.7. Number of infected pods per plant

Total number of infected green pods of selected plants from each plot was recorded at 40, 50 and 60 days after sowing (DAS).

3.6.10.8. Total yield per plot (Kg)

Total yield of mungbean per plot was recorded by adding the yield of different harvesting time and it was included weight of seeds at different harvesting time and was expressed in kilogram.

3.6.10.9. Yield per hectare

Yield/hectare was computed by converted total yield per plot into yield per hectare and was expressed in ton. It included weight of seeds at final harvesting time from 60 days after sowing (DAS) and continued up to several time at 10 days interval.

3.6.11. Assessment of disease incidence

The experimental plots were examined at 10 days interval for the appearance of viral symptoms. The incidence of mosaic was recorded four times. The first counting was made at 30 DAS and the following counting was made at 10 days interval. The *MYMV* were identified by visual observation as yellow patches on mungbean leaves coalesced to form a larger patch that develops into a yellow mottle; eventually the entire leaf could turn yellow. The green areas appear as dark green islands interspersed in yellow chlorotic areas; the infected leaf blade appears wavy (Ahmed, 1985). Disease incidence data were calculated following standard formulae (Nutter *et al*., 2006; Agrios, 2005; Kranz, 1988):

$$\text{Disease incidence (\%)} = \frac{\text{Numbers of infected plants}}{\text{Numbers of inspected plants}} \times 100$$

3.6.12 Assessment of disease severity

Yellow mosaic severity was recorded at 30, 40, 50 and 60 DAS. For scoring the severity (0-9 scale) of the disease, ten infected plants were selected randomly from each replicate plot. Five trifoliate leaves were selected from each selected plant for scoring the disease severity data. Disease severity was determined by calculating the PDI as follows:

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of total ratting} \times 100}{\text{Total number of observations} \times \text{Highest grade in the scale}}$$

The severity of yellow mosaic disease was recorded following the 0-9 grading scale as used by Jalaluddin *et al*., (1994) were.

0 = No visible symptoms on leaves, plant growth, flowering and pod formation normal,

1 = Yellow chlorotic spots or flecks few in number and scattered over younger leaves; plant growth, flowering and pod formation normal

3 =Yellow chlorotic flecks or mottle larger in size and covered about 25% of leaf area; Some coalesced and formed a patch; plant growth, flowering and pod formation slightly affected

5 = Yellow chlorotic mosaic covered 50% of leaf area or some leaves. Some coalesced and formed irregular patches, plant moderately stunted, flowering and pod formation moderately reduced,

7 = Yellow chlorotic mosaic covered about 75% of leaf of several leaves, leaves Reduced in size, pod formation restricted with yellow and curved pods; plants considerably stunted,

9 = Young leaves completely yellow, plant severely stunted, flowering and pod Formation severely affected with very few small yellow curved pods that contained yellow shriveled seeds or without any pod formation.

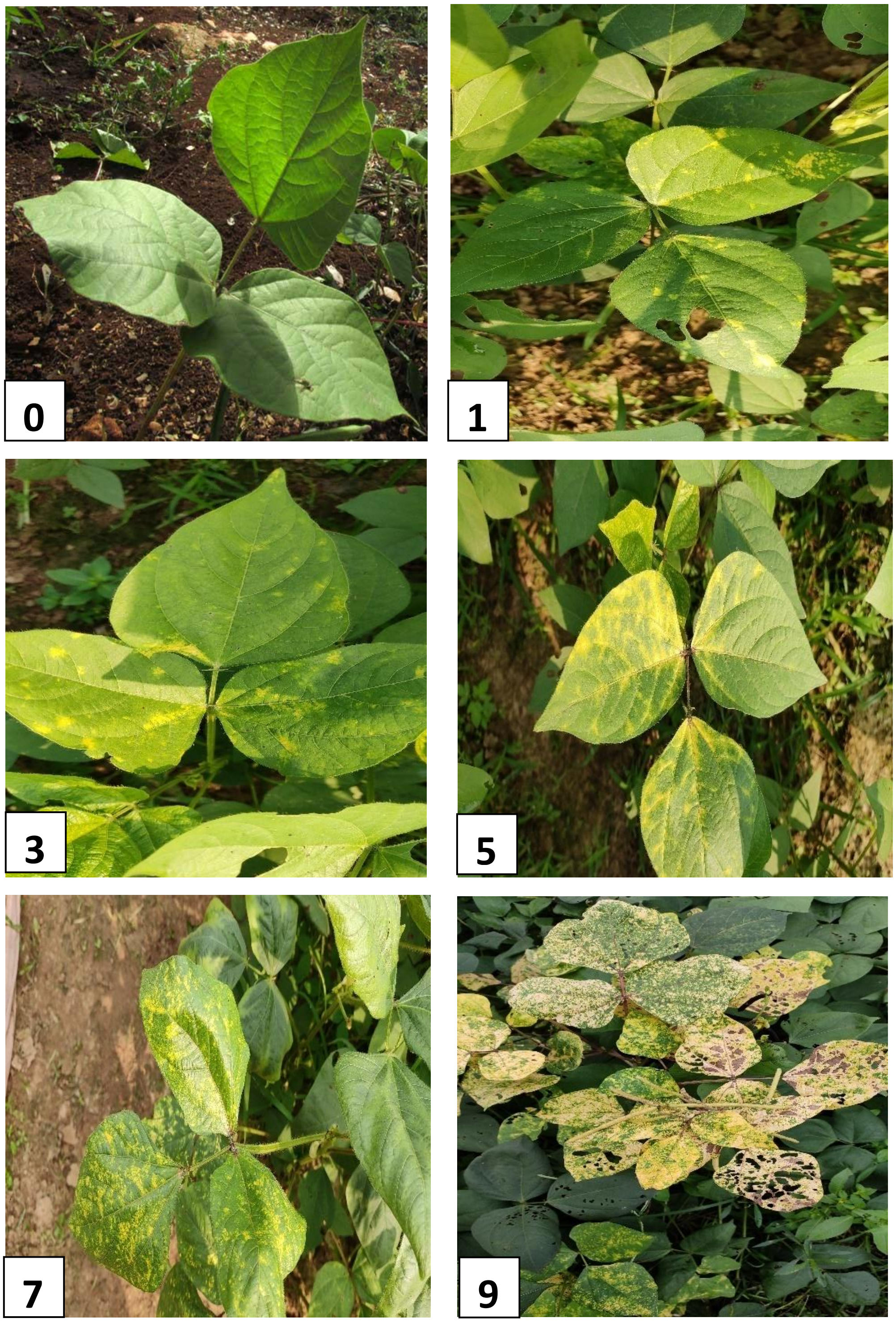


Plate 1: Disease severity grade of *Yellow mosaic disease* of mungbean. Grade 0 = 0%, Grade 1= 10%, Grade 3=25%, Grade 5 = 50%, Grade 7 = 75%, Grade 9 = above 75%.

3.7. Details of Experiment-II: Management of *Mungbean Yellow Mosaic Virus* in field Condition

3.7.1. Experimental period

The 2nd experiment was conducted during the period of July to October, 2020.

3.7.2. Planting material

Local variety of mungbean was used as the test variety in this experiment which was more susceptible to *MYMV* found from first experiment.

3.7.3. Treatment of the experiment

The experiment comprised of chemicals, yellow sticky trap, netting and border crop including an untreated control as treatment. The treatments were-

T_0 = Untreated control (without any treatment)

T_1 = Netting at seedling stage

T_2 = Yellow sticky trap

T_3 = Border crop (maize)

T_4 = 1 spray (Imidacloprid (1ml/L) at 30 DAS

T_5 = 2 spray (imidacloprid (1ml/L) at 30 and 40 DAS

3.7.4. Experimental design and layout

The single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area of the experimental plot was 250 m^2 with length 25 m and width 10 m which were divided into three equal blocks. Each block was divided into six plots where six treatments allotted at random. There were 18 unit plots and the size of each plot was 2.5 m × 2.5 m. The distance between two blocks and two plots were 0.75 m and 0.5 m, respectively. The layout of this experiment shown in Figure 2.

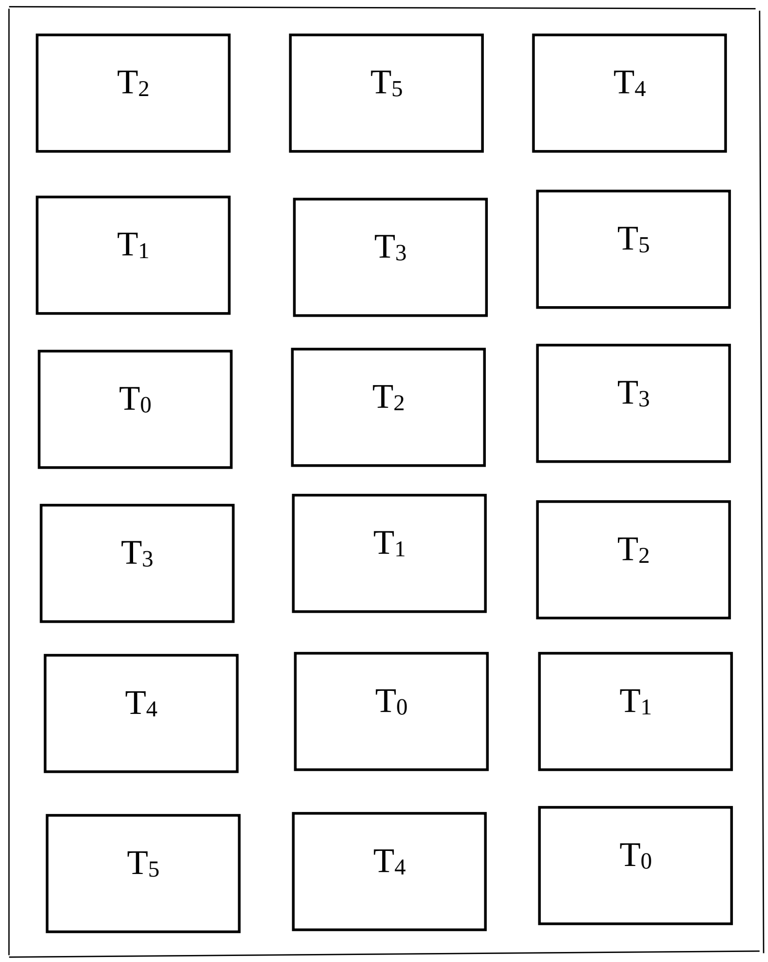


Figure 2. Layout of the experimental plot with three replications

Legend:

1. Width of the plot = 2.5 m	
2. Length of the plot = 2.5 m	
3. Space around the land = 75 cm	
4. Space between the block =75 cm	
5. Space between the plot =50 cm	

3.7.5. Land preparation

The selected experimental plot for 2nd experiment was opened in the 1st July, 2020 with a power tiller and left exposed to the sun for a week. Subsequently cross ploughing was done three times followed by laddering to make the land suitable for seeds sowing. All weeds, stubbles and residues were eliminated from the field and finally, a good tilth was achieved. The soil treatment was done at the time of final land preparation to protect young plants from the attack of soil inhibiting insects. Final land preparation was done on 8th July, 2020.

3.7.6. Application of manure and fertilizer

Manures and fertilizers were applied as per mentioned for 1st experiment.

