MANAGEMENT OF SUCKING INSECT PESTS ON MUNGBEAN AND ITS IMPACT ON THE INCIDENCE OF MOSAIC DISEASE

MD. AKRAM HOSSAIN

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SHER-E-BANGLA NAGAR, DHAKA

DECEMBER, 2010

MANAGEMENT OF SUCKING INSECT PESTS ON MUNGBEAN AND ITS IMPACT ON THE INCIDENCE OF MOSAIC DISEASE

By

MD. AKRAM HOSSAIN

REGISTRATION NO. 09-03712

A Thesis
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in Partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
IN
ENTOMOLOGY
SEMESTER: JULY - DECEMBER, 2010

Approved by:

(Prof. Dr. Md. Abdul Latif)
Supervisor
&
Professor
Depertment of Entomology
SAU, Dhaka

(Prof. Dr. Md. Mizanur Rahman)
Co-Supervisor
&
Professor
Depertment of Entomology
SAU, Dhaka

(Prof. Dr. Md. Razzab Ali)
Chairman
Examination Committee

CERTIFICATE

This is to certify that the thesis entitled, *"MANAGEMENT OF SUCKING INSECT PESTS ON MUNGBEAN AND ITS IMPACT ON THE INCIDENCE OF MOSAIC DISEASE"* 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 ENTOMOLOGY,* embodies the result of a piece of bona fide research work carried out by *MD.AKRAM HOSSAIN* , Registration No. 09-03712 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: December, 2010

Dhaka, Bangladesh

(Prof. Dr. Md. Abdul Latif)
Supervisor

Dedicated to

My

Beloved Parents

Dedicated to My Beloved Parents

ACKNOWLEDGEMENT

All praises and thanks are due to the Supreme Ruler of the Universe, the Almighty Allah for His grace bestowed upon the author for accomplishment of this research study.

The author expresses deepest sense of respect and heartiest gratitude to his respectable supervisor Prof. Dr. Md. Abdul Latif, Department of Entomology, Sher-e-Bangla Agricultural University, for his efficient and scholastic guidance, constructive criticism, valuable suggestions and immense help to carry out the research work toward successful completion and preparation of the thesis by necessary correction through reviewing the text.

He also wishes to express his sincere appreciation and heartfelt gratitude to his co-supervisor Prof. Dr. Md. Mizanur Rahman, Professor, Department of Entomology, Sher-e-Bangla Agricultural University, for his valuable suggestions, constant cooperation, inspiration and sincere advice to improve the quality of the thesis.

Cordial thanks to Prof. Dr. Md. Razzab Ali, Chairman, Department of Entomology, Prof. Md. Serajul Islam Bhuiyan and Prof. Dr. Mohammed Ali and all respected teachers of the Department of Entomology, Sher-e-Bangla Agricultural University for their help and co-operation during study and research.

He is grateful to all these people who made a contribution to this research work although it is not possible to mention all by names.

Last but not the least, the author expresses his immense indebtedness, deepest senses of gratitude to his beloved father, mother and younger sister who sacrificed all their happiness during the whole study period and during his MS study. The author is grateful to all the respondents in the study area for their cooperation and help in accomplishing the objectives of this research work. Finally the wishes to extend his heartfelt thanks and gratitude to all his relatives for their inspiration, blessing and encouragement that opened the gate of his higher study.

The Author

MANAGEMENT OF SUCKING INSECT PESTS ON MUNGBEAN AND ITS IMPACT ON THE INCIDENCE OF MOSAIC DISEASE

BY

MD. AKRAM HOSSAIN

THESIS ABSTRACT

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to November, 2011 to manage the sucking insects of mungbean and observe its impact on incidence of mosaic disease. The mungbean variety, BARI mung 4 was grown in the field and seven treatments viz., Ripcord 10EC, Actara 25WG, Marshal 20EC, Malathion 57EC, Neem oil, Tamarind Fruit extract and an untreated control were set in randomized complete block design (RCBD) with four replications. Insecticides, Neem oil and Tamarind Fruit extract were applied at 7 days interval. Whitefly, jassid, aphid and white leaf hooper were found as sucking insects and whitefly was the most abundant in mungbean field. The lowest population of aphid, jassid, whitefly and white leafhopper (6.65, 3.05, 6.58 and 6.58 plant^{-1} respectively) was found in Marshal 20EC treated plot which showed maximum percent reduction of sucking insects. The percent mosaic infested plant was found lowest in the same treatment. Marshal also produced the maximum plant height (90.25 cm), number of seeds pod^{-1} (8.25), 1000-seed weight (35.50 g) and gave highest yield (566.50 g plot^{-1}) of mungbean. Neem oil showed the intermediate results considering all the parameters. The results of present study indicate that the Marshal 20EC was the most effective treatment against sucking insects and mosaic infection of mungbean.

CONTENTS

CONTENTS (Contd.)

CONTENTS (Contd.)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS

% : Percentage

µM	: Micro mol
^{0}C	: Degree Celcius
BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistics
BRRI	: Rice Research Institute Bangladesh
CRD	: Completely Randomized Design
cv.	: Cultivar
DMRT	: Duncans Multiple Range Test
e.g.	: Exempli gratia (by way of example)
et al	: And others
FAO	: Food and Agriculture Organization
Fig.	: Figure
g	: Gram
GA_3	: Gibberellic acid
HCL	: Hydrochlori acid

$HgCl_2$	: Mercuric Chloide
i.e.	: ed est (means That is)
IRRI	: International Rice research Institute
mgL^{-1}	: Milligram per litre
pH	: Negative logarithm of hydrogen ion
spp	: Species (plural number)
var.	: Variety
Viz.	: Namely

CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) belongs to the family Fabaceae, is a good source of protein, carbohydrates, vitamin for mankind all over the world. Being an important short-duration Kharif grain legume, mungbean is grown extensively in major tropical and subtropical countries of the world. Mungbean is the fifth important pulse crop of Bangladesh (Abedin. *et al.*, 1991). Bangladesh grows various types of pulse crops among which grass pea, lentil, mungbean, chickpea, field pea and cowpea are important. A minimum intake of pulse by a human should be 80.0 g per day (FAO, 1999) wheras it is only 19.35 g per day in Bangladesh (BBS, 2009). It is an important source of protein and several essential micronutrients. It contains 24.5% protein and 59.9% carbohydrate, 75 mg calcium, 8.5 mg iron and 49 mg B-carotine per 100g of split daul (Bakr *et al.*, 2004).The foliage and stem are also a good source of fodder for live stock as well as a green manure. Among pulses, mungbean is favoured for children and the elderly people because of its easy digestibility and low production of flatulence. It is a drought tolerant, grown twice a year and fits well in our crop rotation programme. In Bangladesh, it is grown annually on an area of 57 thousand acres and a total production of 20 thousand tones with an average seed yield of 351 kg per acre (BBS, 2010) which is very low as compared to other countries of the region. The reasons of this low yield are numerous but yield losses due to insect pest complex are distinct one.

Mungbean is attacked by different species of insect pests. Insect pests that attack mungbean can be classified based on their appearance in the field as it related to the phonology of mungbean plant. They are stem feeders, foliage feeders, pod feeders and storage pests. This classification is convenient in judging the economic importance of the pest, especially their influence on seed yield, and in devising control measures. Mungbean is attacked by different species of insect pests but sucking insect pests (aphid, jassids, white leaf hopper and whitefly) are of the major importance (Islam *et al*., 2008). These insect pests not only reduce the vigor of the plant by sucking the sap but transmit diseases and affect photosynthesis as well (Sachan *et al*., 1994). Pest appearance, population fluctuation, infestation rate and crop yield are very much dependent on sowing time. Most of the farmer's usually sown mungbean just after harvesting them rabi crops without considering optimum sowing dates (Hossain *et al*., 2000).

Though many options are available for the management of these insect pests, farmers in Bangladesh mostly use synthetic chemicals because of their quick effect with or without knowing the ill effects of these chemicals. However, farmer education for the safe and timely use of the insecticides is very important. Previously many research workers have also used and evaluated different synthetic chemicals against different insect pests, especially against sucking insects of Mungbean.

Despite its importance, mungbean yields are greatly depressed by a complex of biotic and abiotic factors of which insect pests are the most important. Mungbean is attacked by a number of insect pests which cause a heavy loss to crop. Major insect pests are stemfly, thrips, whitefly, jassid and pod borer. In Bangladesh, insecticides are frequently being used in controlling insect pests of field and horticultural crops (Kabir *et al*. 1996). These conventional chemical control measures failed to adequately control this pest that resulting in severe yield losses. Under these circumstances it becomes necessary to find out some eco-friendly alternative methods for insect pest's management in formulating the Integrated Pest Management approach.

