EVALUATION OF DIFFERENT VARIETIES OF MUNGBEAN AGAINST INSECT PEST COMPLEX

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CERTIFICATE

This is to certify that thesis entitled, *"EVALUATION OF DIFFERENT VARIETIES OF MUNGBEAN AGAINST INSECT PEST COMPLEX"* Submitted to the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE (M.S.)*** in ***ENTOMOLOGY*** embodies the result of a piece of *bona fide* research work carried out by ***MD. SHAFIQUL ISLAM*** Registration No. *26209/00500* 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 been duly acknowledged by him.

Dated: ....

Place: **Dhaka, Bangladesh**

(Md. Abdul Latif)

Supervisor

DEDICATED TO
MY
BELOVED MOTHER

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The author

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LIST OF ABBREVIATIONS

Abbreviation		Full Word
AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
cm	=	Centimeter
^{0}C	=	Degree Centigrade
DAS	=	Days After Sowing
g	=	Gram
Kg	=	Kilogram
LSD	=	Least Significant Difference
MP	=	Muriate of Potash
m	=	Meter
No.	=	Number
RCBD	=	Randomized Complete Block Design
WF	=	Whitefly
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Percent
@	=	at the rate of
r	=	Correlation coefficient
CV	=	Coefficient of variance

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ABSTRACT

A studies were conducted with seven mungbean varieties viz. BARI Mug-2, BARI Mug-3, BARI Mug-4, BARI Mug-5, BARI Mug-6, BINA Mug-2 and BINA Mug-5 on the incidence of insect pests during the Kharif-I season (09 April, 2006 to 30 June, 2006). Whitefly (*Bemisia tabaci* Genn.), jassid (*Empoasca kerri*), bean stemfly (*Ophiomyia phaseoli* Tryon), semilooper (*Diachrysia orochalcea*), pod borer (*Enchrysops cnejus* F.) and mungbean yellow mosaic virus (MYMV) were identified as pests in all tested varieties. Positive correlation was observed between whitefly (*Bemisia tabaci* Genn.) population (adult and nymph) and environmental factors such as temperature and relative humidity. A linear relationship (R^2 = o.7673) was observed between MYMV and adult whitefly population, thus mungbean yellow mosaic virus (MYMV) infection was positively correlated with the whitefly population (adult and nymph) while, BARI Mug-6 and BARI Mug-5 was the least preferred varieties to whitefly and thus they showed the lowest MYMV infection. BARI Mug-6 and BARI Mug-5 was also the tolerance to jassid and stemfly. While BINA Mug-5, BARI Mug-6 and BARI Mug-4 was the most tolerance to pod borer and semilooper, therefore in general, BARI Mug-4, BINA Mug-5 and BARI Mug-6 were least susceptible to pest complex and BARI Mug-6 and BARI Mug-5 appeared to be the best varieties in terms of resistance and yield.

INTRODUCTION

INTRODUCTION

Pulse crops belong to grain legume. Bangladesh grows various types of pulse crops. Among them grass pea, lentil, mungbean, blackgram, chickpea, field pea and cowpea are important. It is important food crops because they provide a cheap source of easily digestible dietary protein. Pulse protein is rich in lysine that is deficient in rice. According to FAO (1999) recommendation, a minimum intake of pulse by a human should be 80g per day, whereas it is 14.19g in Bangladesh (BBS, 2005). This is because of fact that national production of the pulses is not adequate to meet our national demand.

Among the pulse crops, mungbean (*Vigna radiata* L.) has special importance in intensive crop production of the country for its short growing period (Ahmed *et al.* 1973). Mungbean is grown all the three cropping season viz. Robi, Kharif-I and Kharif-II. About 30-35% of mungbean are grown in Kharif-II season in Aus/Jute-Mungbean pattern. In Bangladesh mungbean ranks third in acreage and production but ranks first in market price. Mungbean contains 51% carbohydrates, 26% protein, 10% moisture, 4% mineral and 3% vitamins (Kaul 1982; Khan, 1981). The green plants can also be used as animal feed and residues as manure. The crop is potentially useful in improving cropping as it can be grown as a catch crop due to its rapid growth and early maturing characteristics. It can also fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus improves soil fertility. It has protein content, good flavour and easily digestable. It may play an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh. But the acreage and production of mungbean is steadily declining (BBS, 1983).

The dry period of Kharif-I is not favourable for mungbean germination. Kharif-II period is occupied by T- aman and cultivation of high yielding varieties of wheat and winter rice occupying considerable land suitable for mungbean culture. Beside these, low yield potentiality of these crops is causal factor for decline in area and production. At present the area under pulse crops is 0.406 million hectares with a production of 0.322 million tons (BBS, 2005) where mungbean is cultivated in the area of 0.108 million hectares with production of 0.03 million tons (BBS, 2005).

The average yield of mung bean is 0.69 t /ha (BBS, 2005) in Bangladesh which is far low as compared to the potential yield of this crop and to the average yields of other pulse growing countries (Anon.1998). There are many constraints responsible for the low yield of mungbean. Among them, insect pests cause considerable damage to mungbean both in field and in storage. The major insect pests of mungbean in the field are whitelfy (*Bemisia tabaci* Genn.), bean aphid (*Aphis craceivora* Koch), bean Lycanidae (*Euchrysops cnejus* F.) and bean stemfly (*Ophiomyia phaseoli* Tryon.) (Rahman *et al.*, 1981). The mungbean is attacked by different insect pests (Bakar, 1998; Rahman *et al.* 1981) causing 22% yield loss (Kay, 1979). Mungbean is attacked by about 39 insect pests (Chhabra and Kooner, 1980; Nayar *et al.* 1976; Nair, 1975). Among them whitefly (*Bemicia tabaci* Genn.) is the most serious one which also acts as the vector of mungbean yellow mosaic virus (MYMV) (Chhabra and Kooner, 1981; Chhabra *et al.* 1979).

Whitefly feeds on a wide range of vegetables and is an important pest of many crops including mungbean (Rahman *et al.* 1981). The nymph feeds by sucking sap from the leaf. Winged adult whitefly is very active and like the nymph, usually feed on the underside of the leaf with stylets inserted into the leaf tissue. Severely infested plants wilts, turn yellow and may be killed (Poehlman, 1991). They reduce crop yield (49.2%) and act as a vector of viral pathogens (Aftab *et al.*, 1993).

Another insect pest stemfly (*Ophiomyia phaseoli* Tryon.) has been identified as major pests of mungbean in Bangladesh (Rahman, 1987) and India (Lal, 1985; Agarwal and Pandey, 1961). The stemfly mainly attacks at seedling stage although it may attack at any stage of the crop.

Jassid and semilooper have also been identified as major pests of mungbean (Yadav and Dahiva, 2000; Devesthali and Saran, 1998) causing serious damage of the plant. In case of severe attack the plant may die (Chhabra and Kooner, 1993).

Pod borer, an importent insect pest of mungbean (Rahman *et al.* 1981) may cause flower bud shedding or destroy flower reproductive organ (Poehlman, 1991) and they also consume portion of leaves (Bakar, 1998).

Another constraint of mungbean production are susceptibility to various diseases. A total sixteen diseases of mungbean have been recorded, of which viral diseases are the most damaging to the crops. Among the viral diseases the yellow mosaic virus (MYMV) (Williams *et al.*1968) is the most damaging disease (Jalaluddin and Shaikh, 1981) or chief limiting factors (Verma and Sandhu, 1992) to economic crop production. Whitefly acts as the vector of mungbean yellow mosaic virus (MYMV) (Chhabra and Kooner, 1981; Chhabra *et al.* 1979). Reduction in yield due to MYMV depends on the time of infection and the severity of disease. If the highly susceptible varieties of mungbean are infected within 3 weeks of sowing, no yield is obtained, infection during 4^{th}, 5^{th}, 6^{th} , 7^{th} and 8^{th} week results in yield reductions up to 85, 60, 44, 28 and 10%, respectively, (Verma *et al.*1992). In Bangladesh 63% yield loss due to MYMV was reported in mungbean (Anon.1984). Poor yield was largely associated with excessive vegetative growth, low harvest index etc. (Bashir *et al.*,1998; Bakar and Rahman, 1998)

There are many mungbean genotypes with good agronomic properties in Bangladesh. Most of them are susceptible to different insect pests and diseases and some are resistant. But still they are unknown and it is very important to find out source of resistance from the available mungbean varieties.

Viewing the facts described above the present study was undertaken with the following objectives.

- To find out the incidence of major insect pests in different varieties of mungbean
- To find out the rate of infestation of major insect pests at different growth stage of different varieties of mungbean
- To evaluate the infection rate of mungbean yellow mosaic virus (MYMV) in different varieties of mungbean and to find out the relationship between MYMV and whitefly population.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Pulses play a vital role in the diet of the people in Bangladesh. Nutritionally, these are two to three times richer in protein than cereal grains and have remained the least expensive source of protein for people since the dawn of civilization (Kay, 1979). In fact, until today pulses provide the only high protein component of the average diet of the vast majority of the people of Bangladesh (Rahman *et al.*, 1988). About 73 million hectares of land are used in pulse production, which is 5.3 % of the total cropped area of Bangladesh. Mungbean is one of the most promising pulse crops in Bangladesh and it is the only pulse crop grown during the entire year in the three main seasons under existing cropping patterns. It is tropical and sub-tropical crop resistant to high temperature and in many countries grown as a summer crop and can be cultivated in a wide range of soil. It is sensitive to cloudy weather and can not tolerate frost (Gowda and Kaul, 1982). The average yield of mungbean is 0.69 ton/ha in Bangladesh, which is far low as compared to the potential yield of this crop and to the average yields of other pulse growing countries (Anon.1998). There are many constrain responsible for the low yield of mungbean. The poor yield is largely due to varietal aspect, climatic factors, management practices, insect pests and diseases (Rahman *et al.*, 1981). Among the constraints of mungbean cultivation, the attack of insect pests is considered the important one. Rahman *et al.* (1981) listed the following insect pests that attack mungbean.

Common name	**Order**	**Scientific name**
Bean stemfly	Diptera	*Ophiomyia phaseoli*
Jassid	Homoptera	*Empoasca kerri*
Whitefly	Homoptera	*Bemisia tabaci*
Thrips	Thysanoptera	*Megalurothrips distalis*
Bean aphid	Homoptera	*Aphis craccivora*
Hairy caterpillar	Lepidoptera	*Diachrisia obliqua*
Leaf webber	Lepidoptera	*Laprosoma indicata*
Leaf miner	Lepidoptera	*Acrocerphos phacospora*
Epilachna beetle	Coleoptera	*Epilachna spp.*
Semiloopers	Lepidoptera	*Diachrysia orochalcea*
Spotted pod borer	Lepidoptera	*Maruca testulalis*
Bruchids	Coleoptera	*Callosobruchus chinensis*
Green bug	Homoptera	*Nezara viridula*
Galerucid beetle	Coleoptera	*Madurisia obscurella*
Green semi-looper	Lepidoptera	*Plusia signata*
Bean lycaenidae	Lepidoptera	*Euchrysops cnejus*

Green jassid, bean stemfly, whitefly, hairy caterpillar, galerucid beetle and aphids infest the crop at the seedling stage, vegetative stage and continue to flowering stage while spotted pod borer damage flower buds, flowers and pods of mungbean (Rahman, 1991). Of these insect pests, whitefly, stemfly, hairy caterpillar and pod borer are most damaging (Gowda and Kaul, 1982; Rahman *et al.*, 1981).

2.1 Whitefly

Plate 1. Infested leaf with whitefly nymph

Plate 2. Adult whitefly

The adult whitefly is a tiny soft bodied and pale yellow, change to white within a few hours due to deposition of wax on the body and wings (Haider *et al.*, 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves (Hirano *et al.*, 1993). Eggs are pear shaped and 0.2 mm long. One female can lay up to 136 eggs in its life time in mungbean (Baldev, 1988). The nymphs are pale, translucent white, oval with convex dorsum and flat elongated ventral side. The whitefly adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus thus reducing the photosynthetic area. The infested plants became weakened due to sucking of the plant sap from the leaves and also due to the reduction of photosynthesis of the infested plant parts (Naresh and Nene,1980). Young plant may even be killed in case of severe whitefly infestation in mnungbean (Srivastava and Singh, 1976). The whitefly acts as a mechanical vector of mungbean yelow mosaic virus (MYMV) in mungbean and blackgram. The whitefly-MYMV complex is most severe in the Indian subcontinent (Poehlman, 1978). The principal economic loss in mungbean from whitefly infestation due to the injury from whitefly transmitted MYMV rather than loss from whitefly feeding. The MYMV is acquired or transmitted by the whitefly within a 15-to-30 minute acquisition or transmission period after the insect alights on the mungbean plant (Nene *et al.,* 1972).

Yadav and Dahiya (2004) conducted an experiment that thirty-six mung bean genotypes were evaluated in 2000 under field conditions of Hisar, Haryana, India, for resistance to whitefly [*Bemisia tabaci*] .There were no significant differences among the genotypes in terms of whitefly infestation, but high population was observed in Pusa 97-71, BDYR, BM-4, HUM-8 and OUM 11-5. These genotypes could further be used in the development of resistant mung bean cultivars. Hassan *et al.* (1998) conducted a study to estimate yield losses in mung bean (*Vigna radiata* cultivars NM 19-19, MN 20-21, NM 13-1 and 6601) caused by different insect pests and to identify the most tolerant to insect pests.

Significantly higher populations of whitefly (*Bemisia tabaci*) was recorded on NM 13-1. The remaining cultivars were statistically at par with one another in respect of whitefly. Significantly lower population of jassid and aphid was observed on NM 19-19. NM 13-1 showed comparatively higher yield loss (18.31%), followed by Mash-48 (17.42%) and 6601 (15.9%). NM 19-19 showed comparatively lower yield loss (7.77%), followed by NM 20-21 (9.20%).

Naqvi *et al.* (1995) conducted a field study to carry out on 10 mungbean varieties to study the resistance to *Bemisia tabaci* and mung bean yellow mosaic gemini virus. Observations on *B. tabaci* population and disease intensity were recorded at weekly intervals until maturity. The grain yield was recorded at harvest. Results showed that none of the varieties was immune to the virus disease and insect infestation. The varieties M-8-20, M-20-21 and M-10-30 were found to be comparatively more resistant than others. This resulted in greater yields.

