SCREENING OF MUNGBEAN CULTIVARS AGAINST *MUNGBEAN YELLOW MOSAIC VIRUS (MYMV)* AND IT'S MANAGEMENT

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CERTIFICATE

This is to certify that the thesis entitled "SCREENING OF MUNGBEAN CULTIVARS AGAINST MUNGBEAN YELLOW MOSAIC VIRUS (MYMV) AND IT'S MANAGEMENT" submitted to the ***Faculty of Agriculture****, Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (MS) IN PLANT PATHOLOGY, embodies the results of a piece of bonafide research work carried out by* ***MD. SOREFUL ISLAM Registration no. 09-03438*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: June, 2015
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Dedicated to

My

Beloved Parents

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The Author

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ABSTRACT

An experiment was conducted at the central farm of Sher-e-Bangla Agricultural University (SAU) during June to September, 2014. The screening experiment was carried out with seven mungbean varieties *viz*., V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8). The management experiment was carried out with seven different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neam) and T_7 (Control) in BARI mungbean-5 against *Mungbean yellow mosaic virus*. The performance of the mungbean cultivars against *Mungbean yellow mosaic virus* differed significantly. The highest plant height (86.95 cm) was observed in V_2 but the highest number of branch plant^{-1} (3.30), number of pods plant^{-1} (31.89), pod length (8.19 cm) and seed yield (2433 kg ha^{-1}) were observed in V_5 (BARI Mungbean-6). Again, the minimum disease incidence (2.22, 5.00 and 6.67% at 30, 40 and 50 DAS, respectively) and disease severity (8.67, 12.67 and 17.67% at 30, 40 and 50 DAS, respectively) were found in V_5 (BARI Mungbean-6). In management experiment, the different management option showed significantly different performance against the disease. The highest number of branch plant^{-1} (3.22) and seed yield (1877.33 kg ha^{-1}) were observed with the application of T_1 (Admire). The minimum disease incidence (1.33, 3.11 and 4.44% at 30, 40 and 50 DAS, respectively) and disease severity (8.66, 12.67 and 17.67% at 30, 40 and 50 DAS, respectively) were found with the application of T_1 (Admire). Considering the performances of different management option against *Mungbean yellow mosaic virus*, the highest reduction of disease incidence (71.42%), disease severity (62.66%) and increasing the yield (85.29%) over control were recorded incase of application of T_1 (Admire).

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BARI	=	Bangladesh Agricultural Research Institute
CBR	=	Cost Benefit Ratio
cm	=	Centimeter
^0C	=	Degree Centigrade
DAS	=	Days after sowing
et al.	=	and others *(at elli)*
Kg	=	Kilogram
Kg/ha	=	Kilogram/hectare
g	=	gram (s)
LER	=	Land Equivalent Ratio
LSD	=	Least Significant Difference
MP	=	Muriate of Potash
m	=	Meter
P^H	=	Hydrogen ion conc.
RCBD	=	Randomized Complete Block Design
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Percent

CHAPTER I

INTRODUCTION

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INTRODUCTION

Mungbean *(Vigna radiata* L. Wilczek) belongs to the family Fabaceae, is a good source of protein, carbohydrates, vitamin for mankind all over the world. Being an important short-duration Kharif grain legume, mungbean is grown extensively in major tropical and subtropical countries of the world. Mungbean is the fifth important pulse crop of Bangladesh (Abedin, *et al.,* 1991). Bangladesh grows various types of pulse crops among which grass pea, lentil, mungbean, chickpea, field pea and cowpea are important. In Bangladesh, it is grown annually on an area of 57 thousand acres and a total production of 20 thousand ton with an average seed yield of 351 kg per acre (BBS, 2010) which is very low as compared to other countries of the region. A minimum intake of pulse by a human should be 80.0 g per day (FAO, 2010). whereas it is only 19.35 g per day in Bangladesh (BBS, 2013).

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 100gm of split dual (Bakr *et al.,* 2004). The foliage and stem are also a good source of fodder for livestock as well as a green manure. Among pulses, mungbean is favored for children and the elderly people because of its easy digestibility and low production of flatulence. It is a drought tolerant, grown twice a year and fits well in our crop rotation programmers.

Mungbean is attacked by different species of sucking insect pests *aphid, jassids, white leaf hopper and whitefly* are of the major importance (Islam *et al,* 2008). These insect pests not only reduce the vigor of the plant by sucking the sap but transmit diseases particularly viral disease and affect photosynthesis as well (Sachan *et al.,* 1994). Pest appearance, population fluctuation, infestation rate and crop yield are very much dependent on sowing time. Most of the farmer's usually sow mungbean just after harvesting them rabi crops without considering optimum sowing dates (Hossain *et al.* 2000).

The reasons for low yield are numerous but yield losses due to insect pest complex are distinct one. Mungbean is attacked by different species of insect pests. Insect pests that attack mungbean can be classified based on their appearance in the field as it related to the phonology of mungbean plant. They are stem feeders, foliage feeders, pod feeders and storage pests. Although this crop is affected by various pathogens but *Mungbean yellow mosaic virus* is the most important and widely distributed. *MYMV* causes irregular yellow and green patches on older leaves and complete yellowing of leaves. Affected plants produce less number of pods and flowers and few seeds. This disease is important, serious, destructive, widespread and inflicts heavy loss annually. It was first identified in India in 1955 and is naturally transmitted by whitefly (*Bemisia tabaci Genn*), but not by mechanical inoculation or by seed (Nariani, I960). It infects mungbean, soybean, mothbean, cowpea and urdbean 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, Srilanka and adjacent areas of South East Asia (Bakar, 1981; Malik, 1991). *MYMV* belongs to the genus *Begomovirus* of the family *Geminivirideae* (Bos, 1999). The virus has geminate particle morphology (20 × 30 nm) and the coat protein encapsulates circular, single stranded DNA genome of approximately 2.8 kb. In Pakistan, the virus has been partially characterized and identified on the basis of Polymerase Chain Reaction (PCR) and epitope profile and DNA sequence (Hossain *et al.*, 2004; Hamid and Robinson 2004). Use of disease resistant crop varieties is regarded as an economical and durable method of controlling viral diseases. A good deal of research efforts have been directed towards screening mungbean germplasm against *MYMV* for the identification of resistant sources under diverse environmental conditions and a number of resistant lines have been reported by some workers (Murtaza *et al.*, 1983; Ghafoor *et al.*, 1992; Bashir and Zubair 2002).

Inheritance studies with *MYMV* have also been conducted (Malik 1991; Jayana *et al.*, 1991). Mungbean is also affected by a dozen of insect pest such as pod borer, leaf miner, jassids, foliage caterpillar, cut worm, aphids and white fly (Ayub,1987). White fly (*Bemisia tabaci*) is very important because it acts as vector for the transmission of *MYMV*. The insecticides have been used for the management of whitefly without taking the consideration of environmental conditions. Epidemiological factors play crucial role in the development of *MYMV* and white fly population. The correct time of application of insecticides can be helpful not only to manage whitefly and virus but also to minimize the number of sprays. The study of epidemiological factors determined the most conducive environment for the application of pesticides at right time thus, enhancing the yield of this crop.

The aim of this study is to evaluate the effect of some selected insecticides viz. Mycotal, imidacloprid and tracer against *MYMV* and population of white fly. As a continuity of this approach, several lines of mungbean germplasm mainly of local origin were evaluated in this study for resistance under highly epiphytotic conditions of Mungbean yellow mosaic disease.

Objectives

Keeping all of these constraints in view, the present study was undertaken to fulfill the following objectives:

1. To evaluate mungbean varieties against *MYMV*.
2. To select a suitable pesticide and botanical for the management of yellow mosaic disease through controlling the insect pests.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

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

2.1 Insect and pests of mungbean

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

Islam *et al.* (2008) worked on seven recommend varieties of mungbean viz. BARI mungbean-2, BARI mungbean-3, BARI mungbean-4, BARI mungbean-5, BARI mungbean-6, BARI mungbean-2 and BARI mungbean-5 were tested to know the population dynamics of whitefly under existing environmental conditions and its impact on incidence of *mungbean yellow mosaic virus (MYMV)* disease and yield. The experiment was conducted at the farm of Sher-e-Bangla Agricultural

University (SAU) Dhaka during the kharif-I season (April to June) in 2006. The lowest population of whitefly (adult and nymph) was found in BARI mungbean-6 as against the highest in BARI mungbean-2. The population of whitefly was gradually increased with environmental temperature and relative humidity. However, the peak population was found at 32^0C and 80% relative humidity. The lowest percent of *MYMV* infected plant was found in BARI mungbean-6 and a positive relationship was found between whitefly population and incidence of *MYMV* disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the *MYMV* infection and yield of mungbean.