Moreover, majority of these sucking pests to mungbean yellow mosaic virus (MYMV) disease which is the major cause of unsuccessful cultivation of mungbean. Because of these limitations, the production of mungbean is very low. Thus, available supply for consumption is low as well as costly that it adversely affects the health of the poor urban and rural people. Keeping all these constraints in view, the present study was undertaken to fulfill the following objectives:

i. To study on the infestation status of sucking pests such as aphid, jassid, whitefly, white leaf hopper on mungbean

ii. To know the effect of some chemical insecticides and botanicals on sucking pests and its impact on growth and yield of mungbean and

iii. To find out the effective insecticides/botanicals for the management of sucking insects.

CHAPTER II

REVIEW OF LITERATURE

2.1 Effect of sucking insect and pests on mungbean

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

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

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

University (SAU) Dhaka during the kharif-I season (April to June) in 2006. The lowest population of whitefly (adult and nymph) was found in Barimung 6 as against the highest in Binamoog 2. The population of whitefly was gradually increased with environmental temperature and relative humidity. However, the peak population was found at 320C and 80% relative humidity. The lowest percent of MYMV infected plant was found in Barimung 6 and a positive relationship was found between whitefly population and incidence of MYMV disease. The highest yield of mungbean was obtained from Barimung 6 and there was a strong negative relationship between the MYMV infection and yield of mungbean.

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

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

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

Sharma *et al*. (2004) studied eighteen promising varieties of mungbean for resistance to white fly (*Bemisia tabaci*) and yellow mosaic virus and reported that the cultivar IPU-95-13 showed high tolerance of yellow mosaic virus. Among the 4 control cultivars, PU-35 performed well. T-9, a popular cultivar of the area was highly susceptible to whitefly and yellow mosaic virus.

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

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

Khattak *et al*. (2004) were investigate the resistance of mung bean cultivars (NM-92, NM-98, NM-121-125, M-1 and NCM- 209) against some sucking insect pests was evaluated in Kalurkot, Bhakkar, Pakistan. NM-92 and NM-98 showed significantly low mean whitefly population per leaf than the other cultivars. A similar trend was observed among the cultivars against jassids (A. devastans [A. biguttula biguttula]) and thrips, except that the mean populations of jassids and thrips per leaf in NM-98 and NM-121-125 did not significantly vary. The yields of NM-92 and NM-98 were significantly higher than the other cultivars due to low infestation by sucking insect pests.

Babu *et al*. (2004) conducted an experiment in the field against thrips population. They showed that during kharif season, the thrips catching ranged from 21.2-66.5. The white traps caught the highest number of thrips (297.4) followed by blue traps (227.6). In general, thrips infestation appeared from the first week of the crop, which progressively and significantly increased in successive crop stages up to 6 weeks.

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

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

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

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

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

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

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

2.2 Sucking pest impact on mosaic disease

Iqbal *et al*. (2011) were observed onne hundred genotypes/lines of mungbean germplasm were screened against MYMV during summer season under field conditions at NARC, Islamabad. The germplasm was categorized in to resistant and susceptible depending upon severity of disease. The differential response of mungbean accessions to MYMV was determined and none of the genotype/line was found to be highly resistant to disease.

Four genotypes/lines i.e. 014043, 014133, 014249, 014250 were found as resistant. Eight were moderately resistant and 30 were moderately susceptible. Remaining 30 accessions were classified as susceptible and 43 as highly susceptible accessions.

Sunil and Singh (2010) were conducted a field experiment during the rainy seasons of 2006 and 2007 at the Indian Agricultural Research Institute, New Delhi for the management of yellow mosaic (Mungbean Yellow Mosaic Virus) and cercospora leaf spots (Cercospora canescens and Pseudocercospora cruenta) of mungbean. Insecticides and fungicides as seed dressings, with or without foliar sprays, were evaluated.

Mungbean yellow mosaic virus (MYMV) causes yield loss up to 80 % and is becoming problematic in French bean growing areas. Molecular marker linked selection to MYMV resistance is helpful in rapid identification of genotypes carrying resistant genes. Hence, the present study was undertaken to identify the RAPD marker associated with MYMV resistance in French bean (*Phaseolus vulgaris* L.). Bulk segregant analysis (BSA) was used to identify RAPD marker linked to MYMV resistance (Ravishankar *et al*., 2009).

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

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

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

Shad *et al* (2006) found that there was no resistant line against MYMV and identification of seven susceptible and 247 as highly susceptible lines exhibited meager resistance in mungbean. Bashir (2003) screened 276 lines of mungbean and out of which 10 show résistance. Similarly, nine resistant lines were observed in field conditions from 83 lines against MYMV (Awasthi & Shyam, 2008). The results showed that there were 30 susceptible and 43 highly susceptible genotypes of mungbean. Great variation in genotype response to MYMV represents variability in their genetic makeup.

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

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

Sachan *et al*. (1994) found a drastic reduction in the infection of YMV when whitefly attack was reasonably controlled. The yellow mosaic virus caused 30-70% yield loss (Marimuthu *et al*. 1981). Chamder *et al*. (1991) noticed a significant reduction in the attack of whitefly and infection of YMV in Mungbean when 0.04% monocrotophos, 0.03% dimethoate, and 0.05% chlorvinphos 55 days after sowing were applied.

2.3 Effect of chemicals and botanical control on sucking pest, mosaic disease and growth and yield of mungbean

Sunil and Singh (2010) were conducted a field experiment to management of yellow mosaic (Mungbean Yellow Mosaic Virus) and cercospora leaf spots (Cercospora canescens and Pseudocercospora cruenta) of mungbean. Insecticides and fungicides as seed dressings, with or without foliar sprays, were evaluated. Amongst the treatments, a combination of seed treatment with thiamethoxam (CruiserTM) at 4 g kg71 and carbendazim (BavistinTM) þ TMTD (ThiramTM) at 2.5 g kg71 (1:1 ratio) followed by foliar applications of thiamethoxam (ActaraTM) 0.02% and carbendazim 0.05% at 21 and 35 d, respectively after sowing produced the highest seedling establishment, shoot and root lengths, number of pods, plant biomass, 1000-seed weight, and grain yield in mungbean with the lowest intensity of cercospora leaf spots and mungbean yellow mosaic. Vector (whitefly) populations were also the lowest in this treatment during all stages of the crop. This treatment was cost-effective, as it provided the highest return per Rupee of input. It was second best for the number of Rhizobium root nodules per plant.

Cowpea is an important legume in sub-Sharan Africa where its protein rich grains are consumed. Insect pests constitute a major constraint to cowpea production. Flower bud thrips (FTh) is the first major pest of cowpea at the reproductive stage and if not controlled with insecticides is capable of reducing grain yield significantly. Information on the inheritance of resistance to FTh is required to facilitate breeding of resistant cultivars. The genetics of resistance was studied in crosses of four cowpa lines. Maternal effect was implicated while frequency distributions of the F2 and backcross generations suggest quantitative inheritance. Additive, dominance and epistatic gene effects made large contributions and since improved inbred lines are the desired product, selection should not be too severe in the early generations to allow for desirable gene recombination.

This study suggested that some of the genes involved in the control of resistance of FTh are different in TVu1509 and Sanzi. Broad sense heritability ranged from 56% to 73%. Choice of maternal parent in across will be critical to the success of resistance breeding (Omo-Ikerodah, 2010).

Brier (2010) addresses the questions: “How widely is Integrated Pest Management (IPM) adopted in summer pulses and to what effect”, and “What impediments are there to IPM’s adoption in these crops”? The need for IPM in summer pulses and other grain crops since the 1990’s has been driven by the pesticide resistance crisis for *Helicoverpa armigera*, and the arrival of silverleaf whitefly (SLW) (*Bemisia tabaci* type B) in this country. In both cases, the common thread was the unavailability of effective pesticides to control a major pest. Since that time, new and effective Helicoverpa pesticides have been registered in summer pulses, and SLW activity has been less than predicted in many regions. Arguably this has led to pest management complacency and a drifting away from IPM principals. On the other hand, IPM in pulses is challenged by multi-pest complexes, low pest thresholds, the lack of soft but effective pesticides for many sucking pests, and a restricted number of soft pesticide options at the critical flowering/podding stage. This paper outlines current IPM strategies, and identifies major IPM ‘gaps’ that require further action.

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

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

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

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

Field study was carried out at Bangladesh Agricultural Research Institute (BARI) farm during March to August, 2005 to find out the most appropriate management practices against thrips of mungbean. The experiment consisted of seven treatments of various management practices. The incidence of this pest was first noticed during vegetative and flowering stage. The infestation rate was highest in reproductive stage. Application of Furadan 5 G as a seed treatment gave the maximum yield (950.05 kg ha^{-1}). On the other hand, minimum yield was found in control treatment. Two times application of Shobicron 425 EC also gave the satisfactory result but it was not economically viable. Neem oil with Trix gave the significant result in comparison with other treatments and it may be environmentally friendly (Kyamanywa, 2009).