2.1.1 Yellow mosaic disease (YMD) of mungbean

The yellow mosaic disease (YMD) of mungbean was first observed in 1955 at the experimental Indian Agricultural Research Institute, New Delhi. The causal virus i.e. mungbean yellow mosaic virus (MYMV) is transmitted easily by whitefly (*Bemisia tabaci* Genn) and by grafting but not by sap inoculation (Nariani, 1960). Since then MYMV has been found widely distributed in India. Other countries of the subcontinent causing enormous losses in the production of several leguminous crops (Chenlulu and Varma, 1988). Mungbean yellow mosaic disease was first reported in Bangladesh by Fakir (l983) and he gave detailed description of the disease, some recommendations for the management of the disease.

Chiemsombat (1992) reported that mung bean yellow mosaic bigeminivirus was first detected in Thailand in 1977 when it caused very severe damage to *Vigna radiata* crops, but the disease has not been reported since 1987. It is important to determine the factors responsible for outbreaks of MYMY and its vector (*Bemisia tabaci*) in Thailand and to develop effective control measures, which should include breeding for resistance.

2.1.2 Occurrence and symptoms of yellow mosaic disease

Plate 3. MYMV infected plant

Plate 4. MYMV infected leaflet

Mungbean yellow mosaic disease is the most destructive disease of mungbean and blackgram in the Indian subcontinent and adjacent areas of Southeast Asia (Bakar, 1991; Jayasekera and Ariyaratne, 1988; Benigno and Dollars, 1978; Grewal, 1978; Iwaki and Auzay, 1978).

Pathak and Jhamaria (2004) reported that a total of 14 cultivars of mung bean were evaluated against mungbean yellow mosaic virus (MYMV) in Alwar, Rajasthan, India, during 2000-01. Disease incidence was calculated for necrotic mottle and yellow mosaic types. The cultivars ML-5 and MUM-2 were resistant to MYMV There were no disease incidence for necrotic mottle symptoms in both cultivars, whereas the percent disease incidence for yellow mosaic symptoms was 4.44 and 6.25 in ML-5 and MUM-2, respectively. The average MYMV infection percentage was 2.22 and 3.12 in ML-5 and MUM-2, respectively, compared to 100.0 in K-851 (control cultivar). Most of the cultivars were highly susceptible (72.22%) to the pathogen.

Poehlman (1991) observed the yellow patches on mungbean leaves, which coalesced to form larger patches that developed into and yellow mottle; eventually the entire leaf can turn yellow. Maturity was delayed in the diseased plants and flower and pod production were reduced. Seeds that developed on severely infected plants were small and immature. According to the Bakar (1991) the symptoms of the diseases appear on the leaves as minute yellow specks that may expand and cover the entire area. Mixture of irregular yellow patches could be observed on the leaves. Pods were reduced in size and borne small-shriveled seeds.

Nene (1969) observed that incase of severe infection only few pods were produced. Chlorosis, stunting and fewer branches and premature shedding of leaves have also been reported (Singh *at el.,* 1982).

Nariani (1960) described the first symptom on mungbean appears on young leaves in the form of mild yellow specks or spots. The next leaf emerging from the growing apex showed irregular bright yellow and green patches. The green areas may be slightly raised and leaves may be slightly puckered and reduced in size. Yellow areas increase and apical leaves turn into completely yellow.

2.1.3 MYMV, its vector population and spread of MYMV

Singh and Gurha (1994) reported that *Vigna radiata* plants of all 24 genotypes tested showed a high incidence of this disease, caused by mungbean yellow mosaic bigeminivirus, in summer crops when compared with the incidence in spring and rainy season (kharif) crops. This is attributed to unfavourable conditions for multiplication of the vector, *Bemisia tabaci*, in the spring. It is concluded that tests for resistant genotypes should be carried out in summer.

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*.

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

Chhabra and Kooner (1991) reported that of 67 *Vigna radiata* genotypes screened in the field for 4 yr. (1986-89) against *Bemisia tabaci*, *Empoasca* spp. and mungbean yellow mosaic bigeminivirus, 3 were indentified as potential donors of resistance in breeding programmes.

The virus spreads on mungbean or blackgrarn through all seasons, but spreads faster with the onset monsoon (end of June onwards) along with the build up vector population (Varma *et al.*, 1991).

Brunt *et al.* (1990) found that the virus was observed to be transmitted in nature by an insect vector belonging to the Aleyrodidae: *Bemisia tabaci* in and non persistent manner. Helper virus was not apparently required for transmission. Non-vector transmission was apparently not mechanical inoculation, not by seed and also not by pollen. Honda *et al.* (1983)

reported that many isolates of MYMV have been obtained from different host and region of India. All are transmitted by

Bemisia tabaci, but not by sap inoculation or through seeds. Isolates from Bangladesh, Pakistan, and Srilanka have similar transmission characteristics. However, an isolate from Thailand was found sap-transmissible.

Murugesan Chelliah (1977) reported that mungbean yellow mosaic virus could be transmitted successfully by and single infectious *Bemisia tabaci* but maximum infection was given by10 flies/plant. Infection was ensured when vector had a pre-requisition starvation period of 24 hours.Mungbean yellow mosaic virus disease spread rapidly with increase in the whitefly population (Aftab *et al.*, 1992).

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

Whitefly density is usually the highest between April-June with temperature 29-34^{0}C and July-September with temperature 24-25°C and relative humidity 66-99% (Pimple and Summanwar, 1986). The whiefly population on plants varies at different periods of the day. In mungbean, the lowest number of *B. tabaci* are found at noon when the light intensity is maximum, and the highest number during early morning or late evening hours as reported by Subrahmnayam and Varma (1986).

2.1.4 Effects of yellow mosaic virus on yield of mungbean

Reduction of yield in legumes due to MYMV depends on the time of infection and the severity of the disease. If highly susceptible varieties of blackgram or soybean are infected within three weeks of sowing no yield is obtained. Infection of these species during the fourth, fifth, sixth, seventh, and eighth week results in yield reductions up to 85, 60, 44, 28 and less and 10% respectively. The decrease in yield is significant when infection occurs up to 50 days after sowing. Reduction in number of pods/ plant, seeds/pod, and seed weight are the main contributing factors for the decrease in yield (Dhingra and Chenlulu, 1985; Suteri and Srivastava, 1979; Vohra and Beniwal, 1979).

Gill (1999) conducted an experiment on the effect of mungbean yellow mosaic virus transmitted by *Bemisia tabaci* on yield components of the mungbean cultivar ML-267 in Punjab, India. They briefly reported that infection in the early growth stages reduced yields significantly more than that of infection at the flowering stage.

Jain *et al.* (1995) conducted an experiment in 1990 to study the effect of MYMV 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, and 1000 seed weight and crop growth rate contributed in decreasing grain yield.

Aftab *et al.* (1992) reported that a crop of Vigna *(unguiculata* subsp.) sesqupedalis at Islamabad was found to be infected by mungbean yellow mosaic bigeminivirus during 1990. Symptoms included pale to yellow sposts mixed with green areas on the leaves. The disease spread rapidly with increase in the whithefly (*Bemisia tabaci)* population. Plant height, number of pods, seeds and yield/plant were reduced by 10.3, 50.5, 44.7 and 49.2% respectively. The effect on nodulation was non-significant.

Bakar (1991) described yellow mosaic virus as the most serious limiting factor in mungbean and blackgram cultivation. He also stated that the disease can attack the crop at any stage of growth- but losses are severe when it attacks at an early stage. Total loss had been reported when the crop was infected within 1-2 weeks after germination, 63% at three weeks and around 20-30% in plants, which were infected at the age of 4-7 weeks.

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

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

The plant pathology divisions of the Bangladesh Agricultural Research Institute (BARI) and Bangladesh Agricultural University (BAU) had estimated yield losses for a few diseases in the pulse crops. Yellow mosaic caused 16% yield loss in mungbean and 10% loss in blackgrarn (Anon., 1988, Fakir, 1983). Reduced plant height and fresh shoot weight were also reported along with yield loss of up to 66% (Chanda and Varma *et al.*, 1983)

Singh *et al.* (1982) carried out an experiment to study yield losses 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.

2.1.5 Disease Resistance

Sekhar and Hari-Chand (2001) reported that forty-six mung bean genotypes were screened for resistance against mungbean yellow mosaic virus. Twenty genotypes showed combined resistance to MYMV.

Singh *et al.* (2000) found that forty-four mung bean cultivars were screened for resistance to mung bean yellow mosaic virus (MYMV) under natural infection conditions in Kanpur, India, during 1994 and 1995. Six cultivars were highly resistant to MYMV and ten cultivars exhibiting low disease incidence (ranging from 2.1-3.9%) were designated resistant.

Arutkani *et al.* (1999) conducted a field study in Tamil Nadu, India, to determine the sources of resistance to yellow mosaic virus [mungbean yellow mosaic virus] in 52 *Vigna mungo* genotypes. The accessions which showed resistant reactions to yellow mosaic virus in the field were subjected to artificial inoculation with viruliferous whitefly (*Bemisia tabaci*), a vector of the pathogen. Genotype PDU 102 showed the lowest infection (4%), followed by PLU 155 and PLU 244. The susceptible control, genotype Co 5, showed 68% infection.

Srinives *et al.* (1992) reported that the most important diseases affecting *Vigna radiata* in Thailand are powdery mildew (*Erysiphe polygoni*) and the leaf spot caused by *Cercospora canescens*. Breeding for resistance to these has been carried out for the past decade. Some of the sources of resistance were found not to be stable and new sources shuld be sought.

Verma *et al.* (1992) reported that trends in the production and varietal improvement of *Viqna radiata* in India are outlined and details given of the symptoms and vector (*Bemisia tabaci*) relationships of mungbean yellow mosaic bigeminivirus. Techniques used in breeding for resistance to both virus and vector are described, with current knowledges of the mode of inheritance of reistance and achievements in varietal improvement so far. The directions for future research are outlined.

Since mungbean probably originated in the Indian subcontinent and MYMV also serious in this region, most the MYMV-resistant lines are from the disease prone areas of India. For this regard Jalaluddin and Shaikh, (1986) obtained MB 57, ME 58, MB 59 and Plant moong-2 (Singh, 1983) through gamma-ray breeding.

Virmani *et al.* (1983) reported that the virus symptoms on MYMV-tolerant lines appear late. Most of the tolerant lines were late in maturity (>100 days) and had a semierect viny growth habit. Singh *et al.* (1986) evaluated 842 mungbean lines for days to flower and MYMV. Days to flower ranged from 35 to 71 and MYMV reaction ranged from 1.6 to 3.0 scores. These lines took 42 to 71 days first flower. Of these, lines LM 185, SMIL 70, LM 182, PIMS and LM 438 took only 42 to 48 days to flower, which suggest that earliness can be combined with MYMV resistance.

More than 20 different viruses have been reported to infect mungbean. The more common viruses are MYMV, blackgram leaf crinkle and mungbean mottle virus (MMV) (Anon.1984a). MYMV is transmitted by whitefly (Bemisia tabaci), and appears to be severe in the Indian subcontinent. Potential yield losses by PM and CLS in mungbean were found to be higher than 40% and 58% respectively (Shanmugasundaram and Tschanz, 1987). Th epidemiology of CLS has been studied and the yield loss due to CLS was estimated to be 10% in resistant cultivars (Anon.1984a). Resistant sources for CLS and PM were identified from thousands of mungbean germplasm accessions at AVRDC, and successfully incorporated into advance breeding lines such as VC156OC and VC1482A.

MYMV is not prevalent at AVRDC. However, several viruses have been isolated from mungbean at AVRDC and at Pingtung, Taiwan. They cause mottling, mosaic and leaf crinkle symptoms (Anon. 1984a). One these viruses are seed-transmitted and serologically related to Cucumber mosaic virus (CMV). The host range was found to be largely confined to the legume family. Resistant breeding lines (VC 2755 A and VC1973 A) and accessions (V2010, V2984) have been identified (Anon.1987). The resistant may be due to hypersensitivity, as it seems to be associated with the appearance to necrotic local lesions on the inoculated leaves.

The mungbean is host to disease organisms such as fungi, virus and nematodes in the tropics. Several diseases, especially Cercospora leaf spot (CLS); powdery mildew (PM); mungbean yellow mosaic virus (MYMV) root disease complex and nemic diseases can cause serious yield loss in mungbean (Morton *et al.* 1982).

2.1.6 Inheritance of MYMV

Very little information is available on inheritance of resistance to MYMV, CLS and BLS of mungbean. However Shukla *et al.* (1978) reported that the inheritance of resistance to MYMV using these parents: Tarai local (resistant), L 80 (moderately resistant), L294-1 and LM 214 (tolerant) Jawahar 45 and G 65 (susceptible). They found resistance for MYMV was under digenic control and recessive. Singh and Patel (1978) also reported that a single gene (recessive) governed MYMV tolerance in CU 24-2. It is clear from this study that susceptibility is dominant over resistance and whether 1 or 2 genes control it, one can determine the size of the segregating population for selecting a resistant plant.

Verma *et al.* (1989) conducted that the resistant lines BR61, Sel1 and NP21 were crossed with susceptible UL2. Parents and F1, F2 and F3 generations were inoculated with mungbean yellow mosaic geminivirus (MYMG) through the insect vector *Bemisa tabaci*. Subsceptibility to MYMG was dominant over resistance in the F1 and the presence of 2 recessive resistance genes was demonstrated.

2.2 Stemfly

The stemfly (*Ophiomiya phaseoli* Tryon) is a serious seedling infesting pests of mnungbean (Gupta and Sing, 1984a) and has been identified as a major pest of mungbean in India (Saxena, 1978). The adult beanfly deposits eggs in punctures of the leaf tissue, the first pair of leaves of bean seedlings being favorite sites for oviposition. The maggot bores into young stem and damages the stem. In young plants, the larvae of the fly cause extensive tunneling. The freshly formed tunnels are silvery-white and difficult to locate. The older tunnels are dark brown in colour and contained faces. Due to the decaying of the surrounding pith area around the zig-zag tunnels, the old tunnels turned into straight tunnels (Singh *et al.* 1990). They do not make any exit hole (Sehgal *et al.* 1977-1980). Infested seedlings frequently wilt and subsequently die. The growth of older plants become slowly stunted (Pradhan *et al.* 2000).

Raj-Singh and Kalra (1995) reported that the succession and abundance of insect pests on *Vigna radiata* was observed in Hisar, India, during summer 1987. These crops were attacked by 22 and 16 insect pest species, resp., at different stages of growth. The most important insect pests were *Empoasca kerri*, *Ophiomyia phaseoli*, *Austroagallia* sp., *Bemisia tabaci* and *Nysius* sp. The peak populations of *O. phaseoli* was 0.25 insects/plant on *Vigna radiata* .