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

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

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

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

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

Sharma *et al.* (2004) studied eighteen promising varieties of mungbean for resistance to whitefly *(Bemisia tabaci)* and yellow mosaic disease and reported that the cultivar IPU-9513 showed high tolerance of yellow mosaic disease. Among the 4 control cultivars, PU-35 performed well. T-9, a popular cultivar of the area was highly susceptible to whitefly and yellow mosaic disease.

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

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

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

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

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

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

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

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

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

2.2 Mosaic disease impact on mungbean

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

Gupta and Pathak (2009) reported that the yellow mosaic virus disease of black gram *[Vigna mungo* (Linn.) Hepper] caused by *Mungbean yellow mosaic Gemini virus* and transmitted by whitefly *(Bemisia tabaci* Genn.) is most serious in northern states of India, particularly, Bundelkhand Zone of Madhya Pradesh.

Mungbean yellow mosaic virus (MYMV) causes yield loss up to 80 % and is becoming problematic in French bean growing areas. Molecular marker linked selection to *MYMV* resistance is helpful in rapid identification of genotypes carrying resistant genes. 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 (Ravishankar *et al.,* 2009).

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

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

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)* and yield. The peak population was found at 32^0C and 80% relative humidity. The lowest percent of *MYMV* infected plant was found in BARI mungbean-6 and a positive relationship was found between whitefly population and incidence of *MYMV* disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the *MYMV* infection and yield of mungbean.

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

Bashir (2005) screened 276 lines of mungbean and out of which 10 showed resistance lines against *MYMV*

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

Khatri *et al.* (2003) was conducted survey and determined the spread of *yellow mosaic virus (YMV)* disease and extensive damage was caused by the disease on mothbean *(Vigna aconitifolia)*. They further observed that *MYMV* was the most important disease of mothbean in the region during both years. Yaqoob *et al.* (2005) identified some resistance lines of mothbean in available land races.

Sachan *et al.* (1994) found a drastic reduction in the infection of *YMV* when whitefly attack was reasonably controlled. The yellow mosaic virus caused 30-70% yield loss (Marimuthu *et al.,* 1981). Chamder and Singh (1991) noticed 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 were applied 55 days after sowing.

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

Sunil and Singh (2010) conducted a field experiment to manage yellow mosaic *(Mungbean yellow mosaic virus)* and cercospora leaf spots (*Cercospora canescens* and *Pseudocercospora cruenta*) of mungbean. Insecticides and fungicides as seed dressings, with or without foliar sprays, were evaluated. Amongst the treatments, a combination of seed treatment with thiamethoxam (Cruiser TM) at 4 g kg^{-1} and carbendazim (Bavistin TM), TMTD (Thiram TM) at 2.5 g kg^{-1} (1:1 ratio) followed by foliar applications of thiamethoxam (Actara TM) 0.02% and carbendazim 0.05% at 21 and 35 days, respectively after sowing produced the highest seedling establishment, shoot and root lengths, number of pods, plant biomass, 1000-seed weight, and grain yield in mungbean with the lowest intensity of cercospora 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.

In the field trials at the experiment station and in a farmer's field at Mbita near the shores of Lake Victoria, Kenya, applications of 2 or 3% neem seed extract (NSE) @ 200 ha^{-1} with a knapsack sprayer at 38, 47 and 51 days after emergence (DE) of the cowpea crop or 5, 10 and 20% NSE sprayed @ 10 ha^{-1} with an ultra-low-volume applicator at 31, 39 and 49 DE often significantly reduced the number of larvae of the flower thrips, *Megalurothrips usitatus* (Trybom), in cowpea flowers recorded 2 days after each treatment. Also fewer adults occurred in flowers at 51DE in plots sprayed with 5, 10 and 20% NSE. Cowpea grain yield was significantly higher in plots sprayed with 2% NSE than in untreated control plots and was comparable to the grain yield obtained in plots sprayed thrice with cypermethrin. Because of the low cost of NSE treatment, the net gain was often more when the crop was sprayed with NSE than with cypermethin. Also, grain quality was superior in neem-treated plots than in untreated or cypermethrin-treated plots (Kidiavai, 2009).

Regression analysis was done to quantify yield variations in cowpea due to major insect pests, i.e., aphids, thrips, Maruca pod borer, *Maruca vitrata* Fabricius and a complex of pod sucking bugs. Variability in pest infestation was created by growing Ebelat (an erect cowpea cultivar) in two locations over three seasons and under different insecticide spray schedules. Stepwise regression for individual locations and seasons data indicated that most of the variation in cowpea grain yields was caused by thrips. We estimated that to the total variation in cowpea grain yields, on average, the major pests contribute 51-69% in Pallisa nd 24-48% in Kumi. Thrips alone contribute 35-41% and 13-19% at these two sites, respectively (Kyamanywa, 2009).

Singh *et al.* (2009) investigated certain management schedules against major insect pests of *Vigna radiata* (L.) Wilczek, was carried out for two crop seasons (July to October 2001 and 2002) at the Agronomy Farm and the Department of Agricultural Zoology and Entomology of Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology, Udaipur, India. The efficacy of *Azadirachta indica* A. Juss oil and malathion, as first application against aphids, jassids and whiteflies was significantly lower under sole crop of *V. radiata* than when it was inter-cropped with maize during both years (2001 and 2002). Among the different treatment schedules as third application, endosulfan was the most effective insecticide against the pod borers *(Maruca testulalis* Geyer and *Lampides boeticus* L.) in both sole crop and the intercrop. During the two-year study (2001 and 2002), the maximum yield of maize and green gram in the inter-cropped pattern and that as sole crop of green gram, as well as the maximum rupee equivalent yield value was recorded for the management schedule comprising release of *Chrysoperla carnea* 25 DAS, spray of *A. indica* oil 40 DAS and endosulfan 55 DAS. The lowest yield of *V. radiata* was recorded under the management schedule comprising three release of *Chrysoperla carnea* Stephen at 25, 40 and 55 DAS, irrespective of the cropping pattern.

Gupta and Pathak (2009) reported on the efficacy of some indigenous neem products, insecticides on whitefly and yellow mosaic disease at Research Farm of College of Agriculture, Tikamgarh during *kharif* 2003-2005. The results indicated that admixture treatments, neem seed kernel extract (NSKE) (in cow urine), 3% + dimethoate, 0.03% and neem oil, 0.5% + dimethoate, 0.03% not only reduced the incidence of whitefly and yellow mosaic but also of pod borer. These treatments gave maximum grain yield of 935 and 902 kg ha^{-1}, net profit of Rs 3934 and Rs 3320 ha^{-1} with incremental cost benefit ratio of 11.2 and 10.9, respectively.

Hossain *et al.* (2009) conducted an experiment at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the insect pests attacking mungbean sown at different dates to determine the optimum date(s) of sowing. The highest yield (1548 kg ha^{-1}) was obtained from March 27 sowing crop. The second highest yield (1279 kg ha^{-1}) was obtained from March 13 sowing which was statistically similar to March 20, April 03 and April 10 sowing. Again, the delayed sowing after mid-April to onward provided yield of 717 kg ha^{-1} to 178 kg ha-1 which were very poor. Hence, for ensuring higher yield and less insect pest's infestation, mungbean should be sown within the period of March 13 to April 10 and the best date of sowing should be March 27.

Botanical pesticides are the most cost effective and environmentally safe inputs in integrated pest management (IPM) strategies. There are about 3000 plants and trees with insecticidal and repellant properties in the world, and India is the home of about 70% of this floral wealth (Nazrussalam, 2008). Nazrussalam has chronicled the use of more than 450 botanical derivatives used in traditional agricultural systems and neem is one of the well- documented trees, and almost all the parts of three tree have been found to have insecticidal value. The neem seed kernel extracts, neem oil, extracts from the leaves and barks have all been used since ancient times to keep scores of insect pests away. A number of commercial neem-based insecticides are now available and they have displaced several toxic chemical insecticides. The extracts are of particular value in controlling the sucking and chewing pests. The young caterpillars devouring the tender leaves can be well managed by the botanical insecticides. The plant materials should be thoroughly washed before preparing the extract, and the right quantity should be used. The pest control potential demonstrated by various extracts and compounds isolated from the kernels and leaves of the neem plant *(Azadirachta indica)* neem to be of tremendous importance for agriculture in developing countries.