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

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

Prodhan *et al*. (2008) conducted an experiment was at the field of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna, during March to June 2008 to develop integrated management approaches against insect pest complex of mungbean. The management approaches tested in the study were T1= Seed treatment with Imidachlorpid (5g/kg seeds) + Poultry manure (3t/ha) + Sequential release of bio-control agent (*Trichograma chilonis* + *Bracon habetor*) + Detergent @ 2g/l of water, T2= Seed treatment with Imidachlorpid (5g/kg seeds) + Poultry manure (3t/ha) + Sequential release of biocontrol agent (*Trichograma chilonis* + *Bracon habetor*) +Neem seed karnel extract @ 50gm/lof water, T3= Seed treatment with Imidachlorpid (5g/kg seeds) + Poultry manure (3t/ha) + Spray with Quinalphos @ 1ml / l of water and T4= Untreated control. All the treatments significantly reduced insect’s infestation (except thrips) and produced higher yield compared to control. It was found that the highest yield was obtained from the treatment T3 (1316 kg/ha) which was statistically similar to T2

(1316 kg/ha) and T1 (1283 kg/ha). In case of Benefit Cost Ratio (BCR), the highest value was obtained from the treatment T3 (1.84), which was followed by T1 (1.55) and T2 (1.31).

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

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

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

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

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

Oparaeke *et al*. (2005) reported that the mixtures of Neem and Eucalyptus leaf extracts with extracts of other plant species was investigated for efficacy in the management of two major post flowering insect pests (Maruca pod borers and Clavigralla tomentosicollis Stal.) of cowpea in the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The results revealed that in 2000 and 2001 seasons the mean number of Maruca vitrata (F.) was reduced (< 1.0 / flower and /or pod) on plots sprayed with leaf extracts of Neem +

Lemongrass, Neem + African curry, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. Pod sucking bugs (dominated by C. tomentosicollis) numbers were suppressed (< 1.5 / plant) on plots treated with leaf extracts of Neem + African curry, Neem + Lemongrass, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield compared with the unsprayed plots during the two years of investigation. The complementary roles played by individual plant species used for the extracts mixtures in reducing pests numbers and increasing grain yields on sprayed plots suggest the future direction of new formulations of Biopesticides in the management of field pests of crops on farms owned by resource limited farmers in low input agriculture characterizing the developing countries.

These are the sucking insects and can be controlled by spraying the following insecticides: Malathion 50 EC (malathion) 950 ml OR Rogor 30 EC (dimethoate) 625 ml OR Metasystox 25 EC (oxydemeion methyl) 625 ml in 200 litres of Water. The vector of this disease is whitefly *{Bemisia tabaci).* It is a very devastating disease due to which leaves become pale yellow and even infected pods turn yellow and produce shrivelled grains. Rogue out MYMV affected plains at early crop growth stage and bury them. Grow MYMV resistant varieties like SML 668 and ML 818. Follow control measures as given in insect pest control for whitefly (Sekhon *et al*., 2004).

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

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

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

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

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

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

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

Mustafa (2000) found that Mospilan, polo and confidor resulted almost 72.76% mortality of whitefly. They also investigated the increased susceptibility of whitefly to confider. The finding of the present studies disagree the results of Latif *et al.* (2001) who underestimated the efficacy of Confider than Asmido. Mohan and Katiray (2000) stated that confidor was the most effective in suppressing the whitefly population and its continuous use resulted in increased whitefly population. They also showed better control of jassid by Confidor 200 SL.

CHAPTER III

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter as well as on experimental materials, site, climate and weather, land preparation, experimental design, lay out, data collection on sucking pests and mosaic disease incidence, grain yield etc within a period. Overall discussion about experiment was carried out to study on the management of sucking insect pests on mungbean and its impact on incidence of mosaic disease under the following headings and sub-headings:

3.1 Description of the experimental site

3.1.1 Location and time

The present research was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to November, 2011. The experimental area is located at 23.74^0 N latitude and 90.35^0 E longitude with an elevation of 8.2 m from the sea level (Khan, 1997).

3.1.2 Soil

The soil of the experimental area was to the general soil type series of shallow red brown terrace soils under Tejgaon series. Upper level soils were clay loam in texture, olive-gray through common fine to medium distinct dark yellowish brown mottles under the Agro-ecological Zone (AEZ- 28) and belonged to the Madhupur Tract (UNDP, 1988;FAO, 1988). The selected plot was above flood level and sufficient sunshine was available having available irrigation and drainage system during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done from Soil Resources

Development Institute (SRDI), Dhaka. The experimental plot was also high land, fertile, well drained and having pH 5.8. The physicochemical property and nutrient status of soil of the experimental plots are given in Appendix 1.

3.1.3 Climate and weather

The experimental area is situated in the sub-tropical climatic zone and characterized by heavy rainfall during the months of April to September (Kharif Season) and scanty rainfall during the rest period of the year (Biswas, 1987). The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February. The detailed meteorological data in respect of temperature, relative humidity and total rainfall recorded by the Weather Station of Bangladesh, Sher-e-Bangla Nagar, Dhaka during the period of study have been presented in Appendix II.

3.2 Crop Cultivation

3.2.1 Variety

Mungbean variety BARI mung 4 was used as experimental materials for the study and the seed of the variety of this experiment collected from Bangladesh Agricultural Research Institute (BARI)., Joydebpur, Gazipur.

3.2.2 Treatments

The experiment comprised the seven treatments including an untreated control. The details of the treatments are given below:

T_1= Ripcord 10EC @ 1 ml L^{-1} of water applied at 7 days interval

T_2= Aktara 25WG @ 0.25 g L^{-1} of water applied at 7 days interval

T_3= Marshal 20EC @ 3 ml L^{-1} of water applied at 7 days interval

T_4= Malathion 57EC @ 2 ml L^{-1} of water applied at 7 days interval

T_5= Neem oil @ 3 ml L^{-1} of water + 3 g detergent applied at 7 days interval

T_6= Tamarind Fruit extract @ 100 g L^{-1} of water applied at 7 days interval

T_7= Untreated Control

3.3 Experimental design and layout

The experiment consisted of BARI mung 4 and was laid out in Randomized Complete Block Design (RCBD) with three replications which were divided into seven equal blocks. Thus there were 28 (4 × 7) unit plots altogether in the experiment. The size of each unit plot was 2 m × 2 m. Block to Block and plot to plot distances were 1 m and 0.5 m, respectively. The treatments of the experiment randomly distributed into the experimental plot. Details layout of the experimental plot were presented in Appendix III.

3.4 Land preparation

Power tiller was used for the preparation of the experimental field. Then it was exposed to the sunshine for 7 days prior to the next ploughing. Thereafter, the land was ploughed and cross-ploughed to obtain good tilth. Deep ploughing was done to produce a good tilth, which was necessary to get better yield of this crop. Laddering was done in order to break the soil clods into small pieces followed by each ploughing. All the weeds and stubbles were removed from the experimental field.

3.5 Fertilizers

The fertilizers were applied as per fertilizers recommendation guide (BARI, 2006). The applied manures were mixed properly with the soil in the plot using a spade. The dose and method of application of fertilizers are shown in below:

Fertilizers	**Dose (kg ha^{-1})**
Urea	30
TSP	70
MP	35

3.6 Seed treatments

Before planting seeds were treated with Vitavex-200 @0.25% to prevent seeds from the attack of soil borne disease. Furadan @1.2 kg ha^{-1} was also used as per treatment against wireworm and mole cricket.

3.7 Seed sowing

Treated mature 4-5 seeds of mungbean were sown in each hole by hand. Seeds were sown on 20th April, 2011. The row to row and plant to plant distances were 30 and 6 cm, respectively. Seeds were placed at about 5 cm depth from the soil surface. Three seeds were sown in each hole.

3.8 Intercultural operations

3.8.1 Thinning out

As the seeds were sown continuously into the line, so there were so many seedlings which need thinning. Emergence of seedling was completed within 10 days after sowing. Over crowded seedlings were thinned out two times. First thinning was done after 15 days of sowing which is done to remove unhealthy and lineless seedlings. The second thinning was done 10 days after first thinning.

3.8.2 Gap filling

Seedlings were transferred to fill in the gaps where seeds failed to germinate. The gaps were filled in within two weeks after germination of seeds.

3.8.3 Weeding

There were some common weeds found in the mungbean field. First weeding was done at 30 DAS and then once a week to keep the plots free from weeds and to keep the soil loose and aerated.

3.8.4 Irrigation and drainage

The irrigation was done at after first weeding. Irrigation was used as and when irrigation needed. Proper drainage system was also developed for draining out excess water.

3.8.5 Disease and pest management

The experimental crop was infected with sucking pest and mosaic disease and no fungicide was used. They attacked at the early growing stages of seedlings to harvest period. Various chemicals and botanical extract spray as water solution 14 times at 7 days interval as a treatment from germination to harvest period to control these sucking pests and disease.