Thapa and Timsina (1990) reported that the susceptibility of cultivars of mung beans (*Vigna radiata*) planted after late rice to *Ophiomyia phaseoli* was studied in the field in Nepal during 1985. The 11 varieties of *V. radiata* tested differed in terms of germination, seedling vigour and plant height. Pest incidence was high during the 3rd week after germination. The greatest damage (66.3% infestation) was recorded on Pag-asa-2 and the least (43.4%) on a local variety. After 6 weeks, almost all the plants were damaged with 63-90% infestation.

Rajapakse and Jayasena, (1989) reported that a field experiment was carried out in Sri Lanka in 1986 on the species composition, distribution and control of insect pests of mungbean (*Vigna radiata*). A weak positive correlation was found between *O. phaseoli* infestation and plant height. The mungbean selections VC 4281- B, VC 422-B, VC-4290 B showed less than 10% infestation with *O. phaseoli* under low and high nitrogen regimes. Seed treatment with monocrotphos and Sevin (carbaryl) controlled *O. phaseoli* effectively for 4 weeks after planting. This protection afforded during this vulnerable stage enabled other pest management techniques to be used effectively to control the pest.

2.3 Jassid

Plate 5. Jassid

Yadav and Dahiva (2000) reported that thirty genotypes of mungbean (*vigna radiata*) were evaluated under field comditions for resistance to whitefly (*Bemisia tabaci*), Jassidas (*Empoasca kerri*) And yellow mosaic virus [munabean yellow mosaic virus] (MYMV). There were no significant differences among the genotypes for whitefly and jassid populations. Maximum incidence of YMV was recorded in copergoan (70%) and minimum in ML5 (13%). ML5, ML803, ML839, PDM91-249 and PMB5 genotypes were good sources of resistance against whitefly, jassids and YMV and might be used as donor paremts in breeding programmes.

Chhabra and Kooner (1994) reported that twenty-six genotypes of *Vigna radiata* were screened in the field for 4 years (1989-92) for resistance against *Empoasca* spp. Three genotypes ML 395, ML 505 and ML 543 were found promising in comparison with the standards/local controls ML 5, ML 131, ML 267 and 'Infestor'. These genotypes were identified as 'donors' against insect pests and the virus for use in breeding programmes to develop high-yielding, pest resistant varieties.

Chhabra and Kooner (1993) reported that Thirty-nine accessions of mungbean, *Vigna radiata*, were tested for their reaction to *Bemisia tabaci*, *Empoasca* spp. and mung bean yellow mosaic bigeminivirus (MYMBV). Six genotypes of *V. radiata* (ML 370, ML 428, ML 459, ML 506, ML 508 and ML 537) were identified as being resistant against the insect pests and MYMBV. Genotypes M 537 and ML 370, which had a high degree of resistance, were designated as donors for use in a breeding programme.

Chhabra *et al.* (1988) reported that in field trials 29 cultivars were screened for resistance to *Bemisia tabaci*, jassid (*Empoasca* spp.), *Lampides boeticus*, *Maruca testulalis*, *Heliothis armigera* (*Helicoverpa armigera*) and mungbean yellow mosaic geminiviurs. ML 337, ML 423 and ML 428 showed the least suceptibility to the pests and virus when compared to the controls, ML5 and ML131 and to the susceptible genotype used to encourage pest and disease attack. Preliminary studies on the mechanism of resistance revealed higher percentages of reducing and non-reducing sugars, total phenols free amino acids in the resistant genotypes in the controls and susceptible genotype.

2.4 Pod borer

Plate 6. Infested plant with pod borer

Plate 7. Infested pod with pod borer

Plate 8. Healthy pod

Pod borer (*Enchrysops cnejus* F.) is one of the serious preharvest pests of mungbean in Bangladesh (Rahrnan *et al.* 1981), in India (Sehgal and Ujagir, 1988) and other tropical and sub-tropical countries. The adult moth of pod borer is dark brown in color. There is a white half circle spot on the front pair of wings. Hind pair of wings is grayish white in color and moth having light brown spots on the leaf. The larvae are yellowish in color. They enter into the inflorescence and start feeding the flowers, later they cripple leaves together making nets and nets with leaves, flowers and young pods. They remain inside the nets hiding themselves and eat the young seeds boring the pods.

A complex of polyphagous lepidopterous pod borer damage the developing and partly mature pods during both summer and raingy sasons (Fletcher, 1994; Srivastava *et al.* 1964; Nair, 1986). The damage flowers and devoloping pods by the larvae of pod borer is common and wide spreads in India (Nair,1986). The outbreak of pod borer of munghean in West Bengal and pod damage also reported from Uttar Pradesh states of India (Gupta *et al.* 1976; Srivastava and Singh, 1976).

Hassan *et al.* (1998) conducted a study to estimate yield losses in mung bean (*Vigna radiata* cultivars NM 19-19, MN 20-21, NM 13-1 and 6601) caused by different insect pests and to identify the most tolerant to insect pests. Significantly higher populations of whitefly (*Bemisia tabaci*), and *Heliothis armigera* [*Helicoverpa armigera*] were recorded on NM 13-1. The remaining cultivars were statistically at par with one another in respect of whitefly and pod borer.

Gangwar and Ahmed (1991) reported that ten mungbean (*Vigna radiata*) varieties were evaluated for seed yield and productivity, days to maturity and percentage pod damage due to *Maruca testulalis* at Port Blair, Andamanm, during 1983-84, with a view to identifying varieties suitable for growth in fields after paddy harvest in the Andaman and Nicobar Islands. Mean seed yiled was greatest in

ADT 2 (899 kg/ha), followed by ML 65 CO3, P104 and P105. ML 65 had the highest seed productivity (11.7 kg/ha per day). Pod damange was relatively high ranging from 29.9% in S8 to 39.2% in C03. Following S8, the next most resistant varieties were ML65, P101 and P103.

Sehgal and Ujagir (1985, 86) reported that pod borer damage to mungbean without protection at Pantnagar varied from 8 to 11% during 1985 and 1986. Pod borer alone were reported to grain losses of 136 kg/ha in mungbean, 191 kg/ha in cowpea (Anon.1986) and 400 kg/ha in chickpea (Rahman, 1989).

2.5. Semilooper

Devesthali and Saran (1998) conducted a field experiment with twenty recently developed green gram cultivars to study their reaction to insect pests in Malwa region of Madhya Pradesh, India. The results indicated that green gram had been infested by 8 species of insect pests during the cropping season. Among them, semilooper (*Plusia signata*) was minor pest. Semilooper reached peak population density in the fourth and fifth week of August (1992) when the average weekly maximum and minimum temperatures and relative humidity were around 28 degrees C, 23 degrees C and 89.5%, respectively.

Nath *et al.* (1998) reported that a field experiment was conducted in Jorhat, India, during kharif, 1995 on the insect pest complex of black gram [*Vigna mungo*]. The occurrence of insect pest species followed a succession. Jassids [cicadellids] first appeared at the seedling stage of the crop and maintained their population up to pod formation. Aphids and semiloopers appeared at the early vegetative stage and continued to infest the crop until the post-reproductive stage.

2.6 Pest Resistance

Insect pests attack mungbean from the seedling to maturity resulting in severe yield loss in the tropics. The most common insects are agromyzid beanflies (*Ophiomyia phaseoli* Tryon); pod borers, pod feeders (*Maruca testulalis* Geyer. *Heliothis armigera* Hb.); piercing and sucking insects (aphids and thrips) and storage pest- bruchids (Morton *et al.* 1982). Warm and humid climate favours rapid insecticide degradation enhances pest population buildup (Taleker and Chen, 1983).

Sepswasdi *et al.* (1991) reported that yield loss relationships of major insect pests of mungbean (*Vigna radiata*) in rice based cropping systems were studied in Thailand during 1986-87. Observations of damage and insect density were made at weekly intervals from the vegetative stage to harvesting. Infestations during the vegetative stage had no impact on yield. Infestations of the noctuid *Spodoptera litura* and *Megalurothrips usitatus* during the ends of the vegetative stage to the pod-filling stage were negatively correlated with grain yield and resulted in a reduction of yield. Economic injury levels were established at 16 and 30% infested leaves for *S. litura* and *M. usitatus*, respectively

Thousand of AVRDC mungbean germplasm accessions have been screened for beanfly resistance was identified incorporated into the advanced breeding lines, and are currently being evaluated for yield potential. The beanfly resistance mechanism in V4281 was investigated and appears to be antibiosis (Anon.1986).

Stink bugs, pod borers and pod feeders can cause direct damage to mungbean by feeding on the development seeds on pod. These insects have a wide host range their damage varies among the locations. Accession V2109, V4270 V2106 and V2135 were identified as sources of resistence to pod borer (Anon. 1981.)

MATERIALS AND METHODS

MATERIALS AND METHODS

This chapter includes a brief description of the experimental site, experimental design, land preparation, sowing of mungbean, collection of data, meteorological data and statistical analysis followed in the experiment 'Evaluation of different genotypes of mungbean against insect pest complex'.

3.1 Experimental site:

The research work was conducted at the experimental farm of the Sher-e-Bangla Agricultural University, Sher-e-Bangla nagar, Dhaka-1207, during kharif-I season of 2006. The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ-28) and the general soil type is Shallow Red Brown Terrace soils.

3.2 Design of Experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications in the field.

3.3 Land preparation and fertilization

The field was prepared by ploughing followed by laddering to obtain good tilth, during 1st week of April, 2006. Urea, TSP and MP fertilizers were applied as recommended by Anon. (1997) for mungbean cultivation @ 45 kg urea,100 kg TSP and 60 kg MP respectively per hectare during land preparation.

The whole field was divided into three equal blocks having 1.5m space between the block and each block was again sub-divided into 7 plots (3m X 2m) as treatment plot with 1m space between them. The spacing was 30 cm between rows and 10 cm between plants.

3.4 Sowing of mungbean

Seeds of mungbean varieties namely BARI Mug-2, BARI Mug-3, BARI Mug-4, BARI Mug-5, BARI Mug-6, BINA Mug-2 and BINA Mug-5 were sown on 9th April in 3m x 2m unit plot with spacing 30cm x 10cm. Light irigation was applied after one day of sowing. At first trifoliate stage seedling was carefully thinned to retain one seedling per hill. Mulching and weeding were done three times at 10, 20, and 30 days after sowing. Irrigation was applied three times.

3.5 Collection of Data

For collection of data ten plants were randomly selected from each plot. Data were recorded on incidence and infestation of different insect pests such as whitefly, jassid, bean stemfly, semilooper and pod borer. All the data were collected once in a week. Data were recorded by direct counting and collected at early in the morning (7.00 a.m.-9.00 a.m.). Accordingly, direct counting has to be done early in the morning when the adults (whitefly) are least mobile (Gerling and Horowitz,1984; Hill, 1968; Seif, 1981). Whitefly nymph were counted by using magnifyingglass.

According to Anon. (l984) and Ohnesore and Rapp (1986) sampling of the sedentary immature stages gives more reliable estimates of the absolute population density. The accuracy of the estimates depends on the choice of leaves to be sampled and the manner in which the individual are to be assessed. Wthin plants, eggs and young nymphs occur on the upermost and young leaves, while older nymphs and pupae are found on older leaves. Based on their findings, nymphs on lower, mid and upper leaves were counted visually.

Thus in brief the following data were collected using by the direct counting

3.5.1 Whitefly

a) Whitefly adult direct counting by visual method.

b) Whitefly nymph direct counting on lower, mid and upper leaf by using magnifyingglass.

c) Symptoms of MYMV.

d) Number of MYMV infected plant and healthy plant.

3.5.2 Jassid

a) Number of infested leaf per 10 plant.

b) Number of jassid per 10 plants

3.5.3 Stemfly

a) Number of infested stem per 10 plants.

b) Number of stem fly pupae per 10 plants.

3.5.4 Semilooper

a) Number of infested leaf per 10 plants.

b) Number of semilooper (Caterpillar) per 10 plants.

3.5.5 Pod borer

a) Number of infested pod per 10 Plant and number of healthy plants.

b) Number of pod borer per 10 plant and number of healthy pod.

3.5.6 Yield

(3 consecutive harvests).

First harvest was done after 67 (DAS), second and third harvest was done after 74 (DAS) and 82 (DAS), respectively. The harvested pods were dried, threshed and weighed.

3.5.7 Meteorological data

The data on temperature and relative humidity were collected from the weather station of Sher-e- Bangla Nagar, Dhaka-1207.

3.6 Statistical analysis

All data were subjected to ANOVA for F-test and the means were compared by DMRT. Correlation and regression were carried out where appropriate.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

4.1 Comparative incidence of major insect pests in seven mungbean varieties

The comparative incidence of major insect pests of mungbean observed in seven varieties are presented in Table 1. Whitefly was the most abundant insect pest and the maximum number was observed in BINA Mug-2 and the minimum number was in BARI Mug-6. Jassid was the second most abundant species and the maximum number was found in BINA Mug-2 while, the minimum number was in BARI Mug-5. Stemfly was the third abundant species and the maximum number was found in BARI Mug-2 and the minimum number was in BARI Mug-5. Pod borer was the forth abundant pest and the maximum number was observed in BINA Mug-2 while, the minimum number was in BARI Mug-6. Semilooper was the minor pest and the maximum number was observed in BARI Mug-2 and the minimum number was in BINA Mug-5

Table 1. Comperative incidence of major insect pests in seven mungbean varieties in Kharif-I, 2006

Inset pests / Varieties	Mean no.of whitefly / plant	Mean no. of jassid / plant	Mean no. of Stemfly pupa / plant	Mean no. of Semi looper / plant	Pod borer infestation (%)
BARI Mug-2	1.116 ab	0.959 a	0.241 a	0.286 a	1.059 ab
BARI Mug-3	1.081 b	0.941 a	0.216 abc	0.2133 bc	0.960 bc
BARI Mug-4	0.960 c	0.856 ab	0.183 bc	0.2133 bc	0.923 bc
BARI Mug-5	0.844 d	0.583 c	0.166 c	0.2103 bc	0.732 d
BARI Mug-6	0.827 d	0.780 b	0.166 c	0.1733 cd	0.674 d
BINA Mug-2	0.1188 a	0.980 a	0.235 ab	0.253 ab	1.136 a
BINA Mug-5	0.894 cd	0.848 ab	0.183 bc	0.133 d	0.8827 c
CV(%)	3.67	6.33	14.44	12.78	5.88
LSD(0.01)	0.920	1.341	0.5125	0.673	1.334

Figures with same letter in column are not significantly different at 1% level by DMRT.