Thrips (Thysanoptera) and their predators were investigated from 2005-2007 on a wide range of vegetables grown mostly in the winter period in Eukurova region of Turkey. A total of 2989 adult thrips and 406 thrips larvae were collected from the vegetables. The adults belonged to 14 thrips species of which *Melanthrips* spp. were the most dominant species. The dominance of the commonly found pests *Thrips tabaci* and *Frankliniella occidentalis* differed greatly. *F. occidentalis* was the predominant thrips infesting broad bean, lettuce and parsley, while *T. tabaci* was more abundant on leek, onion and pea. The most thrips were collected from flowers or heads of vegetables in early spring. Numbers of predatory insects dwelling on the sampled vegetables were lower in comparison to total numbers of thrips obtained in the years 2006 and 2007. Of the predators, the hemipteran generalists *Orius laevigatus* and *O. niger* were the most prevalent and high numbers of them were recorded often on flowers of broad bean in winter. (Atakan, 2008).

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 the highest yield of 1563 kg ha^{-1} while the lowest seed yield of 1056 $kgha^{-1}$) was obtained from the control plots where no insecticide was applied.

Prodhan *et al.* (2008) conducted an experiment was at the field of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna, during March to June 2008 to develop integrated management practices against insect pest complex of mungbean. The management practices tested in the study were T_1= Seed treatment with Imidaclorpid (5g kg^{-1} seeds) + Poultry manure (3t ha^{-1}) + Sequential release of bio-control agent *(Trichograma chilonis + Bracon habetor)* + Detergent @ 2g l^{-1} of water, T_2= Seed treatment with Imidaclorpid (5g kg^{-1} seeds) + Poultry manure (3t/ha) + Sequential release of biocontrol agent (*Trichograma chilonis + Bracon habetor)* +Neem seed karnel extract @ 50gm/lof water, T_3= Seed treatment with Imidaclorpid (5g kg^{-1} seeds) + Poultry manure (3t ha^{-1}) + Spray with Quinalphos @ 1ml / l of water and T_4= Untreated control. All the treatments significantly reduced insect infestation (except thrips) and produced higher yield compared to control. It was found that the highest yield was obtained from the treatment T_3 (1316 kg ha^{-1}) which was statistically similar to T_2 (1316 kg/ha) and T_1 (1283 kg/ha). In case of Benefit Cost Ratio (BCR), the highest value was obtained from the treatment T3 (1.84), which was followed by T_1 (1.55) and T_2 (1.31).

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 (YMD). 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) investigated on Mothbean which was severely attacked by yellow mosaic disease. The virus is considered to be transmitted through vector whiteflies *(Bemisia tabaci* Genn). One of the ways to overcome the problem is development of disease resistant varieties. The local land races are highly susceptible to this serious disease. To purify the available germplasms accessions a country-wide survey was conducted and some 66 lines of mothbean including the accession from PGRI, NARC, Islamabad were collected for screening against *MYMV*. All the 66 germ plasm accession were planted at Agricultural Research Institute, D.I. Khan during 2004. Most of the lines were totally destroyed by *MYMV*. 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 mothbean against *MYMV*. The disease data were recorded on a 1-9 rating scale. The observations revealed that there exists greater genetic variability in mothbean lines against their response to *Mungbean yellow mosaic virus*. The results further revealed that selection response was quite positive. The lines showing resistance in previous year had again showed resistance and vice versa.

Experiment with botanical pesticides has also been conducted in Bangladesh on a limited scale. Islam (2004) reported that extract of leaf, seed and oil of neem, showed potential as antifeedants or feeding and oviposition deterrents for the brown plant hopper, green leaf hopper, rice hispa and lesser rice weevil. He also conducted experiments to ascertain the optimal doses of the extract against rice hispa, and pulse beetle. Addition of sesame or linseed oil to extract of neem resulted in higher mortality of the grubs and in greater deterrence in feeding and oviposition compared to those obtained with neem extract alone (Islam, 2006).

Rajnish *et al.* (2006) conducted an experiment to control *Mungbean yellow mosaic virus.* They found dimethoate (0.03%), monocrotophos (0.04%) and carbofuran (0.5 kg a.i ha^{-1}) gave better response and were found most effective followed by neem based formulations as moderately effective. The neem based insecticides *viz.,* NSKE (3%). achook (0.3%), neem gold (0.3%) and nimbecidin (0.3%) were found comparable to monocrotophos and dimethoate in all respects. All the insecticides were found economical but two sprays of dimethoate were found most effective and economical.

Oparaeke *et al.* (2005) investigated on the efficacy of some plant extracts against post flowering insect pestsof cowpea (Maruca pod borers and Clavigralla tomentosicollis Stal.). The results revealed that in 2000 and 2001 seasons the mean number of Maruca vitrata (F.) was reduced (< 1.0 / flower and /or pod) on plots sprayed with leaf extracts of Neem + Lemongrass, Neem + African curry, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. Pod sucking bugs (dominated by C. tomentosicollis) numbers were suppressed (< 1.5 / plant) on plots treated with leaf extracts of Neem + African curry, Neem + Lemongrass, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield compared with the unsprayed plots during the two years of investigation. The complementary roles played by individual plant species used for the extracts mixtures in reducing pests numbers and increasing grain yields on sprayed plots suggest the future direction of new formulations of Biopesticides in the management of field pests of crops on farms owned by resource limited farmers in low input agriculture characterizing the developing countries.

Pathak and Jhamaria (2004) evaluated fourteen mungbean varieties for resistance against *Mungbean yellow mosaic virus* at ARS Navgaon. They found ML-5 and MUM-2 were resistant with only 2.22 and 3.12 percent infection as against hundred percent infection in K-851, a check cultivar.

Khattak *et al.* (2004) conducted an experiment at Agriculture Research Station, Kalurkot, Bhakkar to evaluate the efficacy of Mospilan 20SP, Actara 25WG, polo 500EC, Tamaron 60SI and confidor 200SL against whitefly, jassids, and thrips on mungbean. All the tested insecticides reduced the mean percent population of whiteflies even at 240 hours after spray. Similar trend of efficacy was also noticed against thrips, but Atari 25WG lost its efficacy at 240 hours after spray. Against jassids. Misplay 20 SP, Polo 500 EC, and Confider 200SL at 120 hours and 240 hours after spray were completely ineffective. Variation in the mean percent population of the test insects by insecticides, especially, a sudden drop in the efficacy of insecticides at 72 hours after spray almost against the tested insect pests could be because of the special temporary changes in the environmental conditions.

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

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

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

Sucking insects not only reduce the vigor of the plant by sucking the sap but also transmit disease and affect the photosynthetic activity that is the main source of producing more number of pods plant^{-1} (Sethuraman *et al.,* 2001). He also reported that the minimum 1000 seed weight (41.7 gm) was observed in case of plots where no pesticide was applied to control sucking insect pest complex.

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

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

CHAPTER III

MATERIALS AND METHODS

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MATERIALS AND METHODS

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

3.1. Location and research period

The field experiment was conducted at the Sher-e-Bangla Agricultural University central Farm under the Department of Plant Pathology, Dhaka- 1207 during June to September, 2014.

3.2. Soil

The soil of the experimental field belongs to the Tejgaon series under the Agro ecological Zone, Madhupur Tract (AEZ- 28) and the General Soil. Salient features of the experimental field and initial physical and chemical properties of experimental soil are presented in Appendix I and II respectively.

3.3. Climate

The experimental area has sub-tropical climate characterized by high temperature, heavy rainfall during May to September and scanty rainfall during rest of the year. The annual precipitation of the site is 2052 mm and potential evapotranspiration is 1286mm, the average maximum temperature is 30.35 ^{0}C, average minimum temperature is 21.14 ^{0}C and the average mean temperature is 25.12 ^{0}C (BBS, 2010).

3.4. Seeds and variety

3.4.1. For screening

BARI Mungbean-2, BARI Mungbean-3, BARI Mungbean-4, BARI Mungbean-5, BARI Mungbean-6 variety of Mungbean were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. BINA Mungbean-7, BINA Mungbean-8 variety of Mungbean was collected from Bangladesh Institute of Nuclear Agriculture (BINA).

3.4.2. For management

BARI Mungbean-5, a high yielding variety of mungbean was released by Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur in 1997. It is photo insensitive, short lifespan 55 to 60 days and bold seeded crop. The special characteristic of this variety is its synchronized maturity. It was developed from the NM-92 line introduced by AVRDC in 1992. Its yield potentiality is about 1.5 to 1.7 ton ha^{-1}. This variety is resistant to yellow mosaic virus disease, insect and pest attack.

3.5. Design and layout of experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and two blocks as ‘Screening’ and ‘Treatment’. For screening seven cultivars, there were 21(3 × 7) unit plots. And for treatment six treatments with a control, there were 21(3 × 7) unit plots. Thus there were 42 (21 + 21) unit plots altogether in the experiment. The size of each unit plot was (1.5 m × 1.5) m. Plot to plot distances were 0.5 m. Screening block to treatment block distances 1m. The cultivars and treatments of the experiment randomly distributed into the experimental plot.