3.7.7. Collection of Imidacloprid

The selected insecticides namely Imidacloprid were collected from local market.

Figure 3: Insecticides used in this study (Imitaf)

3.7.8. Preparations of Imidacloprid

For getting 1ml/L concentration, 1ml imidacloprid was added with 1L distilled water. The imidacloprid were applied as foliar spray. Spraying was done 1 and 2 times at 10 days interval start from 30 days after sowing.

3.7.9. Collection of nets

The nets were collected from Siddique Bazar Dhaka. It’s sieve size were very small.

3.7.10. Placing of nets in the main field

Netting was done when seedling emerge in field.

Figure 4: Net in mungbean plants

3.7.11. Collection of yellow sticky trap

Yellow sticky trap was collected from local market.

3.7.12. Placing of yellow sticky trap in the main field

Yellow sticky trap was used after seedling condition of mungbean in field condition.

Figure 5: Placing of yellow sticky trap in plot

3.7.13. Collection of border crop seeds

Border crop (maize) seed was collected from Siddique Bazar Dhaka.

3.7.14. Sowing of border crop

In this experiment maize was used as a border crop. It was sown in the field 15 days before sowing of mungbean seeds in the main field.

Figure 6: Seedling of border crop (maize) in selected plot

3.7.15. Seeds sowing

Seeds were sown in the main field on the 15 July 2020 line to line distance of 30 cm and plant to plant distance of 10 cm.

3.7.16. Intercultural operation

Intercultural operation when necessary was done as described earlier.

3.7.17. Harvesting

Harvesting of mungbean were done as described earlier.

3.7.18. Data collection

Data collection was done as described earlier parameters.

3.7.19. Assessment of disease incidence

Mungbean yellow mosaic disease incidence was estimated as per formula which was described earlier.

3.7.20 Assessment of disease severity

Mungbean yellow mosaic disease incidence was estimated as per formula described earlier.

3.8 Statistical analysis

Data was recorded on disease incidence, severity, yield contributing characters and yield of mungbean. The analysis of variance was performed by using computer based software Statistix-10 program. The significance of the difference among the treatment means was estimated by LSD at 5% add 1% level of probability.

RESULT

4.1. Experiment-I: Response of selected mungbean varieties against *Mungbean yellow mosaic virus* under natural condition

The experiment was conducted to evaluate resistance response of selected mungbean varieties against *Mungbean yellow mosaic virus (MYMV)*. This chapter presented of symptoms, percent disease incidence, percent disease severity, and yield and yield contributing characters like number of leaves per plant, (healthy and infected), plant height (healthy and infected), pods per plant (healthy and infected), pods length (healthy and infected), seed weight (healthy and infected).

4.1.1. Symptoms

Symptoms of *Mungbean yellow mosaic disease* was observed in infected field under natural condition. The following symptoms are described below which are shown in (Plate-2). Initially it was appeared on the leaf. Younger leaves may lose their green color (chlorosis), curl downwards or become papery white. Older leaves show scattered yellow specks that later develop into irregularly shaped green and yellow patches. The green areas are slightly raised giving a leaf puckered appearance. The lesions enlarge and coalesce, and start to die (necrosis). The growth of affected plant is stunted. They produce fewer flower and pods. Their pods are small thin and mottled, and sometimes curl upwards. They also contain fewer and smaller seeds.

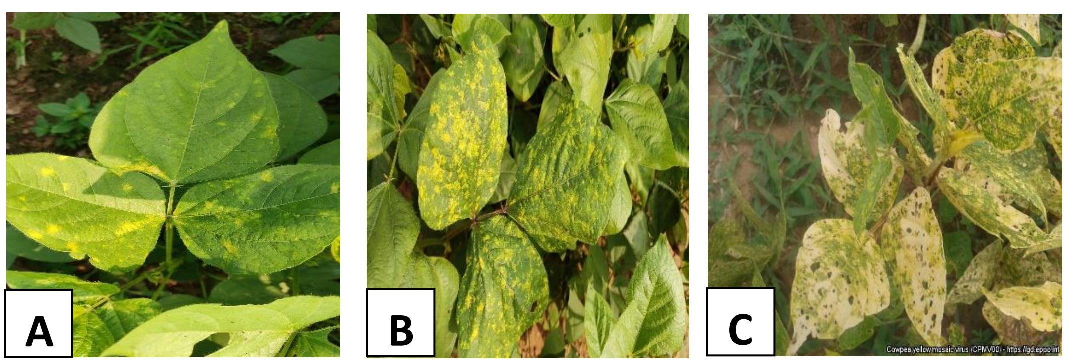


Plate 2: (A-C) Symptoms of *Yellow mosaic disease* in mungbean plant

4.1.2. Effect of *MYMV* on percent disease incidence and disease severity among the selected Mungbean varieties at different DAS

Significant variation was observed in percent disease incidence and percent disease severity due to *MYMV* disease among selected mungbean varieties under field condition. The results are shown in Table 1 and 2.

4.1.2.1. Disease incidence (%)

At 30 DAS, the highest (24.00 %) disease incidence was recorded in local variety. On the other hand, the lowest (17.80 %) disease incidence was recorded in BARI mung 7 followed by BARI mung 5 (18.90 %). At 40 DAS. The highest disease incidence (48.67 %) was recorded from local variety, while the lowest disease incidence (25 %) was recorded from variety BARI mung 7. At 50 DAS, the highest (62.00 %) disease incidence was recorded in local variety and the lowest (38.67 %) disease incidence was recorded in variety BARI mung 7. At 60 DAS. The highest (74.00 %) disease incidence was recorded from local variety and the lowest (48.67 %) disease incidence was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (55.33%).

Table 1. Effect of *MYMV* on percent disease incidence among selected Mungbean varieties at different DAS

Varieties	Disease Incidence (%)			
	30 DAS	40 DAS	50 DAS	60 DAS
BARI mung 5	18.90 b	30.00 c	46.00 c	55.33 bc
BARI mung 6	17.80 b	38.67 b	52.00 b	59.67 b
BARI mung 7	17.80 b	25.00 d	38.67 d	48.67 c
Local variety	24.00 a	48.67 a	62.00 a	74.00 a
CV (%)	9.34	5.64	5.23	6.33

In a column means having similar letter(s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.2.2. Disease severity (%)

All variations of disease severity are shown in (Table 2). At 30 DAS, the highest (9.63 %) disease severity was recorded in local variety. On the other hand, the lowest (5.97 %) disease severity was recorded in BARI mung 7 which is statistically similar with BARI mung 6 (7.43 %) and BARI mung 5 (6.13 %). At 40 DAS, the highest disease severity (19.17 %) was recorded in local variety, while the lowest disease severity (11.67 %) was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (13.67 %). At 50 DAS, the highest (36.47 %) disease severity was recorded in local variety and the lowest (26.47 %) disease severity was recorded from variety BARI mung 7 which was statistically similar with variety BARI mung 5 (28.33 %). At 60 DAS, the highest (45.10 %) disease severity was recorded in local variety and the lowest (31.17 %) disease severity was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (33.90 %).

Table 2. Effect of *MYMV* on percent disease severity among selected Mungbean varieties at different DAS

Varieties	(%) Disease severity			
	30 DAS	40 DAS	50 DAS	60 DAS
BARI mung 5	6.13 b	13.67 bc	28.33 bc	33.90 bc
BARI mung 6	7.43 b	15.70 b	30.47 b	36.60 b
BARI mung 7	5.97 b	11.67 c	26.63 c	31.17 c
Local variety	9.63 a	19.17 a	36.47 a	45.10 a
CV (%)	15.04	9.44	4.85	5.81

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.3. Effect of *MYMV* disease in growth and yield contributing parameters among selected Mungbean varieties

Significant variation was found in growth and yield parameters such as, plant height (cm), leaves per plant (healthy and infected), pods per plant (healthy and infected), pods length (cm) (healthy and infected), seed weight (healthy and infected) due to *MYMV* disease among selected mungbean varieties under field condition. The results are presented in Table 3,4,5 and 6.

4.1.3.1. Plant height (cm)

At 30 DAS, numerically, the highest plant height (13.97 cm) was recorded in variety BARI mung 7 and the lowest (12.89 cm) was recorded in BARI mung 5. At 40 DAS, the highest plant height (23.91 cm) was recorded from variety BARI mung 7 which was statistically similar with variety BARI mung 5 (22.50 cm), while the lowest (19.73 cm) was recorded in local variety which was statistically similar with variety BARI mung 6 (20.53 cm). At 50 DAS, the highest plant height (50.50 cm) was recorded in variety BARI mung 7 and the lowest (36.33 cm) was recorded in local variety. At 60 DAS, the highest plant height (56.33 cm) was recorded in variety BARI mung 7 and the lowest (31.17 cm) as recorded in local variety.

Table 3. Effect of selected Mungbean varieties on plant height at different DAS due to *MYMV* disease

Varieties	Plant height (cm)			
	30 DAS	40 DAS	50 DAS	60 DAS
BARI mung 5	12.89	22.50 a	44.03 b	51.33 b
BARI mung 6	13.84	20.53 b	40.83 b	47.50 c
BARI mung 7	13.97	23.91 a	50.50 a	56.33 a
Local variety	13.61	19.73 b	36.33 c	43.00 d
CV (%)	5.82	4.06	4.93	8.32

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.3.2. Leaves per plant

In case of healthy leaves per plants at 30 DAS, the highest healthy leaves per plant (10.40) was recorded in variety BARI mung 7 and the lowest (7.40) was recorded in local variety which was statistically similar with BARI mung 6 (8.53) (Table 4). At 40 DAS, the highest healthy leaf per plant (19.03) was recorded in variety BARI mung 7 while, the lowest (13.37) was recorded in local variety. At 50 DAS, the highest healthy leaf per plant (30.23) was recorded in variety BARI mung 7 and the lowest (22.20) was recorded from local variety. At 60 DAS, the highest healthy leaf per plant (41.20) was recorded from variety BARI mung 7 and the lowest (29.50) as recorded in local variety.

In case of the lowest infected leaf per plant at 30 DAS, the lowest infected (4.40) was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (4.63) and variety BARI mung 6 (4.80) and the highest (5.80) was recorded in local variety (8.53). At 40 DAS, the lowest infected leaf per plant (6.57) was recorded in variety BARI mung 7 while, the highest (10.03) was recorded from local variety. At 50 DAS, the lowest infected leaf per plant (8.57) was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (9.40) and the highest (18.17) was recorded from local variety. At 60 DAS. The lowest infected leaf per plant (13.17) was recorded from variety BARI mung 7 which was statistically similar with variety BARI mung 5 (14.00) and the highest (22.87) as recorded from local variety.