4.2 Incidence of whitefly population in seven mungbean varieties

Seasonal fluctuation of whitefly population

Seasonal fluctuation of whitefly population throughout the growing season observed in mungbean field are shown in Figure 1. The whitefly population, adult (18.23 per 10 plants) and nymph (20.33 per 10 plants) was the highest in third week of May 2006, which gradually declined with the progress of time and reached the minimum at first of June, 2006. The trend of whitefly population fluctuation recorded by visual method was similar in all the varieties as shown in Figure 1. The highest number of whitefly was recorded in variety BINA Mug-2, having no significant difference with BARI-2 (Table 2.) while it was the lowest in BARI Mug-6 followed by two varieties BARI Mug- 5 and BINA Mug-5. The medium incidence of whitefly (adult) was recorded in BARI Mug-3 and BARI Mug-4. Incase of whitefly (nynph) the highest number of was recorded in BINA Mug-2 with no significant difference from BARI Mug-2, while it was the lowest in BARI Mug-6 followed by BARI Mug-4. So, in both cases (adult and nymph), the highest number of whitefly was recorded in BINA Mug-2 and lowest number was recorded in BARI Mug-6.

Table 2. Seasonal abundance of whitefly population/10 plants in seven mungbean varieties in Kharif-I, 2006

Varieties	Average number of whitefly (adult) per 10 plants	Average number of whitefly (nymph) per 10 plants
BARI Mug-2	11.16 ab	16.38 ab
BARI Mug-3	10.81 b	14.56 b
BARI Mug-4	9.60 c	10.44 cd
BARI Mug-5	8.44 d	11.56 c
BARI Mug-6	8.27 d	8.44 d
BINA Mug-2	11.88 a	18.44 a
BINA Mug-5	8.94 cd	11.78 c
CV(%)	3.67	6.84
LSD(0.01)	0.902	2.234

Data are average of three replication from six observation. Figures with same letter in column are not significantly different at 1% level by DMRT.

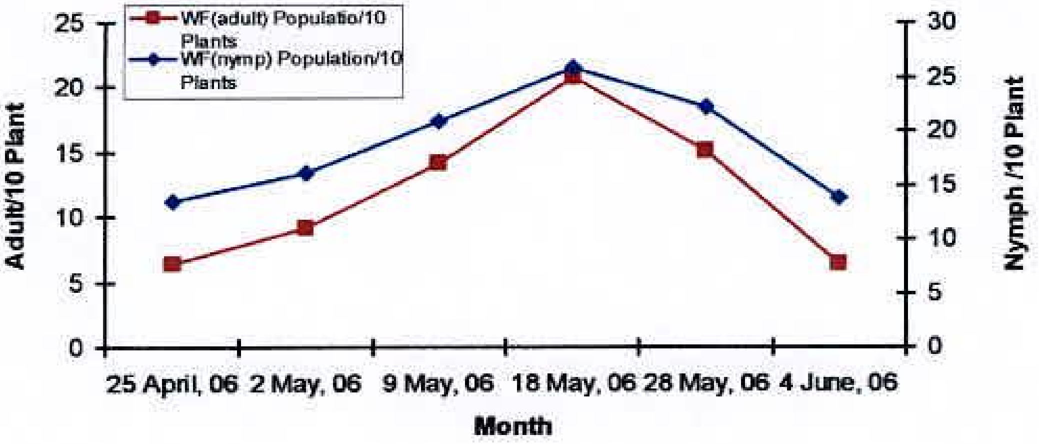

Figure 1. Abundance of whitefly population (adult and nymph) over time (25 April, 2006 to 04 June, 2006) in susceptible variety.

4.3 Factors influencing population fluctuation of whitefly

4.3.1 Whitefly population influenced by temperature

The results shown in Figure 2&3 demostrated that more than 11 adult whitefly were recorded in 7 days when temperature was around 29°c and during that time more than 15 nymphs were recorded. With the progress of time the whitefly (adult & nymph) population was increased. The highest whitefly population (adult) more than 18 was recorded at around 32^{0}c. During the same period the highest population of whitefly (nymph) more than 20 was also recorded.

Whitefly density is usually the highest between April-June with temperature 29-34^{0}C and July-September with temperature 24-25°C (Pimple and Summanwar, 1986). The whiefly population on plants varies at different periods of the day. In mungbean, the lowest number of *B. tabaci* are found at noon when the light intensity is maximum, and the highest number during early morning or late evening hours as reported by Varma and Subrahmnayam (1986).

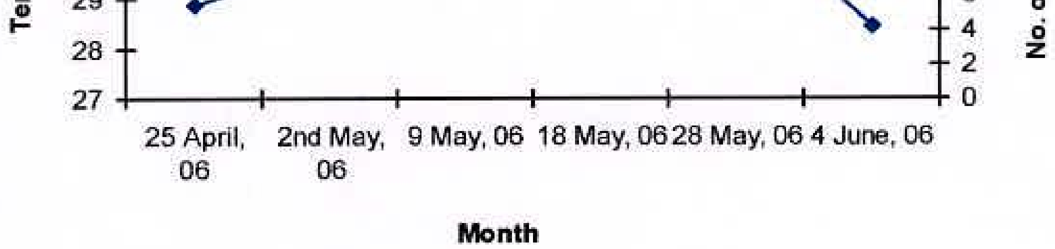

Figure 2. Whitefly (adult) influenced by temperature over time (25 April, 2006 to 04 June, 2006) in mungbean field.

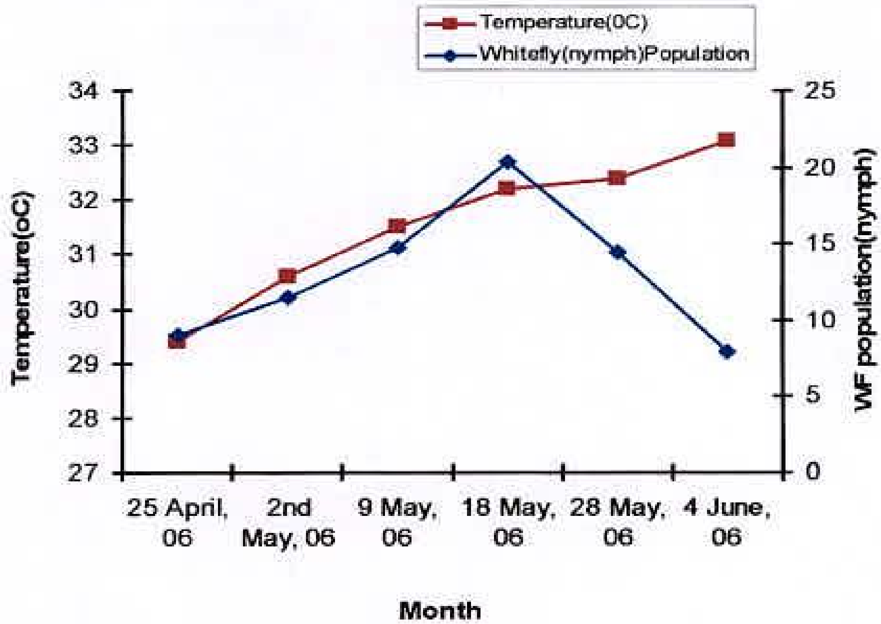

Figure 3. Whitefly (nymph) influenced by temperature over time (25 April, 2006 to 04 June, 2006) in mungbean field.

Relationship between temperature and whitefly population (adult & nymph)

The correlation regression analysis shown in (Figure 4 & 5) that there was a significant polynomial relationship between temperature (x) and whitefly population (y) ($y= - 2.114x^2 + 139.09x-2174$; $R^2= 0.479$ and $Y=-2.046x^2+128.61x-2005.1$; $R^2=0.5097$ for adult and nymphal population respectively)

Pimple and Summanwar (1996) and Verma *et al*. (1991) also reported similar positive relationship between temperature and population build-up of whitefly. The population build-up at higher temperture is attributive to the higher rate of oviposition as well as rapid growth and development of nymph into adults.

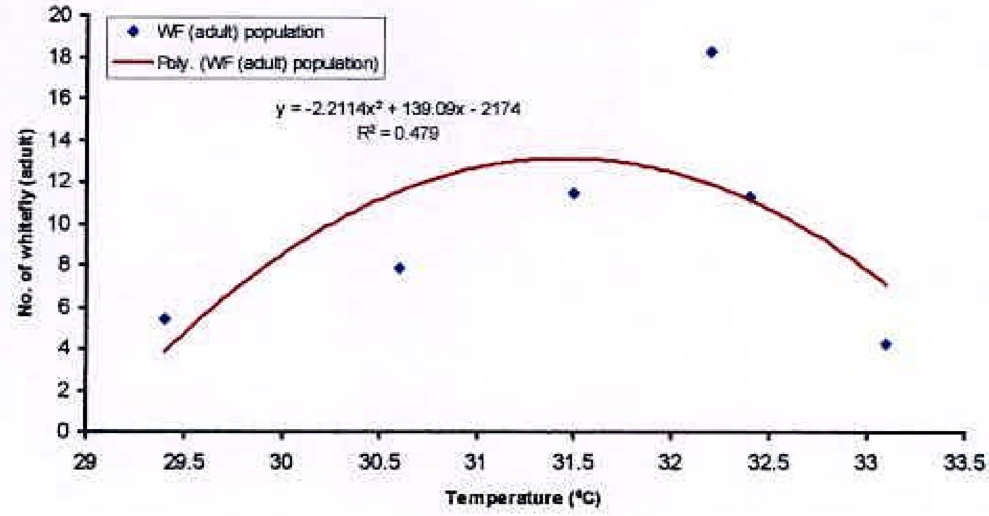

Figure 4. Relationship between temperature and whitefly (adult) population in mungbean field.

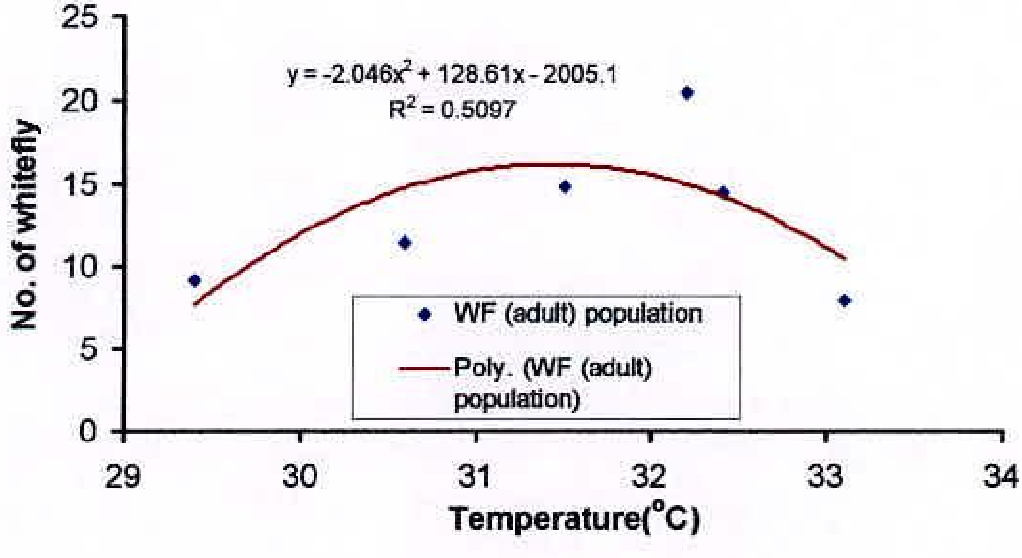

Figure 5. Relationship between temperature and whitefly (nymph) population in mungbean field.

4.3.2 Whitefly population influenced by percent relative humidity

The whitefly (adult and nymph) build up of was related to percent relative humidity as presented in Figure 6 & 7. Higher population of whitefly was recorded during the period of high relative humidity. The results indicated that the highest number of whitefly (adult) more than 18 was recorded (Figure 6.) when percent relative humidity was around 80% and during that time the highest number of whitefly (nymph) more than 20 (Figure 7) was also recorded.

Pimple and Summanwar (1986) also observed that whitefly density is usually the highest between April-June with relative humidity 66-99%.

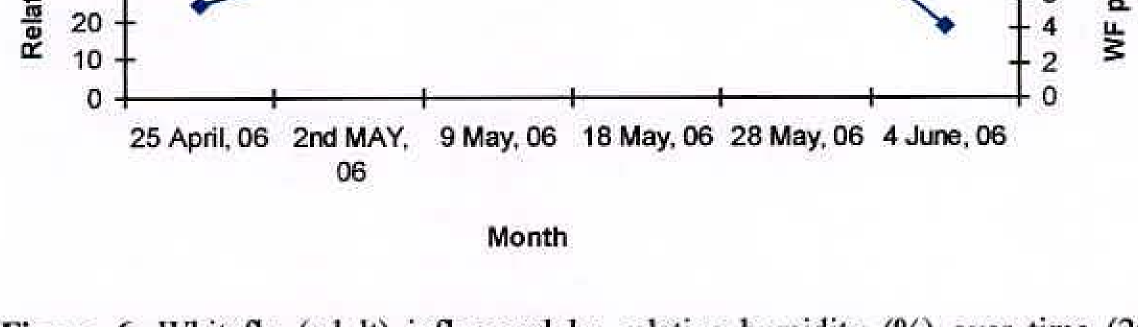

Figure 6. Whitefly (adult) influenced by relative humidity (%) over time (25 April, 2006 to 04 June, 2006).