Screening blokes

V_1	V_3	V_6
V_3	V_5	V_3
V_5	V_1	V_7
V_2	V_4	V_2
V_6	V_7	V_4
V_4	V_2	V_5
V_7	V_6	V_1

Management blokes

T_2	T_6	T_3
T_4	T_1	T_7
T_6	T_5	T_2
T_1	T_3	T_4
T_7	T_2	T_5
T_3	T_4	T_1
T_5	T_7	T_6

Fig. 1. Layout of the experimental field

Legend:

Plot size = 1.5 × 1.5 m^2

Border distance = 0.5 m

Block to block distance = 0.5 m

Distance between two experiment field = 1 m

3.5.1. Cultivars for screening blocks

1. V_1 = BARI Mungbean-2
2. V_2 = BARI Mungbean-3
3. V_3 = BARI Mungbean-4
4. V_4 = BARI Mungbean-5
5. V_5 = BARI Mungbean-6
6. V_6 = BINA Mungbean-7
7. V_7 = BINA Mungbean-8

3.5.2. Treatments for management blocks

1. T_1 = Admire
2. T_2 = Aktara
3. T_3 = Marshall
4. T_4 = Confider
5. T_5 = Garlic Extract
6. T_6 = Neem Extract
7. T_7 = Control

3.6. Land preparation

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

3.7 Fertilizers application

The sources of N, P_2O_5, K_2O were urea, triple superphosphate (TSP), muriate of potash (MOP), were applied, respectively. Whole amount of urea, the entire amounts of TSP, MOP were applied during the final land preparation respectively. Well decomposed 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.

3.8. Sowing of seeds

Seeds were sown in the main field on the 8^{th} June, 2014 having line to line distance of 30 cm and plant to plant distance of 10 cm.

3.9. Cultural and management practices

Various intercultural operations such as thinning of plants, weeding and spraying of insecticides were accomplished whenever required to keep the plants healthy and the field weed free. At the very early growth stage (after l5 days of emergence of seedlings) the plants were attacked by Cutworm, which was controlled by applying Malathion. Special care was taken to protect the crop from birds especially after sowing and germination stages. The field was irrigated twice- one at 15 days and the other one at 30 days after sowing.

3.10. Harvesting

The crop was 1^{st} harvested at maturity on 12^{th} August, 2014. The harvested crop of each plot was bundled separately. Grains were recorded plot wise and the yields were expressed in gram (g) as per plant and per ha.

3.11. Collection of experimental data

Five (5) plants from each plot were selected at random and were tagged for the data collection. Data were collected at different stage. The seed yield per plot was recorded after cleaning and drying those properly in the sun. Data were collected on the following parameters:

A. Collection data for screening blocks

1) Disease incidence
2) Disease severity
3) Plant height (cm)
4) Number of branch plant^{-1}
5) Number of pod plant^{-1}
6) Pod length (cm)
7) Number of seeds pod^{-1}
8) Yield plant^{-1}
9) Yield ha^{-1}

B. Collection data for management blocks

1) Disease incidence
2) Disease severity
3) Plant height (cm)
4) Number of branch plant^{-1}
5) Pod length (cm)
6) Number of seeds pod^{-1}
7) Yield ha^{-1}

3.11.1. Collection of data for screening blocks

a) Disease incidence (%)

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

$$\% \text{ Disease incidence} = \frac{\text{Number of infected leaf}}{\text{Number of total leaf}} \times 100$$

b) Disease severity (%)

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

$$\% \text{ Disease severity} = \frac{\text{Percent leaf area infection}}{\text{Total leaf area}} \times 100$$

c) Plant height (cm)

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

d) Number of branches plant^{-1}

Branches were counted at the ripening stage. Branches of 5 plants randomly from each plot were counted and averaged.

e) Number of pods plant^{-1}

Pods were counted at the ripening stage. Pods of 5 plants randomly from each plot were counted and averaged.

f) Pod length (cm)

Length of 5 pods from each plot were measured randomly and averaged after harvesting.

Plate 1. Length of different mungbean pod

g) Number of seeds pod^{-1}

It was done after harvesting. At first, number of seeds pod^{-1}" was counted. Seeds of 5 pods randomly from each plot were counted and averaged.

Plate 2. Number of seeds pod^{-1} of mungbean

h) Yield (g $plant^{-1}$)

Grain obtained from 5 plants randomly from each plot were dried, weighed and averaged.

Plate 3. Yield $plot^{-1}$ of different mungbean varieties

i) Yield (kg ha^{-1})

Grains obtained from 2.25 m^2 area from the center of each unit plot were dried, weighed carefully and then it was converted to kg ha^{-1}.

3.11.2. Collection data for management blocks

a) Disease incidence (%)

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

$$\%\ \text{Disease incidence} = \frac{\text{Number of infected leaf}}{\text{Number of total leaf}} \times 100$$

b) Disease severity (%)

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

$$\%\ \text{Disease severity} = \frac{\text{Percent leaf area infection}}{\text{Total leaf area}} \times 100$$

c) Plant height (cm)

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

d) No. of branches plant^{-1}

Branches were counted at the ripening stage. Branches of 5 plants randomly from each plot were counted and averaged.

e) Pod length (cm)

Length of 5 pods from each plot were measured randomly and averaged after harvesting.

f) Number of seeds pod^{-1}

It was done after harvesting. At first, number of seeds pod" was counted. Seeds of 5 pods randomly from each plot were counted and averaged.

g) Yield (Kg ha^{-1})

Grains obtained from 2.25 m^2 area from the center of each unit plot were dried, weighed carefully.

3.12. Statistical analysis

The collected data were statistically analyzed by using the ANOVA technique. The test of significance of all parameters was done. The Duncan's Multiple Range Test (DMRT) with Least Significant Difference value was determined with appropriate levels of significance and the means were tabulated. The mean comparison was carried out by DMRT technique (Gomez and Gomez, 1984). The statistical package MSTAT-C was used for this purpose.

CHAPTER IV

RESULTS

CHAPTER IV

RESULTS

The experiment was conducted to screening of mungbean cultivars against *Mungbean yellow mosaic virus (MYMV)* and its management. Seven different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neem Extract) and T_7 (Control) were applied in BARI mungbean-5 against *MYMV*. For disease performance, yield and yield contributing performance, seven mungbean varieties were used *viz*., V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8). The results of the present investigation have been presented, discussed and compared as far as possible with the results of other research.

4.1. Morphological features related to yield contributing characters

4.1.1. Plant height (cm)

Significant variation was found in case of plant height among the different varieties under the present study (Table 1). Results indicated that the highest plant height (86.95 cm) was observed in V_2 (BARI Mungbean-3) which was statistically identical with V_1 (BARI Mungbean-2), V_3 (BARI Mungbean-4) and V_6 (BINA Mungbean-7). The lowest plant height (64.70 cm) was obtained from V_4 (BARI Mungbean-5) which was significantly different from all other varietties. The results obtained from all other tested varieties gave intermediate plant height in respect to highest and lowest results.

4.1.2. Number of branch plant^{-1}

Number of branch plant^{-1} was significantly influenced by the different varieties that were used in the present study (Table 1). Results showed that the highest number of branch plant^{-1} (3.30) was observed in V_5 (BARI Mungbean-6) which was closely followed by V_1 (BARI Mungbean-2) and V_3 (BARI Mungbean-4). The lowest number of branch plant^{-1} (0.97) was obtained from V_4 (BARI Mungbean-5) which was also closely followed by V_2 (BARI Mungbean-3) and V_6 (BINA Mungbean-7). The other variety, V_7 (BINA Mungbean-8) showed intermediate type results.

4.1.3. Number of pods plant^{-1}

Significant variation was observed for number of pods plant^{-1} among the different varieties (Table 1). The highest number of pods plant^{-1} (31.89) was observed in V_5 (BARI Mungbean-6) which was closely followed by V_7 (BINA Mungbean-8). The lowest number of pods plant^{-1} (19.93) was obtained from V_4 (BARI Mungbean-5) which followed by V_2 (BARI Mungbean-3). The results obtained from the rest of the varieties, V_1 (BARI Mungbean-2), V_3 (BARI Mungbean-4) and V_6 (BINA Mungbean-7) were intermediate type compared to highest and lowest value.

4.1.4. Pod length (cm)

Significant influence was found in case of pod length among the different varieties under the present study (Table 1). Results indicated that the highest pod length (8.19 cm) was observed in V_5 (BARI Mungbean-6) which was statistically identical with V_1 (BARI Mungbean-2) and V_7 (BINA Mungbean-8) followed by V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4) and V_6 (BINA Mungbean-7). The lowest pod length (6.02 cm) was obtained in V_4 (BARI Mungbean-5).