In case of percent reduction at 30, 40, 50, 60 DAS the lowest 1.6, 3.34, 4.03, 6.63 was recorded in local variety and the highest 6, 12.46, 21.66, 28.13 was recorded in BARI mung 7 respectively

Table 4. Effect of selected Mungbean varieties on healthy and infected leaves per plant at different DAS due to *MYMV* disease

Varieties	30 DAS			40 DAS			50 DAS			60 DAS		
	Healthy leaves per plant	Infected leaves per plant	Reduction (%)	Healthy leaves per plant	Infected leaves per plant	Reduction (%)	Healthy leaves per plant	Infected leaves per plant	Reduction (%)	Healthy leaves per plant	Infected leaves per plant	Reduction (%)
BARI mung 5	9.00 b	4.63 b	4.37	17.13 b	7.30 bc	9.83	26.20 b	9.40 c	16.80	37.97 b	14.00 c	23.97
BARI mung 6	8.53 bc	4.80 b	3.73	15.60 b	8.27 b	7.33	24.67 bc	14.67 b	10.00	33.47 c	17.67 b	15.80
BARI mung 7	10.40 a	4.40 b	6.00	19.03 a	6.57 c	12.46	30.23 a	8.57 c	21.66	41.30 a	13.17 c	28.13
Local variety	7.40 c	5.80 a	1.6	13.37 c	10.03 a	3.34	22.20 c	18.17 a	4.03	29.50 d	22.87 a	6.63
CV (%)	6.89	8.94		4.90	7.35		5.04	7.58		5.83	7.95	

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.3.3. Pods per plant

In case of Healthy pods per plant of mungbean at 30 DAS, the highest healthy pod per plant (11.33) was recorded in variety BARI mung 7 which was statistically similar with BARI mung 5 (10.47) and the lowest (7.83) was recorded in local variety (Table 5). At 40 DAS. The highest healthy pod per plant (24.83) was recorded in variety BARI mung 7 which was statistically similar with BARI mung 5 (22.63) while, the lowest (16.37) was recorded in local variety. At 50 DAS, the highest healthy pod per plant (42.83) was recorded in variety BARI mung 7 and the lowest (24.67) was recorded in local variety. At 60 DAS. The highest healthy pod per plant (50.50) was recorded from variety BARI mung 7 and the lowest (34.57) as recorded in local variety.

In case of infected pods per plant at 30 DAS, the lowest infected pod per plant (1.07) was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (1.40) and variety BARI mung 6 (2.10) and the highest (5.03) was recorded in local variety. At 40 DAS. The lowest infected pod per plant (4.67) was recorded in variety BARI mung 7 which was statistically similar with variety BARI mung 5 (5.17) while, the highest (9.57) was recorded in local variety. At 50 DAS, the lowest infected pod per plant (9.50) was recorded from variety BARI mung 7 and the highest (18.67) was recorded in local variety. At 60 DAS. The lowest infected pod per plant (12.67) was recorded in variety BARI mung 7 and the highest (25.33) as recorded in local variety.

In case of percent reduction at 30, 40, 50, 60 DAS the lowest 2.8, 6.8, 6, 9.24 was recorded in local variety and the highest 10.26, 20.16, 33.33, 37.83 was recorded in BARI mung 7, respectively.

Table 5. Effect of selected Mungbean varieties on healthy and infected pods per plant at different DAS due to *MYMY* disease

Varieties	30 DAS			40 DAS			50 DAS			60 DAS		
	Healthy pods per plant	Infected pods per plant	Reduction (%)	Healthy pods per plant	Infected pods per plant	Reduction (%)	Healthy pods per plant	Infected pods per plant	Reduction (%)	Healthy pods per plant	Infected pods per plant	Reduction (%)
BARI mung 5	10.47 a	1.40 b	9.07	22.63 a	5.17 b	17.46	37.07 b	11.83 c	25.24	44.67 ab	15.17 c	29.5
BARI mung 6	9.87 b	2.10 b	7.77	20.80 ab	8.07 a	12.73	31.30 c	15.97 b	15.33	39.50 bc	20.50 b	19
BARI mung 7	11.33 a	1.07 b	10.26	24.83 a	4.67 b	20.16	42.83 a	9.50 d	33.33	50.50 a	12.67 d	37.83
Local variety	7.83 c	5.03 a	2.8	16.37 b	9.57 a	6.8	24.67 d	18.67 a	6	34.57 c	25.33 a	9.24
CV (%)	8.53	16.75		11.91	15.62		8.25	7.98		8.67	3.71	

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.3.4. Pods length (cm)

In case of healthy pod length at 30 DAS, the highest healthy pods length (6.47 cm) was recorded in variety BARI mung 7 and the lowest (5.72 cm) was recorded in BARI mung 5 (Table 6). At 40 DAS. The highest healthy pods length (7.43 cm) was recorded in variety BARI mung 7 while, the lowest (6.57 cm) was recorded in local variety. At 50 DAS, the highest healthy pods length (8.37 cm) was recorded in variety BARI mung 7 and the lowest (6.90 cm) healthy pods length was recorded in local variety. At 60 DAS. The highest healthy pods length (8.73 cm) was recorded in variety BARI mung 7 and the (7.10 cm) as recorded in local variety.

In case of infected pod height of mungbean at 30 DAS, the lowest infected pods length (5.64) cm was recorded in variety BARI mung 7 and the highest (6.57 cm) was recorded in local variety. At 40 DAS. The lowest infected pods length (5.90 cm) was recorded in variety BARI mung 7 while, the highest (7.16 cm) was recorded in local variety. At 50 DAS, the lowest infected pods length (6.16 cm) was recorded in variety BARI mung 7 and the highest (7.16 cm) was recorded from local variety. At 60 DAS. The lowest infected pods length (6.16 cm) was recorded in variety BARI mung 7 and the highest (7.13) was recorded in local variety.

In case of percent reduction at 30, 40, 50, 60 DAS the lowest 0.83, 0.20, 0.26, 0.03 was recorded in local variety and the highest 0.85, 1.53, 2.32, 2.57 was recorded from BARI mung 7, respectively.

Table 6. Effect of selected Mungbean varieties on healthy and infected pods length at different DAS due to *MYMV* disease

Varieties	30 DAS			40 DAS			50 DAS			60 DAS		
	Healthy pods length	Infected pods length	Reduction (%)	Healthy pods length	Infected pods length	Reduction (%)	Healthy pods length	Infected pods length	Reduction (%)	Healthy pods length	Infected pods length	Reduction (%)
BARI mung 5	6.00 ab	6.12 b	0.12	7.27 ab	6.39 a	0.88	7.72 b	6.60 b	1.12	8.03 b	6.58 a	1.45
BARI mung 6	5.86 b	6.30 ab	0.44	6.81 ab	6.60 a	0.21	7.13 c	6.80 ab	0.33	7.58 c	6.73 ab	0.85
BARI mung 7	6.49 a	5.64 c	0.85	7.43 a	5.90 b	1.53	8.37 a	6.05 c	2.32	8.73 a	6.16 c	2.57
Local variety	5.72 b	6.55 a	0.83	6.57 b	6.77 a	0.20	6.90 c	7.16 a	0.26	7.10 d	7.13 a	0.03
CV (%)	4.16	3.48		5.36	2.63		2.41	3.24		2.47	4.03	

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.3.5. Healthy and infected seed weight

The highest healthy seed weight (459.0 g $plot^{-1}$ and 0.91 t ha^{-1}) was recorded in variety BARI mung 7 and the lowest healthy seed weight (297.5 g $plot^{-1}$ and 0.59 t ha^{-1}) was recorded in local variety (Table 7). The lowest infected seed weight (144.5 g $plot^{-1}$ and 0.22 t ha^{-1}) was recorded in variety BARI mung 7 and the highest infected seed weight (226.67 g $plot^{-1}$ and 0.35 t ha^{-1}) was recorded in local variety.

In case of percent reduction of seed weight, highest (0.69 t ha^{-1}) was recorded in variety BARI mung 7 and the lowest (0.24 t ha^{-1}) was found in local variety.

Table 7. Effect of selected Mungbean varieties on healthy and infected seed weight due to *MYMV* disease

Varieties	Healthy seed weight (g $plot^{-1}$)	Infected seed weight (g $plot^{-1}$)	Healthy seed weight (t ha^{-1})	Infected seed weight (t ha^{-1})	percent reduction of seed weight (t ha^{-1})
BARI mung 5	416.50 b	164.33 b	0.83 b	0.25 b	0.58
BARI mung 6	374.00 c	175.67 b	0.74 c	0.27 b	0.47
BARI mung 7	459.00 a	144.50 c	0.91 a	0.22 c	0.69
Local variety	297.50 d	226.67 a	0.59 d	0.35 a	0.24
CV (%)	2.77	4.29	2.77	4.29	

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2. Experiment-2: Management of *Mungbean Yellow Mosaic Virus* in field condition

4.2.1. Effect of different treatment on percent *MYM* disease incidence and severity in treated field

Statistically significant variation was observed in *MYM* (%) disease incidence and (%) disease severity under different treatment in field condition. The results are shown in Table 8, 9.

4.2.1.1. Disease incidence (%)

At 30 DAS, the highest (23.00 %) disease incidence was recorded in treatment T_0 (Control). On the other hand, the lowest (4.43 %) was recorded from treatment T_5 (Two Spray) with imidacloprid which was statistically similar with treatment T_4 (One Spray) (5.55 %) and T3 (6.67 %) (Table 8). At 40 DAS. The highest disease incidence (41.10 %) was recorded in treatment T_0 (Control), while the lowest (13.37 %) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (15.50 %) and T3 (13.37 %). At 50 DAS, the highest (53.32 %) disease incidence was recorded in treatment T_0 (Control) and the lowest (25.56 %) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (28.89 %) and T_3 (30.00 %). At 60 DAS, the highest (66.67 %) disease incidence was recorded in treatment T_0 (Control) and the lowest (33.32 %) was recorded in treatment T_5 (Two Spray).

Table 8. Effect of different treatment on *MYM* percent disease incidence of Mungbean at different DAS

Treatment	(%) Disease Incidence			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	23.00 a	41.10 a	53.32 a	66.67 a
T_1 (Netting)	7.78 bc	23.43 c	41.10 b	52.22 b
T_2 (Yellow sticky trap)	6.67 b-d	16.63 d	30.00 c	42.22 c
T_3 (Border crop Maize)	8.89 b	29.97 b	44.43 b	55.55 b
T_4 (One Spray Imidacloprid)	5.55 cd	15.50 d	28.89 c	40.00 c
T_5 (Two Spray Imidacloprid)	4.43 d	13.37 d	25.56 c	33.32 d
CV (%)	16.20	11.99	6.75	8.55

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.1.2. Disease severity (%)

At 30 DAS, the highest (10.83 %) disease severity was recorded in treatment T_0 (Control). On the other hand, the lowest (1.33 %) was recorded in treatment T_5 (Two Spray) with imidacloprid which was statistically similar with treatment T_4 (One Spray) (1.67 %) (Table 9). At 40 DAS. The highest disease severity (18.67 %) was recorded in treatment T_0 (Control), while the lowest (2.63 %) was recorded in treatment T_5 (Two Spray). At 50 DAS, the highest (34.17 %) disease severity was recorded in treatment T_0 (Control) and the lowest (8.33 %) was recorded in treatment T_5 (Two Spray). At 60 DAS. the highest (44.73 %) disease severity was recorded in treatment T_0 (Control) and the lowest (17.17 %) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (17.67 %).

