MANAGEMENT OF MUNGBEAN YELLOW MOSAIC THROUGH SOME SELECTED CHEMICALS, BOTANICALS AND CULTURAL TREATMENTS

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CERTIFICATE

This is to certify that the thesis entitled, *"MANAGEMENT OF MUNGBEAN YELLOW MOSAIC THROUGH SOME SELECTED CHEMICALS, BOTANICALS AND CULTURAL TREATMENTS"* submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE IN PLANT PATHOLOGY*, embodies the result of a piece of bona fide research work carried out by *Asm. Almas Hossain, Registration No.27587/00742,* under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

Mrs. N. A.

Dated:
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Dedicated TO
MY
Beloved Parents

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The Author

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ABSTRACT

A research was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period March to July 2007 for the management of mungbean yellow mosaic through some insecticides, plant extracts and cultural treatments on BARI Mung-5. The ten different treatments of the experiment were T_1 = Admire 200SL @ 1 ml/1 litre of water at 7 days interval; T_2 = Actara 25WG @ 0.4 gm/1 litre of water at 7 days interval; T_3 = Marshal @ 3 ml/1 litre of water at 7 days interval; T_4 = Ripcord @ 1.7 ml/1 litre of water used at 7 days interval, T_5 = Neem leaf extract (1:4 w/v); T_6 = Garlic clove extract (1:4 w/v); T_7 = Allamanda leaf extract (1:4 w/v); T_8 = Yellow trap; T_9 = Reflective tape and T_{10} = Untreated (control). At 50 Days after sowing the lowest (15.85%) disease symptoms expressed in true leaves was recorded for treatment T_1 and the highest (26.33%) in T_{10}. At 50 DAS the lowest (6.67%) disease incidence was recorded for T_1 and the highest (27.67%) in T_{10}. At 50 DAS the lowest (3.95) disease severity was recorded for T_1 and the highest (7.10) in T_{10}. The tallest (46.52 cm) plant was recorded in T_1 and the shortest (38.44 cm) plant was recorded in T_{10}. The highest (23.50) number of pods per plant was recorded in T_1, while the lowest (14.84) number of pods per plant was recorded in T_{10}. The maximum (9.26 cm) pod length was recorded in T_1 and the minimum (8.00 cm) pod length was recorded in T_{10} and T_9. The maximum (11.55) number of seeds per pod was recorded in T_1, while the minimum (8.05) number of seeds per pod was recorded in T_{10}. The highest (41.25 g) 1000 seed weight was recorded in T_1, while the lowest (35.74 g) 1000 seeds weight was recorded in T_{10}. The highest (1.28 t/ha) yield was recorded for treatment T_1 and the lowest (1.02 t/ha) yield was recorded in T_{10}.Chemical treatment showed the best result among the treatments.T_1 gave the best performance in which disease incidence was reduced by 21.02% and the yield was increased by 25.49%. Among all botanicals and cultural treatments T_5 gave the best performance in which disease incidence declined by 18.67% and the yield was increased by 17.65%.

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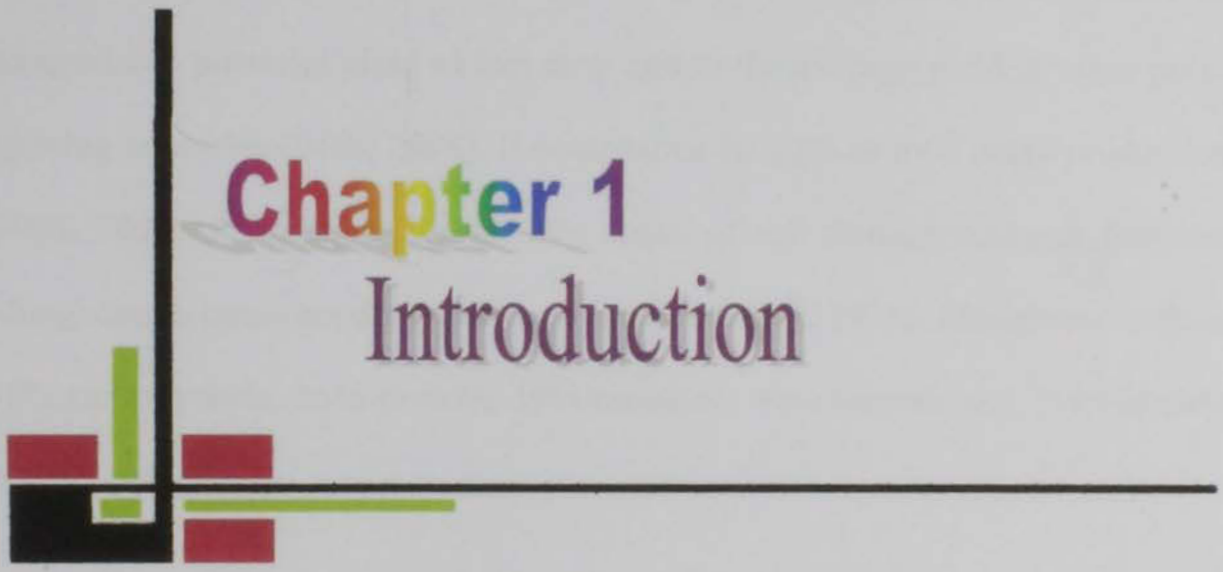
ABBREVIATIONS USED

AEZ	=	Agro-Ecological Zone
@	=	At the rate
Anon.	=	Anonymous
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
cm	=	Centimeter
CT	=	Conventional tillage
cv.	=	Cultivar (s)
DAS	=	Days after sowing
DMRT	=	Duncan's Multiple Range Test
e.g.	=	Example
g	=	Gram
FAO	=	Food and Agriculture Organization
GY	=	Grain yield
ha	=	Hectare
hr	=	Hour
i.e.	=	That is
K	=	Potassium
Kg	=	Kilogram
lb	=	Pound
LSD	=	Least significant difference
m	=	Meter
mm	=	Millimeter
MP	=	Muriate of potash
MYMV	=	Mungbean Yellow Mosaic Virus
N	=	Nitrogen
NT	=	Not conventional tillage
P	=	Phosphorus
RCBD	=	Randomized Complete Block Design
S	=	Sulphur
SAU	=	Sher-e-Bangla Agricultural University

T	=	Treatment
t / ha	=	Ton per hectare
TSP	=	Triple Super Phosphate
wt.	=	Weight
w/v	=	weight/ volume
Zn	=	Zinc
^{0}C	=	Degree Centigrade
%	=	Per cent



Chapter 1
Introduction

1. INTRODUCTION

Mungbean (*Vigna radiata* L. Wilezek) belongs to the family Leguminosae and sub family Papilionaceae is an important pulse crop having global economic importance as dietary ingredient of the staple food. It occupies an important position in the cereal based cropping system in Bangladesh. In Bangladesh among pulses, mungbean ranks third both in acreage and production and first in market price (BBS, 2006).

The average yield of mungbean is 617.50 kg/ ha in Bangladesh which is low as compared to potential yield of this crop and to the average yield of other pulse growing countries (BBS, 2006). It contributes 10-12% of total pulse production (BBS, 2006). It improves the fertility status of soil through nitrogen fixation. Mungbean is considered as poor man protein (Mian, 1976). Mungbean contain 51% carbohydrate, 26% protein, 10% moisture, 4% minerals and 3% vitamins (Khan, 1981).

A total of sixteen diseases of mungbean have been recorded, of which viral diseases are the most damaging to the crop (Nene, 1973). Mungbean yellow mosaic is the most destructive disease of mungbean in this subcontinent and adjacent areas of Southeast Asia (Nariani, 1960; Williams *et al.* 1968; Nene *et al.* 1972, Grewal, 1978; Iwaki and Auzay, 1978; Bakar, 1981; Jayasekera and Ariyarantoe, 1988). It is the most damaging disease of mungbean in Bangladesh (Jalaluddin and Shaikh, 1981). It is widely distributed all over the Bangladesh where mungbean is cultivated. Yield loss due to MYMV in

mungbean was recorded as 63% (Anon., 1984). Estimation of actual losses due to MYMV in farmer's field is difficult as these losses vary from year to year and from variety to variety (Krisnareddy, 1989). Winter mungbean genotypes are highly susceptible to yellow mosaic disease and showed 67-100% loss of grain yield in the field where no control measures were taken (Jalaluddin and Shaikh, 1981).

Whitefly transmitted Mungbean yellow mosaic virus (MYMV) is the major constraints in the productivity of cultivated mungbean in India (Roy and Malathi, 2001). MYMV has not been reported to be transmitted through soil, seed, sap or by any insect vector other than white fly (*Bemisia tabaci*). The incidence and severity of yellow mosaic is considered to be directly related with availability and abundance of insect vector and depend upon the time of infection (Dhingra and Ghosh, 1993).

The characteristics symptoms of the disease appear as yellow patches on mungbean leaves coalesced to form a larger patch that develops into a yellow mottle; eventually the entire leaf may turn yellow. The green areas appear as dark green islands interspersed in yellow chlorotic areas; the infected leaf blade appears wavy. Sometimes the leaves may become malformed and wrinkled. Maturity is delayed in the diseased plants and flowers and pod production are severely reduced. Seeds developed from severely infected plants are small and immature (Poehlman, 1991).

For successful cultivation of mungbean, disease management must be prioritized while trying to develop and release improved high yielding mungbean cultivars. Developing resistant variety is the best way to manage yellow mosaic of mungbean. But till today, high and fairly stable resistant varieties of mungbean against MYMV infections are not available in Bangladesh. Some resistant and tolerant cultivars have been released by Bangladesh Agricultural Research Institute (BARI) which depends on cultural and environmental factors to remain healthy.

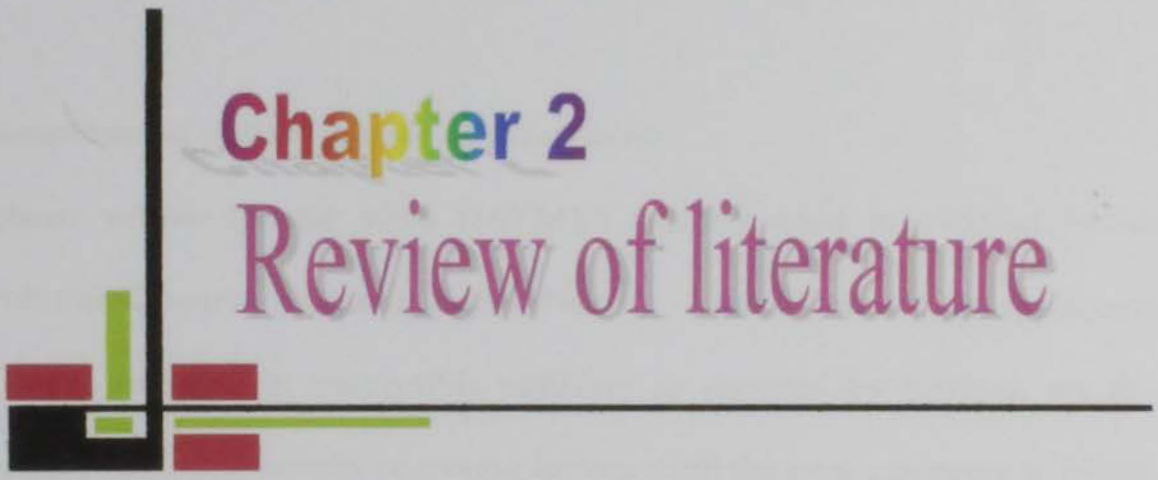
Reports on management of mungbean yellow mosaic are scanty. Generally chemical insecticides are used to management to manage the disease. But other alternatives like plant extracts, cultural practices also used to be investigated for their effectiveness in reducing the incidence of MYMV.

The control of insect vector is an important tactic for managing yellow mosaic of mungbean. Some chemicals were found to be effective in reducing the incidence of yellow mosaic (Borah, 1996). Chemical insecticides are the most popular way of disease management to our farmers. These chemicals pollute the environment to a great extent and health hazard. But other alternate approaches like plants extracts and cultural approaches need to be investigated. Plant extracts are ecofriendly and has a great promise to save the beneficial microbes in soil.

Considering the facts stated above the present investigations were done with the following objectives-

i. To determine the efficacy of some management practices (chemical, botanical and cultural) in reducing the incidence and severity of the yellow mosaic of mungbean.

ii. To assess the impact of management practices on yield and yield contributing characters of mungbean.



Chapter 2
Review of literature

2. REVIEW OF LITERATURE

Mungbean is one of the important pulse crop in Bangladesh and as well as many countries of the world. It suffers from many diseases of which yellow mosaic disease is an important one and cause severe damage to the crop. It is very difficult to manage this disease. Few works have been reported on management aspect in Bangladesh. Research works are not conclusive in most of the cases. Some of the important works on mungbean yellow mosaic have been reviewed in this chapter.