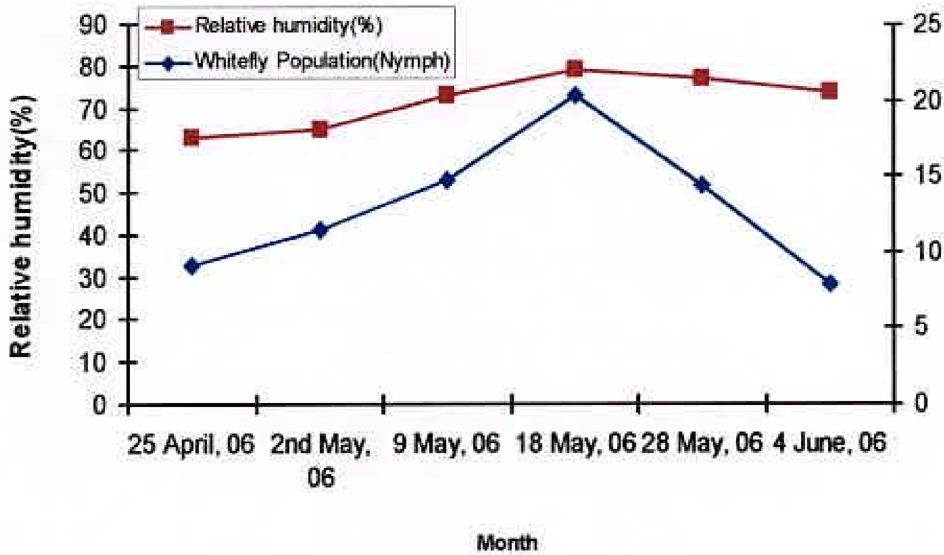

Figure 7. Whitefly (nymph) influenced by relative humidity (%) over time (25 April, 2006 to 04 June, 2006).

Relationship between whitefly (adult & nymph) and percent relative humidity

The correlation regession analysis shown in Figure 8 & 9. Indicated that there was a positive linear correlation between percent relative humidity (x) and whitefly (y) population. It demonstrated that the whitefly population (adult & nymph) were increased with the increase of percent relative humidity. (Incase of adult whitefly, $R^2 = 0.0846$ when, $Y = 0.1688x - 2.9147$ and that of nymph, $R^2 = 0.078$ when, $y = 0.01437x + 2.2259$).

Pimple and summanwar (1996) and Verma *et al.* (1991) also reported similar positive relationship relative between relative humidity (RH) and population build-up of whitefly.

The population fluctuation of whitefly in different season, which are mostly due to the variation of temperature, rainfall and relative humidity (RH) have also been reported by Verma *et al.* (1994).

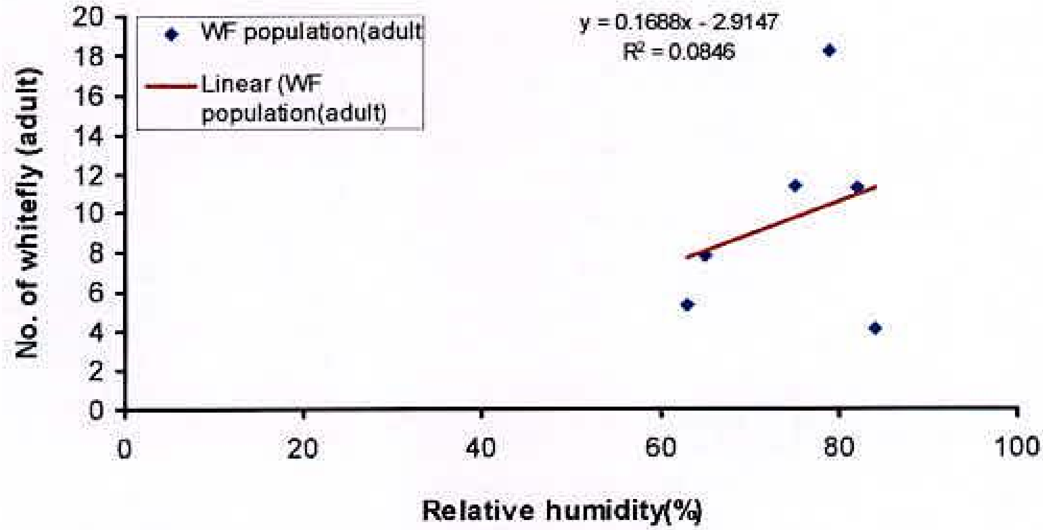

Figure 8. Relationship between whitefly population (adult) and relative humidity (%).

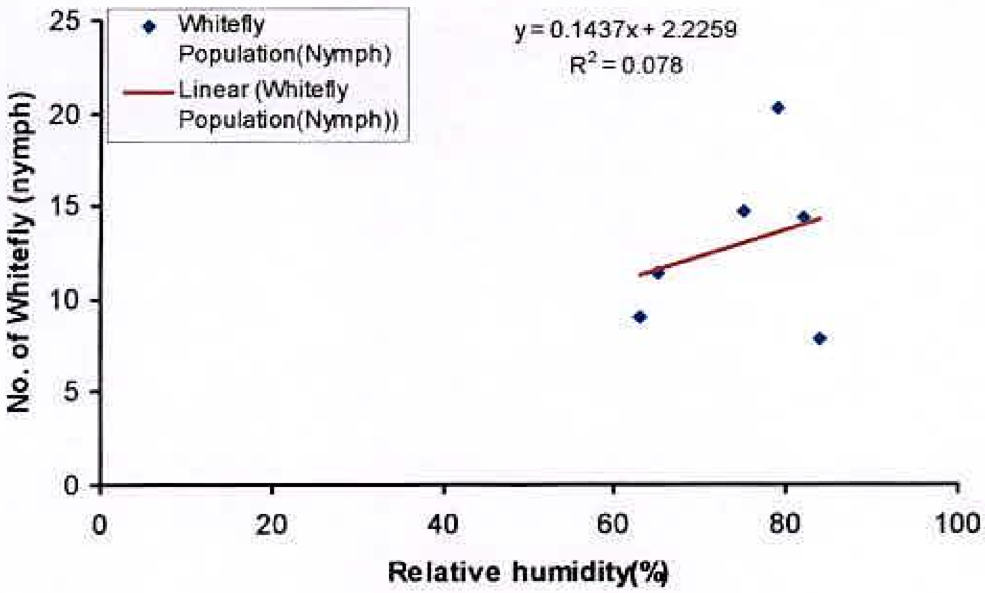

Figure 9. Relationship between whitefly population (nymph) and relative humidity (%).

4.4 MYMV disease:

The symptoms of MYMV on mungbean appeard on young leaves in the form of mild speacks or spots. The next leaf emerging from the growing apex showed irregular yellow and green patches. The infected areas were slightly raised and leaves slightly puckered and reduced in size. Yellow areas increased gradually in the new leaves and ultimately some of the apical leaves became completely yellow. Early infected plant matured late and produced fewer numbers of flowers and pods. Poehlman (1991), Bakar (1991) and Nariani (1960) reported similar symptoms. Pods were small, sometimes curled and contained only a few seeds. In severe infection, only one to few pods were produced. Nene (1969) also reported similar effect of MYMV produce chlorosis, stunting and fewer branches and premature shedding of leaves were observed which were also similar to these reported by Singh *et al.* (1980).

4.4.1 Comparative incidence of MYMV in seven mungbean varieties:

The highest percent of MYMV infection was recorded in BINA Mug- 2 (3.40%) followed by variety BARI Mug-2 (3.29%) (Table 3.). On the other hand, the lowest percent of MYMV infection was found in variety BARI Mug- 6 (2.68%) that was followed by the varieties BARI Mug-5 and BINA Mug-5. The varieties BARI Mug-3 and BARI Mug-4 showed moderate level of infection. The percent leaflet infection was also the highest (67.27%) in BINA Mug-2 Followed by BARI Mug-2, while it was the lowest infection by MYMV in variety BARI Mug- 6 (35.94%).

Table 3. Incidence and severity of MYMV infection in mungbean varieties throughout the growing season (25 April, 2006 to 04 June, 2006)

Varieties	%MYMV infected plants	%leaflet infection
BARI Mug-2	3.297 ab	61.86 b
BARI Mug-3	3.06 bc	8.68 bc
BARI Mug-4	2.85 cd	56.27 c
BARI Mug-5	2.69 d	40.84 e
BARI Mug-6	2.68 d	35.94 f
BINA Mug-2	3.40 a	67.27 a
BINA Mug-5	2.78 d	48.87 d
CV (%)	4.70	4.01
LSD(0.01)	0.245	3.77

Data are average of three replications. Figures with same letter in column are not significantly different at 1% level by DMRT.

4.5 Resistance/Susceptibility mungbean varieties to whitefly

On the basis of the incidence of whitefly (adult & nymph) and MYMV disease, BARI Mug-6, BARI Mug-5 and BINA Mug-5 may be rated as relatively resistant as compared to the other tested varieties (Table 3). Among the seven varieties BINA Mug-2 and BARI Mug-2 appeared to be the most susceptible varieties. The relative resistance of the varieties BARI Mug-6, BARI Mug-5 and BINA Mug-5 may be attributive to the leaf character.

The difference in resistance/susceptibility of mungbean varieties have also been reported by other workers (Virmani *et al.*, 1983; Singh, 1981, 1982 a, b; Singh and Sharma, 1981; Chhabra and Kooner, 1980a, b.).

4.6 Trend of whitefly poulation (adult) and spread of % MYMV injected plant in different mungbean varieties.

The results shown in Figure10. revealed that the incresae of whitefly population in different mungbean varieties increased the % of MYMV infected plants. The figure demonstrated that the highest number (11.88/10 plants) of whitefly (adult) was recorded in BINA Mug-2 and the highest percent (3.4%) infected plant was also found in BINA Mug-2 (Appendix 2). On the other hand, the lowest number of whitefly population (8.27/10 plants) was recorded in BARI Mug-6 and the Lowest % (2.68%) of MYMV infected plant was also found in variety BARI Mug-6. The results are such, because the whitefly population carry the MYMV disease.

Though whitefly nymph does not transmit MYMV disease, its contribution to the adult population (female) might be attributive to the positive relation with MYMV infection. The role of whitefly in transmitting the MYMV is also reported by several workers (Burnt *et al.*, 1990; Honda *et al.*, 1983 and Nene, 1973.).

Dhingra and Ghosh (1993) also studied the efficiency of *Bemisia tabaci* in transmission of MYMV in reciprocal inoculation tests of five different hosts. They reported that the maximum percentage of virus transmission occurred when the test and source plants were of the same species. Mungbean yellow mosaic virus disease spread rapidly with increase in the whitefly population (Aftab *et al.*, 1992).

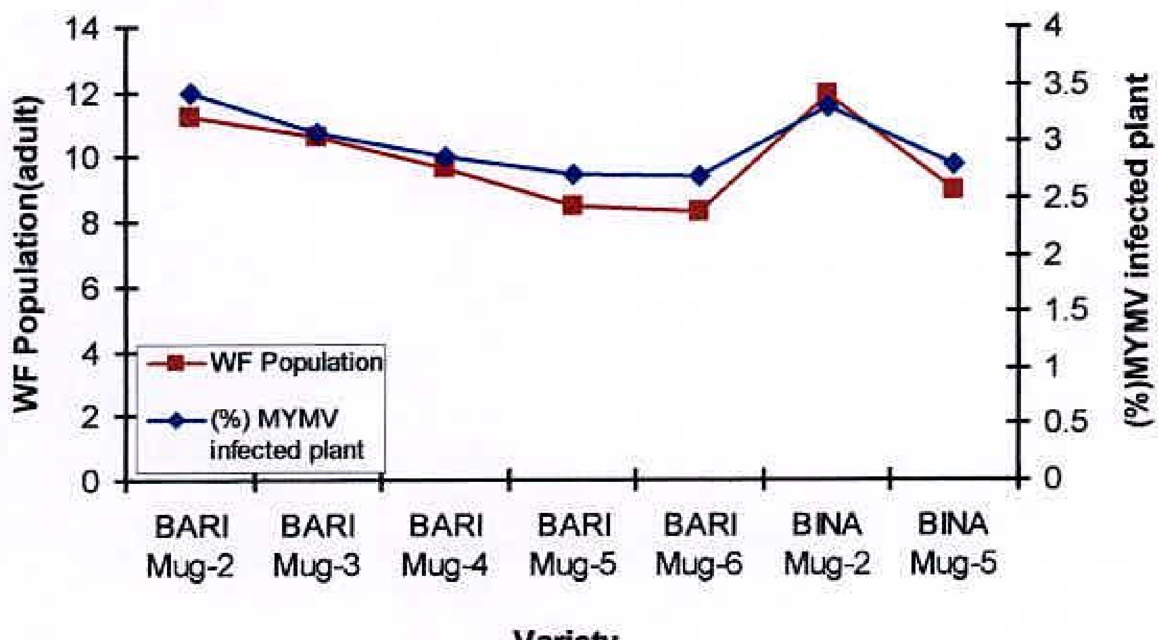

Figure 10. Trend of whitefly Population (adult) and spread of (%) MYMV infected plant in different mungbean varieties.

Relationship between whitefly population (adult) and (%) MYMV infected plant in different mungbean varieties

The results shown in Figure11.revealed that the increase of whitefly (adult & nymph) population in mungbean field increased the (%) of MYMV infected plants. There was a positive relationship between whitefly (adult & nymph) population build-up (in case of whitefly adult, $R^2 = 0.7673$, when $y = 0.273x + 2.1552$) and the percent of MYMV infected plant (Appendix 2)

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

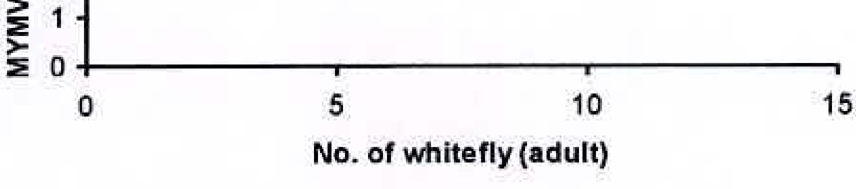

Figure 11. Relationship between whitefly (adult) population and (%) MYMV infected plant.

4.7 Seasonal abundance and level of infestation by jassid in mungbean varieties

The Jassid population fluctuated throughout the growing season shown in Figure 12. It was revealed from the figure that the population of jassid appeared from 25 April, 2006 and continued up to 04 June, 2006. The jassid population was the highest (9.80 per 10 plants) in the third week of May, 2006 which gradually declined with the progress of time (Appendix 3)

The infestation of mungbean varieties by jassid varied significantly shown in Figure 13. The maximum plant infestation (9.8 per 10 plants) caused by jassid was the highest in the variety BINA Mug-2 having no significant difference with BARI Mug-2 (9.6 per 10 plants) and BARI Mug-3 (9.41 per 10 plants), while it was the lowest in the BARI Mug-5 (5.83 per 10 plants) followed by BARI Mug- 6 (7.8 per 10 plants).

Raj-Singh and Kalra (1995) found that infestation of jassid was high during early growing stage. The peak population of *Empoasca kerri* (nymph & adult) was 6.40/plant.