Table 9. Effect of different treatment on *MYMV* percent disease severity of Mungbean at different DAS

Treatment	**(%) Disease severity**			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	10.83 a	18.67 a	34.17 a	44.73 a
T_1 (Netting)	2.97 b	7.67 b	18.30 c	27.33 c
T_2 (Yellow sticky trap)	3.47 b	7.33 b	14.70 d	19.97 d
T_3 (Border crop Maize)	3.43 b	8.33 b	20.73 b	32.83 b
T_4 (One Spray Imidacloprid)	1.67 c	4.33 c	11.17 e	17.67 de
T_5 (Two Spray Imidacloprid)	1.33 c	2.63 d	8.33 f	14.17 e
CV (%)	8.55	9.78	6.50	8.52

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2. Effect of different treatment on growth and yield contributing parameters of Mungbean at different DAS

Significant variation was observed in growth and yield parameters such as, plant height (cm), leaves per plant (healthy and infected), pods per plant (healthy and infected), pods length (cm) (healthy and infected), seed weight (healthy and infected) due to the effect of different treatment. The results shown in Table 10, 11, 12, 13, 14, 15 and 16.

4.2.2.1. Plant height (cm)

At 30 DAS, the highest plant height (14.47 cm) was recorded in treatment T_5 (Two Spray) and the lowest (8.83 cm) was recorded in treatment T_0 (Control) (Table 10). At 40 DAS, the highest plant height (20.83 cm) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (19.33cm), while the lowest (14.00 cm) was recorded in treatment T_0 (Control). At 50 DAS, the highest plant height (42.56 cm) was recorded in treatment T_5 (Two Spray) and the lowest plant height (30.35 cm) was recorded in treatment T_0 (Control). At 60 DAS. The highest plant height (48.57 cm) was recorded in treatment T_5 (Two Spray) and the lowest (317.27 cm) as recorded in treatment T_0 (Control).

Table 10. Effect of different treatment on plant height (cm) of Mungbean at different DAS

Treatment	Plant height (cm)			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	8.83 c	14.00 c	30.35 d	37.27 e
T_1 (Netting)	12.33 ab	18.00 b	36.69 bc	42.21 cd
T_2 (Yellow sticky trap)	12.50 ab	18.97 ab	37.52 b	43.17 bc
T_3 (Border crop Maize)	12.00 b	17.87 b	34.68 c	40.21 de
T_4 (One Spray Imidacloprid)	12.83 ab	19.33 ab	39.19 b	45.39 b
T_5 (Two Spray Imidacloprid)	14.47 a	20.83a	42.56 a	48.57 a
CV (%)	9.92	6.91	3.96	3.78

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.2. Healthy leaf per plant

In case of healthy leaf per plant at 30 DAS, the highest (12.61) was recorded in treatment T_5 (Two Spray) and the lowest (6.77) was recorded in treatment T_0 (Control) (Table 11). At 40 DAS, the highest healthy leaf per plant (21.50) was recorded in treatment T_5 (Two Spray) while, the lowest (13.33) was recorded in treatment T_0 (Control). At 50 DAS, the highest healthy leaf per plant (33.83) was recorded in treatment T_5 (Two Spray) and the lowest (22.17) was recorded in treatment T_0 (Control). At 60 DAS, the highest healthy leaf per plant (43.67) was recorded in treatment T_5 (Two Spray) and the lowest (30.33) as recorded in treatment T_0 (Control).

Table 11. Effect of different treatment on healthy leaves per plant of Mungbean at different DAS

Treatment	Healthy leaves per plant			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	6.77 c	13.33 d	22.17 d	30.33 e
T_1 (Netting)	9.80 bc	17.47 c	27.40 c	34.50 cd
T_2 (Yellow sticky trap)	11.29 ab	19.63 b	30.00 b	36.83 bc
T_3 (Border crop Maize)	9.89 bc	16.13 c	25.67 c	32.40 de
T_4 (One Spray Imidacloprid)	14.60 ab	19.83 ab	31.67 b	38.50 b
T_5 (Two Spray Imidacloprid)	12.61 a	21.50 a	33.83 a	43.67 a
CV (%)	16.98	5.24	3.97	4.20

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.3. Infected leaves per plant

In case of infected leaf per plant at 30 DAS, the lowest infected leaf per plant (1.33) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (1.83) and the highest (4.00) was recorded in treatment T_0 (Control) (Table 12). At 40 DAS, the lowest infected leaf per plant (2.00) was recorded in treatment T_5 (Two Spray) while, the highest (6.17) was recorded in treatment T_0 (Control). At 50 DAS, the lowest infected leaf per plant (3.17) was recorded in treatment T_5 (Two Spray) and the highest (8.00) was recorded in treatment T_0 (Control). At 60 DAS, the lowest infected leaf per plant (5.80) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (6.67) and the highest (14.17) as recorded from treatment T_0 (Control).

Table 12. Effect of different treatment on infected leaves per plant of mungbean at different DAS

Treatment	**Infected leaves per plant**			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	4.00 a	6.17 a	8.00 a	14.17 a
T_1 (Netting)	2.50 b	4.50 b	6.17 c	10.17 b
T_2 (Yellow sticky trap)	1.93 bc	3.00 c	4.83 d	7.17 c
T_3 (Border crop maize)	3.40 a	5.00 b	7.33 b	11.33 b
T_4 (One spray imidacloprid)	1.83 c	2.47 cd	3.83 e	6.67 c
T_5 (Two spray imidacloprid)	1.33 c	2.00d	3.17f	5.80 c
CV (%)	13.45	8.36	6.29	8.71

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.4. Healthy pods per plant

At 30 DAS, the highest healthy pod per plant (18.27) was recorded in treatment T_5 (Two Spray) and the lowest (6.33) was recorded in treatment T_0 (Control) (Table 13). At 40 DAS, the highest healthy pod per plant (24.33) was recorded in treatment T_5 (Two Spray) while, the lowest (12.17) was recorded in treatment T_0 (Control). At 50 DAS, the highest healthy pod per plant (47.00) was recorded in treatment T_5 (Two Spray) and the lowest (21.50) was recorded in treatment T_0 (Control). At 60 DAS, the highest healthy pod per plant (57.70) was recorded in treatment T_5 (Two Spray) and the lowest (33.17) as recorded in treatment T_0 (Control).

Table 13. Effect of different treatment on healthy pods per plant of Mungbean at different DAS

Treatment	Healthy pods per plant			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	6.33 e	12.17 e	21.50 f	33.17 e
T_1 (Netting)	13.63 c	19.67 c	34.83 d	43.83 cd
T_2 (Yellow sticky trap)	14.17 bc	20.33 bc	37.97 c	47.33 bc
T_3 (Border crop maize)	11.40 d	17.63 d	31.00 e	41.50 d
T_4 (One spray imidacloprid)	15.97 b	21.67 b	42.50 b	51.00 b
T_5 (Two spray imidacloprid)	18.27 a	24.33 a	47.00 a	57.70 a
CV (%)	7.63	5.64	4.36	4.59

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.5. Infected pods per plant

At 30 DAS, the lowest infected pod per plant (1.33) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (1.50) and the highest (2.83) was recorded in treatment T_0 (Control) (Table 14). At 40 DAS. The lowest infected pod per plant (2.07) was recorded in treatment T_5 (Two Spray) while, the highest (4.00) was recorded in treatment T_0 (Control). At 50 DAS, the lowest infected pod per plant (4.17) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (2.67) and the highest (7.30) was recorded in treatment T_0 (Control). At 60 DAS, the lowest infected pod per plant (6.23) was recorded in treatment T_5 (Two Spray) which was statistically similar with treatment T_4 (One Spray) (7.00) and the highest (10.23) as recorded in treatment T_0 (Control).

Table 14. Effect of different treatment on infected pods per plant of Mungbean at different DAS

Treatment	**Infected pods per plant**			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	2.83 a	4.00 a	7.30 a	10.23 a
T_1 (Netting)	2.03 b	2.83 c	5.33 c	8.83 bc
T_2 (Yellow sticky trap)	1.83 b	2.67 c	4.67 cd	8.17 c
T_3 (Border crop maize)	2.67 a	3.33 b	6.30 b	9.07 b
T_4 (One spray imidacloprid)	1.50 c	2.67 c	4.33 d	7.00 d
T_5 (Two spray imidacloprid)	1.33 c	2.07 d	4.17 d	6.23 d
CV (%)	8.28	8.22	6.90	5.75

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.6. Healthy pods length (cm)

At 30 DAS, the highest healthy pods length (6.28 cm) was recorded in treatment T_5 (Two Spray) and the lowest (4.90 cm) was recorded treatment T_0 (Control) (Table 15). At 40 DAS, the highest healthy pods length (7.07 cm) was recorded in treatment T_5 (Two Spray) while, the lowest (5.52 cm) was recorded in treatment T_0 (Control). At 50 DAS, the highest healthy pods length (7.72 cm) was recorded in treatment T_5 (Two Spray) and the lowest (6.03 cm) was recorded in treatment T_0 (Control). At 60 DAS, the highest healthy pods length (8.03 cm) was recorded in treatment T_5 (Two Spray) and the lowest (6.27 cm) as recorded in treatment T_0 (Control).

Table 15. Effect of different treatment on healthy pods length of Mungbean at different DAS

Treatment	Healthy pod length (cm)			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0 (Control)	4.90 f	5.52 f	6.03 f	6.27 f
T_1 (Netting)	5.61 d	6.32 d	6.90 d	7.17 d
T_2 (Yellow sticky trap)	5.84 c	6.58 c	7.19 c	7.47 c
T_3 (Border crop maize)	5.33 e	6.00 e	6.55 e	6.82 e
T_4 (One spray imidacloprid)	5.96 b	6.71 b	7.33 b	7.63 b
T_5 (Two spray imidacloprid)	6.28 a	7.07 a	7.72 a	8.03 a
CV (%)	3.06	2.16	2.25	5.25

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.7. Infected pods length (cm)

At 30 DAS, the lowest infected pods length (4.92 cm) was recorded from treatment T_5 (Two Spray) and the highest (6.30 cm) was recorded in treatment T_0 (Control) (Table 16). At 40 DAS, the lowest infected pods length (5.16 cm) was recorded in treatment T_5 (Two Spray) while, the highest (6.60 cm) was recorded in treatment T_0 (Control). At 50 DAS, the lowest infected pods length (5.13 cm) was recorded in treatment T_5 (Two Spray) and the highest (6.80 cm) was recorded in treatment T_0 (Control). At 60 DAS, the lowest infected pods length (5.52 cm) was recorded in treatment T_5 (Two Spray) and the highest (7.07 cm) as recorded in treatment T_0 (Control).

Table 16. Effect of different treatment on infected pods length of Mungbean at different DAS

Treatment	**Infected Pod length (cm)**			
	30 DAS	40 DAS	50 DAS	60 DAS
T_0(Control)	6.30 a	6.60 a	6.80 a	7.07 a
T_1(Netting)	5.87 c	6.14 c	6.33 c	6.58 c
T_2 (Yellow sticky trap)	5.63 d	5.90 d	6.08 d	6.32 d
T_3(Border crop maize)	5.99 b	6.27 b	6.46 b	6.71 b
T_4(One spray imidacloprid)	5.35 e	5.60 e	5.77 e	6.00 e
T_5(Two spray imidacloprid)	4.92 f	5.16 f	5.31f	5.52 f
CV (%)	2.45	2.45	6.32	3.43

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.2.8. Healthy and infected seed weight

The highest healthy seed weight (650.67 g $plot^{-1}$ and 1.00 t ha^{-1}) was recorded in treatment T_5 (Two Spray) and the lowest healthy seed weight (266.67 g $plot^{-1}$ and 0.41 t ha^{-1}) was recorded in treatment T_0 (Control) (Table 17). The maximum (143.90 %) increase (%) healthy seed yield over control was recorded in treatment T_5.