2.1 Symptoms of yellow mosaic of mungbean

Mungbean yellow mosaic virus (MYMV) was recorded in 1955 at Indian Agricultural Research Institute, Delhi (Nariani, 1960). The earliest symptoms of MYMV infection in susceptible cultivars as reported by Nariani, are the appearance of yellow specks on young leaves, with the next emerging trifoliate leaf exhibiting irregular yellow and green patches, and slight puckering and reduced leaf size.

Nene (1969) observed that in case of severe infection only very few pods were produced. Chlorosis, stunting and fewer branches and premature shedding of leaves have also been reported by Singh *et al.*, (1982). Nair *et al.* (1974) observed that due to this disease a necrotic centre may 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.

Singh and Singh (1979) reported that MYMV causes diseases in a variety of leguminous crops, but the most seriously affected are blackgram, 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.

Fakir (1983) first reported mungbean yellow mosaic disease was first in Bangladesh. He gave a detailed description of the disease and some recommendations for the management of the disease.

Ahmed (1985) described the chronological development of symptoms of the disease as appearance of scattered yellow spots on young leaves which eventually turn to large irregular green and yellow mosaic with light stunting of emerging trifoliate leaves associated with occasional puckering of green area along with increase in size of yellow area in subsequent emerging leaves which completely turned to yellow mosaic in some plants. Disease plants mature late. Pods were stunted, curled and frequently contained small, immature seeds.

Bakr (1991) reported that 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 are smaller in size and borne small shriveled seeds.

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

2.2 Transmission of the virus

Nene (1971) observed that mungbean yellow mosaic virus could be acquired from and transmitted to *Phaseolus nungo* by *Bemisia tabaci* adults after 15 minutes feeding period. Nene (1972) and Butter (1977) studied the life history of the vector (*Bemisia tabaci*), its maintenance, multiplication and dispersal on *Vigna radiata* and cotton, respectively. They found that the females laid between 38 and 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. Population builds up from April to October when the average maximum temperature ranged from 21 to 35°C.

Murugeson 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 $^{-1}$. Infection was ensured when vector had a pre-acquisition starvation period of 24 hours.

According to Chenulu *et al.* (1979) MYMV is transmitted by the white fly in circulatory manner. Per-acquisition starvation either increases the efficiency of transmission or has no effect.

Honda *et al.* (1983) reported that many isolates of MYMV have been obtained from different hosts and regions in India. All are transmitted by *Bemisia tabaci*, but not by sap inoculation or through seeds. Isolates from Bangladesh, Pakistan and Srilanka have similar characteristics.

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

An experiment was conducted by Patel and Srivastava (1990) observed that the number of *Bemisia tabaci* infestation was 1.67-2.67/10 leaves with corresponding amount of yellow mosaic virus infected plants ranged between 0.90-2.47%. Aftab *et al.* (1992) observed that mungbean yellow mosaic virus disease spread rapidly with increase in the whitefly (*Bemisia tabaci*) population.

Dhingra and Ghosh (1993) also studied on the efficiency of *Bemisia tabaci* in transmission of mungbean yellow mosaic Gemini virus 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 tested as source plants than French bean (*Phaseolus vulgaris*) and pigeon pea for the test and / or the vector. They also described that the virus transmission percentage increased with the increase in the number of adult whitefly or test plant and that the nymphs were less efficient vectors than the adults.

Nath (1994) studied the relationship between disease incidence and population size of *Bemisia tabaci* in the crop sown. He observed a positive correlation between incidence and population size of *Bemisia tabaci*.

Dantre *et al.* (1996) studied on yellow mosaic virus disease of soybean and mungbean and reported that the mungbean yellow mosaic bigemini virus was transmitted by whitefly (*Bemisia tabaci*).

2.3 Vector of the virus

Nariani (1960) reported that the virus causing yellow mosaic of mungbean is transmitted by the whitefly (*Bemisia tabaci*). The life history of the vector, its maintenance, multiplication and dispersal on *Vigna radiata* were studied by Nene (1972).

Nene (1972) observed that MYMV could be acquired from and transmitted to *Phaseolus nungo* by *Bemisia tabaci* adults after 15 minutes feeding period.

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Basu (1986) reported that whitefly (*Bemisia tabaci* Gen.) is an effective vector of MYMV. So far, no intraspecific diversity has been identify mainly due to host and season correlated variation in pupal morphology which forms the main basis for the identified of taxa in these group.

Aftab *et al.* (1992) reported that mungbean yellow mosaic virus disease rapidly with increase in the whitefly (*Bemisia tabaci*) population.

Dantre *et al.* (1996) reported that whitefly (*Bemisia tabaci*) was the vector of mungbean yellow mosaic bigeminivirus.

2.4 Virus disease control by chemicals

Dhingra and Silva (1979) reported that the occurrence of some pathogens was favored by weed development. They suggested that controlling weeds in soybean fields may help to reduce infection by seed infecting fungi.

Agrawal *et al.* (1980) reported on field trials with mungbean (*Vigna radiata*) against mungbean yallow mosaic virus. They found that Nuvan (DDVP), Nuvacron (monocrotophos) and Phosphamidon reduced disease incidence and increased yield in all the cropping seasons except one. Two sprays, at fortnightly intervals of any one of the compounds Nuvan at 500 ml/ ha, Nuvacron at 875 ml/ ha and phosphamidion at 250 ml/ ha were recommended. Gupta and Singh (1984) reported that when applied at 2 kg a.i./ ha in summer as well as in the rainy season, insecticides controlled *Bemisia tabaci* and concomitantly mungbean yellow mosaic virus on *Vigna radiata*.

Sadana and Verma (1989) reported that applications of dimethoate (0.03 and 0.05%) gave maximum reduction of mungbean yellow mosaic virus incidence by controlling the whitefly vector, *Bemisia tabaci*. Applications of fertilizers alone without aldicarp (1.5 kg/ha) encouraged the build up of whitefly population and increased also the incidence of yellow mosaic disease. They also reported that the maximum yield was obtained by the combined use of aldicarp and fertilizer.

Farias and Zimmermann (1990) reported that in a field trial against bean golden mosaic geminivirus in mungbean, a significant correlation ($P = 0.01$, $n = 96$) was found between disease incidence at 22-53 days after planting and yield. They also observed that Carbofuran at 2 kg a.i./ ha with monocrotophos at 800 ml a.i./ ha sprayed 3 times kept disease incidence in the first 45 days after planting at <37%, resulting in a yield increase of up to 87%>. The rate of disease progress was not affected by the insecticides with the cultivar Porrillo sintetico, which has a higher tolerance of the disease. They found that insecticides gave adequate control.

Chander and Singh (1991) carried out an experiment with foliar applications of monocrotophos(0.04%), dimethoate(0.03%) and chlorpyrifos(0.05%) 55 days after sowing. Spraying of insecticides reduced the incidence of *Bemisia tabaci* and yellow mosaic virus in *Vigna radiata*. The effect of seed treatments with these insecticides could not be evaluated, as the aleyrodid appeared on the crop 25 days after sowing, by which time the seed treatment had lost its efficacy.

Quaiser and Ahmad (1991) carried out an experiment during 1986-87, to estimate crop loss in mungbean loss due to mungbean yellow mosaic Gemini virus. Maximum growth reduction (62.94%) and yield loss (83.9%) were recorded for plants on which symptoms appeared 20 d after sowing (DAS). For plants on which symptoms appeared 30 or 40 DAS growth parameters and yield were less affected. It was concluded that early crop infection reduced yield more than late infection.

Kumawat and Kumawat (1996) investigated the efficacy of 0.03% dimethoate (as Rogor 30 EC), 0.04% monocrotophos (as Nuvacron 36 WSC), 0.05% endosulfan (as Endocel 35 EC), 0.03% Phosphamidon (as Dimecron, SSEC) against Empoasca Kerri and *Bemisia tabaci* on acontifolia. They observed that the monocrotophos sprayed twice at an interval of 20 days, was effective in reducing the population of the pest insects and the incidence of yellow mosaic disease, increasing the yield as compared to control.

Borah (1996) conducted field experiment to find out a cheap and effective control of *Bemisia tabaci* and minimize the incidence of yellow mosaic (mungbean yellow mosaic bigemini virus) in green gram (*Vigna radiata*). They used Cypermethrin (0.01, 0.015%), Deltamethrin (0.0028, 0.0042%), Dimethoate (0.03, 0.045%) and Malathion (0.5, 0.075%), as foliar sprays during summer 1993 and 1994 in field trials in Assam, India. They reported that foliar application of Cypermethrin, Drltamethrin and Dimethoate, 50 days after sowing, proved effective in reducing the incidence of B. tabaci and the virus.

Borah *et al.* (1997) repeated the earlier experiment in which dimethoate and malathion were used in different schedule. They reported that the greatest effectiveness was recorded for dimethoate 0.03% at 15 days after germination. This was followed by spraying dimethoate 0.03% at 15 days after germination + malathion 0.05% at 30 days after germination in effectively controlling both *B. tabaci* and yellow mosaic virus.

Madhuban *et al.* (1997) studied the efficacy of imidacloprid against *B. tabaci* in two pulse crops. Seed treatment with imidacloprid reduced the population of the aleyrodid in black gram and soybean. Higher grain yield was recorded from plots where imidacloprid-treated seeds were sown and foliar sprays of monocrotophos were applied in comparison with other combinations comprising conventional and new insecticides.

Thakur and Agrawal (1998) reported that three foliar sprays of dimethoate (0.1%) not only reduced the yellow mosaic bigemini virus but also increased the grain yield considerably.

Singh and Sihori (1998) carried out an experiment to investigate the effects of insecticides used to control *Bemisia tabaci*, the vector of mungbean yellow mosaic bigemini virus on disease incidence in *Vigna mungo*. They reported that Octanol and demeton-5-methyl (as Metasystox) gave the best disease control and highest yield, followed by phosphamidon (as Dimecron).

Improved mungbean (*Vigna radiata*) germplasm having high yield potential and large seed size developed at the Asian Vegetable Research and Development Centre (AVRDC), Taiwan, was crossed with indigenous material from Pakistan by Sadiq *et al.* (1999). F_1 seeds from single plants in each cross combination were collected to raise F2 populations for selection via the pedigree method. Succeeding generations were grown for the selection of desirable recombinants having resistance to mungbean yellow mosaic virus

(MYMV), large seed size, higher numbers of pods per plant and grain yield. Plant progeny rows were raised, and true breeding selections were bulked and evaluated for yield potential and other desirable plant characteristics. Out of these, NIAB Mung 92 (NM92) was been released as a commercial variety on the basis of its high yield performance, large seed size, resistance to number of other elite lines were developed through this breeding approach.

2.5 Virus disease control by plant extract

Singh *et al.* (2004) reported that yellow mosaic disease of mungbean (*V. radiata*), could be successfully controlled by the application of root extract of *Boerhaavia diffusa*. Treatments were administered weekly, as foliar sprays, at a concentration of 10%, commencing from the seedling stage. Six sprays of *B. diffusa* root extract were found most effective, as it considerably delayed symptom appearance, suppressed symptom severity and decreased disease incidence by 80-90%. This treatment also increased root nodulation, plant height, primary and secondary branches, pod formation and grain yield.

Ganapathy and Karuppiah (2004) conducted field trials to determine the efficacy of new insecticides against whitefly, mungbean yellow mosaic virus (MYMV) and urdbean leaf crinkle virus (ULCV) in mungbean cv. CO-4. Whitefly population was observed at 25, 35 and 50 DAS, while disease incidence was observed at 30 and 60 DAS. Plant extracts effectively decreased whitefly population and disease incidence, and gave the highest yield (800 kg/ ha).

2.6 Virus disease control by yellow traps

Murugesan and Chelliah (1977) reported that various method including direct counts of adults or pupae on the leaves, or yellow sticky traps and water traps, have been used to assess to whitefly populations.

Subrahmanyam and Verma (1986) also reported that the direct leaf count is, however, time consuming and should be done either early in the morning or late in the evening to obtain reliable results.

Krishnareddy (1989) reported that the direct leaf counts on yellow stricky traps at the canopy level are most useful for regular monitoring and give good relative estimates.

2.7 Yield and yield components of mungbean

Reduction in yield in legumes due to MYMV depends on the time of infection and severity of the disease. If highly susceptible varieties of Blackgram or soybean are infected within three week of sowing, no yield was obtained. Infection of these species durings the fourth, fifth, sixth, seventh and eighth week results in yield reductions up to 85, 60, 44, 28 and less than 20% respectively. The decrease in yield is significant 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 disease in yield (Dhingra and Chenlulu, 1985; Nene, 1973; Suteri and Srivastava, 1979; Voha and Beniwal 1979).

Vohra and Beniwal (1979) observed that mungbean yellow mosaic virus infection affect grain yield when the plant having infection up to 50 days after planting. They found healthy mungbean cultivars Mung and B-105 gave yield 6.5 and 5.14g seed/ plant respectively and the respective yields were decreased to 4.4 and 2.03g in slightly infected plants by mungbean yellow mosaic virus and to 1.92 and 1.55g in severely infected plants.

Singh *et al.* (1982) carried out an experiment to study yield loss in mungbean due to mungbean yellow mosaic virus and 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.