3.8.6 Procedure of spray application

The actual amount of each chemical insecticide was taken in knapsack sprayer having pressure of 4-5 kg cm^{-2} and thoroughly mixed with water and sprayed in the respective plot. The required amount of Neem oil was taken by measuring cylinder in the sprayer then 3.0 g detergent were added with it and mixed properly before spraying. 100 g ripe fruits of Tamarind was soaked in 5.0 liter water for 24 hours then thoroughly mixed with hand and filtrated through fine mesh. Then it was sprayed in assigned plots by using Knapsack sprayer. Each treatment was repeated at 7 days interval and 14 sprays were applied in the field.

3.9 Data collection

3.9.1 Number of sucking insect pests and reduction percentage

Number of sucking pests (aphid, jassid, whitefly and white leaf hopper) were recorded at vegetative and reproductive stage. Five randomly plants were selected for the collection of data. Data on number of insects were recorded at an interval of 7 days commencing from first incidence and continued up to the 14 weeks (14 times).

Plate 1. Adult White leaf Hopper on mungbean leaves

Reduction percentage was also recorded on the basis of control treated plant where the maximum number of sucking pest was attack. The following formula were used for taking the reduction percentage

Reduction (%) = $\dfrac{\text{No. of insect pests in treatments - No. of insect pests in control}}{\text{No. of insect pests in control}} \times 100$

3.9.2 Number of mosaic disease

Incidence of mosaic diseases were recorded at before and after flowering. Five plants were randomly selected from each plot and the mosaic symptoms were observed carefully for the collection of data. Data on mosaic disease were recorded at an interval of 7 days commencing from first incidence and continued up to the 14 weeks (14 times).

Plate 2. Mosaic disease infected mungbean

3.9.3 Plant height

Plant height was measured in centimetre by a meter scale at vegetative and reproductive stage and their average data was recorded per replication. Data were also recorded as the average of randomly selected 5 plants from the inner rows of each plot. Plant height the ground surface to the top of the main shoot and the mean height were expressed in cm.

3.9.4 Number of leaves plant^{-1}

Number of leaves per plant^{-1} data was also recorded at before and after flowering from the randomly selected five plants of inner rows of each plot.

3.9.5 Length of leaves (cm)

Randomly selected five plant plot^{-1} and their five leaves plant^{-1} were removed from the plant then measured in centimeter (cm) scale. Mean value of them was recorded as treatment wise.

3.9.6 Pod length (cm)

Pod length was measured in centimeter (cm) scale from randomly selected five pods. Mean value of them was recorded as treatment wise.

3.9.7 Number of pods plant^{-1}

All pods were separated from five sample plants and the total number of pods were counted and recorded. Average number of pods per plant was calculated.

3.9.8 Plant Dry weight (g)

The plant dry matter weight was taken by over dry method. Five plants samples randomly collected from unit pods at the harvest period were gently washed to remove sand and dust particles adhere to the plants. Then the water adhere to the plants were soaked with paper towel. After then the samples were kept in an oven at 70^{o}C for 72 hours to attain constant weight. When the plant samples were attained at constant weight, the dry weights were recorded at harvest.

3.9.9 Dry weight of husk (g)

Dry weight of husk were recorded from randomly selected fives pods. After harvesting the plant was sun-dried and threshed by pedal thresher. Husk was properly sun-dried and their weights recorded. Dry weight of husk was then converted to g plot^{-1}.

3.9.10 Number of seed pod^{-1}

Number of seeds pod^{-1} was recorded after harvesting of the crop from the five randomly selected pods from five pre-selected plants was counted. The seed per plant was calculated from their mean values.

3.9.11 1000-grain weight (g)

One thousand grains were randomly counted and selected from the stock seed and weighed in gram by digital electric balance. It was expressed as 1000-seed weight in gram (g).

3.9.12 Yield plot^{-1} (g)

Seed yield were recorded from randomly selected fives pods. After harvesting the plant was sun-dried and threshed by pedal thresher. Seed were properly sun-dried and their weights recorded. Seed yield was then converted to g plot^{-1}.

3.10 Statistical analysis

The data obtained from experiment on various parameters were statistically analyzed in MSTAT-C computer program (Russel, 1986). The mean values for all the parameters were calculate and the analysis of variance for the characters was accomplished by Duncan's Multiple Range Test (DMRT) and the significance of difference between pair of means was tested by the Least Significant Differences (LSD) test at 5 % levels of probability (Gomez and Gomez, 1984).

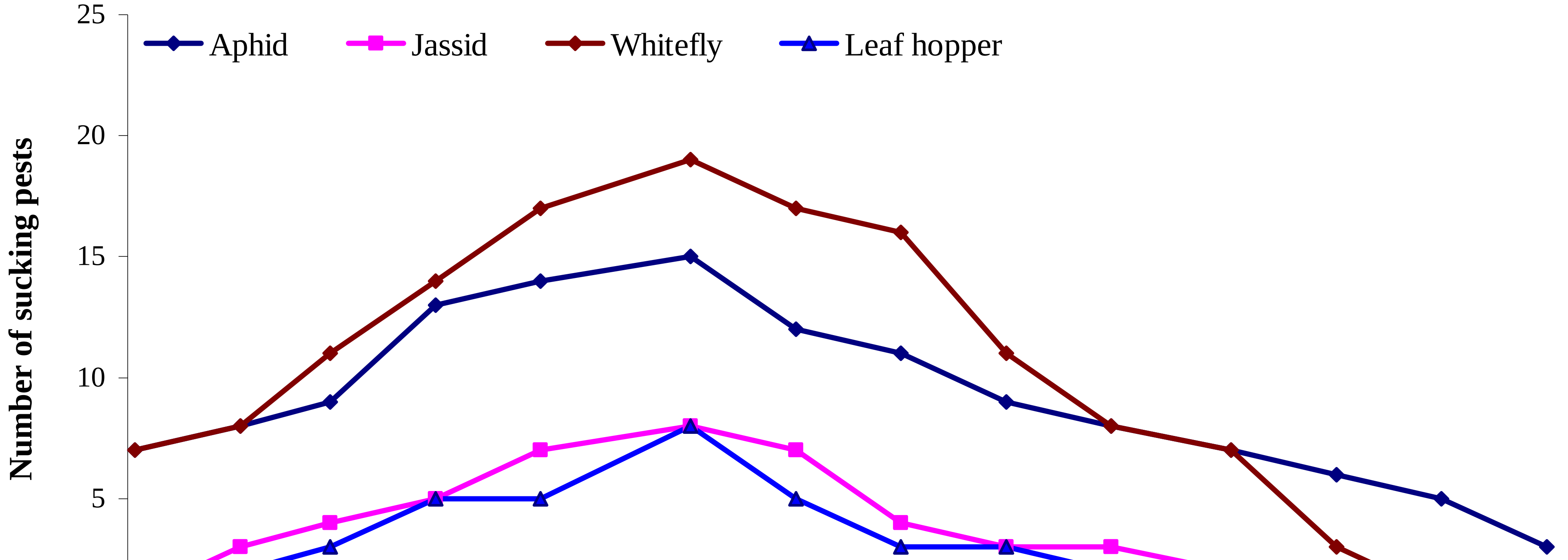
CHAPTER IV

RESULTS AND DISCUSSION

The results obtained from the present study for incidence of sucking insects at vegetative and reproductive stage on mungbean and their impact on mosaic disease incidence have been presented and discussed separately. Besides different crop characters, yields and yield contributing characters have been also presented and discussed in this chapter with some tables and figures as follows:

4.1 Incidence of sucking insects on mungbean

The comparative population dynamics of sucking insects from untreated control plot in relation to plant age is shown in Graph 1. The graph expresses that the population of all sucking insects was increased with plant age and it was reached maximum at 8th week after germination and then declined with plant age. The whitefly (B*emisia tabaci*) was the most abundant insect and aphid (*Aphis craccivora*) was the second highest insect attacking mungbean. Jassid (*Amrasca biguttula biguttula*) population occupied the 3rd position and leafhopper *(Empoasca fabae)* population was found lowest on mungbean during the cropping season. These results support the findings of Ganapathy and Karuppiah (2004) who reported that aphid, whitefly and jassid were the major sucking insects of mungbean.



3rd week 4th week 5th week 6th week 7th week 8th week 9th week 10th week 11th week 12th week 13th week 14th week 15th week 16th week

Vegetative stage Reproductive stage

Age of the plant

Fig. 1: Population dynamics of sucking insects on mungbean throughout the cropping season

4.2 Effect of treatments on incidence of aphid on mungbean

The average population of aphid at vegetative and reproductive stage of mungbean under different treatments has been shown in Table 1. The data (Table 1) express that the lowest number of aphid (3.85/plant at vegetative and 2.80/plant at reproductive stage) was observed in Marshal 20EC treated plot followed by ripcord 10EC treated plot (4.40/plant at vegetative and 4.05/plant at reproductive stage) having significant difference between them. Other insecticides have intermediate number of aphid. However, the highest number of aphid (10.40/plant at vegetative and 8.30/plant at reproductive stage) was found in control plot which was significantly higher than all other treated plots. Similarly Marshal 20EC showed the best performance in reduction of aphid population over control followed by ripcord 10EC and Malathion 57EC. Neem oil and Tamarind Fruit extract showed poor results in reducing aphid population over control. However, none of the insecticides gave standard level of reduction (80%) of aphid population.