4.1.5. Number of seeds pod^{-1}

Number of seeds pod^{-1} did not show significant difference among the varieties(Table 1). The highest number of seeds pod^{-1} (11.40) was observed in V_5 (BARI Mungbean-6) and the lowest number of seeds pod^{-1} (10.33) was obtained from V_4 (BARI Mungbean-5).

4.1.6. Yield (g plant^{-1})

Significant variation was found in case of yield plant^{-1}, among the different varieties under the present study (Table 1). The highest yield (6.73 g plant^{-1}) was observed in V_5 (BARI Mungbean-6) which was statistically identical with V_7 (BINA Mungbean-8). The lowest yield (3.80 g plant^{-1}) was obtained from V_1 (BARI Mungbean-2). The results obtained from the rest of the varieties, V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5) and V_6 (BINA Mungbean-7) provided intermediate results compared to the highest and the lowest value.

4.1.7. Yield (kg ha^{-1})

Significant variation was observed for number of seed yield ha^{-1} among the different varieties (Table 1). The highest seed yield (2433 kg ha^{-1}) was observed in V_5 (BARI Mungbean-6) which was significantly different from all other tested varieties. The second highest seed yield (2023.33 kg ha^{-1}) and the third highest seed yield (1837.15 kg ha^{-1}) was obtained from the varieties of V_7 (BINA Mungbean-8) and V_6 (BINA Mungbean-7) respectively. Conversely, the lowest seed yield (1240.67 kg ha^{-1}) was obtained from V_4 (BARI Mungbean-5) which was significantly different from all other varieties. The results obtained from the rest of the varieties, V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3) and V_3 (BARI Mungbean-4) also provided comparatively lower seed yield but significantly higher than that of V_4 (BARI Mungbean-5).

Table 1: Morphological features related to the yield and yield contributing characters of mungbean cultivars against *Mungbean yellow mosaic virus*

Cultivars	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	Yield plant^{-1} (g plant^{-1})	Yield (kg ha^{-1})
V_1	82.54 a	2.86 ab	24.87 a-c	8.10 a	10.60	3.80 e	1383.10 e
V_2	86.95 a	1.30 bc	22.00 bc	6.40 ab	10.73	5.00 cd	1507.30 d
V_3	85.97 a	2.66 ab	26.87 a-c	7.10 ab	10.93	4.60 d	1333.24 f
V_4	64.70 d	0.97 c	19.93 c	6.02 b	10.33	5.20 c	1240.67 g
V_5	70.15 c	3.30 a	31.89 a	8.19 a	11.40	6.73 a	2433.00 a
V_6	83.92 a	1.52 bc	28.67 a-c	7.46 ab	10.87	6.00 b	1837.15 c
V_7	77.13 b	2.33 a-c	30.67 ab	8.02 a	11.13	6.60 a	2023.33 b
DMRT	4.87	1.527	8.753	1.721	NS	0.419	18.19
CV (%)	8.28	9.11	13.29	9.41	9.59	11.98	10.39

V_1 = BARI Mungbean-2

V_2 = BARI Mungbean-3

V_3 = BARI Mungbean-4

V_4 = BARI Mungbean-5

V_5 = BARI Mungbean-6

V_6 = BINA Mungbean-7

V_7 = BINA Mungbean-8

4.2. Response of mungbean cultivars against *Mungbean yellow mosaic virus*

4.2.1. Disease incidence (%)

Disease incidence of different Mungbean cultivars like as V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8) against *Mungbean yellow mosaic virus* were measured at 30 days after sowing, 40 DAS and 50 DAS differed significantly (Table 2). At 50 DAS, minimum disease incidence was found in V_5 (BARI Mungbean-6; 6.67%) followed by V_2 (BARI Mungbean-3; 8.89%) and V_7 (BINA Mungbean-8; 11.67%). The maximum disease incidence was found in V_4 (BARI Mungbean-5; 17.22%), followed by V_1 (BARI Mungbean-2; 15.00%) and V_6 (BINA Mungbean-7; 14.44%). At 30 and 40 DAS, the higher disease incidence (5.00% and 15.00% respectively) was found in V_1 (BARI Mungbean-2) followed by V_6 (BINA Mungbean-7) and V_4 (BARI Mungbean-5). But the minimum disease incidence was found in V_5 (BARI Mungbean-6) (2.22% and 5.00% at 30 and 40 DAS respectively) followed by V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4) and V_7 (BINA Mungbean-8). So, it was found that at all stages the minimum disease incidence in V_5 (BARI Mungbean-6).

Table 2. Disease incidence of different Mungbean cultivars against *Mungbean yellow mosaic virus*

Cultivars	Disease incidence (%)		
	30 DAS	40 DAS	50 DAS
V_1	5.00 ab	15.00 a	15.00 ab
V_2	3.88 b	6.11 e	8.89 c
V_3	5.55 ab	8.33 d	12.22 b
V_4	3.33 bc	12.22 ab	17.22 a
V_5	2.22 c	5.00 e	6.67 d
V_6	6.66 a	14.45 a	14.44 ab
V_7	3.88 b	11.67 c	11.67 b
DMRT	1.668	2.479	2.968
CV (%)	6.36	8.03	9.70

V_1 = BARI Mungbean-2

V_2 = BARI Mungbean-3

V_3 = BARI Mungbean-4

V_4 = BARI Mungbean-5

V_5 = BARI Mungbean-6

V_6 = BINA Mungbean-7

V_7 = BINA Mungbean-8

4.2.2. Disease severity (%)

Under the present study, disease severity of different Mungbean cultivars *viz*., V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8) against *Mungbean yellow mosaic virus* were measured at 30, 40 and 50 DAS differed significantly (Table 3). At 50 DAS, the minimum disease severity (17.67%) was found in V_5 (BARI Mungbean-6) that was statistically different from all other results followed by V_7 (BINA Mungbean-8; 28.33%). Likewise, the maximum disease severity (47.33%) was found in V_3 (BARI Mungbean-4) that was statistically same with second maximum disease severity (45.00%) found in V_4 (BARI Mungbean-5) followed by V_6 (BINA Mungbean-7). At 30 and 40 DAS, V_3 (BARI Mungbean-4) showed higher disease severity (19.33% and 38.00% respectively) followed by V_6 (BINA Mungbean-7) (25.00% and 35.00% at 30 and 40 DAS respectively). V_5 (BARI Mungbean-6) gave minimum disease severity (8.67% and 12.67% at 30 and 40 DAS respectively) followed by V_7 (BINA Mungbean-8). So, it was found that at all stages, the minimum disease severity was in V_5 (BARI Mungbean-6).

Table 3. Disease severity of different mungbean cultivars against *Mungbean yellow mosaic virus*

Cultivars	Disease severity		
	30 DAS	40 DAS	50 DAS
V_1	20.00 ab	27.33 bc	34.33 b
V_2	20.67 ab	27.00 bc	33.33 b
V_3	19.33 ab	38.00 a	47.33 a
V_4	10.67 cd	30.00 ab	45.00 a
V_5	8.67 d	12.67 d	17.67 c
V_6	25.00 a	35.00 ab	43.67 a
V_7	15.00 bc	21.00 c	28.33 b
DMRT	5.719	7.751	8.133
CV (%)	18.86	11.39	9.14

V_1 = BARI Mungbean-2

V_2 = BARI Mungbean-3

V_3 = BARI Mungbean-4

V_4 = BARI Mungbean-5

V_5 = BARI Mungbean-6

V_6 = BINA Mungbean-7

V_7 = BINA Mungbean-8

4.2.3. Relationship between disease incidence and severity at 50 DAS with yield of different mungbean varieties.

Yield ha^{-1} (kg) of different mungbean varieties was releted with disease incidence and disease severity (Fig. 2). Increased yield was observed with decreased disease incidence and severity. Results showed that the highest yield was found in BARI mungbean-5 where disease incidence and disease severity was the lowest. Similarly, the lowest yield was found in BARI mungbean-4 which was affected by disease severely. It was observed that yield is negatively functioned with the severity of disease incidence.