Chand and Varma (1983) conducted a field experiment under natural condition at Hissar, India to study the effect of mungbean yellow mosaic virus on growth components and yield of mungbean and Urd bean. They observed that plant height was reduced upto 38.2%; fresh shoot weight by 28.5% and losses in yield/plant reached 66.6% while 1000 seed weight was reduced up to 25.7%. The shape, size and appearance of pods and seeds of diseased plants, also seed germinability was found to be unaffected.

The plant pathology division of the Bangladesh Agricultural Research Institute (BARI) and Bangladesh Agricultural University (BAU) had estimated yield losses for a few diseases in pulse crops. Yellow mosaic caused 16% yield loss in mungbean and 10% yield loss in blackgram (BARI, 1987, 1988, Bakr and Ahmed, 1988; Fakir, 1983).

Baub *et al.* (1984) stated that infection of *Vigna radiata* plants by MYMV caused significant reduction in number of pods/plant, seed yield and 100-seed weight.

Ahmed (1985) conducted a survey during 1982-84 about mungbean yellow mosaic virus (MYMV) and observed 85% incidence both in summer and winter planting in most varieties under their observation.

Khan (1985) reported that the virus causing mungbean mosaic showing 20-30% natural infection depending on varieties/ lines.

Bisht *et al.* (1988) conducted an experiment to study the effect of yellow mosaic virus on yield and yield components. Under natural condition 4 promising cultivars were cultivated and they observed variations in reduction of growth components and subsequent yield loss amongst the cultivars.

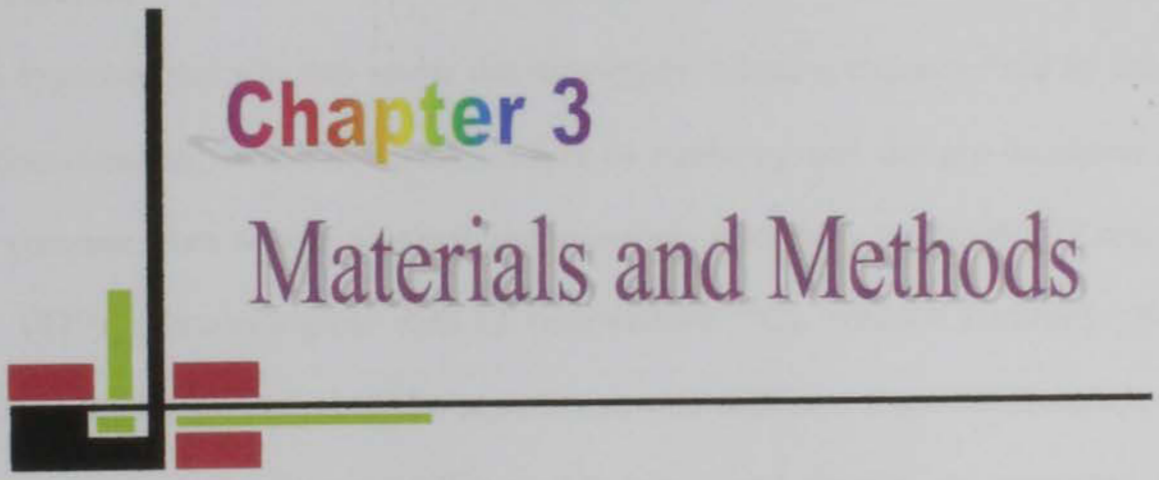
Krisnareddy (1989) studied that yield loss models based on components like number of pods per plants, severity of disease and stage of infection by MYMV could predict yield loss very close to the actual loss in Blackgram. The application of such model will provide better estimates of losses due to the virus in different crops.

Ahmad (1991) described that the extent of *Vigna radiata* cv. Baisakhi crops losses due to mugbean yellow mosaic geminivirus infection in Bihar, India.

Maximum growth reduction (62.94%) and yield loss (83.9%) were recorded for plants on which symotoms appeared 20 days after sowing (DAS). For plants on which symptoms appeared 30 or 40 DAS growth parameters and were less affected. It is concluded that early crop infection reduced yield more than late infection.

Jain *et al.* (1995) conducted an experiment to study the effect of mungbean yellow mosaic virus on yield and yield components of some blackgram varieties. They reported that the reduction in grain yield ranged from 39.9% to 51.5%. They also observed that reduction in plant height, pods/ plant, 100-seed weight and crop growth rate contributed to low yield.

Gill *et al.* (1999) reported that MYMV infection at early stage of crop growth caused much higher reduction of yield than infection at late stage of crop growth.



Chapter 3

Materials and Methods

3. MATERIALS AND METHODS

3.1 Experimental Site

The research was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The location of the experimental site is $23^0 74'$ N latitude and $90^0 35'$ E longitude with an elevation of 8.2 meter from the sea level (Anon., 1989).

3.2 Experimental period

The experiment was carried out during the period March to July 2007.

3.3 Climate

The experimental site was under the subtropical climate, characterized by three distinct seasons, winter from November to February and the pre-monsoon or hot summer from March to April and monsoon from May to October (Edris *et al.*, 1979). Meteorological data of temperature (^{0}C), relative humidity (%), rainfall during the period of the experiment was collected from the Bangladesh Meteorological Department (Climate Division) and details are presented in Appendix I.

3.4 Characteristics of Soil

The selected experimental plot was medium high land, the soil series belonged to Tejgaon and the pH of the soil was 5.6. The soil of the experimental area was Red brown terrace soil and belongs to the Modhupur Tract under AEZ 28. The characteristics of the soil under the experimental plot were analyzed in the

SRDI, Soil testing Laboratory, Khamarbari, Dhaka and details of the soil characteristics including nutrient contents are presented in Appendix II.

3.5 Planting Materials

The seeds of BARI Mung-5 were used and the seeds were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

3.6 Treatment of the Experiment

The ten different treatments of the experiment were as follows:

T_1 = Admire 200SL (Imidacloprid) @ 1 ml/1 litre of water for four times at 7days interval

T_2 =Actara 25WG (Thiamethoxam) @ 0.4 gm/1litre of water for four times at 7days interval

T_3 = Marshal (Carbosulfan) @ 3 ml/1 litre of water for four times at 7 days interval

T_4 = Ripcord (Cypermethrin) @ 1.7 ml/1 litre of water four times at 7 days interval

T_5 = Neem leaf extract (1:4 w/v)

T_6 = Garlic clove extract (1:4 w/v)

T_7 = Allamanda leaf extract (1:4 w/v)

T_8 = Yellow trap

T_9 = Reflective tape

T_{10} = Untreated (control)

3.6.1 Collection of botanicals

Botanicals were collected from different places (Plate 1). Leaves of neem and allamanda were collected from Sher-e-Bangla Agricultural University campus where garlic collected from the agargoan market, Tejgaon Dhaka.

The particulars of botanicals used in this study

Common name	English name	Scientific name	Plant parts used
Neem	Margosa tree	*Azadirachta indica*	Leaf
Garlic	Garlic	*Allium sativum*	Clove
Allamanda	Allamanda	*Allamanda cathartica*	Leaf

3.6.2 Preparation of extract

The extracts were prepared by using the method of Ashrafuzzaman and Hossain, 1992. For preparation of extracts, collected leaves were weighted in an electric balance and then washed in the water. After washing the big leaves were cut into small pieces. For getting extract, weighted plant parts were blended in an electric blender and then distilled water was added into the jug of the blender (Plate 2). The pulverized mass was squeezed through 3 folds of fine cotton cloth. The filter thus obtain was used as a crude extract for spraying. For getting 1:4 (w/ v) ratio 1000 ml of distilled water was added with 250 g plant parts.

Allamanda (*Allamanda cathartica*)

Neem (*Azadirachta indica*)

Garlic (*Allium sativum*)

Plate 1. Photograph showing plant materials used for the preparation of botanicals pesticide

Plate 2. A blender used for preparing plant extract

3.6.3 Yellow trap

Yellow trap was prepared with a yellow plastic container for attracting white fly. Some oily substances were kept on it for catching whitefly. Two traps were used per plot ($3m^2$).Traps were set at 20 DAS and they stayed upto50 DAS. Traps were changed in every week.

3.6.4 Reflective tape

Reflective tape of cassette was used for avoiding whitefly.

3.7 Design and layout of the Experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatment combinations in each plot of each block. There were 30 unit plots altogether in the experiment. The size of the plot was 2.0 m × 1.5 m. The distance between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experimental plot presented in Appendix III.

3.8 Preparation of the main field

The selected experimental plot was opened in the First week of March 2007 with a power tiller and was exposed for one week for sun drying. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. The experimental plot was partitioned into unit plots in accordance with the experimental design.

Yellow trap

Reflective tapes

Plate 3. Yellow trap and reflective tapes used in the experiment

3.9 Application of manure and fertilizers

Fertilizers were applied as per recommendation of Bangladesh Agricultural Research Institute (BARI), Mungbean in Bangladesh, 2004. The following dose of fertilizers and manures were applied to the plot for Mungbean cultivation.

Fertilizers/ Manures	Dose/ha
Urea	45 kg
TSP	100 kg
MP	55 kg
Cow dung	05 tones

Well decomposed cowdung as per treatment was applied at the time of final land preparation.The entire amounts of TSP, MP were applied during final land preparation. Only urea was applied in two equal installments at 20 and 30 Days after sowing (DAS).

3.10 Sowing of seeds

The seeds were sown in the field on 31st March, 2007 @ 40 kg/ha. Seeds were placed continuously in lines at the depth of 3-4 cm and covered by the soil with the help of hand.

3.11 Intercultural operation

After emergence of seedlings, various intercultural operations like loosening of the soil, weeding was done for better growth and development.

3.12 Irrigation

Light over-head irrigation was provided with a watering can to the plots immediately after germination of seed. Irrigation was also applied two times considering the moisture status of field.

3.13 Weeding

Weeding was done three times in these plots considering the optimum time for removal.

3.14 Calculation of % mosaic expressing leaves

The per cent of mosaic expressing leaves was recorded four times. The first counting was made at 20 DAS and the following counting was made upto 50 days at 10 days interval. For this calculation 10 infected plants were selected randomly from each replicate plot. The per cent mosaic expressing leaves was calculated as follows:

$$\% \text{ Mosaic expressing true leaves} = \frac{\text{No. of mosaic expressing true leaves in each plot}}{\text{Total no. of leaves in each plot}} \times 100$$

Plate 4. Whitefly (*Bemisia tabaci*) the vector of mungbean yellow mosaic virus

3.15 Assessment of disease incidence

The experimental plots were examined at 10 days interval for the appearance of viral mosaic. The incidence of mosaic was recorded four times. The first counting was made at 20 DAS and the following counting was made at 10 days interval. The mosaic infected plants 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 by Ahmed, 1985. The incidence of yellow mosaic was calculated as follows:

$$\% \text{ Yellow mosaic infected plants} = \frac{\text{Number of infected plant in each plot}}{\text{Total number of plants in each plot}} \times 100$$

Healthy mungbean plants

MYMV Infected mungbean Plants

Plate 5. Photograph showing healthy and infected plots of Mungbean

3.16 Assessment of disease severity

Disease severity was recorded at 20, 30, 40 and 50 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:

$$\% \text{ Disease Index (PDI)} = \frac{\text{Sum of disease rating}}{\text{Total number of leaves observed} \times \text{Highest grade in scale}} \times 100$$

Healthy leaves

MYMV Infected Leaves

Plate 6. Healthy and infected leaves of Mungbean

Healthy pods

MYMV infected pods

Plate 7. Healthy and infected pods of mungbean

The severity of yellow mosaic disease was recorded following the grade as used by Jalaluddin *et al.* (1994).

Numeric score	Symptom severely on plants at maximum flowering and pod formation stage
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

0

1

3

5

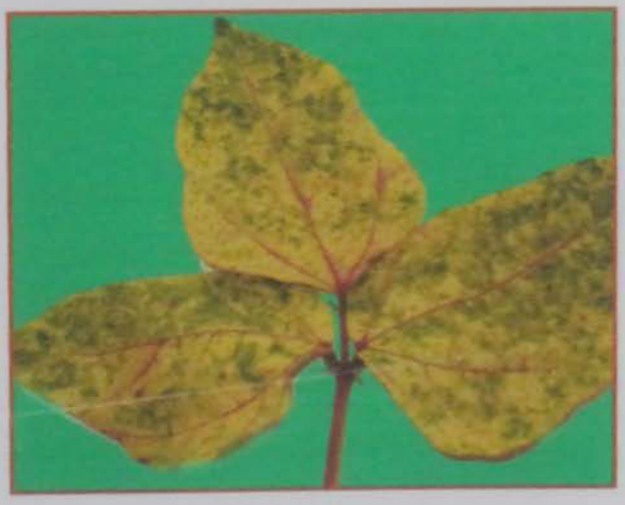


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Plate 8. MYMV severity of Mungbean showing 0-9 rating scale (Jalaluddin *et al.* 1994)

3.17 Harvesting and recording of data on yield contributing characters and yield

The crop was harvested at full ripening stage. Before harvesting 10 apparently healthy plants and 10 infected plants (which have initially produced the symptoms) in each unit plots were selected randomly on collection of data for the following parameters:

i. Disease symptom expressed in true leaves (%)
ii. Disease incidence (%)
iii. Disease severity (0-9 scale)
iv. Plant height (cm)
v. Number of primary branches per plant
vi. Number of pods per plant
vii. Pod length (cm)
viii. Number of seeds per pod
ix. 1000 seed weight (g)
x. Yield per plot (kg)
xi. Yield per hectare (tones)

3.18 Statistical analysis

The data obtained for different characters were analyzed. The analysis of variance was performed by using MSTAT Program. The significance of the difference among the treatment means was estimated by DMRT (Duncan's Multiple Range Test) at 5% level of probability (Gomez and Gomez, 1984).