The lowest infected seed weight (53.27 g $plot^{-1}$ and 0.08 t ha^{-1}) was recorded in treatment T_5 (Two Spray) and the highest infected seed weight (177.93 g $plot^{-1}$ and 0.27 t ha^{-1}) was recorded in treatment T_0 (Control). The maximum (-70.37 %) decreased (%) infected over control was recorded in treatment T_5.

Table 17. Effect of different treatment on healthy and infected seed weight of Mungbean

Treatment	Healthy seed weight (g $plot^{-1}$))	Infected seed weight (g $plot^{-1}$)	Healthy seed weight (t ha^{-1})	Increased yield over control (%)	Infected seed weight (t ha^{-1})	Decreased yield over control (%)
T_0(Control)	266.67 f	177.93 a	0.41 f	-	0.27 a	-
T_1(Netting)	464.00 d	94.07 c	0.71 d	73.17	0.14 c	-48.15
T_2 (Yellow sticky trap	533.33 c	78.20 d	0.82 c	100.00	0.12 d	-55.56
T_3(Border crop maize)	410.67 e	122.40 b	0.63 e	53.66	0.19 b	-29.63
T_4(One spray imidacloprid)	597.33 b	70.83 e	0.92 b	124.39	0.11 e	-59.26
T_5(Two spray imidacloprid)	650.67 a	53.27 f	1.00 a	143.90	0.08 f	-70.37
CV (%)	2.37	3.26	2.37		3.26	

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2.3. Relationship between percent disease severity and healthy seed yield (t ha^{-1}) of mungbean at different DAS

Correlation study was done to establish the relationship between the percent disease severity and healthy seed yield of mungbean at different DAS among different management practices. From the figure 16-19, it was revealed that negative correlation was observed between the parameters.

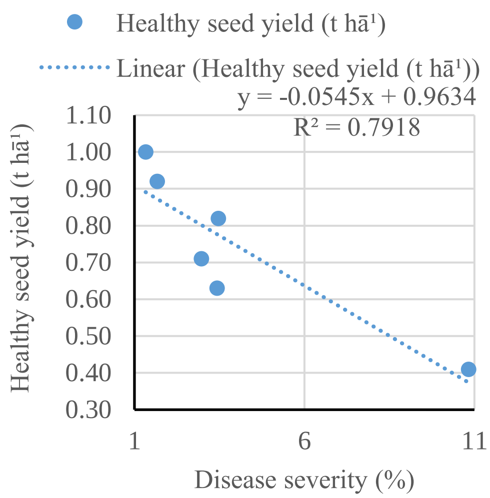
At 30 DAS, it was evident that the equation y = y = -0.0545x + 0.9634, gave a good fit to the data and the co-efficient of determination R^2 = 0.7918 fitted regression line had a significant regression co-efficient.

At 40 DAS, it was observed that the equation y = -0.0362x + 1.0434, gave a good fit to the data and the co-efficient of determination (R^2 = 0.8992) fitted regression line had a significant regression co-efficient.

At 50 DAS, it was proved that the equation y = -0.023x + 1.1595, gave a good fit to the data and the co-efficient of determination (R^2 = 0.9726) fitted regression line had a significant regression co-efficient.

At 50 DAS, it was observed that the equation y = y = -0.0187x + 1.2358, gave a good fit to the data and the co-efficient of determination (R^2 = 0.9857) fitted regression line had a significant regression co-efficient.

From the figure it may be concluded that disease severity at different DAS as well as negatively correlated with healthy seed yield of mungbean.



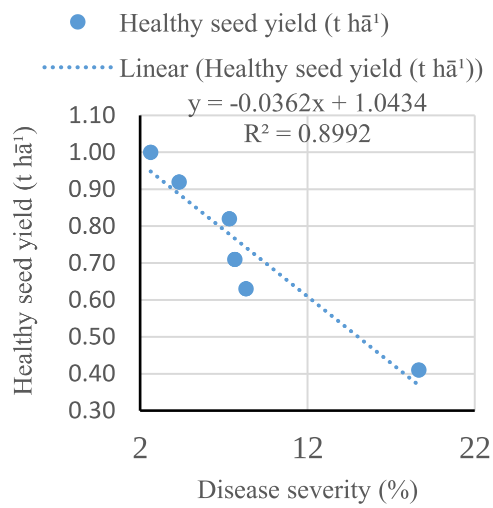
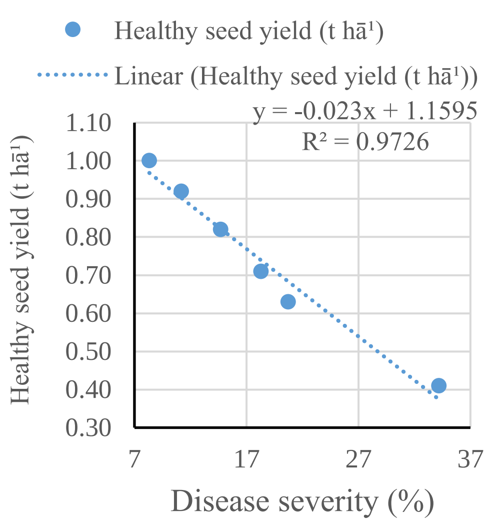


Figure 7. Relationship between percent disease severity and healthy seed yield of mungbean at 30 DAS

Figure 8. Relationship between percent disease Severity and healthy seed yield of mungbean at 40 DAS



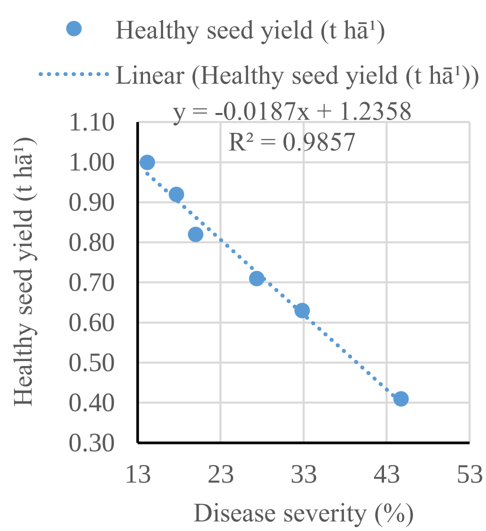


Figure 9. Relationship between percent disease severity and healthy seed yield of mungbean at 50 DAS

Figure 10. Relationship between percent disease severity and healthy seed yield of mungbean at 60 DAS

DISCUSSION

Mungbean (*Vigna radiata* L.) is an important pulse crop having global economic importance as dietary ingredient of the staple food. Nutritional status of crop mainly consists of carbohydrate 51%, protein 24-26%, minerals 4% and vitamins 3% (Jayappa, 2017). In Bangladesh, Mungbean is traditionally cultivated in the rabi in about 41322.04 ha of land and about 33915 m tons of grains are produced (BBS 2018-2019) which is very low as compared to other countries of the region. The main objectives of this experiment were to find out resistant varieties and yield parameters against *Mungbean yellow mosaic virus* and its management using different treatment under field condition.

During response of selected mungbean varieties against *Mungbean Yellow Mosaic Virus* under natural condition. In this experiment BARI mung-5, BARI mung-6, BARI mung-7, local variety were used as planting materials.

It is evident that some of the variety showed resistance against *MYMV* under natural condition in respect of percent disease incidence,and disease severity. The highest percent disease incidence and percent disease severity was recorded from local variety whereas the lowest disease incidence and severity was recorded from BARI mung 7 followed by BARI mung 5 and BARI mung 6. Similar findings were recorded by Islam *et al*., (2008) and observed the lowest percent of *MYMV* infected plant was found in BARI mung 6 and a positive relationship was found between whitefly population and incidence of *MYMV* disease. Sing *et al*., (2000) reported an incidence ranging from 0 to 58.5 percent among various varieties during their evaluation program for resistance against *MYMV*. Almost similar findings were done by Islam *et al*., (2008) studied on seven recommend varieties of mungbean viz. BARI mung 2, BARI mung 3, BARI mung 4, BARI mung 5, BARI mung 6, BINA moog 2 and BINA moog 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 maximum number of Plant height (cm), leaves per plant, pods per plant, pods length (cm) was recorded from BARI mung 7 followed by BARI mung 5 and BARI mung 6 and the minimum number was recorded from local variety. Almost similar findings were recorded from Premchand and Varma (1983) screened the mung and urd bean cultivars for growth components and yield against *Yellow mosaic disease* incidence. There was a reduction of 9.6 to 38.2 percent in height, 7 to 28.5 percent in fresh weight of shoot and 4.3 to 22.1 percent in dry weight, 25.7 percent in susceptible cultivar. Similar findings were recorded by Quaiser Ahmed (1991) reported a yield loss of 83.9 percent and a maximum growth reduction of 62.94 percent in Vigna radiata cv. *Pusa baisakhi* due to *Mungbean yellow mosaic Gemini virus* infection and he also concluded that early crop infection reduced yield more than late infection. Aftab *et al*. (1993) reported *MYMV* infection on Vigna (*Ungiliculata* sub sp. *Sesquipedalis*). The disease spread rapidly with increase in whitefly population. Plant height, number of pods, seeds and yield/plant were reduced by 10.3, 50.5, 44.7 and 49.2 per cent, respectively.

In Bangladesh there is a very few reports on the management of *Mungbean yellow mosaic disease.* Generally chemical insecticides are used to manage the disease. But other alternatives like cultural practices also used to be investigated for their effectiveness in reducing the incidence of *MYMV*. In this experiment one selective insecticides were used with different number of sprays. Besides using insecticides yellow sticky trap, border crop and netting were used for effective management of *Mungbean Yellow Mosaic Virus*.

In the present study, it is evident that the highest percentage of disease incidence and severity was observed in control plots while the minimum was in the plots, which received chemicals with two spray of imidacloprid followed with one spray of imidacloprid. Chemicals performed better in respect of percent disease incidence and severity than that of cultural practices. Similar findings were observed in the previous works has been done by Haque (2012) reported at 50 DAS, the lowest disease incidence and severity was recorded for Admire (Imidacloprid) received plants and the highest was found in control.

In the present study it has been observed that the maximum plant height was recorded from treatment T_5 (Two time spraying with Imidacloprid) followed by T_4 (one time spraying with Imidacloprid) and the minimum plant height was obtained from T_0 (control). The almost similar findings were found by Jain *et al.*, (1995) observed that reduction in plant height, pods/plant and crop growth rate contributed to decreased grain yield by *MYMV*.

In case of number of pods per plant, pod length, number of seeds per pod the highest number was recorded from treatment T_5 (Two time spraying with Imidacloprid) followed by T_4 (one time spraying with Imidacloprid) and the lowest number was recorded from T_0 (control). Saran and Giri (1990) observed that numbers of pods/ plant, pod length, number of seeds per pod were increased significant with 30 and 60 kg/ ha. Vohra and Beniwal (1979) reported that mungbean yellow mosaic virus infection affects grain yield when the plants have infection up to 50 days after planting and reduction in yield contributing characters such as pods/ plants, seeds/ pod. Almost similar findings were reported in the previous works has done by Shah *et, al*., (2008) imidacloprid 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.