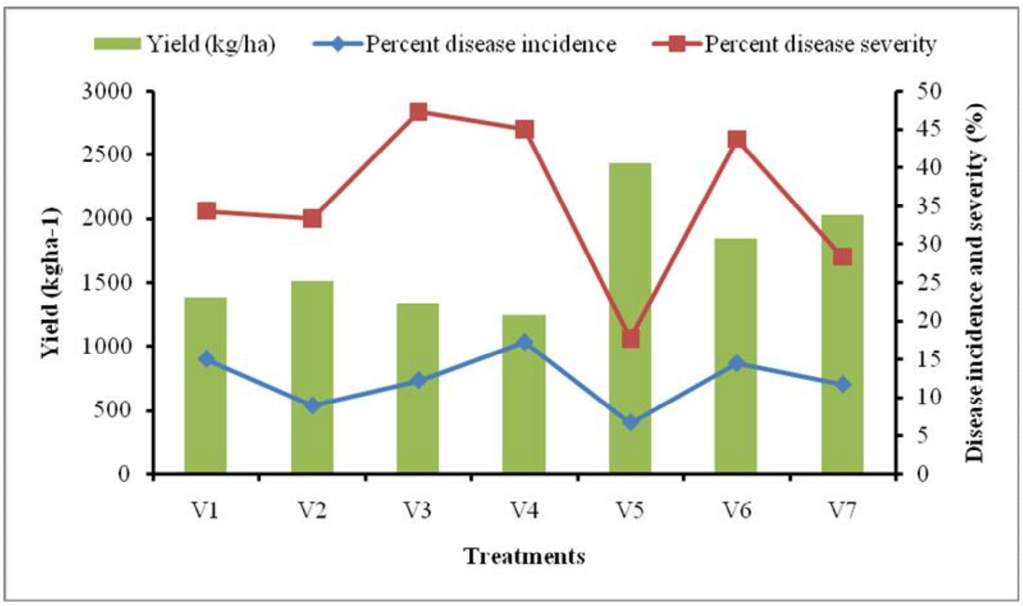

Fig. 2. Yield of different mungbean varieties in rrelation to disease incidence and disease severity

V_1	=	BARI Mungbean-2	V_5	=	BARI Mungbean-6
V_2	=	BARI Mungbean-3	V_6	=	BINA Mungbean-7
V_3	=	BARI Mungbean-4	V_7	=	BINA Mungbean-8
V_4	=	BARI Mungbean-5			

4.3. Effect of different treatments on yield and yield contributing characters of BARI mungbean-5

4.3.1. Plant height (cm)

In the present study, great influence was found in case of plant height among the different treatments for controlling *Mungbean yellow mosaic virus* (Table 4). Results indicated that the highest plant height (68.03 cm) was observed in T_3 (Marshall) which was statistically different from all other treatments. The second highest plant height (65.60 cm) was observed in T_4 (Confider) followed by T_1 (Admire) and T_7 (Control). Results also indicated that the lowest plant height (60.45 cm) was obtained from T_6 (Neem Extract) which was also significantly different from all other treatments. The results obtained from all other treatments gave mid-level plant height in respect to the highest and the lowest results.

4.3.2. Number of branch plant^{-1}

Number of branch plant^{-1} was significantly influenced by the different treatments that were used in the present study (Table 4). Results showed that the highest number of branch plant^{-1} (3.22) was observed in T_1 (Admire) which was closely followed by T_3 (Marshall). Similarly, the lowest number of branch plant^{-1} (1.99) was obtained from control treatment (T_7) which was statistically identical with T_5 (Garlic Extract) followed by T_6 (Neem Extract). The results obtained from the rest of the treatments, T_2 (Aktara) and T_4 (Confider) showed intermediate result compared to the highest and the lowest value.

4.3.3. Pod length (cm)

Variation in pod length was insignifecant (Table 4). However the highest pod length (8.95 cm) was observed in T_1 (Admire) where the lowest pod length (8.55 cm) was obtained from T_7 (Control).

4.3.4. Number of seeds pod^{-1}

No significant variation was also found in terms of number of seeds pod^{-1} among the different treatments in the present study (Table 4). Results showed that the highest number of seeds pod^{-1} (12.40) was observed in T_1 (Admire) where the lowest number of seeds pod^{-1} (11.40) was obtained from T_7 (Control).

4.3.5 Yield (kg ha^{-1})

Significant variation was observed for number of seed yield ha^{-1} among the different treatments (Table 4). Results indicated that the highest seed yield (1877.33 kg ha^{-1}) was observed in T_1 (Admire) which was significantly different from all other treatments. The second highest seed yield (1720.00 kg ha^{-1}) and third highest seed yield ha^{-1} (1013.00 kg) was obtained from the treatments of T_2 (Aktara) and T_3 (Marshall) respectively. Conversely, the lowest seed yield (1013.00 kg ha^{-1}) was obtained from T_7 (Control) followed by T_6 (Neem Extract) and T_5 (Garlic Extract). The results obtained from the rest of the variety, T_4 (Confider) provided intermediate result considering the highest and the lowest seed yield.

Table 4: Effect of different treatments on yield and yield contributing characters in BARI Mungbean-5 against *Mungbean Yellow Mosaic Virus*

Treatments	Plant height (cm)	Number of branch $plant^{-1}$	Pod length (cm)	Number of seeds pod^{-1}	Yield (kg ha^{-1})
T_1	63.55 bc	3.22 a	8.95	12.40	1877.33 a
T_2	62.70 d	2.55 b	8.83	12.33	1790.67 b
T_3	68.03 a	2.89 ab	8.80	11.47	1720.00 c
T_4	65.60 b	2.55 b	8.73	12.13	1553.67 d
T_5	63.08 c	2.00 d	8.57	11.80	1390.38 e
T_6	60.45 e	2.33 cd	8.65	11.87	1323.00 f
T_7	64.74 b	1.99 d	8.55	11.40	1013.00 g
DMRT	1.087	0.197	NS	NS	16.42
CV (%)	8.47	8.57	4.47	3.59	12.32

T_1 = Admire

T_2 = Aktara

T_3 = Marshall

T_4 = Confider

T_5 = Garlic Extract

T_6 = Neem Extract

T_7 = Control

4.4. Response of different chemical and bio-pesticides with BARI mungbean-5 for controlling *Mungbean yellow mosaic virus*

4.4.1. Disease incidence (%)

Disease incidence was measured after application of different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neem Extract Extract) and T_7 (Control) in BARI mungbean-5 against *Mungbean yellow mosaic virus* were considered at 30, 40 and 50 DAS differed significantly (Table 5). In terms of 50 DAS, minimum disease incidence (4.44%) was found from T_1 (Admire) treatment followed by T_2 (Aktara) (7.55%) where the maximum disease incidence (15.55%) was found from T_7 (Control) treatment followed by T_5 (Garlic Extract) and T_6 (Neem Extract Extract). Similar trend was also found for 30 and 40 DAS and it was found that T_1 (Admire) gave the best performance where T_7 (Control) showed the lowest performance. In the present study T_1 (Admire) proved to be the best in terms of disease incidence during cropping season compared to other treatments.

Plate 4. Disease incidence in BARI mungbean-5 with the treatment of different chemical and bio-pesticides

Table 5. Effect of different treatment on disease incidence of *Mungbean yellow mosaic virus* in BARI mungbean-5 at different days after sowing

Treatment	Disease incidence (%)		
	30 DAS	40 DAS	50 DAS
T_1	1.33 d	3.11 f	4.44 e
T_2	3.55 c	4.89 ef	7.55 d
T_3	5.33 a	9.33 b	12.44 b
T_4	3.55 c	7.55 cd	10.22 c
T_5	4.00 ab	10.67 ab	12.00 b
T_6	4.00 ab	8.44 c	12.45 b
T_7	4.00 ab	12.44 a	15.55 a
DMRT	1.044	1.123	1.597
CV (%)	40.01	30.45	21.04

T_1 = Admire

T_2 = Aktara

T_3 = Marshall

T_4 = Confider

T_5 = Garlic Extract

T_6 = Neem Extract

T_7 = Control

4.4.2. Disease severity (%)

Disease severity was measured after application of different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neem Extract Extract) and T_7 (Control) in BARI mungbean-5 against *Mungbean yellow mosaic virus* were considered at 30, 40 and 50 DAS differed significantly (Table 6). In terms of 50 DAS, minimum disease severity (17.67%) was found from T_1 (Admire) treatment followed by second minimum disease severity (28.33%) T_2 (Aktara) treatment. The maximum disease severity (47.33%) was obtained from T_7 (Control) treatment which was statistically identical with second and third maximum disease severity (45.67 and 42.00 respectively) were obtained from T_4 (Confider) and T_6 (Neem Extract Extract) respectively followed by T_5 (Garlic Extract) treatment. Similar trend was also found for 30 and 40 DAS and T_1 (Admire) gave the best performance where T_7 (Control) showed the lowest performance for controlling disease. In the present study T_1 (Admire) proved to be the best in terms of disease severity during cropping season compared to other treatments.