Chapter 4
Results

4. RESULTS

The present experiment was conducted to manage of mungbean yellow mosaic disease through some insecticides, plant extracts and cultural practices. Data were recorded on disease incidence, severity, yield contributing characters and yield of mungbean. The analyses of variance (ANOVA) of the data on different characters are given in Appendix IV-VIII. The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Disease symptom expressed (%) in true leaves

Disease symptoms expressed (%) in true leaves were calculated at 20, 30, 40 and 50 DAS and recorded significant differences for different insecticides, plant extract and cultural practices that were used as treatments for managing mungbean yellow mosaic diseases under the present experiment (Appendix IV).

At 20 DAS variation was not significant variations. The lowest (2.33%) disease symptoms expressed in true leaves was recorded for treatment T_9 (reflective tape), while the highest (2.80%) for treatment T_7 (application of Allamanda leaf extract) (Figure 1). Significant difference was recorded for disease symptoms expressed in true leaves for different treatments at 30 DAS. The lowest (6.25%) disease symptoms expressed in true leaves was recorded for treatment T_1 (Admire) which was statistically similar (6.72%) with T_4 (Ripcord). On the other hand the highest (16.66%) disease symptoms expressed in true leaves was recorded for treatment T_{10} (control) which was closely (11.08%) followed by

treatment T_9 (reflective tape). At 40 DAS a remarkable variation was recorded in disease symptoms expressed in true leaves for different treatments. The lowest (9.22%) disease symptoms expressed in true leaves was recorded for treatment T_1 which was closely (10.35%) followed by T_4, while the highest (21.84%) was recorded for treatment T_{10} which was closely (15.95%) followed by treatment T_9. At 50 DAS different treatments showed a significant variation in disease symptoms expressed in true leaves for managing mungbean yellow mosaic virus. The lowest (15.85%) disease symptoms expressed in true leaves was recorded for treatment T_1 which was statistically identical (16.15%) with T_5 treatment as application of neem leaf extract. On the other hand the highest (26.33%) in disease symptoms expressed in true leaves was recorded for treatment T_{10} which was closely (19.21%) followed by treatment T_8 as application of yellow trap.

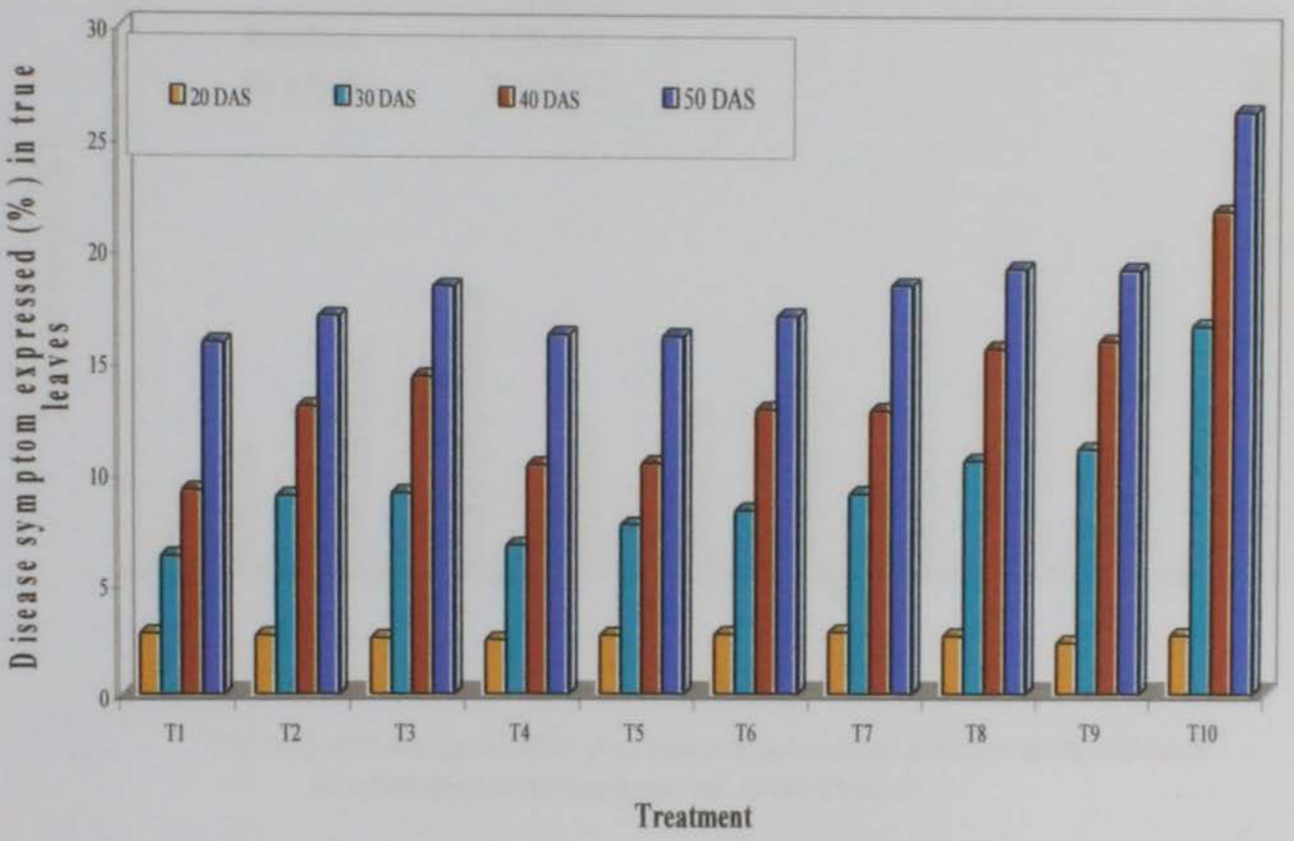


Figure 1. Effect of insecticides, plant extracts and cultural practices on the expression of disease symptom in true leaves of mungbean (var. BARI Mung-5)

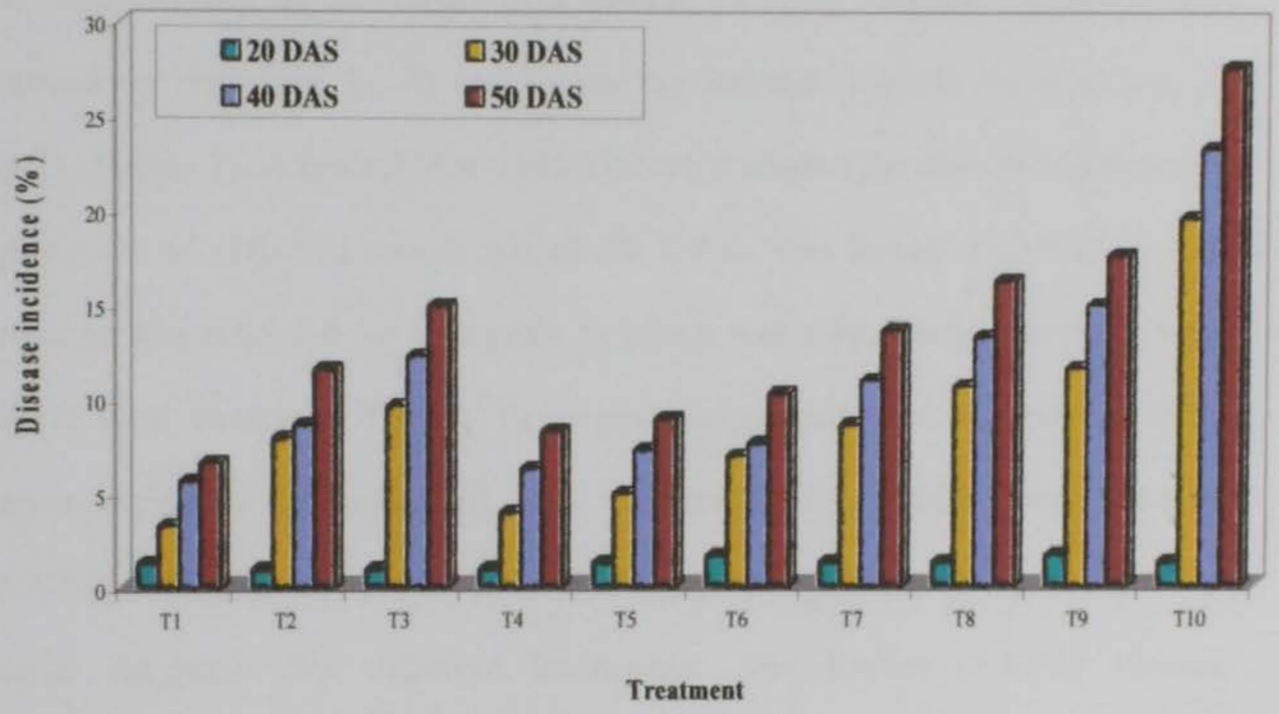


Figure 2. Effect of insecticides, plant extracts and cultural practices on the incidence of yellow mosaic of mungbean (var. BARI Mung-5)

4.2 Disease incidence (%)

Different insecticides, plant extract and cultural practices that were used as treatments for managing mungbean yellow mosaic diseases in this trial were observed statistically significant differences for disease incidence (%) that were calculated at 20, 30, 40 and 50 DAS (Appendix V). Disease incidence did not vary significantly at 20 DAS. The lowest (1.00%) disease incidence was recorded for treatment T_2, T_3 and T_4 and the highest (1.67%) for treatment T_6 and T_9 (Figure 2). A remarkable variation was recorded for disease incidence in application of different treatments at 30 DAS. The lowest (3.33%) disease incidence was recorded for treatment T_1 which was statistically identical (4.00, 5.00%) with treatment T_4 and T_5, respectively, while the highest (19.67%) disease incidence was recorded for treatment T_{10} which was closely (11.67%) followed by T_9. At 40 DAS a significant difference was recorded in disease incidence for different treatments. The lowest (5.67%) disease incidence was recorded for treatment T_1 which was statistically identical (6.33%) with T_4, while the highest (23.33%) was recorded for treatment T_{10} which was closely (15.00%) followed by treatment T_9. At 50 DAS different treatments showed a significant variation in disease incidence for managing mungbean yellow mosaic virus. The lowest (6.67%) disease incidence was recorded for treatment T_1 which was statistically identical with T_4 (8.33%) and T_5 (8.86%) treatment. On the other hand the highest (27.67%) in disease incidence was recorded for treatment T_{10} which was closely (17.67%) followed by treatment T_9.

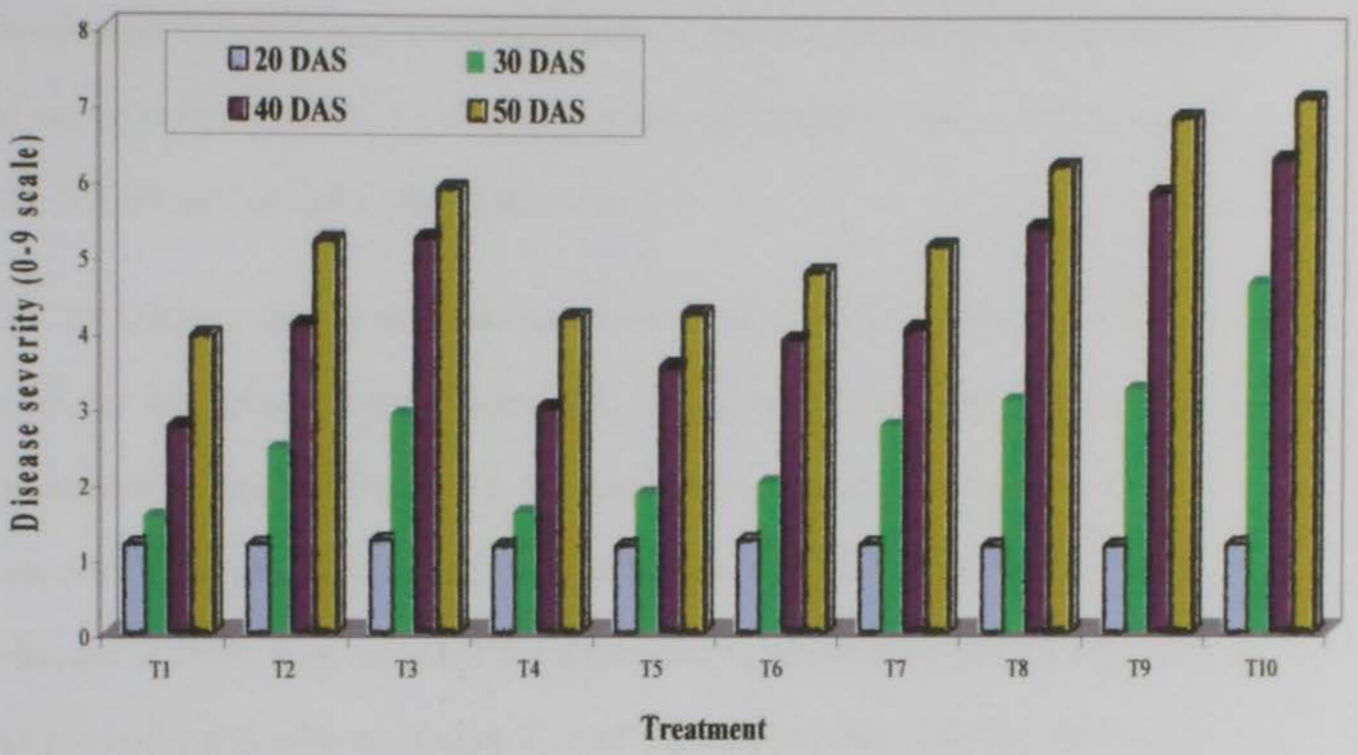


Figure 3. Effect of insecticides, plant extracts and cultural practices on the severity of yellow mosaic of mungbean (var. BARI Mung-5)

4.3 Disease severity

Different treatment such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases in this trial showed a statistically significant variation for disease severity that were calculated at 20, 30, 40 and 50 DAS (Appendix VI).