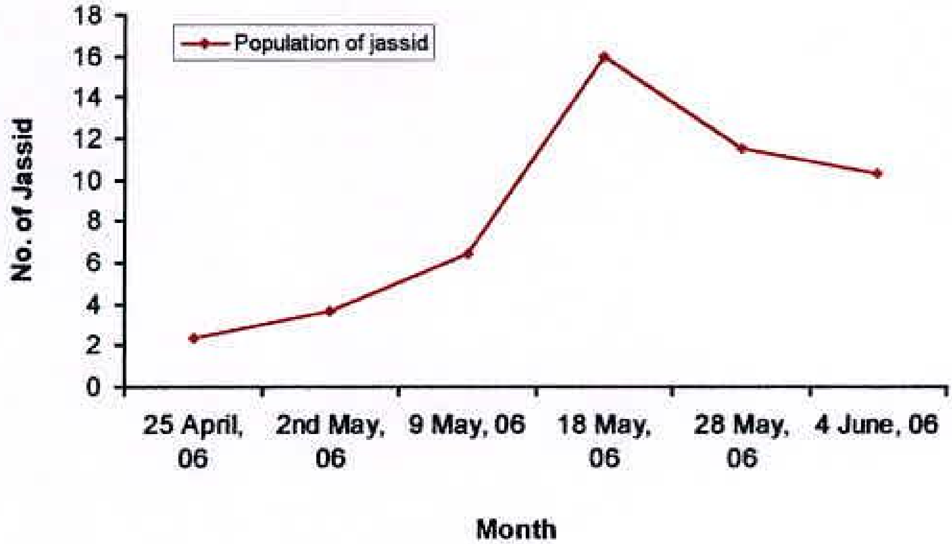

Figure 12. Seasonal abundance of jassid population over time (25 April , 2006 to 04 June, 2006) in mungbean field.

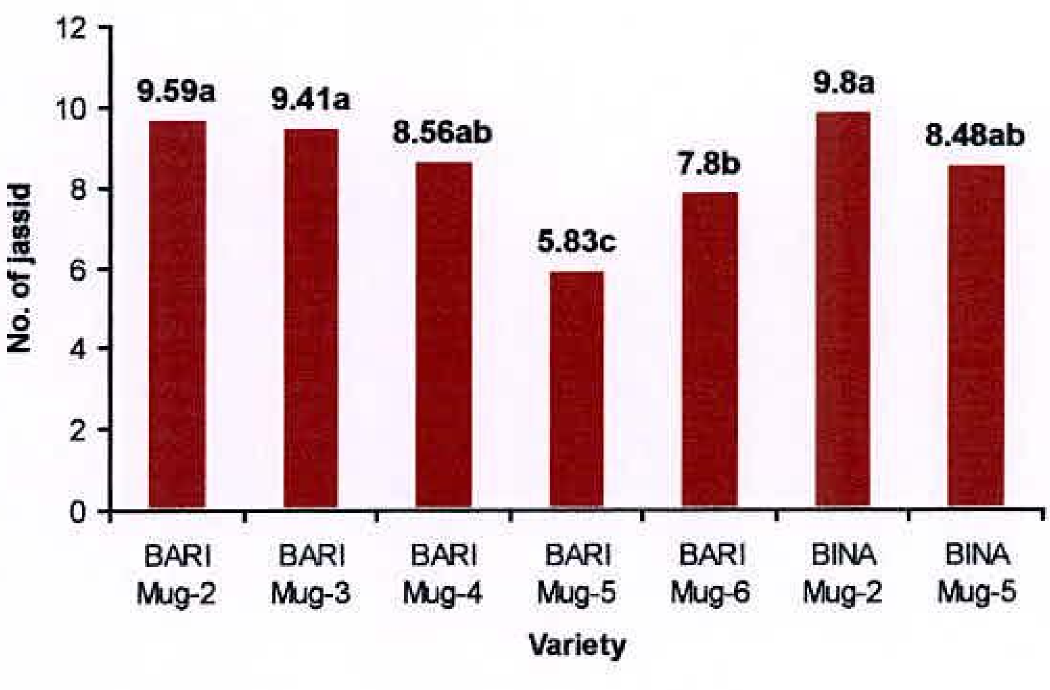

Figure 13. Effect of infestation by Jassid in different mungbean varieties.

4.8 Incidence of stemfly and level of infestation in mungbean varieties

The incidence of stemfly pupal population showed that the highest number of stemfly pupae per ten plants was recorded in BARI Mug-2 (2.41/10 plants) followed by BINA Mug-2 (2.35/10 plants) with no significant difference among them. On the other hand, it was the lowest in the variety BARI Mug-5 (1.66/10 plants) and BARI Mug-6. Varieties BARI Mug-2, BARI Mug-3 and BINA Mug-5 showed medium level of infestation. The incidence of stemfly in general varied throughout the growing season as shown in Table 4.

The incidence of stemfly on *Vigna radiata* was observed by several workers (Raj-Singh and Kalra, 1995). They reported that the most important insect pest was stemfly (*Ophiomyia phaseoli*). The peak population of *Ophiomyia phaseoli* was 0.25/plant on *Vigna radiata*.

Table 4. Incidence of stemfly and level of infestation in seven mungbean varieties in Kharif-I, 2006

Varieties	% Plant infestation	Number of stemfly pupae/10 plants
BARI Mug-2	5.59 a	2.41 a
BARI Mug-3	4.82 bc	2.16 abc
BARI Mug-4	4.81 bc	1.83 bc
BARI Mug-5	4.33 c	1.66 c
BARI Mug-6	4.44 c	1.66 c
BINA Mug-2	5.31 ab	2.35 ab
BINA Mug-5	4.69 bc	1.83 bc
CV (%)	4.74	14.44
LSD(0.01)	0.574	0.512

Data are average of three replication at five observations. Figures with same letter in column are not significantly different at 1% level by DMRT.

Infestation by stemfly

The infestation of mungbean varieties by stemfly also varied significantly. The highest percentage of infestation was in variety BARI Mug-2 (5.59%) followed by variety BINA Mug-2 (5.21%), while it was the lowest in BARI Mug-5(4.39%) followed by BARI Mug-6, having no significant difference among them. Medium infestation occurred in BARI Mug-2 (4.82%), BARI Mug- 4 (4.81%) and BINA Mug-5 (4.69%)[Table 4.]

The infestation of mungbean varieties by stemfly also reported by other workers (Thapa and Timsina ,1990). They observed that the greatest damage (66.3% infestation) was recorded on Pag-asa-2 and the least (43.4%) on a local variety. After 6 weeks, almost all the plants were damaged with 63-90% infestation.

Seasonal abundance of stemflySeasonal abundance of stemfly pupae in general, varied throughout the growing season as shown in Fig. 14. It was revealed from the figure that pupae of stemfly appeared from 18 April, 2006 and continued up to 16 May, 2006. The stemfly pupae reached the highest peak on third week (May 02, 2006) after germination and then drastically reduced with the progress of time (Appendix 3)

Thapa and Timsina (1990) observed similar results. The 11 varieties of *V. radiata* tested differed in terms of germination, seedling vigour and plant height against *Ophiomyia phaseoli*. Pest incidence was high during the 3rd week after germination.

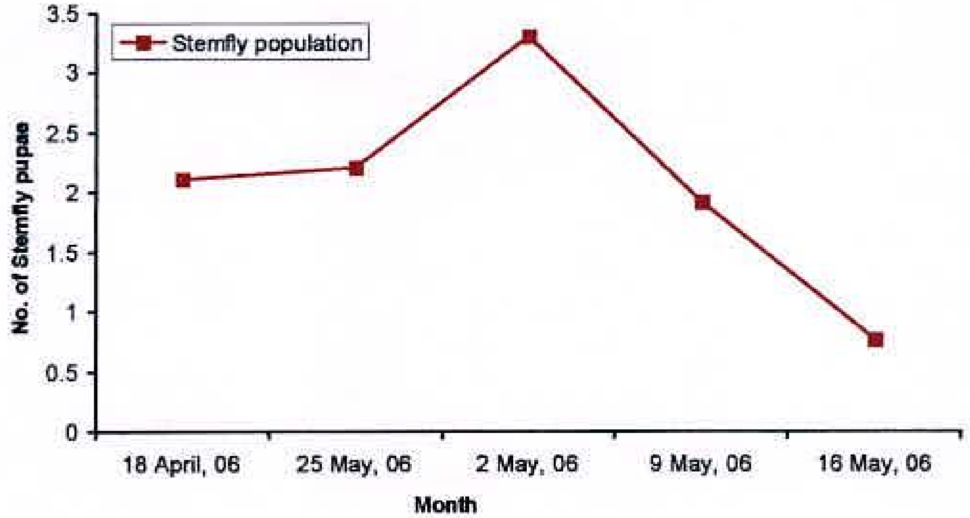

Figure 14. Seasonal abundance of stemfly throughout the growing season (25 April, 2006 to 16 May, 2006).

Relationship between stemfly pupal population and age of the plant.

The correlation regression analysis shown in Figure 15. indicated that there was a negative correlation between age of the plant and stemfly pupal popultion. (R^2 = 0.4982, when y = 0.612x + 3.365). The results revealed that early growing stage of mungbean was favourable to infest stem of mungbean. At early stage stem of mungbean remain soft and succulent. It was revealed from the figure 14. that stemfly reached the highest peak on May 02, 2006 when the stem of mungbean was soft and succulent and then reduced with the progress of the age of the plant because the stem of mungbean plant became hard to infest

A negative correlation was found between *Ophiomyia phaseoli* infestation and plant height reported by other workers (Rajapakse and Jayasena, 1989).

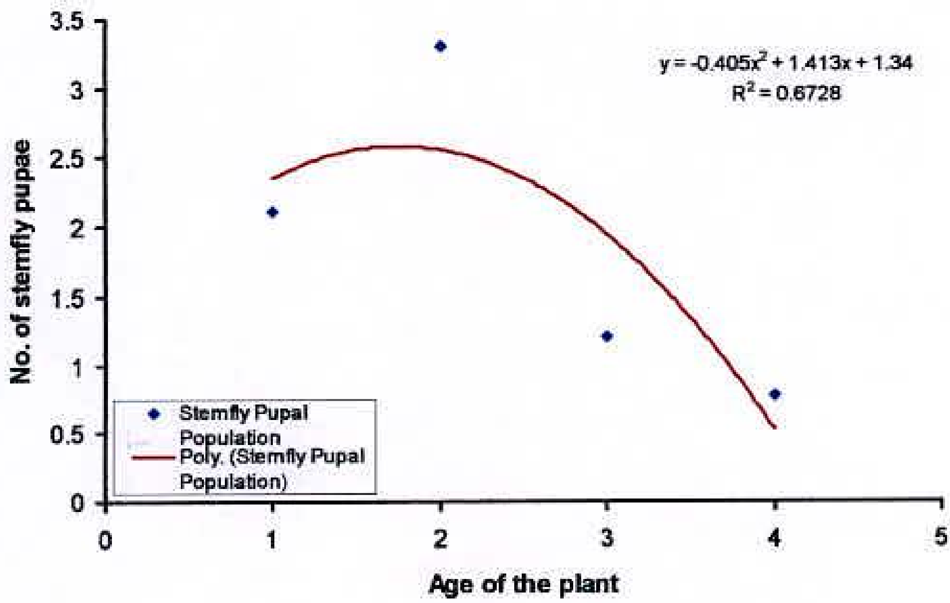

Figure 15. Relationship between stemfly pupal population and age of the plant.

4.9 Infestation by pod borer in mungbean varieties

The plant having pod infestation by pod borer varied significantly, the highest percent plant having pod infestation was in the BARI Mug-2 (5.64%) followed by BINA Mug-2 (5.495%) having no significant difference among them, while it was the lowest in BARI Mug-6 (4.13%) followed by BARI Mug-5 (4.44%).[Table 5]. However, the pod infestation was the highest in BINA Mug-2 (11.32%) followed by BARI Mug-2 (10.59%) having also no significant difference among them, while it was the lowest is variety BARI Mug-6 (6.74%) followed by BARI Mug-5 (7.32%) with no significant difference among them. In both cases, the other varieties showed medium infestation by pod borer.

Pod damage by pod borer was also agreement with several other workers (Gangwar and Ahmed, 1991). Pod borer infested the pod during pod formation and pod maturation.

Table 5. Infestation by pod borer in seven mungbean varieties in Kharif-I, 2006

Varieties	% plant having pod infestation	% pod infestation
BARI Mug-2	5.64 a	10.59 ab
BARI Mug-3	4.93 ab	9.60 bc
BARI Mug-4	4.79 ab	9.23 bc
BARI Mug-5	4.44 ab	7.32 d
BARI Mug-6	4.13 b	6.74 d
BINA Mug-2	5.49 ab	11.36 a
BINA Mug-5	4.68 ab	8.82 c
CV (%)	10.88	5.88
LSD (0.01)	1.322	1.334

Data are average of three replications. Figures with same letter in column are not significantly different at 1% level by DMRT.

4.10 Incidence and level of infestation by semilooper in mungbean varieties

The Incidence of semilooper population varied significantly throughout the growing season. In Figure 16 it was indicated that the population of semilooper appeared from 02 May, 2006 and continued up to 04 June, 2006 which reached the peak (3.24 per 10 plats) on May 18, 2006 and then reduced with the progress of time (appendix 3)

The infestation of mungbean varieties by semilooper varied significantly shown in Figure 17. The maximum plant infestation caused by semilooper was the highest in the variety BARI Mug- 2 (2.86 per 10 plants) followed by BINA Mug- 2 (2.53 per 10 plants) while, it was the lowest in variety BINA Mug-5 (1.33 per 10 plants) followed by BARI Mug-6 (1.73 per 10 plants). Medium infestation occured in BARI Mug-3, BARI Mug-4 (2.13 per 10 plants) and BARI Mug-5.

The incidence of semilooper on mungbean varieties was agreement with several workers (Devesthali and Saran, 1998). They reported that semilooper was the minor pest of mungbean. Semiloopers appeared at the early vegetative stage and continued to infest the crop until the post-reproductive stage (Nath *et al.*, 1998).