The results of the study reveal that all the insecticides significantly reduced aphid population infesting mungbean. However marshal 20EC was the most effective insecticide against aphid and ripcord 10EC was second effective insecticides but malathion 20EC and actara 25WG were less effective insecticides. Neem oil and Tamarind Fruit extract was poorly effective against aphid infesting mungbean in field condition. The order of effectiveness is Marshal > Ripcord > Malathion > Actara > Neem oil > Tamarind Fruit extract. The result of the present study was similar with the findings of Singh *et al*. (2009) who reported that malathion and neem oil reduced aphid population on mungbean.

Table 1: Effect of chemical insecticides and botanical extracts on aphid population attacking mungbean

Treatments	Vegetative stage		Reproductive stage	
	No. of aphid Plant^{-1}	**% reduction over control**	**No. of aphid Plant^{-1}**	**% reduction over control**
Ripcord 10EC	4.40 f	57.87 b	4.05 e	51.67 b
Aktara 25WG	7.00 d	32.80 d	4.95 d	40.96 c
Marshal 20EC	3.85 g	63.17 a	2.80 f	66.65 a
Malathion 57EC	5.45 e	47.76 c	4.85 d	42.04 c
Neem oil	7.40 c	29.16 e	5.45 c	34.87 d
Tamarind Fruit extract	8.25 b	20.70 f	6.95 b	19.42 e
Control	10.40 a	-	8.30 a	-
$LSD_{(0.05)}$	**0.124**	**2.672**	**0.199**	**3.979**
CV (%)	**1.22**	**5.01**	**2.51**	**7.33**

In a column, means having different letter(s) are significantly different at 5% level of probability

4.3 Effect of treatments on incidence of jassid on mungbean

The average population of jassid at vegetative and reproductive stage of mungbean under different treatments has been shown in Table 2. The data express that the lowest number of jassid (1.80/plant at vegetative and 1.25/plant at reproductive stage) was observed in Marshal 20EC treated plot followed by ripcord 10EC treated plot (2.35/plant at vegetative and 1.95/plant at reproductive stage) having significant difference between them. Other insecticides have intermediate level of jassid. The highest number of jassid (4.00/plant at vegetative and 3.50 at reproductive stage) was found in control plot which significantly higher than all other treated plots. Similarly Marshal 20EC showed the best performance in reduction of jassid population over control followed by ripcord 10EC and Malathion 57EC. Neem oil and Tamarind Fruit extract showed poor performance in reducing jassid population over control.

The results of the study indicate that all the insecticides, Neem oil and Tamarind Fruit extract significantly reduced jassid population infesting mungbean. However Marshal 20EC was the most effective insecticide against jassid and ripcord 10EC was second effective insecticides but Malathion 20EC and Actara 25WG were less effective insecticides. Neem oil and Tamarind Fruit extract was poorly effective against jassid infesting mungbean in field condition. The order of effectiveness is Marshal > Ripcord > Actara >Malathion > Neem oil > tetul extract. The result of the present study supports the findings of Khattak et al. (2004) who reported that insecticides application reduced population of jassid on mungbean.

Table 2: Average population of jassid under different treatments at vegetative and reproductive stage of mungbean

Treatments	Vegetative stage		Reproductive stage	
	No. of jassid Plant^{-1}	% reduction over control	No. of jassid Plant^{-1}	% reduction over control
Ripcord 10EC	2.35 e	41.83 b	1.95 e	43.51 b

Aktara 25WG	3.15 d	22.07 c	2.65 d	24.77 c
Marshal 20EC	1.80 f	55.70 a	1.25 f	65.01 a
Malathion 57EC	3.10 d	22.76 c	2.65 d	24.85 c
Neem oil	3.35 c	16.51 d	2.95 c	16.08 d
Tamarind Fruit extract	3.55 b	11.32 e	3.20 b	8.91 e
Control	4.00 a	-	3.50 a	-
$LSD_{(0.05)}$	**0.105**	**4.770**	**0.133**	**5.291**
CV (%)	**2.41**	**13.21**	**3.54**	**13.61**

In a column, means having different letter(s) are significantly different at 5% level of probability

4.4 Effect of treatments on incidence of whitefly on mungbean

The population incidence of whitefly at vegetative and reproductive stage of mungbean under different treatments has been shown in Table 3. The data (Table 3) show that the lowest number of whitefly (4.90/plant at vegetative and 3.80/plant at reproductive stage) was observed in Marshal 20EC treated plot followed by ripcord 10EC treated plot (7.35/plant at vegetative and 6.00/plant at reproductive stage) having significant difference between them. Other insecticides have intermediate number of whitefly. The highest number of whitefly (11.50/plant at vegetative and 9.20 at reproductive stage) was found in control plot which significantly higher than all other treated plots. Similarly marshal 20EC showed the best performance in reduction of whitefly population over control followed by Ripcord 10EC and Malathion 57EC. Neem oil and Tamarind Fruit extract showed poor results in reducing whitefly population over control.

The results of the study reveal that all the insecticides significantly reduced whitefly population infesting mungbean. However, Marshal 20EC was the most effective insecticide against whitefly and ripcord 10EC was second effective insecticides but Malathion 20EC and Actara 25WG were less effective insecticides. Neem oil and Tamarind Fruit extract was poorly effective against aphid infesting mungbean in field condition. The order of effectiveness is Marshal > Ripcord >Malathion >Actara > Neem oil > Tamarind Fruit extract. The result of the present study was in accordance with the findings of other researchers (Khattak et al. 2004; Yaqoob et al. 2004). They reported that insecticides application reduce whitefly on mungbean and increased yield.

Table 3: Population incidence of whitefly on mungbean under different treatements at vegetative and reproductive stage

Treatments	Vegetative stage		Reproductive stage	
	No. of whitefly Plant^{-1}	% reduction over control	No. of whitefly Plant^{-1}	% reduction over control
Ripcord 10EC	7.35 f	35.88 b	6.00 e	34.87 b
Aktara 25WG	9.10 d	20.56 d	6.70 d	27.28 c
Marshal 20EC	4.90 g	57.33 a	3.80 f	58.89 a
Malathion 57EC	7.95 e	30.68 c	6.65 d	28.35 c
Neem oil	9.80 c	14.48 e	8.30 c	9.75 d
Tamarind Fruit extract	10.40 b	9.22 f	8.90 b	3.31 e
Control	11.50 a	-	9.20 a	-
$LSD_{(0.05)}$	0.1627	**2.002**	0.1409	**2.782**
CV (%)	**1.24**	**5.61**	**1.32**	**8.07**

In a column, means having different letter(s) are significantly different at 5% level of probability

4.5 Effect of treatments on incidence of white leaf hopper on mungbean

The population incidence of white leaf hopper at vegetative and reproductive stage of mungbean under different treatments has been shown in Table 4. The data indicate that the lowest number of leaf hopper (1.35 /plant at vegetative and 0.55 /plant at reproductive stage) was observed in Marshal 20EC treated plot followed by Ripcord 10EC treated plot (1.70 /plant at vegetative and 1.00 /plant at reproductive stage) having significant difference between them. Other insecticides have intermediate number of white leaf hopper. The highest number of white leaf hopper (3.750 /plant at vegetative and 2.150 at reproductive stage) was found in control plot which significantly higher than all other treated plots. Similarly Marshal 20EC showed the best performance in reduction of white leaf hopper population over control followed by Ripcord 10EC and Malathion 57EC. Neem oil and Tamarind Fruit extract showed poor results in reducing white leaf hopper population over control.

The results of the study indicate that all the insecticides significantly reduced white leaf hopper population on mungbean. However Marshal 20EC was the most effective insecticide against white leaf hopper and ripcord 10EC was second effective insecticides but Malathion 20EC and Actara 25WG were less effective insecticides. Neem oil and Tamarind Fruit extract was poorly effective against aphid infesting mungbean in field condition. The order of effectiveness is Marshal > Ripcord >Malathion >Actara > Neem oil > Tamarind Fruit extract. The result of the present study agrees with the findings of Lal (2008) who reported that application of insecticides reduced sucking insects of mungbean.