At 20 DAS variation recorded was non significant.The lowest (1.15) disease severity was recorded for treatment T_4, T_5, T_8 and T_9 and the highest (1.22) for treatment T_3 and T_6 (Figure 3). A significant variation was recorded for disease severity in application of different treatments at 30 DAS. The lowest (1.55) disease severity was recorded for treatment T_1 which was statistically identical (1.60 and 1.85) with treatment T_4 and T_5, respectively. On the other hand the highest (4.65) disease severity was recorded for treatment T_{10} which was closely (3.25) followed by treatment T_9. At 40 DAS a significant differences was recorded in disease severity for different treatments for managing mungbean yellow mosaic diseases. The lowest (2.75) disease severity was recorded for treatment T_1 which was statistically identical (3.00) with T_4, while the highest (6.30) was recorded for treatment T_{10} which was closely (5.85, 5.40) followed by treatment T_9 and T_8. At 50 DAS different treatments showed a significant variation in disease severity for managing mungbean yellow mosaic virus. The lowest (3.95) disease severity was recorded for treatment T_1 which was statistically identical (4.20 and 4.25) with T_4, T_5 treatment. On the other hand the highest (7.10) in disease severity was recorded for treatment T_{10} which was statistically similar (6.85) with treatment T_9.

4.4 Plant height

Different treatment such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases in this trial showed a statistically significant difference for plant height (Appendix VII). The tallest (46.52 cm) plant was recorded for treatment T_1 which was statistically identical (46.81 cm) with T_4 treatment. On the other hand the shortest (38.44 cm) plant was recorded for treatment T_{10} which was statistically similar (40.41 cm) with T_9 treatment (Table 1). Plant height increase over control was also differing for different treatment. The maximum (21.02%) plant height increase over control was recorded for T_1 treatment and the minimum (6.19%) was recorded for treatment T_9.

4.5 Number of primary branches per plant

Number of primary branches per plant varied significantly for different treatments (Appendix VII). The highest (5.20) number of primary branches per plant was recorded for treatment T_1 which was statistically similar (5.15) with T_4 treatment. On the other hand the lowest (3.05) number of primary branches per plant was recorded for treatment T_{10} which was closely followed (3.75) with T_9 treatment (Table 1).

Table 1. Plant height and number of primary branches in treated and yellow mosaic infected mungbean (var. BARI Mung-5)

Treatments	Plant height (cm)	Increase over control (%)	Number of primary branches/ plant	Increase over control (%)
T_1 = Admire (I midacloprid)	46.52 a	21.02	5.20 a	70.49
T_2 = Actara (Thiamethoxam)	44.08 ab	14.67	4.25 b	39.34
T_3 = Marshal(Carbosulfan)	42.36 abc	10.20	4.00 bc	31.15
T_4 = Ripcord (Cypermethrin)	46.81 a	21.77	5.15 a	68.85
T_5 = Neem leaf extract (1:4 w/v)	45.28 ab	17.79	4.90 a	60.66
T_6 = Garlic clove extract (1:4 w/v)	45.25 ab	17.72	4.90 a	60.66
T_7 = Allamanda leaf extract (1:4 w/v)	43.11 abc	12.15	4.15 b	36.07
T_8 = Yellow trap	42.41 abc	10.33	4.00 bc	31.15
T_9 = Reflective tape	40.82 bc	6.19	3.75 c	22.95
T_{10} = Untreated (control)	38.44 c	--	3.05 d	--
LSD $_{(0.05)}$	**4.646**	--	**0.297**	--
CV	**6.22**	--	**4.00**	--

Number of primary branches per plant increase over control also showed different for various treatments. The highest (79.49%) number of primary branches per plant increase over control was recorded for T_1 treatment and the lowest (22.95%) was recorded for treatment T_9.

4.6 Number of pods per plant

A remarkable variation for number of pods per plant was recorded for different treatments (Appendix VII). The highest (23.50) number of pods per plant was recorded for treatment T_1 which was statistically similar (23.22, 22.18) with T_4 and T_5 treatment, while the lowest (14.84) number of pods per plant was recorded for treatment T_{10} which was closely followed (16.45) with T_9 treatment (Table 2). Number of pods per plant increase over control also gave different value for various treatments. The highest (58.36%) number of pods per plant increase over control was recorded for T_1 treatment and the lowest (10.85%) was recorded for treatment T_9.

4.7 Pod length

Different treatments showed a remarkable variation for pod length (Appendix VII). The maximum (9.26 cm) pod length was recorded for treatment T_1 which was statistically similar (9.00 cm) with T_4 treatment. On the other hand the minimum (8.00 cm) pod length was recorded for treatment T_{10} and T_9 which was statistically similar (8.32 cm) with T_7 treatment (Table 1). Pod length increase over control was also differing for different treatment. The maximum (29.332%) pod length increase over control was recorded for T_1 treatment and the minimum (11.73%) was recorded for treatment T_9.

Table 2. Number and length of pod in treated and yellow mosaic infected mungbean (var. BARI Mung-5)

Treatments	Number of pods per plant	Increase over control (%)	Pod length (cm)	Increase over control (%)
T_1 = Admire (Imidacloprid)	23.50 a	58.36	9.26 a	29.33
T_2 = Actara (Thiamethoxam)	20.81 ab	40.23	8.54 bcd	19.27
T_3 = Marshal(Carbosulfan)	18.22 bc	22.78	8.24 d	15.08
T_4 = Ripcord (Cypermethrin)	23.22 a	56.47	9.00 ab	25.70
T_5 = Neem leaf extract (1:4 w/v)	22.18 a	49.46	8.84 abc	23.46
T_6 = Garlic clove extract (1:4 w/v)	20.84 ab	40.43	8.80 abc	22.91
T_7 = Allamanda leaf extract (1:4 w/v)	18.36 bc	23.72	8.32 cd	16.20
T_8 = Yellow trap	18.00 bcd	21.29	8.00 d	11.73
T_9 = Reflective tape	16.45 cd	10.85	8.00 d	11.73
T_{10} = Untreated (control)	14.84 d	--	7.16 e	--
$LSD_{(0.05)}$	3.097	--	0.515	--
CV	9.19	--	3.57	--

4.8 Number of seeds per pod

A remarkable variation for number of seeds per pod was recorded for different treatments such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases (Appendix VIII). The maximum (11.55) number of seeds per pod was recorded for treatment T_1 which was statistically similar (11.40) with T_4 treatment, while the minimum (8.05) number of seeds per pod was recorded for treatment T_{10} which was closely followed (9.32) with T_9 treatment (Table 3). Number of seeds per pod increase over control also gave different value for different treatments. The maximum (69.31%) number of seeds per pod increase over control was recorded for T_1 treatment and the minimum (25.15%) was recorded for treatment T_9.

4.9 1000 seed weight

Significant variation was recorded for 1000 seed weight for different treatment such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases (Appendix VIII). The highest (41.25 g) 1000 seed weight was recorded for treatment T_1 which was statistically similar (40.94 g) with T_4 treatment, while the lowest (35.74 g) 1000 seeds weight was recorded for treatment T_{10} which was closely followed (38.00 g) with T_9 treatment (Table 3). 1000 seed weight increase over control also varied differently for different treatments. The maximum (15.42%) 1000 seed weight increase over control was recorded for T_1 treatment and the minimum (6.32%) was recorded for treatment T_9.

Healthy seeds

MYMV Infected seeds

Plate 9. Healthy and MYMV infected seeds of Mungbean

4.10 Yield per plot

Yield per plot varied significantly for different treatment such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases (Appendix VIII). The highest (3.84 kg/plot) yield was recorded for treatment T_1 which was statistically similar (3.72 kg/plot) with T_4 treatment, while the lowest (3.06 kg/plot) yield was recorded for treatment T_{10} which was closely followed (3.36 kg/plot) with T_9 treatment (Table 4). Yield per plot increase over control also varied differently for different treatments. The maximum (25.49%) yield per plot increase over control was recorded for T_1 treatment and the minimum (9.80%) was recorded for treatment T_9.

Table 3. Number of seed per pod and 1000 seed in treated and yellow mosaic infected mungbean (var. BARI Mung-5)

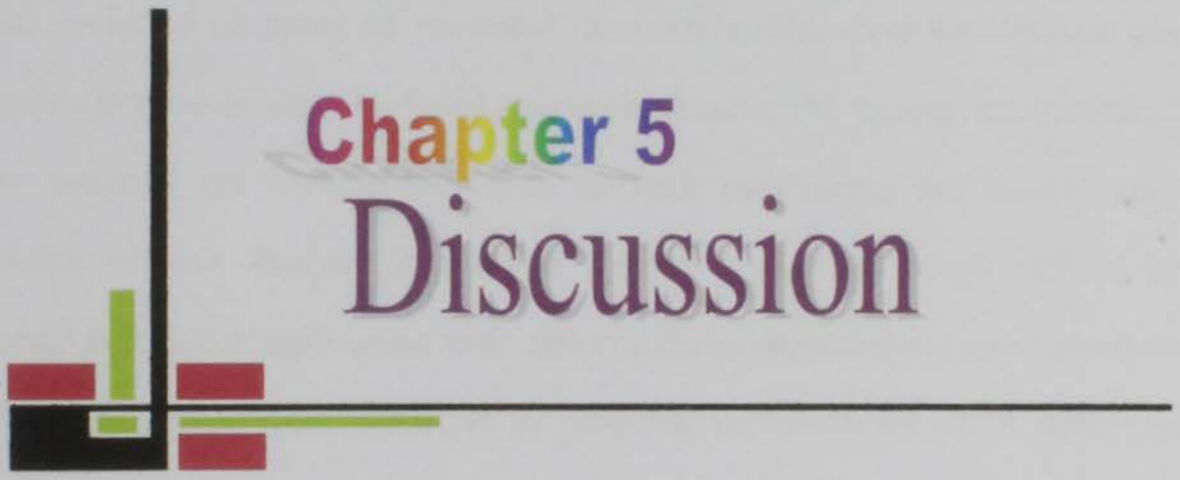
Treatments	Number of seeds per pod	Increase over control (%)	1000 seed weight (g)	Increase over control (%)
T_1 = Admire (Imidacloprid)	11.55 a	69.31	41.25 a	15.42
T_2 = Actara (Thiamethoxam)	10.48 bc	48.12	39.15 a	9.54
T_3 = Marsha (Carbosulfan)	10.00 cd	38.61	38.54 ab	7.83
T_4 = Ripcord (Cypermethrin)	11.40 a	66.34	40.94 a	14.55
T_5 = Neem leaf extract (1:4 w/v)	11.10 ab	60.40	40.91 a	14.47
T_6 = Garlic clove extract (1:4 w/v)	10.45 bc	47.52	39.89 a	11.61
T_7 = Allamanda leaf extract (1:4 w/v)	10.00 cd	38.61	39.00 ab	9.12
T_8 = Yellow trap	9.54 d	29.50	38.39 ab	7.41
T_9 = Reflective tape	9.32 d	25.15	38.00 ab	6.32
T_{10} = Untreated (control)	8.05 e	--	35.74 b	--
$LSD_{(0.05)}$	0.630	--	3.023	--
CV	5.11	--	4.50	--

4.11 Yield per hectare

Different treatment such as insecticides, plant extract and cultural practices that were used for managing mungbean yellow mosaic diseases varied significantly for yield per hectare (Appendix VIII). The highest (1.28 t/ha) yield was recorded for treatment T_1 which was statistically similar (1.24 t/ha) with T_4 treatment. On the other hand the lowest (1.02 t/ha) yield was recorded for treatment T_{10} which was closely followed (1.12 t/ha) with T_9 treatment (Table 4).