In this experiment yellow sticky trap and netting performed better than border crop over control. Almost similar findings were found that have been done by Islam *et al*., (2009) reported among the different cultural practices like yellow polyethylene mulch followed by yellow pot trap and yellow cloth trap performed better in respect of growth characters and yield. Yellow polyethylene mulch increased 25.84% yield of mungbean over untreated control.

SUMMARY AND CONCLUSION

The two experiment were conducted to evaluate the resistance response of different mungbean varieties against *Mungbean Yellow Mosaic Virus* under natural condition. And its management in field condition in the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

The 1st experiment was done during the period of July to october, 2019. The experiment consists of 4 varieties such as V_1 = BARI mung-5 (83.3 gm/Plot), V_2 = BARI mong-6 (83.3 gm/Plot) V_3 = BARI mung-7 (83.3 gm/Plot), V_4 = Local variety (83.3 gm/Plot). The experiment was laid out in Randomized Complete Block Design with three replications. Data was recorded on disease incidence (%), disease severity (%), growth and yield contributing characters and yield of mungbean for different variety.

At 30, 40, 50 and 60 DAS, the highest disease incidence 24 %, 48.67 %, 62 %, 74 % was noted in local variety, respectively, while the lowest disease incidence 17.80%, 25 %, 38.67 %, 48.67 % in BARI mung-7.

At 30, 40, 50 and 60 DAS, the maximum disease severity (0-9 scale) 9.63 %, 19.17 %, 36.47 % and 45.10 % was recorded from local variety, respectively, while the minimum disease severity 5.97 %, 11.67 %, 26.63 % and 31.17 % from BARI mung-7.

At 30, 40, 50 and 60 DAS, plant height was ranged in 13.61 cm to 13.97 cm, 19.73 cm to 23.91 cm, 36.33 cm to 50.50 cm and 43 cm to 56.33 cm at different treatments, respectively. At all cases, the highest plant height was recorded in BARI mung-7 and the lowest was found from local variety.

At 30, 40, 50, 60 DAS, the highest healthy leaf per plant (10.40, 19.03, 30.23, 41.30 was recorded in variety BARI mung 7 and the lowest (7.40, 13.37, 22.20, 29.50) was found in local variety. In case of infected leaves per plant the lowest (4.40, 6.57, 8.57, 13.17) in local variety and the highest (5.80, 10.03, 18.17, 22.87) was recorded in BARI mung 7. In case of (%) reductions, the lowest 1.6, 3.34, 4.03, 6.63 was recorded in local variety and the highest 6, 12.46, 21.66, 28.13 was recorded in BARI mung 7.

At 30, 40, 50 and 60 DAS, highest (11.33, 24.83, 42.83, 50.50) healthy pods per plant was recorded in BARI mung 7 and the lowest (7.83, 16.37, 24.67 and 34.57) was found in local variety. In case of infected pods per plant the lowest (1.07, 4.67, 9.50, 12.67) was recorded in local variety and the highest was (5.03, 9.57, 18.67 and 25.33) was in BARI mung 7. In case of (%) reductions, the lowest 2.8, 6.8, 6, 9.24 was recorded in local variety and the highest 10.26, 20.16, 33.33, 37.83 was recorded in BARI mung 7.

At 30, 40, 50 and 60 DAS, the highest pods length per plant (6.47 cm, 7.43 cm, 8.37 cm, 8.73 cm) was recorded in variety BARI mung 7 and the lowest was (5.72 cm, 6.57 cm, 6.90 cm and 7.10 cm) was found in local variety. In case of infected pods length per plant the lowest was recorded in (5.64 cm, 6.77 cm, 7.16 cm, 7.13cm) local variety and the highest (6.57 cm, 6.77 cm, 7.16 cm and 7.13 cm) was recorded in variety BARI mung 7. In case of (%) reductions, the lowest 0.85, 0.20, 0.26, 0.03 was recorded in local variety and the highest 0.83, 1.53, 2.32, 2.57 was recorded in BARI mung 7.

The highest and lowest healthy seed weight (459.0 g $plot^{-1}$ and 0.91 t ha^{-1}) to (297.5 g $plot^{-1}$ and 0.59 t ha^{-1}) was recorded in variety BARI mung 7 and local variety. The maximum healthy yield (54.24 %) increase over control was recorded in variety BARI mung 7. The lowest and highest infected seed weight (144.5 g $plot^{-1}$ and 0.22 t ha^{-1}) to (226.67 g $plot^{-1}$ and 0.35 t ha^{-1}) was recorded from variety BARI mung 7 and local variety. The maximum infected yield (28.57 %) decreased over control was recorded in variety BARI mung 7.

The 2nd experiment was conducted during the period of July to October, 2020. local variety of mungbean was used as the test crop in this experiment. The experiment comprised of chemicals, yellow sticky trap, netting and border crop including an untreated control. The treatment was T_0= Control, T_1= Netting at seedling stage, T_2=

Yellow sticky trap, T_3= Border crop (Maize), T_4= One Spray (Imidacloprid), T_5= Two Spray (Imidacloprid). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data was recorded on disease incidence (%), disease severity (%), plant height (cm), healthy and infected leaves per plant, healthy and infected pods per plant, healthy and infected pod height per plant and on healthy and infected seed weight.

At 30, 40, 50 and 60 DAS, disease incidence varied from 4.43 to 23 %, 13.37 to 41.10 %, 25.56 to 53.32 % and 33.32 to 66.67 %. At all cases highest disease incidence (%) was noted in T_0 (Control), While the lowest disease incidence was recorded from T_5 (Two spraying with imidacloprid).

At 30, 40, 50 and 60 DAS, the maximum disease severity (0-9 scale) 10.83 %, 18.67 %, 34.17 % and 44.73 % was recorded from T_0 (control), respectively, while the minimum disease severity 1.33 %, 2.63 %, 8.33 % and 14.17 % in T_5 (Two spraying with imidacloprid).

At 30, 40, 50, 60 DAS, the lowest and highest healthy leaf per plant was ranged from 6.77 to 12.61, 13.33 to 21.50, 22.17 to 33.83 and 33.33 to 43.67. At all cases, the highest was recorded in T_5 (Two spraying with imidacloprid) and the lowest was found in T_0 (control).

In case of infected leaves per plant the lowest and highest was ranged from 1.33 to 4, 2 to 6.17, 3.17 to 8 and 5.80 to 14.17. At all cases the lowest infected leaves per plant was found from T_5 (Two spraying with imidacloprid) and the highest infected leaf per plant was recorded from T_0 (control).

At 30, 40, 50 and 60 DAS, the minimum and maximum healthy pods per plant was ranged in 6.33 to 18.27, 12.17 to 24.33, 21.50 to 47 and 33.17 to 57.70. The maximum was recorded in T_5 and the minimum was found in T_0. In case of infected pods per plant the minimum and maximum was ranged in 1.33 to 2.83, 2.07 to 4, 4.17 to 7.30 and

6.23 to 10.23. The minimum was found in T_5 (Two spraying with imidacloprid) and the maximum was recorded in T_0 (control).

At 30, 40, 50 and 60 DAS, the highest healthy pod lengths (6.28 cm, 7.07 cm, 7.72 cm, 8.03 cm) per plant was recorded in T_5 (Two spraying with imidacloprid) and the lowest 6.90 cm, 5.52 cm, 6.03 cm and 6.27 cm) was recorded in T_0.

In case of infected pods lengths per plant the lowest and highest was ranged in 4.92 to 6.30 cm, 5.16 to 6.60 cm, 5.31 to 6.80 cm and 5.52 to 7.07. The lowest was found in T_5 and the highest was obtained from T_0.

The highest healthy seed weight (650.67 g plot^{-1} and 1.00 t ha^{-1}) was recorded in T_5 and the lowest healthy seed weight (266.67 g plot^{-1} and 0.41 t ha^{-1}) was recorded in T_0. The maximum (143.90 %) increase healthy seed yield over control was recorded in T_5 (Two spraying with imidacloprid).

The lowest infected seed weight (53.27 g plot^{-1} and 0.08 t ha^{-1}) was recorded in T_5 and the highest infected seed weight (177.93 g plot^{-1} and 0.27 t ha^{-1}) was recorded in T_0. The maximum (-70.37 %) decreased infected seed yield per hectare over control was recorded from T_5. From the present study it may be concluded that,

I) BARI mung 7 showed resistance against *Mungbean yellow mosaic virus* in field response on the basis of persent disease incidence and disease severity

II) BARI mung 7 showed better performance than other varieties against *MYMV* in case of growth and yield parameters.

III) Imidacloprid (two spray) showed effective performance for managing the *MYMV* diseases than other selected treatments in field condition.

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.

Aftab, M., Asad, S., Khokhar, K.M., Ayub, M.A. and Butt, T.B., (1993). Effect of mungbean yellow mosaic virus on the yield and growth components of asparagus bean. *Pakistan J. Phytopathol*., **5**(1-2): 58-61.

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.

Ahmed, H. U. (1985). Disease problems of pulse and oilseed crops in Bangladesh. Presented at the First Biennial Conference of the Bangladesh Phytopathological Society. BARI, Joydebpur, Gazipur, Bangladesh.

Ahmed, Z., (2001), Studies on okra (bhendi) yellow vein mosaic virus, M.Sc. Thesis, University of Agricultural Sciences, Dharwad.

Akram, M., & Singh, N. P. (2016). Yellow mosaic of mungbean and urdbean: current status and future strategies. *J. Food Legumes.* **29**(2), 77-93.

Asthana, A.N., (1998). Pulse crops research in India. *Indian J. of Agric Sci*., **68**(8): 448-452.

Awasthi, L.P. and Shyam, S. (2008). Screening of mungbean germplasm for field resistance to mungbean yellow mosaic viruse. *Indian. J. Plant. Sci. Res*. **35**: 1-4.

Babu, R.C., Rathinaswamy, R. and Srinivasan, P.S. (1984). Certain physiological changes in green gram plants infected by mungbean yellow mosaic virus. *Madras Agric. J.* **71**(12): 795-798.

Bakar, A.K. (1991). Pest and disease problems of mungbean in West Malaysia. *Malaysian Agril J*. **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, 60 p.

Basandrai, A.K., Gartan, S.L., Basandrai, D. and Kalia, V., (1999). Blackgram (*Phseolus mungo*) germplasm evaluation against different diseases. *Indian J. Agril. Sci*. **69**(7): 506-508.

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). (2012). Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the People’s Republic of Bangladesh, Dhaka. pp.25.

BBS (Bangladesh Bureau of Statistics). (2020). Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the People’s Republic of Bangladesh, Dhaka. pp.110.

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.

Bisht, I.S., Shamsher, S and Dabas, B.S., (1988). Effect of yellow mosaic virus on growth components and yields of four promising cultures of mungbean. *Indian J. Mycol. and Plant Pathol*. **18**(2): 204-205.

Bos, L., (1999). Plant viruses: Unique and Intriguing pathogens: Text Book of Plant Virology. Backhuys Publishers, Netherlands, pp 305-306.

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.

Byrne, D. N., & Bishop, G. W. (1979). Relationship of Green Peach Aphid Numbers to Spread of Potato Leaf Roll Virus in Southern Idaho. *J. Econ. Entomol*. **72**(6), 809-811.

Cahill, M., F.J. Byrne., K. Gorman., I. Denhoim and A. L. Devonshire. (1995) Pyrithroid and Organophosphate resistance in tobacco Whitefly, *Bemisia tabaci* (Homoptera Aleyrodidae). *Bull. Entomol. Res*. **85**: 181-187.