Table 4. Population of white leaf hopper on mungbean under different treatments at vegetative and reproductive stage

Treatments	Vegetative stage		Reproductive stage	
	No. of white leaf hopper Plant^{-1}	Reduction (%)	No. of white leaf hopper Plant^{-1}	Reduction (%)
Ripcord 10EC	1.70 e	55.37 b	1.00 e	54.57 b
Aktara 25WG	2.25 c	40.56 cd	1.55 c	28.42 d
Marshal 20EC	1.35 f	64.76 a	0.55 f	75.79 a
Malathion 57EC	2.05 d	46.20 c	1.40 d	35.62 c
Neem oil	2.40 c	36.55 de	1.55 c	28.42 d
Tamarind Fruit extract	2.60 b	30.80 e	1.80 b	16.67 e
Control	3.750 a	0.000 f	2.150 a	0.000 f
LSD$_{(0.05)}$	**0.1694**	**6.211**	**0.08137**	**6.756**
CV (%)	**4.96**	**10.67**	**3.74**	**13.29**

In a column, means having different letter(s) are significantly different at 5% level of probability

4.6 Effect of treatments on incidence mosaic disease of mungbean

The effect of chemical insecticides and plant products on incidence of mosaic disease infested at before flowering and after flowering is shown in Table 5. The number of mosaic infected plant (13.25/plot at vegetative and 11.25/plot at reproductive stage) was significantly higher in control plot than treated plots. However, the lowest number of mosaic infected plant (6.75/plot at vegetative and 4.75/plot at reproductive stage) was recorded from Marshal 20EC treated plot followed by Ripcord 10EC treated plot having no significant difference between them. Almost same level of mosaic infected plant was found in Neem oil and Tamarind Fruit extract plots at vegetative and reproductive stage of mungbean.

The result indicates that application of chemical insecticides and plant products reduced the mosaic infection in mungbean although their performance was different. Marshal 20EC showed the best performance and Ripcord 10EC was second effective insecticides. The application of insecticides reduced the population of sucking insects of mungbean and thus reduced the mosaic infection. These results agree with the reports of several researchers (Gupta an Pathak 2009; Shah *et al*. 2007; Yaquoob *et al*. 2007) who reported that schedule spraying of insecticides and Neem products reduced the population of whitefly and jassid, and reduced the infection of virus. However, the results might be vary with some other researchers due to some external factors like spraying time, dose of chemicals or plant products environmental factors etc.

Table 5: Number of mosaic infected mungbean plant per plot under different treatments at before and after flowering stage

Treatments	Mosaic infested plant $plot^{-1}$	
	Before flowering	**After flowering**
Ripcord 10EC	7.75 de	6.00 cd
Aktara 25WG	10.00 bc	8.25 b
Marshal 20EC	6.75 e	4.75 d
Malathion 57EC	8.75 cd	6.50 c
Neem oil	11.00 b	9.00 b
Tamarind Fruit extract	11.25 b	9.50 b
Control	13.25 a	11.25 a
$LSD_{(0.05)}$	**1.372**	**1.669**
CV (%)	**9.40**	**14.23**

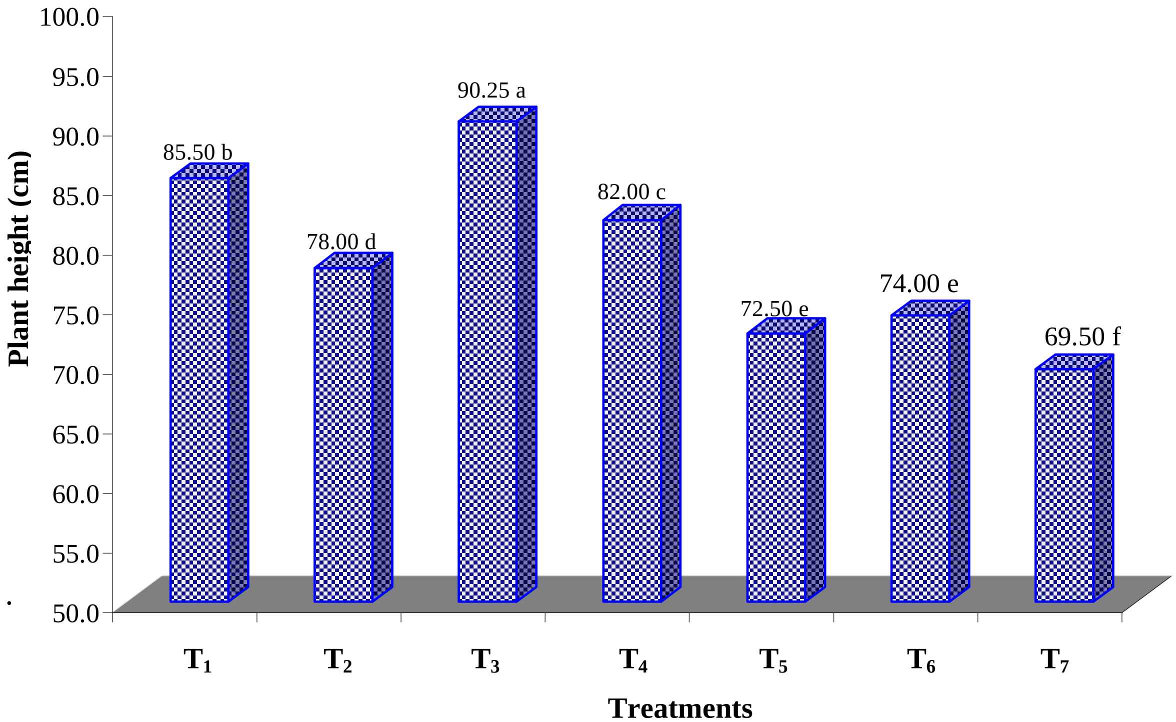
In a column, means having different letter(s) are significantly different at 5% level of probability

4.7 Effect of chemical insecticides and plant extracts on growth of mungbean

4.7.1 Plant height

Plant height was significantly affected by the application of chemical insecticides and botanical extracts. Among the treatments, the tallest plant (90.25 cm) was observed in Marshal 20EC application where minimum number and more reduction of sucking insects was recorded which was closely followed by Ripcord 10EC (85.50 cm). On the other hand, the shortest plant (69.50

cm) was recorded from control treatment where maximum number of sucking pests was found (Fig. 1).



T_1= Ripcord 10EC T_2= Aktara 25WG T_3= Marshal 20EC T_4= Malathion 57EC

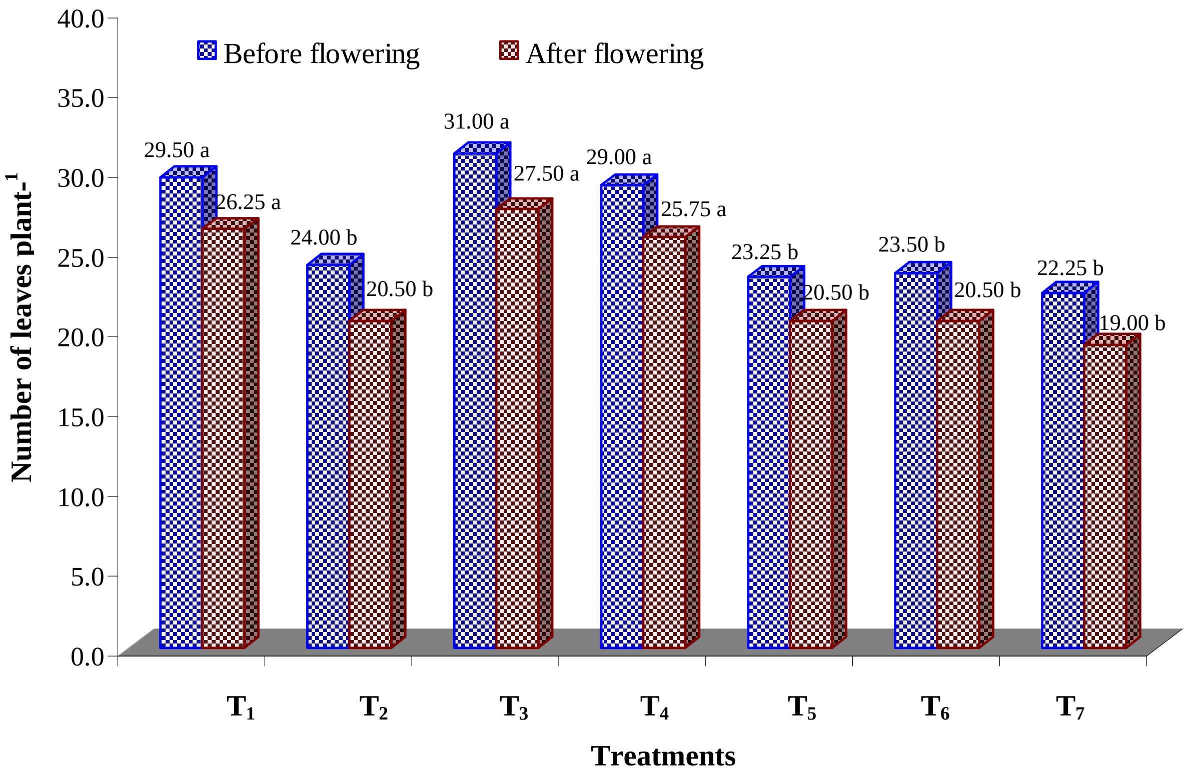
T_5= Neem oil T_6= Tamarind Fruit extract T_7= Control

Figure 2: Effect of chemical insecticides and plant products on height of mungbean.