Table 4. Yield of mungbean (var. BARI Mung-5) in yellow mosaic infected and treated plots

Treatments	Yield (kg/plot)	Increase over control (%)	Yield (t/ha)
T_1 = Admire (Imidacloprid)	3.84 a	25.49	1.28 a
T_2 = Actara (Thiamethoxam)	3.51 ab	14.71	1.17 ab
T_3 = Marshal (Carbosulfan)	3.42 b	11.76	1.14 b
T_4 = Ripcord (Cypermethrin)	3.72 ab	21.57	1.24 ab
T_5 = Neem leaf extract (1:4 w/v)	3.60 ab	17.65	1.20 ab
T_6 = Garlic clove extract (1:4 w/v)	3.54 ab	15.69	1.18 ab
T_7 = Allamanda leaf extract (1:4 w/v)	3.45 b	12.75	1.15 b
T_8 = Yellow trap	3.39 bc	10.78	1.13 bc
T_9 = Reflective tape	3.36 bc	9.80	1.12 bc
T_{10} = Untreated (control)	3.06 c	--	1.02 c
$LSD_{(0.05)}$	**0.330**	--	--
CV(%)	**5.55**	--	--



Chapter 5
Discussion

5. DISCUSSION

The present experiment was conducted to manage mungbean yellow mosaic virus. The main objective of this study was to find out a suitable management practice, which could be effective to manage the disease in winter mungbean. BARImung-5 is found moderately susceptible to mungbean yellow mosaic virus. The other reason to choose this cultivar was that it is a popular variety having good agronomic characters.

Different approaches were tried to control the mungbean yellow mosaic virus, which included (i) spray of chemical insecticides (ii) spray of different plant extracts (iii) use of some cultural practices. Among the treatments insecticidal spray reduced the disease incidence through controlling the insect vectors (*Bemisia tabaci*). Present findings is similar to that of Borah (1996) who reported that foliar application with cypermethrin, deltamethrin and dimethoate at 50 DAS proved quite effective in reducing the incidence of *B. tabaci* and thereby lowering the virus infection. Similar findings were obtained by Kumawat and Kumawat (1996) by using different chemicals. They observed that the monochrotophos sprayed twice at an interval of 20 days, was effective in reducing the population of the pest insects and the ultimate results was the lowest incidence of the yellow mosaic disease.

Botanical extracts also effectively and it was more or less similar with chemical practices. Miah *et al.* (1990) reported that neem extract had a potential ability for controlling yellow mosaic virus in mungbean. Among the different plant extracts neem extracts was more effective, Garlic clove extract also more

effective than allamanda leaf extract. Islam *et al.* (2006) found a remarkable reduction of this diseases severity by seed treatment with garlic and bishkatali. The works of Singh and Dwvedi (1990); Achimu and Schloesser (1992) and others confirmed that neem leaf have high pesticidal properties.

The highest percentage of mosaic expressing true leaves in winter mungbean was observed in control plots while the minimum was recorded in plots, which received Chemicals and botanical extracts. Chemicals and botanical extracts performed better in respect of per cent mosaic expressing true leaves than that of cultural practices. The findings of Katyal and Friescen (1972) may partially support the findings of the present study who reported that chemical and plant extracts were more effective but in control condition plants become more vulnerable to disease. Chemical and plant extracts control insect vector avoid the abundance of insect vectors in the crop field. Thus plants protect itself from the severity of yellow mosaic disease.

Among the different treatment insecticidal sprays alone increased plant height higher than the other treatment. However, plant extract also performed better than cultural practices in relation to plant height. The findings of Singh *et al.* (1982) are consistent with out finding. They observed that application of chemicals and botanicals resulted more vigorous vegetative growth allowing the plants to escape viral infections and effect of infection. The findings of Saran and Giri (1990) and Jain *et al.* (1995) are also relevant with our findings.

All the treatments used in this work showed significant positive effect on the number of pods, reduced number of pods per plant, increased number of seeds

per pod, pod length, and 1000 seed weight. The number of inflorescence, number of pods per plant, pod length and 1000 seed weight was maximized in plots which received chemical and plant extract spray as against control plots. The number of pods per plant, which depends on the incidence and severity of yellow mosaic of mungbean was minimum in chemically treated plot than botanical extracts and the minimum in control plots. Chemicals and botanical extract might have great impact in reducing disease incidence and severity of yellow mosaic disease and producing disease free plants which performed better in all yield components under the present experiment. Williams *et al.* (1968), Poehlman (1991); Roy and Malathi, (2001) reported the similar effect on number of inflorescence per plant and plant height of mungbean. *Vigna radiata* plants in pots, kept in the field, were protected against natural viral infections by spraying with leaf extract of *C. aculeatum*, together with soil amendment with dry leaf powder or fresh extract by Barman and Das (1996).

Previous reports regarding the combined effects chemicals, botanical extracts and cultural practices on the yield promoting characters of winter mungbean are not available. But reports on the individual effects of these factors are available in limited number. Bayan and Saharia (1996) observed that effective chemical could be achieved at 20 DAS adding that branches/ plant were significantly influenced by chemicals application.

This finding also supports the findings of the present study. Saran and Giri (1990) observed that number 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 affect 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, 100-seed weight.

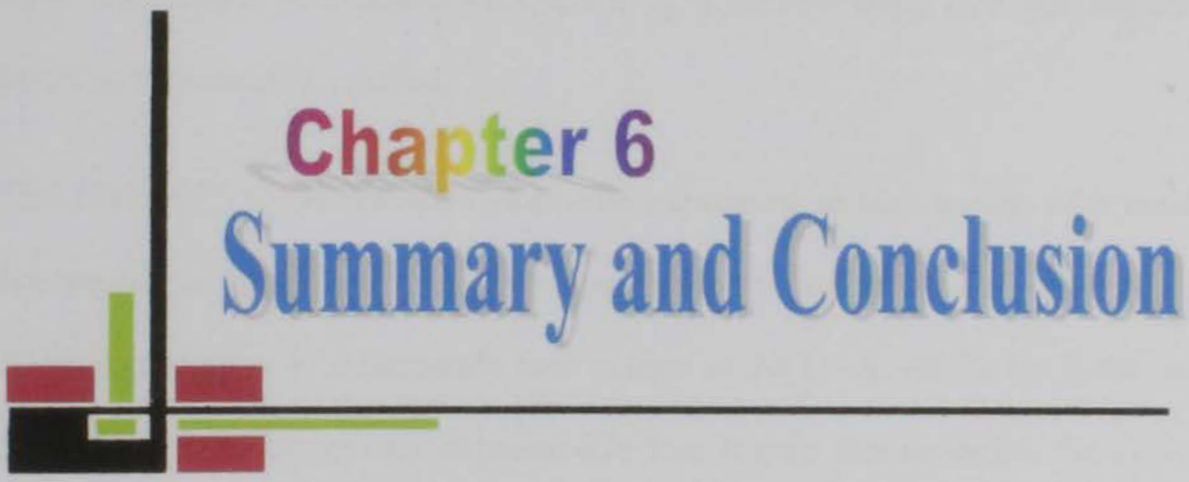
Baker (1991) reported that total loss occurred when the crop was infected within 1-2 weeks after germination, 63% at the three weeks and around 20-30% in plants which were infected at the age of 4 to 7 weeks. So treatments could be applied in that period. Kumar and Kairon (1988) reported that optimum time for the application of treatment may be 30 DAS. They also observed that to get maximum seed yield of mungbean, application may be done 30 or 40 days after crop sowing. Sarkar and Mondal. (1985) reported that grain yield was reduced by 49-55% when weeds are allowed to grow undisturbed.

The findings in relation to seed yield of mungbean as influenced by insecticide spray was relevant with the findings of Thakur and Agrawal *et al* (1998).They reported that three foliar sprays of dimethoate (0.1%) not only reduce the yellow mosaic bigeminivirus but also increased the grain yield significantly. Botanical extract also played a predominant part in increasing seed yield. Reports on the effects of botanical extract in grain yield of mungbean are in a limited number but available on other crops. Zaman *et al.* (1996) suggested that in addition to recommended many botanicals extracts applied in mungbean for attaining higher grain yield and net returns. Sontakey *et al.* (1999) observed that pod yield increased by the application of neem and garlic in groundnut. Mian (1976); Jalaluddin and Shaik (1981); Shyam *et al.* (2004) reported that plant extracts was more effective control measures than the other for cost effective production. Further works of Singh Dwvedi (1991); Tariq and Magee

(1990); Lakshmonan *et al.* (1990) supported the earlier findings and recommended the use of garlic as a pesticidal agent.

As yellow mosaic disease is different from diseases caused by fungi, bacteria and nematodes, curative measures are very difficult to control the yellow mosaic disease. Cultural control may play a vital role in controlling the yellow mosaic disease of winter mungbean. Smith *et al.* (1996) reported that sugarcane mosaic disease can be significantly controlled by cultural practices. Cultural practices as a control method also promises indirect influence on disease control.

The yellow mosaic disease of mungbean is mainly vector transmitted (insect borne). There is no other means of effectively controlling these insect vectors except insecticide. But continuous and extensive use insecticides resulted environmental pollution and hazards to living beings. Use of insecticide may be minimized by the application of botanical extract and cultural practices. In promoting yield contributing parameters and yield as observed here as number of inflorescence per plant, plant height, number of primary branches per plant, number of pod per plant, pod length, number of seed per pod, 1000 seed weight, yield per plot and hectare, the performance of treatments chemical were more effective than the botanicals. But any of the plant extracts improved significantly the yield contributing parameters and also yield comparing to cultural practices and than the control.



Chapter 6
Summary and Conclusion

6. SUMMARY AND CONCLUSION

A research was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period March to July 2007 for management of mungbean yellow mosaic disease through some insecticides, plant extracts and cultural treatment. The ten different treatments of the experiment were as T_1 = Admire 200SL @ 1 ml/1 litre of water at 7 days interval; T_2 = Actara 25WG @ 0.4 gm/1 litre of water at 7 days interval; T_3 = Marshal @ 3 ml/1 litre of water at 7 days interval; T_4 = Ripcord @ 1.7 ml/1 litre of water used at 7 days interval, T_5 = Neem leaf extract (1:4 w/v); T_6 = Garlic clove extract (1:4 w/v); T_7 = Allamanda leaf extract (1:4 w/v); T_8 = Yellow trap; T_9 = Reflective tape and T_{10} = Untreated control.

The lowest (2.33%) disease symptoms expressed in true leaves was recorded for treatment T_9 as used reflective tape, while the highest (2.80%) for treatment T_7 as application of Allamanda leaf extract at 20 DAS. At 30 DAS the lowest (6.25%) disease symptoms expressed in true leaves was recorded for treatment T_1 comprising of Admire application and the highest (16.66%) disease symptoms expressed in true leaves was recorded for treatment T_{10} that is untreated (control). At 40 DAS the lowest (9.22%) disease symptoms expressed in true leaves was recorded for treatment T_1, while the highest (21.84%) was recorded for treatment T_{10}. At 50 DAS the lowest (15.85%) disease symptoms expressed in true leaves was recorded for treatment T_1 and the highest (26.33%) in disease symptoms expressed in true leaves was recorded for treatment T_{10}.

At 20 DAS the lowest (1.00%) disease incidence was recorded for treatment T_2, T_3 and T_4 and the highest (1.67%) for treatment T_6 and T_9. At 30 DAS the lowest (3.33%) disease incidence was recorded for treatment T_1, while the highest (19.67%) disease incidence was recorded for treatment T10. At 40 DAS the lowest (5.67%) disease incidence was recorded for treatment T_1, while the highest (23.33%) was recorded for treatment T_{10}. At 50 DAS the lowest (6.67%) disease incidence was recorded for treatment T_1 and the highest (27.67%) in disease incidence was recorded for treatment T_{10}.