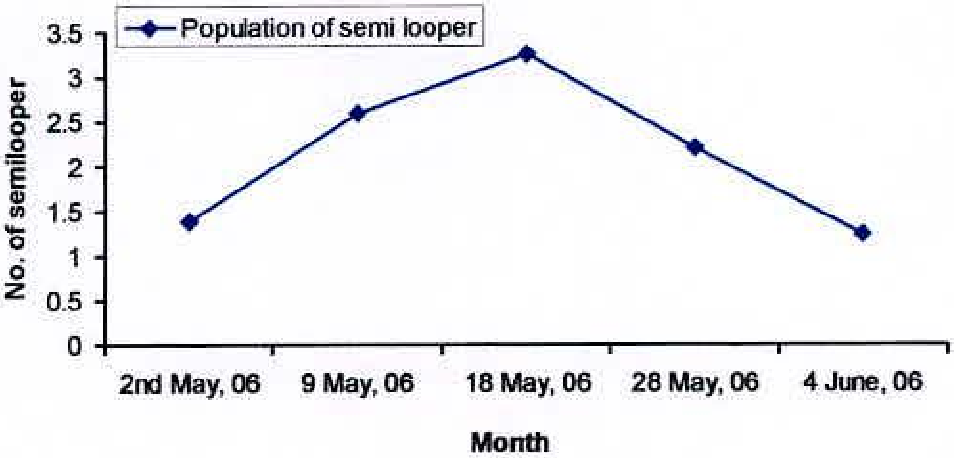

Figure 16. Seasonal abundance of Population of semilooper over time (02 May, 2006 to 04 June, 2006) in mungbean field.

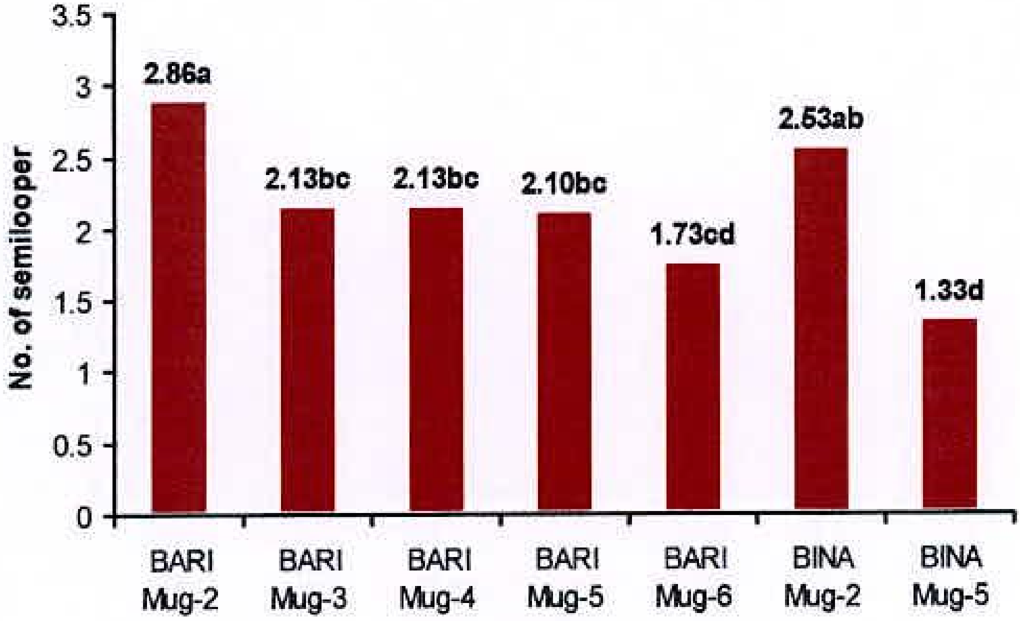

Figure 17. Effect of infestation by semilooper in different mungbean varieties.

4.11 Yield of mungbean

The yield at different harvest time with its, percentage of total and total yield obtained from seven mungbean varieties were presented in Table 6. At first harvest, 67 days after sowing (DAS), the highest yield obtained was 785 kg/ha (52.96% of total yield) from BARI Mug-6 which was followed by BARI Mug-5 (736 kg/ha i.e. 52.08% of total yield), BARI Mug-4 (712 kg/ha i.e. 57.74% of total yield) and BINA Mug-5 (720 kg/ha i.e. 50.94% of total yield). At first harvest, the lowest yield obtained was 578kg/ha (50.61% of total yield) in BINA Mug-2 that was followed by the BARI Mug-2 (613 kg/ha i.e. 50.36% of total yield). These results revealed that BARI Mug-6 is early maturity variety and had the highest yield during first harvest. Second harvest made after 74 DAS of most of the varieties produced lower yield than first harvest. The highest yield obtained was 489 kg/ha (32.99% of total yield) from BARI Mug-6 which was followed by BARI Mug-4 (407 kg/ha i.e. 29.57% of total yield) and BINA Mug-5 (403 kg/ha i.e. 29.24% of total yield), while it was the lowest yield 346 kg/ha (30.29% of total yield) from BINA Mug-2 followed by BINA Mug-3 (376 kg/ha i.e. 29.51% of total yield).

Again the third harvest made after 82 DAS gave the highest yield from BINA Mug-5 (273 kg/ha i.e. 19.81% of total yield), while the lowest yield was obtained from BARI Mug-6 (208 kg/ha i.e. 14.03% of total yield).

On a cumulative basis the total yield was the highest from BARI Mug-6 (1482 kg/ha) which was followed by BARI Mug-5 (1413 kg/ha), BINA Mug-5 (1378 kg/ha) and BARI Mug-4 (1376 kg/ha). The yield was the lowest from BINA Mug-2 (1142 kg/ha) which was followed by BARI Mug-2 (1217 kg/ha) and BARI Mug-3 (1274 kg/ha).

The yield of seven mungbean varieties as obtained in the present study was similar to that obtained by other workers (Mannan and Chowdhury, 2001; Bakar, 1991). The variation in the yield of the varieties may be mostly attributed to this inherent varietal characteristics although there might be some influences of some other factors including pests and diseases, which are evident from the subsequent analysis of the incidence of pests and diseases.

Table 6. Yield of seven mungbean varieties obtained from three consecutive harvests

Varieties	1st harvest (67 DAS)		2nd harvest (74 DAS)		3rd harvest (82DAS)		Total yield (kg/ha)
	kg/ha	% Total	kg/ha	% Total	kg/ha	% Total	
BARI Mug-2	613.0 cd	50.36	388 cd	31.88	216 b	17.74	1217 c
BARI Mug-3	6440. c	50.54	376 d	29.51	254 a	19.93	1274 c
BARI Mug-4	712.7 b	51.74	407 bc	29.57	256 a	18.65	1376 b
BARI Mug-5	736.0 b	52.08	426 b	30.14	251 a	17.76	1413 b
BARI Mug-6	785.0 a	52.96	489 a	32.99	2.8 b	14.03	1482 a
BINA Mug-2	578.0 d	50.61	346 e	30.29	217 b	19.00	1142 d
BINAMug-5	702.0 b	50.94	403 bc	29.24	273 a	19.81	1378 b
CV (%)	2.44		2.46		4.19		1.89
LSD (0.01)	41.45		24.87		25.01		62.42

Data are average of three replications. Figures with same letter in column are not significantly different at 1% level by DMRT.

4.11.1 Effect of MYMV on yield of different mungbean varieties

Yield and yield contributing characters were seriously affected by MYMV infection. Yield of seven mungbean varieties varied significantly. The yield was highest in BARI Mug-6 (1482 kg/ha) which was followed by BARI Mug-5(1413 kg/ha), BINA Mug-5 (1378 kg/ha) and BARI Mug-4 (1376 kg/ha) while, it was the lowest in BINA Mug-2(1142kg/ha) and BARI Mug-2(1217 kg/ha). The variation in yield among different varieties may be due to inherent characteristics of the varieties which however, may also be significantly influenced by the MYMV disease incidence as shown in Figure 18 & 19.

There was a strong negative correlation (R^2 = 0.8816 when, y = -384.79x + 2466.4) (Figure 19) between percent of MYMV infection (x) and yield of seven mungbean varieties (y), which indicated that with the increase of MYMV infection in crop there was a progressive fall in the yield.(Appendix 4)

The effect of MYMV on the yield as observed in the present study was in agreement with the findings of several other workers (Gill, 1999; Jain *et al*., 1995; Bakar 1991; Bisht *et al*., 1988.). They also observed that the reduction on yield of mungbean occurs due to the MYMV incidence. The MYMV reduces the growth, vigour and photosynthetic function of the crop and thus ultimately reduction the yield.

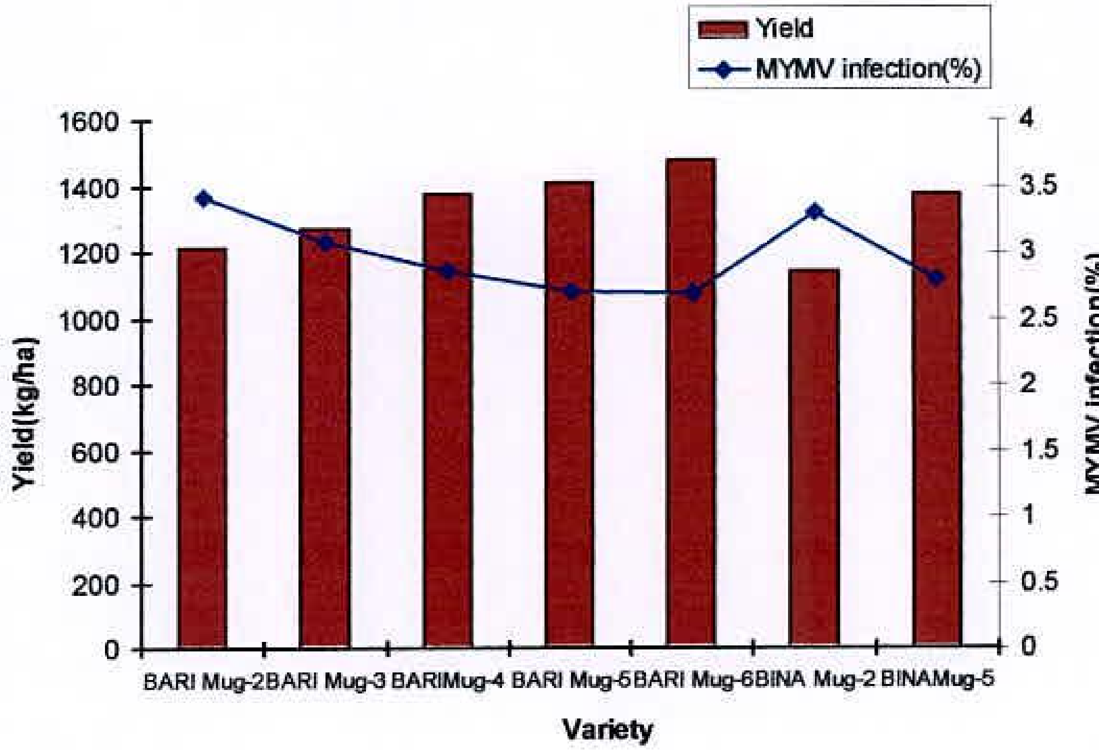

Figure 18. Effect of MYMV infection on yield of different mungbean varieties.

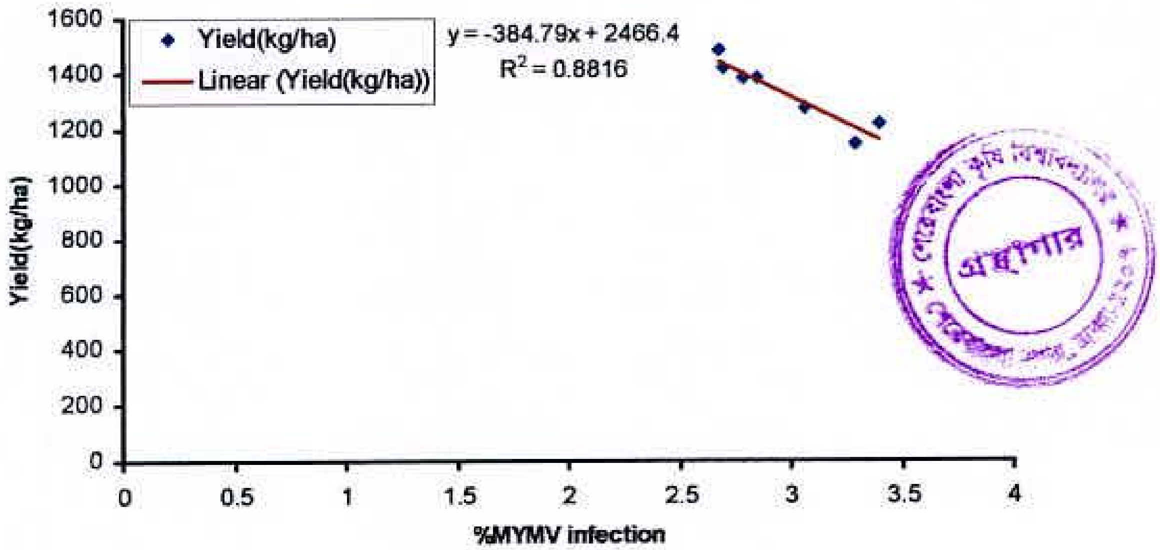

Figure 19. Relationship between MYMV infection (%) and yield of different mungbean varieties.

4.12 Relationship between jassid infestation and yield

The infestation of mungbean by jassid was observed in the present study affected the yield of the crop which is indicated by the relationship between plant infestation by jassid and yield of seven mungbean varieties/genotypes is presented in Figure 20. There was a strong negative correlation ($R^2 = 0.5743$ when, $y = -65.714x+1884.1$) between jassid infestation (x) and yield (y). Jassid reduces the leaf area by eating away the leaf, which reduces photosynthesis and thus may ultimately reduce the yield.

Yield losses due to infestation by jassid was agreement with sevsral other workers, Hassan, *et al.* (1998). They reported that population of jassid showed comparatively higher yield loss (18.31%).