4.7.2 Number of leaves plant^{-1}

Leaves plant^{-1} was significantly affected by the application of chemical insecticides and botanical extracts. Among the treatments, the maximum number of leaves (31.00 at before flowering and 27.50 at after flowering) was found from the treatment Marshal 20EC because minimum number and more reduction of sucking insect pests was recorded which was closely followed by Ripcord 10EC (29.50 and 29.00 respectively). On the other hand,the minimum number of leaves (20.50 at before flowering and19.00 at after flowering) was recorded from control treatment where maximum number of sucking insect pests was found (Fig. 2). Almost same level of leaves number was found in Neem oil and Tamarind Fruit extract plots at before and after flowering of mungbean.

The result indicates that application of chemical insecticides and plant products reduced the pest infestation in mungbean although their performance was different. Marshal 20EC showed the best performance and Ripcord 10EC was second effective insecticides. The application of insecticides reduced the population of sucking insects of mungbean and thus number of leaves is increase.



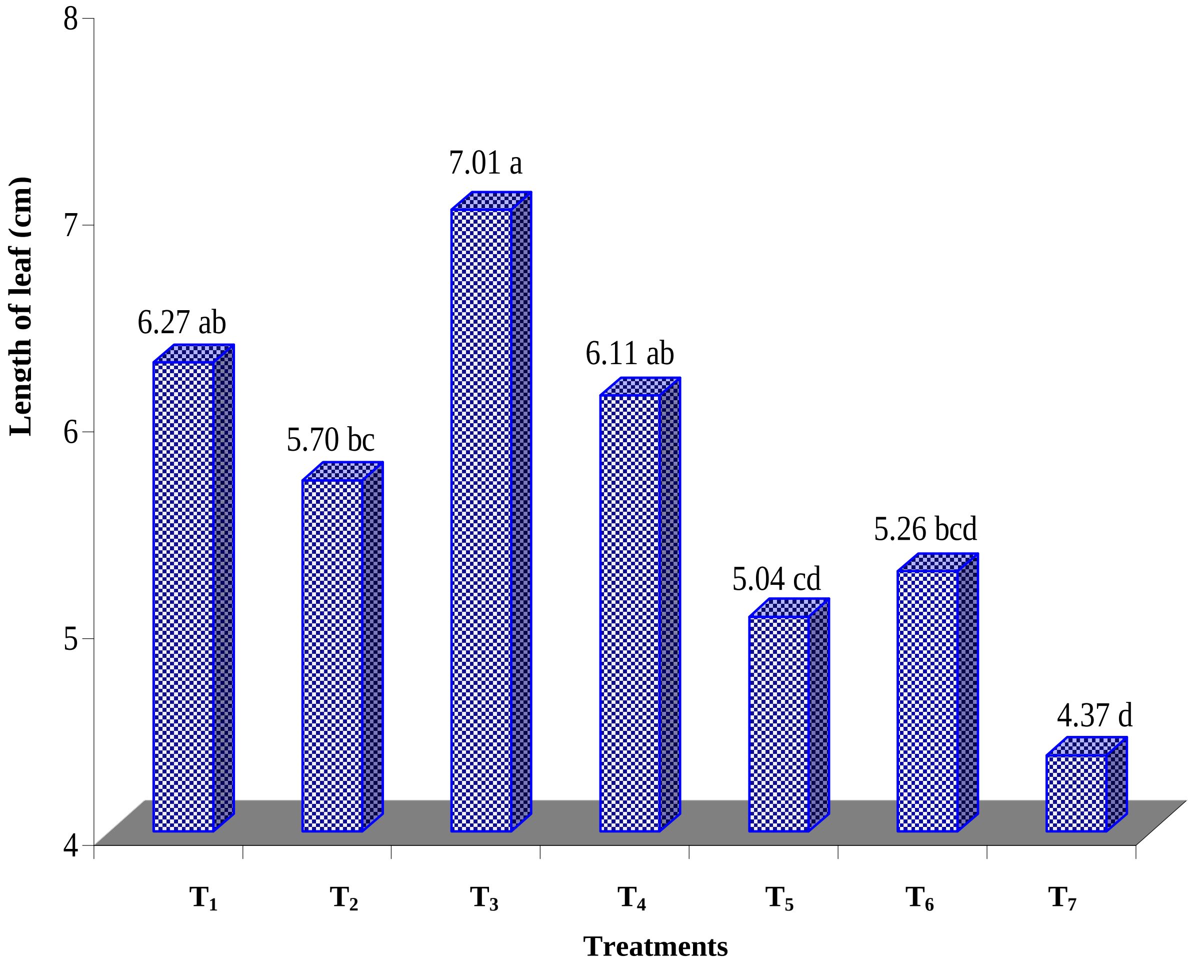
T_1= Ripcord 10EC T_2= Actara 25WG T_3= Marshal 20EC T_4= Malathion 57EC

T_5= Neem oil T_6= Tamarind Fruit extract T_7= Control

Figure 3: Effect of chemical insecticides and botanical extract to manage the sucking pests and its impact on number of leaves plant^{-1} of mungbean

4.7.3 Length of leaf (cm)

Length of leaf was significantly affected by the different chemical insecticides and botanical management of sucking pests on mungbean plant. The longest leaf (7.01 cm) was found at Marshal 20EC where the sucking insects was not more effective incase of highest control was obtained by Marshal 20EC. However, control treatment showed the minimum control on sucking pests as well as the shortest leaf (4.37 cm) was recorded (Fig. 8). The second longest leaf (6.27 cm) was found at Ripcord 10EC @ 1 ml L^{-1} of water which was statistically similar to Malathion 57EC @ 2 ml L^{-1} of water (6.11 cm). The result observed that the maximum sucking pest attack reduce the plant growth but pesticide using reduce the sucking pests and maximum the plant growth as well as plant height, number of leaves, length of leaf etc.



T_1= Ripcord 10EC T_2= Aktara 25WG T_3= Marshal 20EC T_4= Malathion 57EC

T_5= Neem oil T_6= Tamarind Fruit extract T_7= Control

Figure 4: Effect of chemical insecticides and botanical extract to manage the sucking insects and its impact on length of leaves of mungbean

4.8 Effect of chemical insecticides and plant extracts on yield of munbean

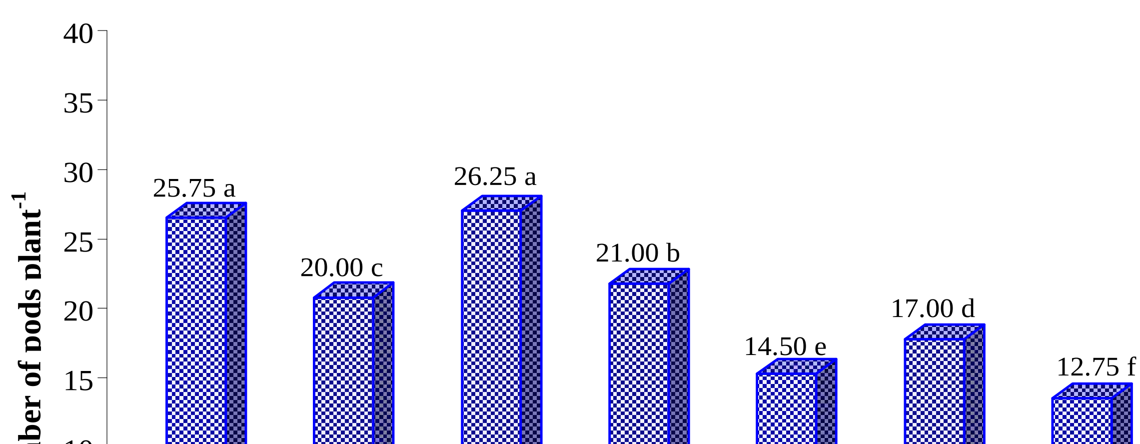
4.8.1 Pod length (cm)

Pod length was significantly affected by the different chemical insecticides and botanical management of sucking pests on mungbean plant .Among the treatment, marshal produced the longest pod (7.19 cm) which was closely followed by Ripcord 10EC (6.79 cm). On the other hand, the shortest pod (5.37 cm) was recorded in control or untreated treatment which was followed by Neem oil where they are statistically identical. Rest of the treatments, actara 25WG and Tamarind Fruit extract showed the statistically more or less similar results (6.08 and 5.91 cm, respectively) (Table 6).