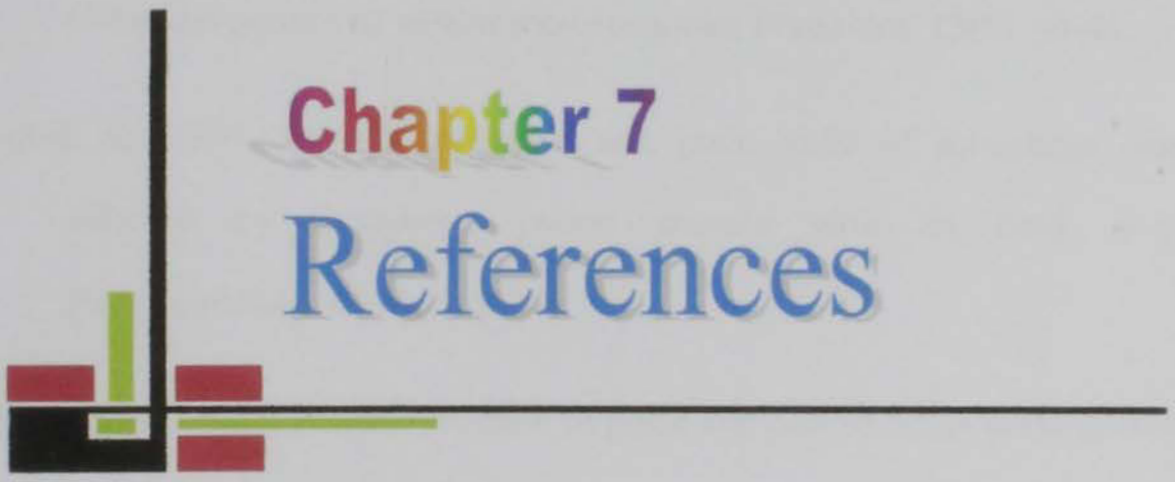
At 20 DAS the lowest (1.15) disease severity was recorded for treatment T_4, T_5, T_8 and T_9 and the highest (1.22) for treatment T_3 and T_6. At 30 DAS the lowest (1.55) disease severity was recorded for treatment T_1 and the highest (4.65) disease severity was recorded for treatment T_{10}. At 40 DAS the lowest (2.75) disease severity was recorded for treatment T_1, while the highest (6.30) was recorded for treatment T_{10}. At 50 DAS the lowest (3.95) disease severity was recorded for treatment T_1 and the highest (7.10) in disease severity was recorded for treatment T_{10}.

The tallest (46.52 cm) plant was recorded for treatment T_1 and the shortest (38.44 cm) plant was recorded for treatment T_{10}. The highest (5.20) number of primary branches per plant was recorded for treatment T_1 and the lowest (3.05) number of primary branches per plant was recorded for treatment T_{10}. The highest (23.50) number of pods per plant was recorded for treatment T_1, while the lowest (14.84) number of pods per plant was recorded for treatment T_{10}. The maximum (9.26 cm) pod length was recorded for treatment T_1 and the

minimum (8.00 cm) pod length was recorded for treatment T_{10} and T_9. The maximum (11.55) number of seeds per pod was recorded for treatment T_1, while the minimum (8.05) number of seeds per pod was recorded for treatment T_{10}. The highest (41.25 g) 1000 seed weight was recorded for treatment T_1, while the lowest (35.74 g) 1000 seeds weight was recorded for treatment T_{10}. The highest (3.84 kg/plot) yield was recorded for treatment T_1, while the lowest (3.06 kg/plot) yield was recorded for treatment T_{10}. The highest (1.28 t/ha) yield was recorded for treatment T_1 and the lowest (1.02 t/ha) yield was recorded in treatment T_{10}. Chemical treatment showed the best result among the treatments.T_1 gave the best performance in which disease incidence was reduced by 21.02% and the yield was increased by 25.49%. Among all botanicals and cultural treatments T_5 gave the best performance in which disease incidence declined by 18.67% and the yield was increased by 17.65%.

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Other chemicals and plant extracts may be included the future study;
2. Only plant extract may be included in the future program;
3. Further study may be undertaken to spell out the extract concentration.



Chapter 7
References

7. REFERENCES

Achimu, P. and Schlosser, E. 1992. Effect of neem seed extracts against leaf spot. International symposium Sytofarmacie Chemical control of yellow mosaic moong Pesticides. **13**(5): 44-47.

Aftab, M. S., Asad, K. M. Khokong, M. A. Ayub and Butt. 1992. effect of mungbean yellow mosaic virus on yield and growth components *Vigna radiata*. *Pakistan Journal of Phytopathology*. **5**(1-2): 58-61.

Agrawal, H. S., M. K. Gupta, V. K. Prasad, S. L. Vishwakarma. 1980. Chemical control of yellow mosaic moong Pesticides. **13**(5): 44-47.

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

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

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

Anonymous, (1989). Annual Weather Report, IPSA. Meteorological Station, IPSA, Salna, Gazipur. 8-15.

Anonymous. 1984. Assessment of yield loss of Mungbean due to yellow mosaic virus disease. Annual Report of Plant Pathology Division. 1983/84. BARI, Joydevpur, Bangladesh.

Ashrafuzzaman, H. and Hossain, I. 1992. Antifungal activity of crude extracts of plants against *Rhizoctonia solani* and *Bipolaris sorokiniana*. Proc, BAU. Res. Prog. **6**: 188-192.

Bakar, A. K. 1981. Pest and disease problems of mungbean in West Malaysia. *Malaysian Agricultural Journal*. **53**: 29-33.

Bakr, M. A. and F. Ahmed. 1988. Yield loss assessment of chickpea due to collar rot disease. Paper Presented at the 3rd Biennial conference of the Bangladesh Agricultural University, Mymensingh, Bangladesh.

Bakr, M. A. 1991. Management of important disease of major pulses. Advances in pulses research in Bangladesh: Proceedings of second National Workshop in Pulses, 6-8 June, 1989, Joydebpur, Bangladesh.

BARI (Bangladesh Agricultural Research Institute). 1987. Assessment of yield loss of mungbean due to yellow mosaic virus disease. Plant pathology division. Annual report 1986-1987. Joydevpur, Gazipur, Bangladesh. 109 p.

BARI (Bangladesh Agricultural Research Institute). 1988. Assessment of yield loss of mungbean due to yellow mosaic virus disease. Plant pathology division. Annual report 1987-1988. Joydevpur, Gazipur, Bangladesh. 116 p.

BARI (Bangladesh Agricultural Research Institute). 2004. Assessment of yield loss of mungbean due to yellow mosaic virus disease. Plant pathology division. Annual report 2003-2004. Joydevpur, Gazipur, Bangladesh. 133 p.

Barman, M. and P. Das. 1996. Effect of chemical seed dressing and organic amendment alone and in combination for the management of root-knot nematode, Meloidogyne incognita on green gram. *Indian Journal of Nematology*. 26 (1): 72-76.

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

Baub, R. C., R. Rathinaswamy, P. S. Srivasan, N. Natarajaratnam and S. R. Sreerangsswamy. 1984. Certain physiological changes in green gram plants infected by mungbean yellow mosaic virus. *Madras Agricultural Journal*. **71** (12): 795-798.

Bayan, H. C. and P. Saharia. 1996. Effect of weed management and phosphorus on kharif green gram. *J. Agril. Sci. Soc.* North East India. **9** (2): 151-154.

BBS (Bangladesh Bureau of Statistics). 2006. Monthly statistical bulletin of Bangladesh, Dhaka. May, 2006, p. 56.

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

Borah R. L. Keshwal and M. N. Khare. 1997. Studies on a yellow mosaic virus disease of soybean and mungbean. Annals of Plant Protection Sciences. **6** (2): 75-89.

Borah, R. K. 1996. Effect of systemic pyrethroids and organophosphates insecticides on the incidence of whitefly, *Bemisia tabaci (*Genn.) and yellow mosaic virus in green gram, *Vigna radiata* (L) Wilzek. *Indian Journal of Virology*. **11** (1): 75-76.

Brunt, A., K. Crabtree, and A. Gibbs. 1990. Viruses of tropical Plants. Cab International, Wallingford. U. K. p. 355.

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

Chanda, P. and J. P. Varma. 1983. Effect of yellow mosaic on growth components and yield of mungbean and urdbean. *Journal of Research.* Haryana Agricultural University. **13** (1): 98-102.

Chander, S. and Y. Singh. 1991. Effect of insecticides on white fly, *Bemisia tabaci* (Gennadius) and yellow mosaic virus in green gram, *Vigna radiata* (L) Wilczek. *Indian Journal Entomology*. **53**: 2, 248-251.

Chenulu, V. V., V. Venkateshwarlu and R. Rangraja. 1979. Studies on yellow mosaic disease of mungbean. *Indian Phytopathology*. **32**: 230-235.

Dantre, R. K., R. L. Keshwal and M. N. Khare. 1996. Studies on a yellow mosaic virus disease of soybean and mungbean. Annals of Plant Protection Sciences. **4** (1): 67-70.

Dhingra, O.D. and Silva, J. F. D. A. 1979. Effect of weed control on the internally seeds-borne fungi in soybean seeds. Plant disease reporter (1978). **62** (6): 513-516.

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

Dhingra, K. L., and Ghosh, D. K. 1993. Efficacy of white fly vector (*Bemisia tabaci* Genn) in transmission of mungbean yellow mosaic virus in different source test plant combination. *International Journal of Tropical Agricultural*. **11** (2): 149-152.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haque, A. K. M. M. 1979. Detailed Soil Survey of Bangladesh Agricultural University Farm, Mymensingh, Dept. Soil Survey, Govt. People's Republic of Bangladesh. 118 p.

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

FAO. 1988. Production Year Book. Food and Agricultural of the United Nations Rome, Italy. 42: 190-193.

Farias, J. C. and M. J. O. Zimmermann. 1990. Control of bean golden mosaic by means of varietal resistance and insecticides. *Fitopatologia Brasileira*. **13** (1): 32-35.

Ganapathy, T and R. Karuppiah. 2004. Evaluation of new insecticides for the management of whitefly (Bemisia tabaci Genn.), mungbean yellow mosaic virus (MYMV) and urdbean leaf crinkle virus (ULCV) diseases in mungbean (Vigna radiata (L.) Wilezek). *Indian Journal of Plant Protection*. **32** (1): 55-68.

Gill, C. K., Labh, S. and Singh, L. 1999. Effect of mungbean yellow mosaic virus on yield components in mungbean cultivar. *Insect Environment*. **5**: 3, 112-113.

Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst., A Willey Int. Sci., Pub., pp. 28-192.

Grewal, J. S. 1978. Disease of mungbean in India. Proceedings 1st International Mungbean Symposium. Asian Vegetable Research and Development Centre, Shanhua, Taiwan. 44p.

Gupta, P. K. and Singh, J. 1984. Effect of systemic granular insecticides on whitefly population and yellow mosaic infection in green gram, *Indian J. of Agril. Sci.*, **53**(8): 737-742.

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

Islam, M. A. Aminuzzaman, F. M., Islam, M. R. and Zamal, M. S. 2006. Seed treatment with plant extract and vitavax 200 in controlling leaf spot with increasing grain yield of wheat. *International J. Sustain. Agril. Tech.*, 2 (8): 15-20.

Iwaki, M. and H. Auzay. 1978. Virus disease of mungbean in Indonesia. Proceedings of first International Mungbean Symposium. Asian Vegetable Research and Development Centre, Shanhua, Taiwan. 45p.

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

Jalaluddin, M., and M. A. Q. Shaikh. 1981. Evaluation of Mungbean (*Vigna radiata* L. Wilczek) germplasm for resistance to yellow mosaic virus. *SABRAO Journal.* **13** (1): 61-68.

Jalaluddin, M., M. Rahizuddin and M. A. Razzaque. 1994. Effects of sowing dates on cercospora leaf spot, yellow mosaic and grain yield of two winter mungbean strains. *Bangladesh Journal of Nuclear Agriculture*. **10**: 83-88.

Jayasekera, S. J. B. A. and H. P. Ariyarantoe. 1988. Current status of mungbean improvement for the farming systems in Sri Lanka. Mungbean: Proceedings of the second International Symposium. Asian Vegetable Research and Development Centre, Shanhua, Taiwan. 26p.

Katayal, J. C. and Friescen, D. K. 1972. Efficiency of micronutrients and sulphur in wheat production country in tropical environment Proc. 2nd Confec. Held Chiang Mai, Thailand. Jan. 19-23, 1987.

Khan, M. A. 1985. Antifungal activity of crude plant extracts against *Bipolaris sorokiniana*. Paper presented in the 5th Biennial conference. Bangladesh Phytopathological Society. 27-28 June, 1993. BAU, Mymensingh. 10p.

Khan, M. R. I. 1981. Nutritional quality characters in pulses. In Proc. Nat. Workshop in Pulses. pp. 199-206.

Krisnareddy, S. 1989. Studies on crop weed competition in summer mungbean. Legume Res. **13** (3): 110-112.

Kumar, S. and M. S. Kairon. 1988. Studies on crop weed competition in summer mungbean. Legume Res. **13** (3): 110-112.

Kumawat, K. C. and G. L. Kumawat. 1996. Effect of some insecticides on sucking pests and yellow mosaic incidence of mothbean,Vigna acontifilia Masechel. *Indian J.of virology*. **11** (2): 69-72.

Lakshmonan, P., Mohan, S. and Jeyarajan, R. 1990. Antifungal properties of some plant extracts against *Thanatephorus cucumeris*, the casual agent of collar rot disease of *Phaceolus aureum*. *Madras Agric J.* **77** (1): 1-4.

Madhuban, Gopal, I. Mukherjee, K. P. Srivastava, M. Gopal, I. Mukherjee. 1997. Efficacy of imidacloprid and its comparison with other insecticides for controlling whitefly in pulses. Annals of Plant Protection Sciences. **5**: 1, 29-33.