Plate 5. Disease severity in BARI mungbean-5 with the treatment of different chemical and bio-pesticides

Table 6. Effect of different treatments on disease severity of mungbean yellow mosaic virus in BARI mungbean-5 at different days after sowing

Treatments	Disease severity		
	30 DAS	40 DAS	50 DAS
T_1	8.66 d	12.67 e	17.67 d
T_2	15.00 bc	21.00 d	28.33 c
T_3	19.33 a	25.33 cd	31.67 bc
T_4	21.00 a	37.00 a	45.67 a
T_5	20.67 a	30.67 b	39.33 ab
T_6	17.33 b	32.33 ab	42.00 a
T_7	14.00 c	32.67 ab	47.33 a
DMRT	3.915	5.13	8.876
CV (%)	26.85	14.83	9.89

T_1 = Admire

T_2 = Aktara

T_3 = Marshall

T_4 = Confider

T_5 = Garlic Extract

T_6 = Neem Extract

T_7 = Control

4.4.3. Relationship between disease incidence and severity at 50DAS with yield of BARI mungbean-5 influenced by different chemical and bio-pesticides

Yield ha^{-1} (kg) of BARI mungbean-5 variety was related to disease incidence and severity (Fig. 3). Increased yield was observed with decreased disease incidence and severity. It was found that the highest yield was achieved by T_1 (Admire) followed by T_2 (Aktara) and T_3 (Marshall) where control treatment showed lowest yield because of highest disease incidence and severity.

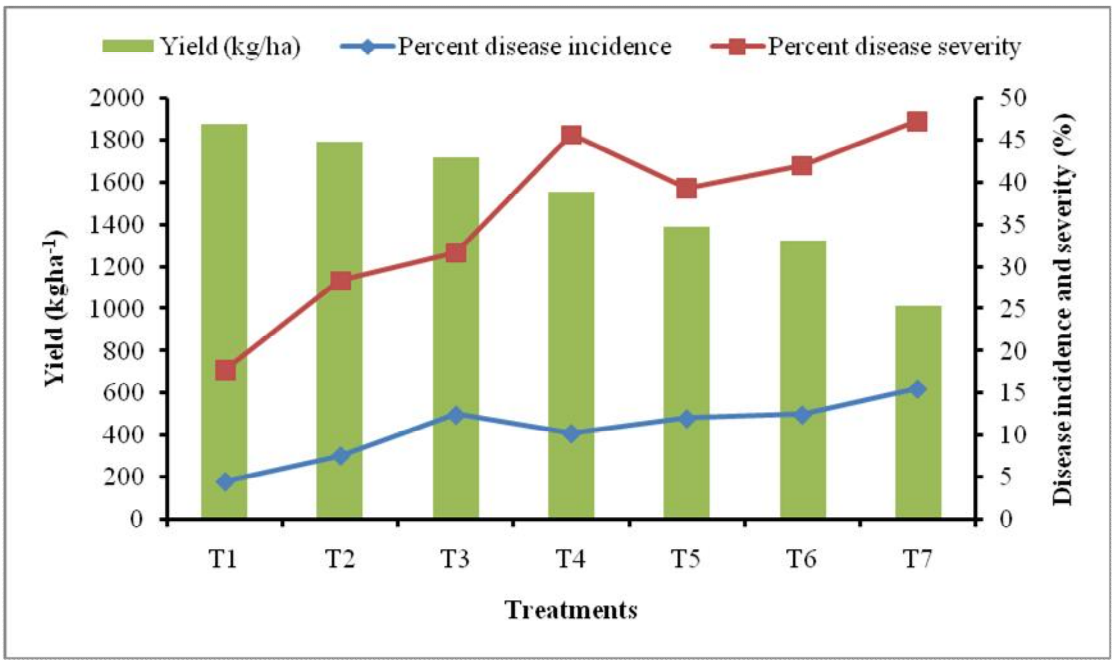

Fig. 3. Yield of BARI mungbean-5 variety relation to disease incidence and disease severity controlled by different treatments

T_1	=	Admire	T_5	=	Garlic Extract
T_2	=	Aktara	T_6	=	Neem Extract
T_3	=	Marshall	T_7	=	Control
T_4	=	Confider			

4.5. Performances of different treatments against *Mungbean yellow mosaic virus* in BARI mungbean-5

4.5.1. Disease incidence (%) over control

At 50 DAS the lowest disease incidence (4.44) was found with the application of T_1 (Admire) and the highest percent decreased over control (71.42%) was observed with the same treatment. Similarly the second highest percent decreased over control of disease incidence (51.40%) was observed with the treatment of T_2 (Aktara) (Table 7). The highest disease incidence (15.55) was performed with T_7 (Control) and after that the highest disease incidence (12.45) was observed with T_6 (Neem Extract) at 50 DAS. For this reason the lowest percent decreased over control (19.93%) of disease incidence was found with T_6 (Neem Extract) and the second lowest percent decreased over control (20.00%) of disease incidence was found with T_3 (Marshall).

4.5.2. Disease severity (%) over control

At 50 DAS the lowest disease severity (17.67) was found with the application of T_1 (Admire) and the highest percent decreased over control (62.66%) was observed with the same treatment. Similarly the second highest percent decreased over control of disease severity (40.14%) was observed with the treatment of T_2 (Aktara) (Table 7). The highest disease severity (47.33) was performed with T_7 (Control) and after that the highest disease severity (45.67) was observed with T_6 (Neem Extract) at 50 DAS. For this reason the lowest percent decreased over control (3.50%) of disease severity was found with T_4 (Confider) and the second lowest percent decreased over control (11.26%) of disease severity was found with T_6 (Neem Extract).

4.5.3. Increase of yield plot^{-1} (%) over control

In terms of yield plot^{-1}, the highest result (187.70 g) was found with the treatment of T_1 (Admire) and the second highest result (179.00 g) was found with T_2

(Aktara) where the lowest yield plot^{-1} (101.30 g) was obtained from T_7 (Control) and the second lowest result (132.30 g) was obtained with T_6 (Neem Extract). So, the highest % increase of yield over control (85.29%) was performed with the treatment of T_1 (Admire) and the second highest % increase of yield over control (76.70%) was obtained with T_2 (Aktara) (Table 7). Similarly, the lowest % increase of yield over control (30.60%) was found with T_6 (Neem Extract) and the second lowest % increase of yield over control (37.21%) was found with T_5 (Garlic Extract).

Table 7. Performances of different treatments on disease incidence, disease severity and yield of mungbean against mungbean yellow mosaic virus in BARI mungbean-5

Treatment	Disease incidence		Disease severity		Yield per plot	
	50 DAS	Decreased over control (%)	50 DAS	Decreased over control (%)	Yield plot^{-1} (g)	Increased over control (%)
T_1 (Admire)	4.44	71.42	17.67	62.66	187.70	85.29
T_2 (Aktara)	7.55	51.40	28.33	40.14	179.00	76.70
T_3 (Marshall)	12.44	20.00	31.67	33.08	172.00	69.79
T_4 (Confider)	10.22	34.27	45.67	3.50	155.30	53.30
T_5 (Garlic Extract)	12.00	22.82	39.33	16.90	139.00	37.21
T_6 (Neem Extract)	12.45	19.93	42.00	11.26	132.30	30.60
T_7 (Control)	15.55	-	47.33	-	101.30	-

T_1 = Admire

T_2 = Aktara

T_3 = Marshall

T_4 = Confider

T_5 = Garlic Extract

T_6 = Neem Extract

T_7 = Control

CHAPTER V

DISCUSSION

CHAPTER V

DISCUSSION

The present study was carried out with seven different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neem Extract) and T_7 (Control) in BARI mungbean-5 against *Mungbean yellow mosaic virus*. For disease performance, yield and yield contributing performance, seven mungbean varieties were used *viz*., V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8).

Significant variation was observed for number of seed yield ha^{-1} among the different varieties (Table 1). Results proved that the highest seed yield (2433 kg) was observed in V_5 (BARI Mungbean-6) and the lowest seed yield (1240.67 kg ha^{-1}) was obtained from V_4 (BARI Mungbean-5). *Mungbean yellow mosaic virus (MYMV)* causes yield loss up to 80 % and is becoming problematic in French bean growing areas. Gupta and Pathak (2009) reported that the yellow mosaic virus disease of black gram (*Vigna mungo* L.) caused by *Mungbean yellow mosaic Gemini virus* and transmitted by whitefly *(Bemisia tabaci* Genn.) is most serious in northern states of India. *MYMV* infects mungbean and some other leguminous hosts (Qazi *et. al*., 2007). Yellow mosaic is reported to be the most destructive viral disease in Bangladesh (Biswass *et. al.,* 2008. John *et. al.,* 2008). The virus causes uneven yellow and green specks or patches on the leaves which finally turn entire yellow. Affected plants generate fewer flowers and pods, which also develop mottling and remain small and contain fewer, smaller and shrunken seeds. Islam *et al.* (2008) observed population dynamics of whitefly under existing environmental conditions and its impact on incidence of *Mungbean yellow mosaic virus (MYMV)* disease and yield. In the present study, minimum disease incidence was found in V_5 (BARI Mungbean-6) at all growth stages (2.22, 5.00 and 8.89 % at 30, 40 and 50 DAS respectively) where finally the highest disease incidence found in V_4 (BARI Mungbean-5) (17.22 %). Minimum disease severity was found in V_5 (BARI Mungbean-6) (8.67, 12.67 and 17.67 % at 30, 40 and 50 DAS respectively) where finally the maximum disease severity (47.33) was found in V_3 (BARI Mungbean-4). Sachan *et al.* (1994) found a drastic reduction in the infection of *YMV* when whitefly attack was reasonably controlled. The yellow mosaic virus caused 30-70% yield loss (Marimuthu *et al.* 1981). Awasthi & Shyam, (2008) obtained 30 susceptible and 43 highly susceptible genotypes of mungbean. Great variation in genotype response to *MYMV* represents variability in their genetic makeup.