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

Chamder, S. and Singh, Y. (1991). Effects of insecticides on whitefly Bemisa tabaci yellow mosaic virus in green gram *Vigna radiata* (L) wilczek. *Indian J. Virol.* **53**(2): 248-251.

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

Chenulu, V.V. and Verma, A., (1988). Virus and virus like diseases of pulse crops commonly grown in India. In: *Pulse Crops*, Eds. Baldev, B., Ramanujam, S. and Jain, H.K., Oxford and IBH Publishing Co., New Delhi, pp.338-370.

Cohen, S. and Marco, S., (1973). Reducing the spread of aphid-transmitted viruses in peppers by trapping the aphids on sticky yellow polyethylene sheets. Phytopathology, **63**: 1207-1209.

Dantre, R.K., Keshwal, R.l. and Khare, M.N. (1996). Studies on a yellow mosaic virus disease of soybean and mungbean. *Ann. Plant Prot. Sci*. **4**(1): 67-70.

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

Dhingra, K. L., & Ghosh, D. K. (1993). *Efficiency of whitefly vector (Bemisia tabaci Gen.) in trnasmission of mungbean yellow mosaic virus in different source-test plant combinations* (No. RESEARCH).

Ekbom, B. S. (1980). Some aspects of the population dynamics of TrialeuTodes vaporariorum and Encarsia formosa and their importance for biological control. Bul! Organ. Int. Lutte Biol./West Palearctic Reg. **3**: 25-34.

Engel, W.R. (1978). The importance of legumes as a protein source in Asia diets. In. Cowell, Red. Proc. First Int. mungbean symp. AVRDC, Shanhua, Taiwan. 35-39 p.

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

Gan, R.-Y.; Lui, W.-Y.; Wu, K.; Chan, C.-L.; Dai, S.-H.; Sui, Z.-Q.; Corke, H. (2017). Bioactive compounds and bioactivities of germinated edible seeds and sprouts: An updated review. *Trends Food Sci. Technol.* **59**: 1–14.

Ganapathy, T. and Karuppiah, R. (2004). Evaluation of new insecticides for the management of whitefly (*Bemisia tabici* Genn.), mungbean yellow mosaic virus (MYMV) and urdbean leaf crinkle virus (ULCV) diseases in mungbean (*Vigna radiata* (L.) Wilczek). *Indian J. Plant Prot*. **32**: 35-38.

Ganapathy, T., Kuruppiah, R. A and Gunasekaran, K., (2003). Identifying the source of resistance for mungbean yellow mosaic virus (*MYMV*), urd bean leaf crinkle virus and leaf curl virus disease in urd bean (*Vigna mungo* (L.) Hepper). In Annual Meeting and Symposium on recent Developments in the diagnosis and Management of Plant Diseases for Meeting Global Challenges, University of Agricultural Sciences, Dharwad, p.30.

Gerling, D., & Horowitz, A. R. (1984). Yellow traps for evaluating the population levels and dispersal patterns of *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae). Annals of the Entomological Society of America, **77**: 753-759.

Ghosh A. (2008). Management of yellow mosaic virus by chemical control of its vector, Whitefly (*Bemisia tabaci*) and its impact on performance of green gram (*Phaseolus aureus*) under rainfed lowland rice fallow. *Arch Phytopathol. Plant Prot*. **41**(1):7578.

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

Green, S.K., (1999), In project 3, legumes for crop diversification. AVRDC Report – pp.35-43.

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.

Greathead, A.H. (1986) Host plants. In: Cock, MJW (ed*). Bemisia tabaci*- a literature survey. CAB International Institute of Biological Control, Silwood Park, UK, pp. 17-26

Habib, S., N. Shad, A. Javaid and U. Iqbal. (2007). Screening of mungbean germplasm for resistance/tolerance against yellow mosaic disease. **5**: 89-94.

Haque, A. M., Kamal, M. M., & Akhanda, A. M. (2012). Effect of Four Selected Chemicals on the Incidence and Severity of Mungbean Yellow Mosaic Virus and Its Relation to the Seed Yield of Mungbean. *J. Food Sci and Engineer.*, **2**(9), 51.

Hossain, A. S. M. A., Islam, S. M. A., Akhtera, K., Akheter, N., & Muqit, A. (2010). Effect of plant extracts, insecticides and cultural practices on growth characters and disease severity of mungbean yellow mosaic. *International J. Sustain. Crop Prod.* **5**(2), 16-20.

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. (2010). Management of sucking insect pest on mungbean and its impact on the incidence of mosaic (Doctoral dissertation, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207).

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

Huang, C.C., Peng, W.K. and Talekar, N.S. (2003). Characteristics of infestation by the bean pod borer, (Maruca virata) on Sesbania cannabina. Formosan Entomologist. **23**(1): 1-11.

Iqbal, U., Iqbal, S. M., Afzal, R., Jamal, A., Farooq, M. A., & Zahid, A. (2011). Screening of mungbean germplasm against mungbean yellow mosaic virus (MYMV) under field conditions. *Pak. J. Phytopathol*, **23**(1): 48-51.

Islam, M. S. (2016). *Management of Mungbean Yellow Mosaic Virus (MYMV) through peak performance neutrient (ppn) and some selected insecticides* (Doctoral dissertation, Department of Plant Pathology, Sher-e-Bangla Agricultural University).

Islam, M. T., & Faruq, A. N. (2009). Effect of some cultural practices for the management of mungbean yellow mosaic disease. *J. Sher-e-Bangla Agricultural University*, **3**(1): 40-45.

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. *Int. J. Sustain. Agric. Tech*. **5**(4):41-46.

Idris A.B.; S. A. N. Khalid and M. N. Mohamad Roff (2012). Effectiveness of Sticky Trap Designs and Colours in Trapping Alate Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae). *Pertanika J. Trop. Agric. Sci.* **35** (1): 127 – 134.

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.

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

John, P., Sivalingam, P.N., Haq, Q.M.I. and Kumar, N. (2008). Cowpea golden mosaic disease in Gujrat is caused by a mungbean yellow mosaic India virus isolate with a DNA B variant. *Archives Virol*. **153**(7): 1359-1365.

Jayappa, R. H., & Devamani, B. D. (2017). Management of mungbean yellow mosaic virus (MYMV) in mungbean (*Vigna radiata* L.). *J. Entomol. and Zool. Stud.* **5**(5), 596-601.

Joly, Y. N. (2017). Efficacy of Imitaf and Acmix to prevent *Mungbean yellow mosaic virus (MYMV)*. Department of Plant Pathology. Sher-e- Bangla Agricultural University. Dhaka-1207.

Khatri, N.K, Nanda, U.S., Kakani, R.K., Henry, A., Kumar, D. and Singh, N.B. (2003). Extent of Yellow mosaic virus disease of moth bean in Bikaner Region. Proceedings of the National Symposium on arid legumes, for food nutrition security and promotion of trade, Hisar, India.

Khattak, M.K., Ali, S. and Chishti, J.I. (2004). Varietal resistance of mungbean (*Vigna radiata* L.) against whitefly (*Aemisia tabaci* genn.), jassid (*Amrasca devastans dist*.), and thrips (Thrips *tabaci lind*.). *Pakistan Entomol*. **26**(1): 9-12.

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

Kuldip, S., Sarvjeet, S., and Gumber, R.K., (1996). Resistance to mungbean yellow mosaic virus in mungbean. *Indian J. Pulses Res*. **9**(1): 90.

Lambrides, C. J.; Godwin, I. D., (2006). Mungbean. In: Chittarajan, K., Genome Mapping and Molecular Breeding in Plants, **3**: 69-90.

Marappa, N., S, D.L., Nagaraju, Prameela, H.A. and Krishnamurthy, R.A., (2003). Evaluation of mungbean genotypes against powdery mildew, yellow mosaic virus and bacterial blight diseases at Bangalore. In: Annual Meeting and Symposium on Recent Developments in the Diagnosis and Management of Plant Diseases for Meeting Global Challenges, University of Agricultural Sciences, Dharwad, p.31.

Marimuthu, T., Subramaniam, C. L. and Mohan, R. (1981). Assesment of yield loss due to yellow mosaic infection in mungbean. Pulse Crops Newsletter. **1**: 104.

Masood, K.K., Ali, S. and Chishti, J.I. (2004). Varietal resistance of mungbean (*Vigna radiata* L.) against whitefly (*Bemisia tabaci* Genn.), jassid (*Amrasca devastans* Dist.), and thrips (Thrips *tabaci Lind*.). *Pakistan Entomol*. **26**(1): 9-12.

Mogotsi, K. K., (2006). *Vigna radiata* (L.) R. Wilczek. In: Brink, M. & Belay, G. (Editors). PROTA 1: Cereals and pulses/Céréales et légumes secs. [CD-Rom]. PROTA, Wageningen, Netherlands.

Mote, U.N., (1976). Effect of different insecticides on the control of whitefly (*Bemisia tabaci* Gennadius) population in tomato crop and the incidence of the tomato

Mound, L. A. (1962). Studies on the olfaction and colour sensitivity of *Bemisia tabaci* (Genn.) (Homoptera, Aleyrodidae). Entomologia Experimentalis et Applicata, **5**(2): 99-104.

Mubarak, A.E. Nutritional composition and antinutritional factors of mung bean seeds (*Phaseolus aureus*) as affected by some home traditional processes. *Food Chem.* **89**: 489–495.

Muniyappa, V., (1980), Whiteflies, In: Vectors of Plant Pathogens, Eds. Harris K. F. and Maramorosch K., Academic Press, New York, pp.39-85.

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

Nariani, T.K. (1960). Yellow mosaic of mungbean. *Indian. Phytopathol*.**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 Agril. Res.***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

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. *J. Mycol. and Plant Pathol*., **34**(1): 64-65.

Peerajade, D.A., Ravikumar, R.L. and Rao, M.S.L., (2004). Screening of local mungbean collections for powdery mildew and yellow mosaic virus resistance. Indian Journal of Pulses Research, **17**(2): 190-1.

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

Premchand and Varma, J.P., (1983). Effect of yellow mosaic on growth components and yield of mungbean and urdbean. *Haryana Agric Uni. J. Res*. **13**(1): 98-102.

Prodhan Z.H., Altaf Hossain M., Hosna Kohinur, Mollah M.K.U. and Rahman, M.H. (2008). Development of Integrated Management Approaches against Insect Pest Complex of Mungbean. J. Soil. Nature. **2**(3): 37-39.

Quaiser A., (1991). Growth attributes and grain yield of mungbean plants affected by mungbean yellow mosaic virus in field. *Indian Phytopathol*., **43**(4): 559-560.

Raghupathi, N. and Sabitha, D., (1994). Effect of barrier crops, mulching and yellow sticky traps in the management of yellow mosaic virus disease of soybean. In Crop Diseases **-** Innovative Techniques and Management. Eds. Sivaprakasam, K. and Seetharaman, K., Kalyani Publishers, New Delhi, pp.419-420.

Raje, R.S. and Rao, S.K., (2002). Screening of mungbean (Vigna radiata L. Wilczek) germplasm for yellow mosaic virus, cercospora leaf spot and powdery mildew. Legume Research, **25**(2): 99-104.