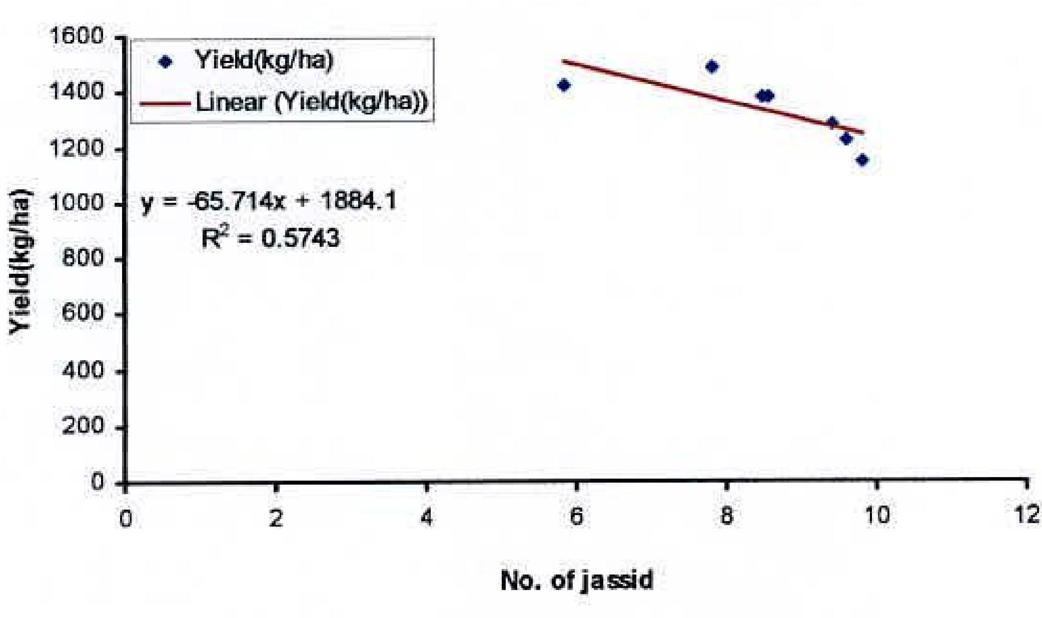

Figure 20. Relationship between jassid population and yield (kg/ha)

4.13 Relationship between stemfly infestation and yield

The infestation of mungbean crop by stemfly as observed in the present revealed that the stemfly infestation increases with the reduction of yield. In the Figure 21. a strong negative correlation ($R^2 = 0.7694$ when, $y = -268.33x + 2622.9$) between stemfly infestation (x) and yield (y) of seven mungbean varieties/genotypes was observed. The stemfly infestation in young mungbean plant weakens the plant by feeding inside the stem and making tunnel and ultimately reduces the growth of the plant, reduces the pod and grain production. This effect by stemfly also in agreement with the study of Pradhan *et al.* (2000) and Singh *et al.* (1990).

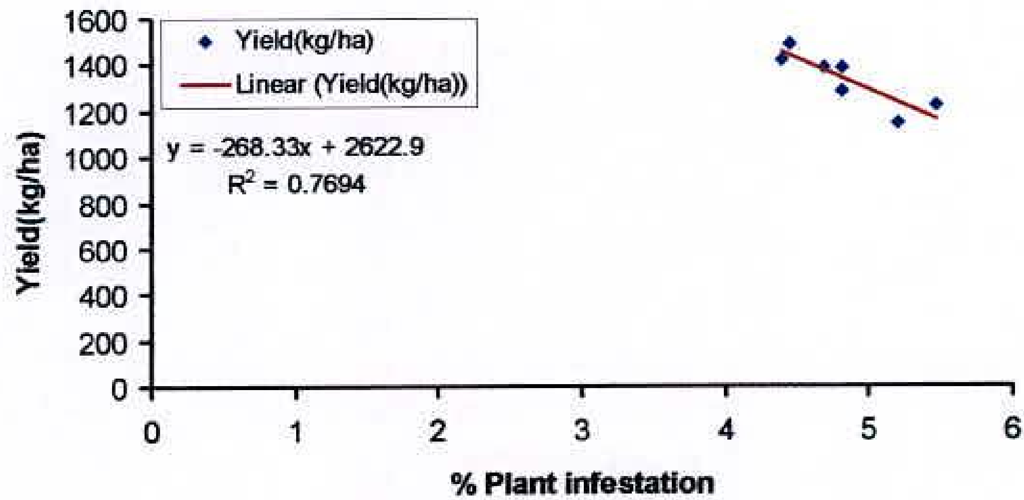

Figure 21. Relationship between stemfly infestation (%) and yield (kg/ha) of different mungbean varieties.

4.14 Relationship between pod borer infestation and yield

The relationship between pod borer infestation and the yield of different mungbean varieties/genotypes are presented in Figure 22. A strong negative correlation ($R^2 = 0.903$ when, $y = -209.43x + 2346.2$) was observed between pod borer infestation (x) and yield (y) of seven mungbean varieties. Pod borer alone were reported to grain losses of 136 kg/ha in mungbean (Anon. 1986).

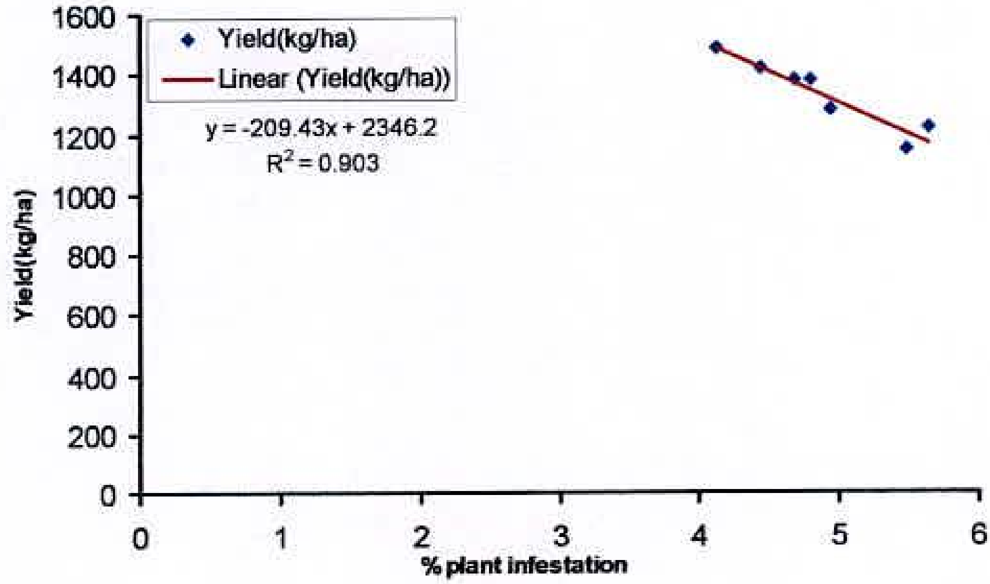

Figure 22. Relationship between pod borer infestation and yield (kg/ha) of different mungbean varieties.

4.15 Relationship between semilooper infestation and yield.

Semilooper infestation also directly affected yield of mungbean. With the increase of plant infestation by semilooper, the yield was reduced. There was strong negative correlation between semilooper infestation and yield ($R^2 = 0.3659$ when, $y = -144.28x + 1631.2$) as shown in Figure 23.

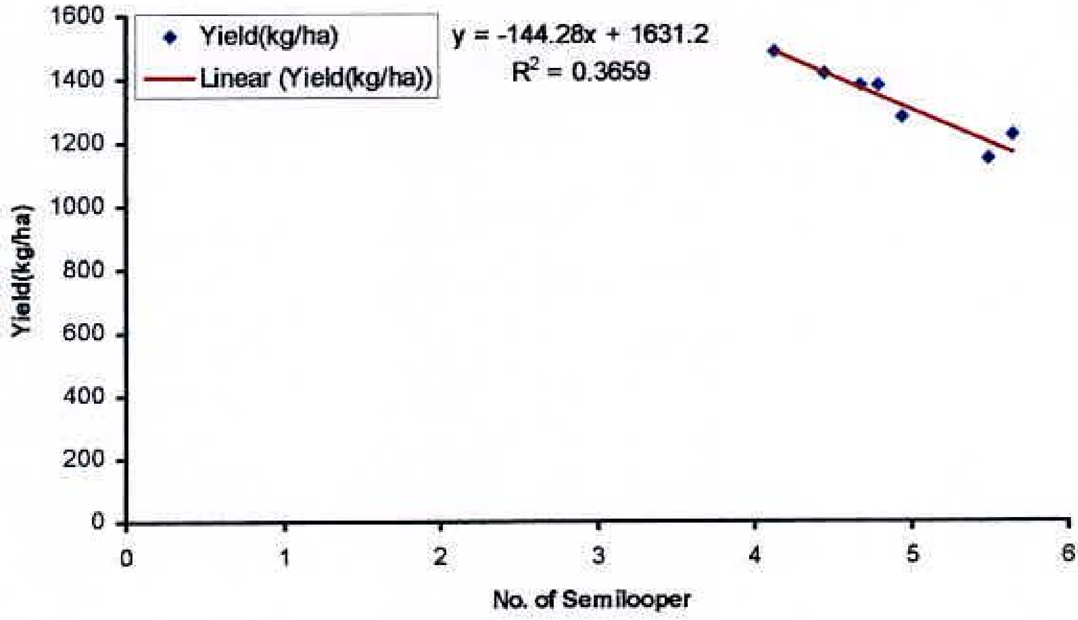

Figure 23. Relationship between population of semilooper and yield (kg/ha) of different mungbean varieties.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

An experiment was conducted to find out source of resistance against different insect pests particularly whitefly/MYMV infection in seven mungbean varieties. Effect of MYMV on growth and yield as well as field spread in relation to whitefly population (nymph and adult) was determined. The study was conducted also to determine the rate of infestation of major insect pests such as whitefly, stemfly, jassid, semi looper and pod borer at different grwoth stage. Seeds of seven mungbean verieties namely BARI Mug-2, BARI Mug-3, BARI Mug-4, BARI Mug-5, BARI Mug-6, BINA Mug-2 and BINA Mug-5 in 3m x 2m unit plot with specing 30cm x10 cm were sown to maintain 200 plants of each variety per plot.

Data on parameters related to whitefly transmission/MYMV infection, pests incidence and infestation were recorded. Whitelfy was counted visually on mungbean leaves of ten randomly selected palnts on each plot. Data of whitefly population (nymph and adult) were collected at morning (7.00 a.m. to 9.0 a.m.) when whitefly was least mobile. Data on severity of whitefly and other pest infestation were collected once in a week.

The population build up of whitefly in mungbean field was positively correlated with the increase of temperature and relative humidity. Moreover, MYMV infection was positively correlated with the whitefly (nymph and adult) population. The whitefly population was the highest in the third week of May, 2006 which declined during the progress of time and reached the minimum at June 04, 2006. BINA Mug-2 was fuond to be the most preferred variety by whitefly while BARI Mug-6 and BARI Mug-5 were the least preferred varieties.

BINA Mug-2, BARI Mug-2 and BARI Mug-3 was highly suscepitble to jassid while, BARI Mug-5 and BARI Mug-6 was less susceptible. The highest number of plants (9.80/10 plants) was infested by jassid in the variety BINA Mug-2, while it was the lowest (5.83/10 plants) in BARI Mug-5. Jassid also showed a negative correlation with yield of mungbean.

Stemfly infestation was the highest on May 02, 2006, which drastically declined at the middle of May, 2006. The stemfly infestation was limited at early growht stage. The highest stemfly infestation was recorded in the BARI Mug-2, while it was lowest in BARI Mug-5.

The highest Pod borer infestation was found in BARI Mug-2 (5.64%), while it was the lowest in BARI Mug-6 (4.133%).However, the pod infestation was the hightest in BINA Mug-2 (11.36%) and was the lowest in BARI Mug-6 (6.74) .

Semilooper infestation was the highest recoreded in BARI Mug-2 (3.86/10 plants), while it was the lowest in BINA Mug-5 (1.33/10 plants).

All the pests infestation as well as MYMV infection were strongly negatively correlated with yield of mungbean. Among the mungbean varieties the highest yield (1482 kg/ha) obtained from BARI Mug-6 while, it was the lowest (1142 kg/ha) in BINA Mug-2.

RECOMMENDATION

RECOMMENDATIONS

•Based on all the parameters studied BARI Mug-6 and BARI Mug-5 appeared to be the best varieties in terms of resistance to whitefly, MYMV and other pest incidence as well as grain yield.

•Further field trial should be conducted with the variety BARI Mug-6 and BARI Mug-5 to test their relative resistance against pest complex particularly whitefly and MYMV.

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APPENDICES

APPENDICES

Appendix 1. Meteorological conditions and number of whitefly population during the crop growing season.

Month	Air Temp. (oC)	Relative Humidity(%)	Whitefly (adult)	Whitefly (Nymph)
April,2006				
1*	29.4	63	5.37	9.04
May,2006				
1	30.6	65	7.80	11.42
2	31.5	73	11.38	14.71
3	32.2	79	18.23	20.33
4	32.4	77	11.23	14.38
June,2006				
1	32.8	74	4.14	7.86

1* stands for 25th April i.e. 1st week, 2 for 2nd week, 3 for 3rd week and 4 for 4th week of respective month

Appendix 2. Trend of whitefly population (adult & nymph) and (%)MYMV infected plant in different mungbean varieties

Varieties	Whitefly (adult)	Whitefly(nymph)	(%)MYMV infected plant
BARI Mug-2	11.16 ab	16.38 ab	3.29 ab
BARI Mug-3	10.60 b	14.55 b	3.06 bc
BARI Mug-4	9.60 c	10.44 cd	2.85 cd
BARI Mug-5	8.44 d	11.55 c	2.69 d
BARI Mug-6	8.27 d	8.61 d	2.68 d
BINA Mug-2	11.88 a	18.44 a	3.40 a
BINA Mug-5	8.94 cd	11.77 c	2.78 d

Appendix 3. Seasonal abundance of jassid, stemfly and semilooper in seven mungbean varieties during the crop growing season , Kharif-I, 2006

Observation Date	No. of jassid/10 plant	No. of stemfly/10 plant	No. of semilooper/10 plant
25/04/2006	2.26	2.10 (18/04/06)	1.37
02/05/2006	3.60	2.20	2.57
09/05/2006	6.33	3.29	3.24
18/05/2006	15.90	1.91	2.19
28/05/2006	11.04	0.76 (16/05/06)	1.23
04/06/2006	10.22		

Appendix 4 Effect of MYMV infection on yield of different mungbean varieties

Varieties	Yield (kg/ha)	(%)MYMV infected plant
BARI Mug-2	1217 c	3.29 ab
BARI Mug-3	1274 c	3.06 bc
BARI Mug-4	1376 b	2.85 cd
BARI Mug-5	1413 b	2.69 d
BARI Mug-6	1482 a	2.68 d
BINA Mug-2	1142 d	3.40 a
BINA Mug-5	1378 b	2.78 d