Response to different chemical and bio-pesticides, minimum disease incidence (1.33, 3.11 and 4.44% at 30, 40 and 50 DAS respectively) was found with the application of T_1 (Admire) where control treatment showed maximum disease incidence. Again, the minimum disease severity (8.66, 12.67 and 47.33% at 30, 40 and 50 DAS respectively) was found with the application of T_1 (Admire) where control treatment showed the maximum disease severity and after that the maximum disease severity (45.67) were obtained from T_4 (Confider). Results also showed that using of T_1 (Admire) performed highest percent decreased over control (71.42%) of disease incidence and disease severity (62.66%) where the lowest percent decreased over control (19.93%) of disease incidence was found with T_6 (Neem Extract) and % decreased over control (3.50%) of disease severity was found with T_4 (Confider). Mohan and Katiyar (2000) stated that confidor was the most effective in suppressing the whitefly population and its continuous use resulted in increased whitefly population. They also showed better control of jassid by Confidor 200 SL. Sunil and Singh (2010) observed that the foliar applications of thiamethoxam (ActaraTM) 0.02% and carbendazim 0.05% at 21 and 35 DAS, respectively produced the highest seedling establishment, number of pods, plant biomass and grain yield in mungbean with the lowest intensity of mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in this treatment during all stages of the crop. Gupta and Pathak (2009) reported that admixture treatments, Neem Extract seed kernel extract (NSKE) (in cow urine), 3% + dimethoate, 0.03% and Neem Extract oil, 0.5% + dimethoate, 0.03% not only reduced the incidence of whitefly and yellow mosaic but also of pod borer. These treatments gave maximum grain yield of 935 and 902 kg ha^{-1}. Kidiavai, 2009 found that cowpea grain yield was significantly higher in plots sprayed with 2% NSE than in untreated control plots and was comparable to the grain yield obtained in plots sprayed thrice with cypermethrin. Because of the low cost of NSE treatment, the net gain was often more when the crop was sprayed with NSE than with cypermethin. Also, grain quality was superior in Neem Extract-treated plots than in untreated or cypermethrin-treated plots.

CHAPTER VI

SUMMARY AND CONCLUSION

CHAPTER VI

SUMMARY AND CONCLUSION

The experiments were conducted at the experiment field of Sher-e-Bangla Agricultural University, Dhaka, under the Department of Plant Pathology, during the period from, June to September, 2014. The experiment was carried out with seven different treatments *viz*., T_1 (Admire), T_2 (Aktara), T_3 (Marshall), T_4 (Confider), T_5 (Garlic Extract), T_6 (Neem Extract) and T_7 (Control) in BARI mungbean-5 against mungbean yellow mosaic virus. For disease performance, yield and yield contributing performance, seven mungbean varieties were used *viz*., V_1 (BARI Mungbean-2), V_2 (BARI Mungbean-3), V_3 (BARI Mungbean-4), V_4 (BARI Mungbean-5), V_5 (BARI Mungbean-6), V_6 (BINA Mungbean-7) and V_7 (BINA Mungbean-8).

Among the all varieties significant influence was found in case of plant height, Number of branch plant^{-1}, pods plant^{-1}, pod length and seed yield ha^{-1} among the different varieties under the present study. Results indicated that the highest plant height (86.95 cm) was observed in V_2 (BARI Mungbean-3) where the lowest plant height (64.70 cm) was obtained from V_4 (BARI Mungbean-5). Results also showed that the highest number of branch plant^{-1} (3.30), number of pods plant^{-1} (31.89), pod length (8.19 cm) and seed yield (2433 kg ha^{-1}) was observed in V_5 (BARI Mungbean-6) where the lowest number of branch plant^{-1} (0.97), number of pods plant^{-1} (19.93), pod length (6.02 cm) and seed yield (1240.67 kg ha^{-1}) was obtained from V_4 (BARI Mungbean-5). Non-significantly effect was found in case of number of seeds pod^{-1}.

Again, practices with different cultivars, the minimum disease incidence (2.22, 5.00 and 6.67 % at 30, 40 and 50 DAS respectively) was found in V_5 (BARI Mungbean-6) where maximum disease incidence (6.66, 15.00 and 17.22 % at 30, 40 and 50 DAS respectively) from V_6 (BINA Mungbean-7), V_1 (BARI Mungbean-

2) and V_4 (BARI Mungbean-5) respectively. The minimum disease severity (8.67, 12.67 and 17.67 % at 30, 40 and 50 DAS respectively) was originated in V_5 (BARI Mungbean-6) where maximum disease severity (25.00) was found in V_6 (BINA Mungbean-7) at 30 DAS and but at 40 and 50 DAS (38.00 and 47.33 respectively) were found in V_3 (BARI Mungbean-4).

Using different treatments in BARI Mungbean-5, under the present study, the highest plant height (68.03 cm) was observed in T_3 (Marshall) where the lowest plant height (60.45 cm) was obtained from T_6 (Neem Extract). Results also showed that the highest number of branch plat^{-1} (3.22) and seed yield (1877.33 kg ha^{-1}) was observed with the application of T_1 (Admire) where the lowest number of branch plant^{-1} (1.99) and seed yield (1013.00 kg ha^{-1}) was obtained from control treatment (T_7) and also using of T_6 (Neem Extract) and T_5 (Garlic Extract) showed comparatively lower results. Non-significant influence was found in case of pod length and umber of seeds pod^{-1}.

The minimum disease incidence (1.33, 3.11 and 4.44 % at 30, 40 and 50 DAS respectively) was found with the application of T_1 (Admire) where the maximum disease incidence (5.33 %) was found with the application of T_3 (Marshall) at 30 DAS but at 40 and 50 DAS T_7 (Control) showed maximum disease incidence (12.44 and 15.55 respectively). Comparatively higher disease incidence was also found from T_5 (Garlic Extract) and T_6 (Neem Extract) treatment. Again, the minimum disease severity (8.66, 12.67 and 17.67 % at 30, 40 and 50 DAS respectively) were found with the application of T_1 (Admire) in BARI mungbean-5 whereas the maximum disease severity (21.00 and 37.00 at 30 and 40 DAS) were found with the application of T_4 (Confider) but at 50 DAS maximum disease severity (47.33 %) was initiated with T_7 (Control) showed maximum disease severity.

Considering the performances of different treatments against *mungbean yellow mosaic virus* in BARI mungbean-5, at 50 DAS the highest percent decreased over control (71.42%) of disease incidence was observed with T_1 (Admire). Again, the the lowest percent decreased over control (19.93%) of disease incidence was found with T_6 (Neem Extract). At 50 DAS the highest percent decreased over control (62.66%) of disease severity was observed with T_1 (Admire) where the lowest % decreased over control (3.50%) of disease severity was found with T_4 (Confider). The highest % increase of yield over control (85.29%) was performed with the treatment of T_1 (Admire) where the lowest percent increase of yield over control (30.60%) was found with T_6 (Neem Extract).

From the discussion and summary, it can be concluded that BARI mungbean-6 showed minimum disease incidence & severity and gave the best performances in respect of yield and yield contributing characters. In case of different chemicals and bio-pesticides assyed for controlling *Mungbean yellow mosaic virus*, Admire showed the best performances reducing the disease incidence and severity compared to other treatments and in boast up yield and yield contributing characters. In case of bio-pesticides, garlic and Neem Extracts showed poor performance in controlling *Mungbean yellow mosaic virus*.

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APPENDICES

APPENDICES

Appendix I: Salient features of the experimental field

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

Appendix 2: Initial physical and chemical properties of experimental soil analyzed at Soil Resources Development Institute (SRDI), 2012, Farmgate, Dhaka

Characteristics	Value
Partical size analysis	
% Sand	33
%Silt	41
% Clay	26
Textural class	Silty-clay
Ph	5.7
Organic matter (%)	1.09
Total N (%)	0.05
Available P (ppm)	21.54
Exchangeable K (me/100 g soil)	0.15