Ravindrababu, R., (1987). Studies on mung bean yellow mosaic virus disease. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Ravishankar, K.V., Aghora, T.S., Mohan, N., Naveen, A.H. and Krishnareddy, M. (2009). Identification of RAPD marker linked to Mungbean Yellow Mosaic Virus resistance in French bean (Phaseolus vulgaris L.). *J. Hort. Sci*. **4**(2): 167-169.

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.

Sana Habib, Nadeem Shad, Arshad Javaid and Umer Iqbal. (2007). Screening of mungbean germplasm for resistance/tolerance against yellow mosaic disease. Mycopathol. **5**(2): 89- 94.

Saran, G. and G. Giri. (1990). Influence on nitrogen phosphate and sulphur on under semiarid and rainfed condition of North-west. *Indian J. Agron*. **35** (l -2): 131-136.

Sastry, K.S.M. and Singh, S.J., (1974). Effect of yellow vein mosaic virus infection on growth and yield of okra crop. *Indian Phytopathol*. **27**: 294-297.

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

Sharma, M.L., Nayak, M.K. and Bhadouria, S.S. (2004). Screening of newly developed mungbean varieties against whitefly and yellow mosaic virus. Shashpa. **11**(1): 71-74.

Siddiqui, K.H., Trimohan, Rana, V.K.S. and Lal, S.K., (1999). Location of sources of resistance amongst soybean genotypes to yellow mosaic virus disease due to whitefly, *Bemisia tabaci* Genn. under natural conditions. Shashpa, **6**(1): 37-40.

Singh, A., Mukherjee, V. and Kumar, S., (2018). Viral Diseases in Mung Bean and their Integrated Management, *Int. J. Pure App. Biosci*. SPI: **6**(1): 184-189.

Singh, B.R., Chandra S., Ram, S., (2000). Evaluation of mungbean varieties against yellow mosaic virus. *Ann. Plant Prot. Sci*. **8**(2): 233-280.

Singh, B.R.M., M.D. Yadav and S.M. Dianger. (1982). Yield loss in mungbean due to Mungbean yellow mosaic virus. Science and Culture. **48** (12): 435-436.

Singh, G., Singh, K., Gill, A.S. and Chhabra, K.S., (1980). National Seminar on Disease Resistance in Crop Plants. Tamil Nadu Agricultural University, Coimbatore.

Singh, J. P., (1980). Effect of virus diseases on growth components and yield of mungbean and urd bean. *Indian Phytopath*. **33**: 405–408.

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

Singh, S.J., (1985). Management of virus diseases of vegetable crops. In: Integrated Pest and Disease Management. Eds. Jayaraj S., Proceedings National Seminar, Tamil Nadu Agricultural University, Coimbatore, pp.193-201.

Southwood, T. R. E. (1978). Ecological methods with particular reference to the study of insect populations. 2nd Edition. London, UK: Chapman and Hall.

Sreekant, M., Sreeramulu, M., Rao, R.D.V.J.P., Babu, B.S. and Babu, T.R. (2004). Effect of intercropping on Thrips palmi (Karny) population and peanut bud necrosis virus (PBNV) incidence in mungbean (*Vigna radiata*). *Indian J. Plant Protect.* **32**(10): 45-48.

Sridhar, K., (1986). Studies on cucumber mosaic virus infection on chillies (*Capsicum annuum* L.). *M. Sc. (Agri.) Thesis*, Tamil Nadu Agricultural University, Coimbatore, p.82.

Sudha M, Anusuya P, Ganesh NM, Karthikeyan A, Nagarajan P, Raveendran M, Senthil N, Pandiyan M, Angappan K, Balasubramanian P. (2013). Molecular studies on mungbean [*Vigna radiata* (L.) Wilczek] and rice bean [*Vigna umbellata* (Thunb.)] Interspecific hybridization for Mungbean yellow mosaic virus resistance and development of species specific SCAR marker for rice bean. *Arch Phytopathol Plant Prot*. **46** (5):503517.

Sudha, M., A. Karthikeyan, P. Anusuya, N. M. Ganesh, M. Pandiyan, N. Senthil, M. Raveendran, P. Nagarajan and K. Angappan. (2013). Inheritance of Resistance to *Mungbean Yellow Mosaic Virus* (*MYMV*) in Inter and Intra Specific Crosses of Mungbean (*Vigna radiata*). *Afr. J. Plant Sci*. 4: 1924-1927.

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). Intl. J. Pest Mange*. **56**(4): 309–314.

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.

Uthamasamy, S., (1989). Whitefly - the emerging pest. In: State Level Plant Protection Workers Project, May 2-3, CPPS, Tamil Nadu Agricultural University, Coimbatore, pp.62-63.

Vaishampayan, S. M., Kogan, M., Waldbauer, G. P., & Woolley, J. T. (1975). Spectral specific responses in the visual behavior of the greenhouse whitefly Trialeurodes vaporariorum (Homoptera: Aleyrodidae). Entomologia Experimentalis et Applicata, **18**(3): 344-356.

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.

Wang ZY, Yao MD, Wu YD. (2009). Cross-resistance, inheritance and biochemical mechanisms of imidacloprid resistance in B-biotype *Bemisia tabaci*. *Pest Manag. Sci*. **65**:11891194.

Webb, R. E., F. F. Smith, H. Affeldt, R. W. Thimijnn, R. F. Dudley & H. F. Webb., (1985). Trapping greenhouse whitefly with colored surfaces: variables affecting efficacy. *Crop Prot*. **4**: 381-393.

William, F. J., Grewal, J. S. and Amin, K. S. (1968). Serious and new diseases of pulse crop in India. Plant disease reporter, **52**: 300-304.

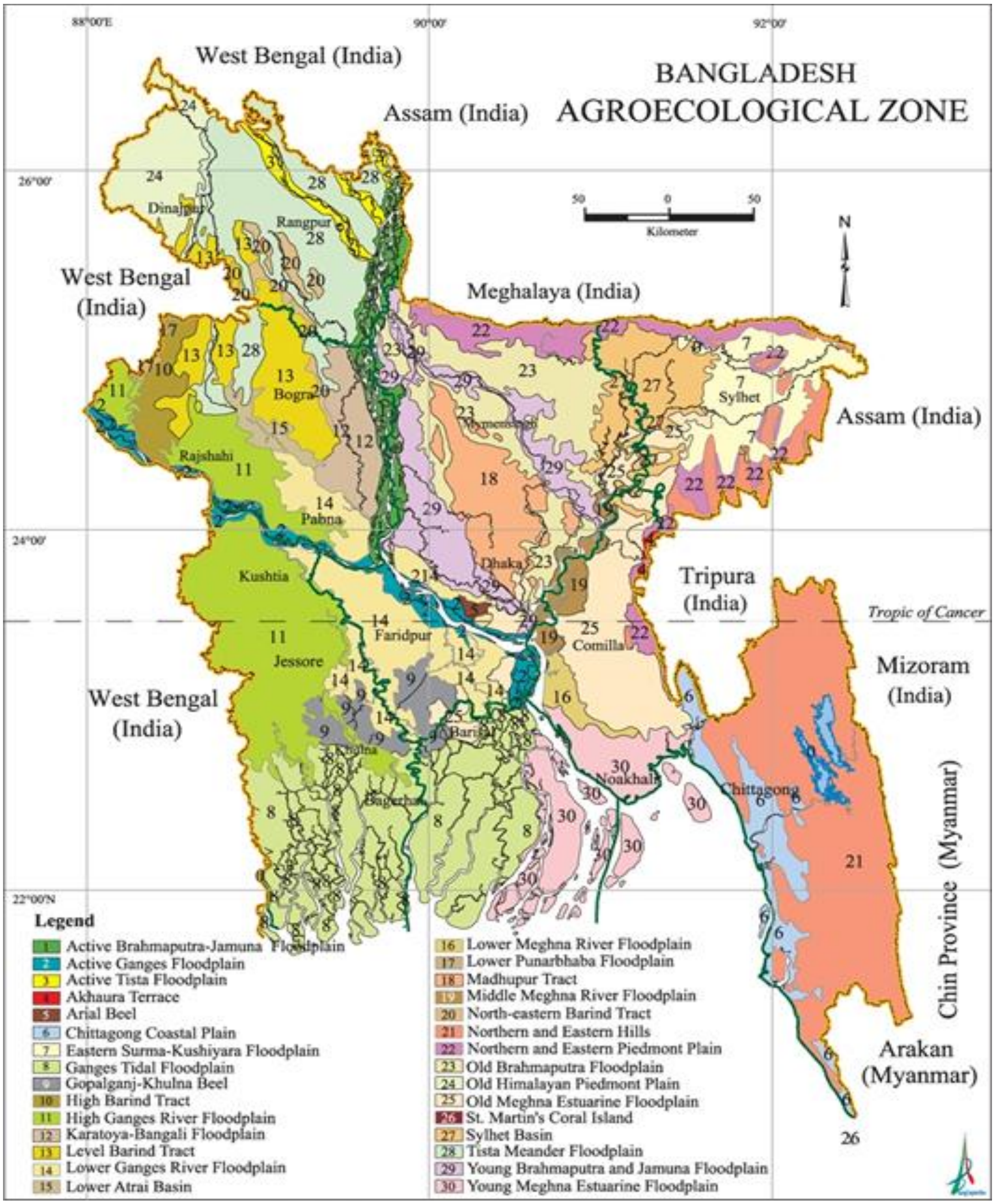
Yadav, G.S. and Dahiya, B. (2000). Screening of some mungbean genotypes against major insect pests and yellow mosaic virus. *Ann. Agric. Bio. Res*. **5**(1): 71-73.

Yano, E. & T. Koshihnra. (1984). Monitoring techniques for adults of the greenhouse whitefly. Bull. Veg. Om. Res. Stn., Ano, Mie Japan. Ser. A, No. **12**: 85-96.

Yaqoob, M. Najibullah and Khaliq, P. (2005). Mothbean germplasm evaluation for yield and other important traits. *Indus J. Plant Sci*. **4**(2): 241-248.

APPENDICES

Appendix I: Map showing the experimental site



Appendix II: Soil characteristics of experimental farm of Sher-e-Bangla Agricultural University are analyzed by soil Resources Development Institute (SRDI) Farmgate, Dhaka.

A. Characteristics of the experimental field

Morphological features	**Characteristics**
Location	Farm, SAU, Dhaka
AEZ	Modhupur 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
Drainage	Well drained
Cropping pattern	**N/A**

B. Physical and chemical properties of the initial soil

B. Physical and chemical properties of the initial soil Characteristics	**Value**
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
pH	5.56
Organic matter (%)	1.00
Total N (%)	0.06
Available P (µgm/gm soil)	42.64
Available K (me/100g soil)	0.13

Source: SRDI

Appendix III. Monthly average relative humidity, average temperature (ºC) and total rainfall (mm) of the experimental period (July 2019 to December 2019).

Month	Average RH (%)	Average Temperature (ºC)	Total Rainfall (mm)
July	82	29.3	383
August	79	29.9	223
September	80	29.1	161
October	78	27.6	188
November	74	24.9	37
December	74	19.3	5

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

APPENDIX IV: A view of healthy mungbean plants

APPENDIX V: Existence of white fly (*Bemesia tabaci*) in the lower surface of infected leaf

APPENDIX VI: View of healthy (A) and infected (B) seeds of Mungbean