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

Miah, A., Ahmed, M. U., Sharma, N. R., Ali, A. and Miah, S. A. 1990. Antifungal activity of some plant extract. *Bd. J. Botany*. **19** (1): 5-20.

Mian, A. L. 1976. Grow more pulse to keep your pulse well. An essay of Bangladesh Pulse, Dept. of Agronomy, Bangladesh Agricultural University, Mymensingh. 11-15.

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

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

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

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

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

Nene, Y. L. 1971. Control of *Bemicia tabaci* Genn, a vector of several plant viruses. *Indian Journal of Agricultural Sciences*. **43** (5): 433-436.

Nene, Y. L. 1972. A survey of viral diseases of pulse crops in Uttar Prodesh, Research Bulletin No. 4. University of Agriculture and Technology, Pantnagar, U. P. 95 p.

Nene, Y. L. 1973. Viral disease of some warm weather pulse crop in India. Plant Disease. **57** (5): 463-467.

Nene, Y. L., Y. P. S. Rathi, N. G. Nair and Naresh, J. S. 1972. Yellow mosaic. A survey of viral diseases of pulse crops in Uttar Pradesh. G. B. Plant University of Agriculture and Technology. Research Bulletin. 4.

Patel, M. B. and K. P. Srivastava. 1990. Field screening of some high yielding genotypes of mungbean, Vigna radiata, Wilezek, to white fly. *Indian Journal of Entomology*. **52** (4): 547-551.

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

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

Roy, A. and Malathi, V. G. 2001. Molecular cloning of cowpea golden mosaic geminivirus and its relationship with mungbean yellow mosaic geminivirus. *Tropical-Agricultural Research*. **13**: 341-352.

Sadana, H. R. and Verma, S. 1989. Effect of fertilizers and insecticides on the incidence of yellow mosaic disease of green gram. *Plant protection Bulletin*. **39** (4): 3-6.

Sadiq, M. S., Khattak, G. S. S., Saleem, M. and Sarwar, G. 1999. Exotic mungbean (*Vigna radiata* L. Wilczek) germplasm: its utilization through conventional breeding approach. *Tropical Agril. Res. and Extn.* **2**: 1, 4-6.

Saran, G. and Giri, G. 1990.Influence on nitrogen phosphate and sulphur on under semi arid and rainfed condition of North-West. *Indian J. Agron.* **35** (1-2): 131-136.

Sarker and Mondal, M. H. 1985. A study on the effect of weeding on yield and yield to attributes of several varieties/strains of mungbean. *Bangladesh J, Agril. Res.* **10** (1): 34-40.

Shyam, S. L. P. Awasthi and H. N. Verma. (2004). Prevention and control of yellow mosaic disease of mungbean by application of aqueous root extract of *Boerhaavia diffusa*. *Indian Phytopathology*. **57** (3): 303-307.

Singh, A. and A. Sihori. 1998. Effect of various insecticides for the control of yellow mosaic of blackgram. Plant Disease Research. **12** (1): 37-38.

Singh, A. and D. P. Singh. 1991. Recent advances in mungbean production. Indian Farming. **24**: 8-20.

Singh, A., B. B. Singh and C. S. Patel. 2004. Response of vegetable pea to zinc, boron and molybdenum in an acid Alfisol of Meghalaya. *Indian Journal of Agronomy*. **37** (3): 615-616.

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

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

Singh, R. K. and Dwivedi, R. S. 1990. Fungitoxicity of different plants. National Aca. Science. **10** (3): 89-91.

Smith, G. R., Croft, B. J., Piggin, C. M., Wallis, E. S. and Hogarth, D. M. 1996.Sugercane mosaic and Fijii disease. Sugercane germplasm conservation and exchange; Report on International Workshop held in Brisbane, Queensland, Australia, 28-30, June, 1995. 1996, 120-122, ACIAR Proceedings no. 67.

Sontakey, P. Y., Chore, C. N.,Potkile, S. N., Deotale, R. D. and Nair, B. 1999. Response to sulphur and Zinc as soil application in ground nut. Journal of Soils and crops. **9** (2): 258-261.

Subrahmanyam, K. and Varma, A. 1986. Management of yellow mosaic disease of blackgram through cultural practices chemical treatment. In: National Seminar on whitefly Transmitted Plant Virus Diseasse .IARI, New Delhi. p. 43.

Suteri, B. D., and Srivastava, S. B. 1979. Effect of soybean yellow mosaic on growth and yield on soybean. Plant disease report. **63**: 151-153.

Tariq, V. N. and A. C. Magee. 1990. Effect of volatiles from garlic bulb extract on *Fusarium oxysporum f. sp. lycopersici*. Mycological Res. **94** (5): 617-620.

Thakur, M. P. and K. C. Agrawal. 1998. Management of yellow mosaic disease of urdbean in Chhattisgarh region. *Indian Journal of Virology*. **14** (1): 85-87.

Vohra, K. and S. P. S. Beniwal. 1979. Effect of mungbean yellow mosaic virus on yield and seed quality of urdbean. *Seed Research*. 7 (2): 168-174.

Williams, F. J., Grewal, J. S., and Amin, K. S. 1968. Serious and new diseases of pulse crops in India in 1966. *Pl. Dis. Report*. **52**: 302-304.

Zaman, A. K. M., Alam, M. S.,Biswas, B. K. and Roy, B. 1996. Effect of B and Mo application on mungbean. *Bangladesh Journal of Agricultural Research*. **21** (1): 118-124.

Appendices

APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from March to July 2007

Month	Air temperature (^{0}C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
March 2007	31.25	21.55	26.40	74.65	35
April 2007	32.98	23.72	28.35	88.24	65
May 2007	34.00	24.65	34.33	79.55	155
June 2007	33.85	26.15	30.0	69.05	184
July 2007	34.20	24.50	29.35	89.5	281

Appendix II. Results of mechanical and chemical analysis of soil of the experimental plot

Mechanical analysis

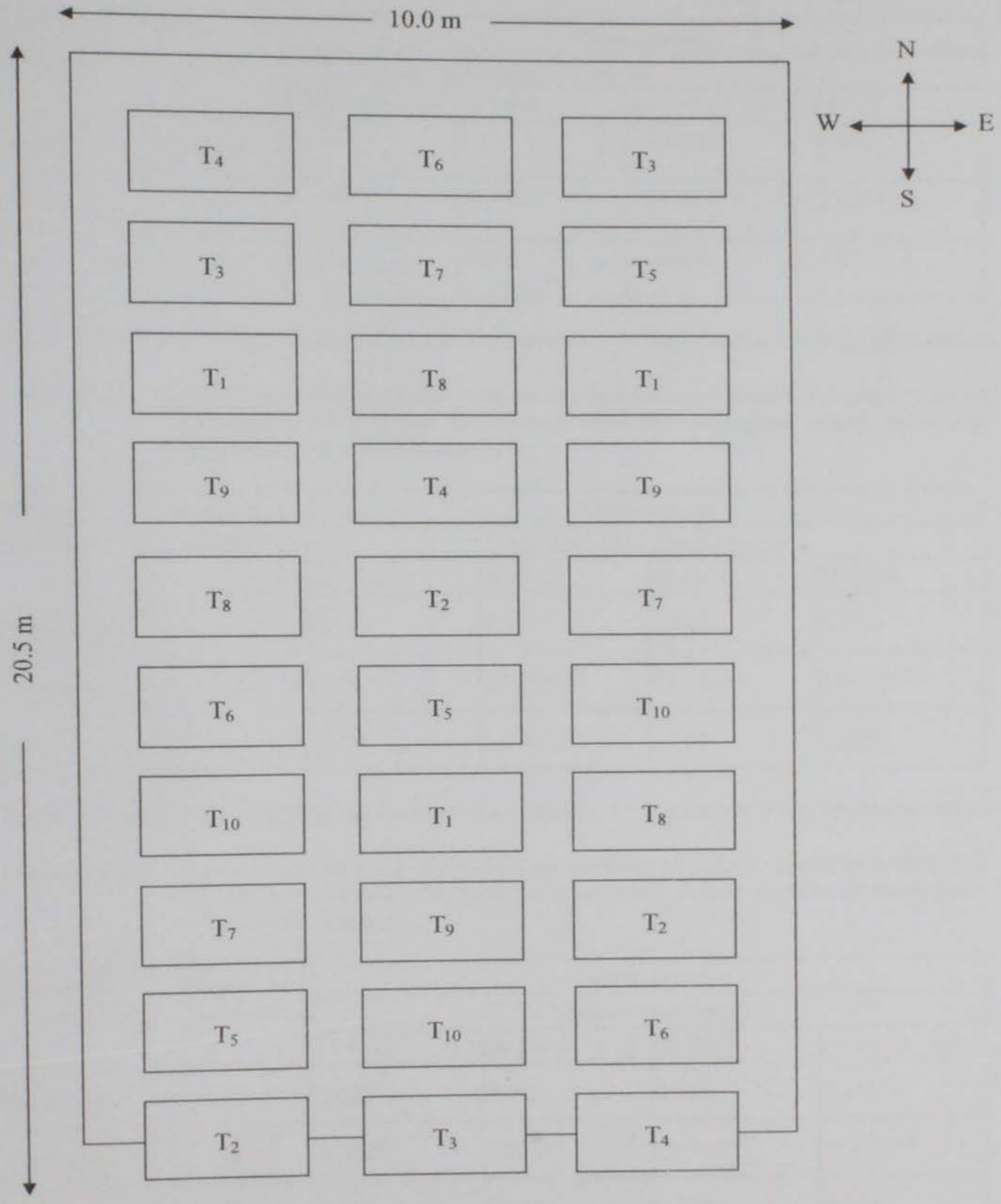
Constituents	Per cent
Sand	32.45
Silt	61.35
Clay	6.10
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil pH	6.15
Organic carbon (%)	1.32
Total nitrogen (%)	0.075
Available P (ppm)	19.5
Exchangeable K (%)	0.2

Appendix III. Design of the experimental plot

Plot size = 2.0 m × 1.5 m
Plot spacing = 50 cm
Between replication = 1.0 m



Appendix IV. Analysis of variance of the data on per cent mosaic expression of yellow mosaic as influenced by different treatments used for managing yellow mosaic of mungbean (var. BARI Mung-5)

Source of variation	Degrees of freedom	Mean square			
		% mosaic expressing true leaves			
		20 DAS	30 DAS	40 DAS	50 DAS
Replication	2	0.007	1.451	1.498	0.002
Treatment	9	0.060^{NS}	26.212**	39.803**	28.054**
Error	18	0.051	0.674	2.026	2.872

NS: Non significant; *: Significant at 5% level of probability; **: Significant at 5% level of probability

Appendix V. Analysis of variance of the data on the incidence of yellow mosaic disease as influenced by different treatments used for managing yellow mosaic of mungbean (var. BARI Mung-5)

Source of variation	Degrees of freedom	Mean square			
		Incidence (% plant infected			
		20 DAS	30 DAS	40 DAS	50 DAS
Replication	2	0.100	0.133	0.633	0.233
Treatment	9	0.181^{NS}	67.263**	85.170**	111.737**
Error	18	0.248	0.874	1.004	1.270

NS: Non significant; *: Significant at 5% level of probability; **: Significant at 5% level of probability

Appendix VI. Analysis of variance of the data on Severity of yellow mosaic as influenced by different treatments used for managing yellow mosaic of mungbean (var. BARI Mung-5)

Source of variation	Degrees of freedom	Mean square			
		Severity (0-9 scale)			
		20 DAS	30 DAS	40 DAS	50 DAS
Replication	2	0.020	0.042	0.016	0.256
Treatment	9	0.002^{NS}	2.678**	10.903**	14.643**
Error	18	0.015	0.054	0.234	0.443

NS: Non significant; *: Significant at 5% level of probability; **: Significant at 5% level of probability

Appendix VII. Analysis of variance of the data on plant height, number of primary branches per plant, number of pod per plant and pod length as influenced by different treatments used for managing yellow mosaic of mungbean (var. BARI Mung-5)

Source of variation	Degrees of freedom	Mean square			
		Plant height (cm)	Number of primary branches per plant	Number of pod per plant	Pod length (cm)
Replication	2	6.288	0.002	8.519	0.061
Treatment	9	20.690*	1.437**	25.512**	1.120**
Error	18	7.334	0.030	3.260	0.090

*: Significant at 5% level of probability; **: Significant at 5% level of probability;

Appendix VIII. Analysis of variance of the data on number of seed per pod, 1000 seed weight, yield per plot and per hectare as influenced by different treatments used for managing yellow mosaic of mungbean (var. BARI Mung-5)

Source of variation	Degrees of freedom	Mean square			
		Number of seed per pod	1000 seed weight (g)	Yield (kg/plot)	Yield (t/ha)
Replication	2	0.012	3.379	0.020	0.002
Treatment	9	3.375**	8.391*	0.136**	0.015**
Error	18	0.135	3.106	0.037	0.004

*: Significant at 5% level of probability; **: Significant at 5% level of probability;