4.8.2 Number of pods plant^{-1}

Number of pods plant^{-1} was significantly influenced by the effect of various chemical insecticides and botanical extract .whereas, treatment Marshal 20EC produced the maximum number of pods plant^{-1} (26.25) and it was statistically similar to Ripcord 10EC (25.75) where the maximum reduction of sucking insects was taken. Among the other treatments, the minimum number of pods plant^{-1} (12.75) was recorded in untreated or control treatment (Fig. 9). These results agree with the reports of several researchers Jahangir Shah *et al*. (2007) who reported that pods/plant and seed yield kg ha-1 varied significantly among different insecticides. Out of all the insecticides used in this study, Imidacloprid treated plots had significantly the highest yield of (1563 kg ha-1) while the lowest seed yield of (1056 kg/ha) was obtained from the control plots where no insecticide was applied.

.



T_1= Ripcord 10EC T_2= Aktara 25WG T_3= Marshal 20EC T_4= Malathion 57EC
T_5= Neem oil T_6= Tetul extract T_7= Control

Figure 5: Effect of chemical insecticides and botanical extract to manage the sucking insects and its impact on number of leaves plant^{-1} of mungbean. Vertical bar represent LSD at 1% level of probability

4.8.3 Plant dry weight (g)

Plant dry weight did not vary significant variation due to the effect of different chemical insecticides and botanical extract. However, the maximum plant dry weight (62.85 g) was recorded at the application of marshal 20EC and the minimum plant dry weight (51.45 g) was obtained in untreated or control treatment. Another treatment also showed the statistically similar results with each others in respect of plant dry weight because of all chemical insecticides and botanical pesticides application on mungbean plant did not vary on their dry weight shown in Table 6.

4.8.4 Dry weight of husk (g)

Effect of various chemical insecticides and botanical pesticides against sucking insects on mungbean showed significant difference in respect of dry weight of husk. Dry weight of husk range was 2.81 to 4.06 g, where the highest dry weight of husk (4.06 g) was found at Marshal 20EC and the lowest dry weight of husk (2.81 g) was recorded in control treatment. But the second highest dry weight of husk (3.97 g) was found in Ripcord 10EC and it was closely followed by Actara 25WG (3.66 g) and Malathion 57EC (3.77 g) shown in Table 6.

Table 6: Effect of chemical insecticides and botanical extract to manage the sucking pests and its impact on yield contributing characters of mungbean

Treatments	Pod length (cm)	Plant dry weight (g)	Dry weight of husk (g)
Ripcord 10EC	6.49 ab	60.83	3.97 ab
Aktara 25WG	6.08 bc	52.50	3.66 abc
Marshal 20EC	7.19 a	62.85	4.06 a
Malathion 57EC	6.17 bc	56.35	3.77 abc
Neem oil	5.60 c	53.30	3.16 cd
Tamarind Fruit extract	5.91 bc	57.63	3.34 bcd
Control	5.37 c	51.45	2.81 d
LSD(0.05)	**0.734**	**13.57**	**0.599**
CV (%)	**8.08**	**16.19**	**11.43**

In a column, means having different letter(s) are significantly different at 5% level of probability

4.8.5 Number of seed pod^{-1}

A significant variation was found due to the effect of different chemical insecticides and botanical control agent against sucking insects on mungbean in respect of number of seeds pod^{-1} .Among the treatment, Marshal 20EC @ 3 ml L^{-1} produced the maximum number of seeds pod^{-1} (8.25) which was closely followed by Ripcord 10EC @ 1 ml L^{-1} of water (6.75) where the minimum number of sucking pest was effective on mungbean. Similarly, the minimum number of seeds pod^{-1} (4.00) was recorded in control treatment and Tamarind Fruit extract @ 100 g L^{-1} of water. Treatment T_6 (Neem oil @ 3 ml L^{-1} of water + 3 g detergent) also showed statistically similar results (4.25) with the lowest results (Table 7).

4.8.6 1000-seed weight (g)

Effect of chemical insecticides and botanical extract showed significant variation in respect of 1000-seed weight. Among the treatments, Marshal 20EC produced the highest reduction of sucking insects as well as the highest weight of 1000- seeds (35.50 g) and it was followed by the second highest (30.50 g) at Ripcord 10EC. Maximum sucking pest reduced the yield because of the lowest 1000-seeds weight (23.25 g) was recorded in control treatment where the minimum reduction of sucking pests was obtained (Table 7).

4.8.7 Yield plot^{-1} (g)

Yield plot^{-1} was significantly affected by the application of various chemical insecticides and botanical extract as a pesticide of sucking insects. Insects attack is general effects of any crops, but more insect incidence in crops decrease the growth and yield of those crops. So, to control the sucking pests attack need to use pesticides. Various chemical insecticides and botanical extract were used as pesticide to manage the insect in this study. As a result, Marshal 20EC showed the highest yield plot-1 (566.5 g) where the maximum reduction was found in sucking pests. On the other hand, the lowest yield plot-1 (463.50 g) was found in control treatment because less reduction of sucking pests was recorded on mungbean field (Table 7).

These results agree with the reports of several researchers (Altaf *et al*. 2009) who reported that the highest yield (1548 kg/ha) was obtained from March 27 sowing crop. The second highest yield (1279 kg/ha) was obtained from March 13 sowing which was statistically identical to March 20, April 03 and April 10 sowings crop. Again, the delayed sowings after mid April to onward provide yield of 717 kg/ha to 178 kg/ha which were very poor. Hence, for ensuring higher yield and less insect pests' infestation, mungbean should be sown within the period of March 13 to April 10 and the best date of sowing should be March 27.

Table 7: Effect of chemical insecticides and botanical extract to manage the sucking pests and its impact on yield characteristics of mungbean

Treatments	No. of seed pod^{-1}	1000-seed weight (g)	Yield plot^{-1}
Ripcord 10EC	6.75 b	30.50 b	558.80 ab
Aktara 25WG	4.75 d	26.25 d	527.50 cd
Marshal 20EC	8.25 a	35.50 a	566.50 a
Malathion 57EC	6.00 c	27.50 c	543.30 bc
Neem oil	4.25 e	24.50 e	490.00 e
Tamarind Fruit extract	4.00 e	25.50 d	511.30 d
Control	4.00 e	23.25 f	463.50 f
LSD$_{(0.05)}$	**0.477**	**0.873**	**18.46**
CV (%)	**5.92**	**2.13**	**2.38**

In a column, means having different letter(s) are significantly different at 5% level of significance

From the above results investigate, it was found that the among all applied chemical insecticides and botanical extract treatments, Marshal 20EC showed the superior performance on control the sucking pest as well as on growth and yield. If so, control treatment was more effective to incidence the sucking insects and mosaic disease on mungbean to compare chemical insecticides and botanicals treatments but minimum sucking pest and their more reduction was recorded by chemical insecticides treatment Marshal 20EC to compare control treatment. However, control or untreated treatment also showed lower perform on growth and yield of mungbean whereas untreated gave the bigger performance to incidence sucking pest and mosaic disease over and above growth and yield. Finally, it was also concluded that the further study may be needed to ensuring the sucking pest incidence on mungbean and its impact on mosaic diseases as well as the growth and yield performance and to make sure the better performance of Marshal.

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at the field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to November, 2011 for sustainable management of sucking pests on mungbean and its impact on incidence of mosaic disease. The experiment comprised seven treatments viz. T_1 = Ripcord 10EC @ 1 ml L^{-1} of water at 7 days interval, T_2 = Actara 25WG @ 0.25 g L^{-1} of water at 7 days interval, T_3 = Marshal 20EC @ 3 ml L^{-1} of water at 7 days interval, T_4 = Malathion 57EC @ 2 ml L^{-1} of water at 7 days interval, T_5 = Neem oil @ 3 ml L^{-1} of water + 3 g detergent at 7 days interval, T_6 = Tamarind Fruit extract@ 100 g L^{-1} of water at 7 days interval and T_7 = untreated control. Mungbean variety BARI mung 4 was grown in the field to evaluate the treatments' effect on sucking insects. The experiment was laid out in randomized complete block design (RCBD) with four replications.

Aphid, jassid, whitefly and white leaf hopper were the major sucking insects in the field and their population was increased with plant age up to 8^{th} week after germination and then declined with the age of the plant. Whitefly was the most abundant insects among all other sucking pests. All the chemical insecticides and plant products had significant effect against sucking insects attacking mungbean and reduced their population. However, Marshal 20EC @ 3 ml L^{-1} was more effective against sucking insects in terms of number of insects and percent reduction of insect pests. It reduced 63.17% aphid, 55.70% jassid, 57.33% whitefly and 64.76% white leafhopper at vegetative stage, and 66.65% aphid, 65.01% jassid, 58.89% white whitefly and 75.79% white leafhopper at reproductive stage. Ripcord 10EC showed almost similar performance in reduction of sucking insect population over control.

Application of treatments also has significant impact on mosaic infection on mungbean. Maximum number of mosaic infected plant per plot was found in the untreated control (13.25/plot at vegetative stage and 11.25/plot at reproductive stage) where population of sucking insects was the highest. On the other hand the minimum number of mosaic infected plant per plot (6.75 /plot at vegetative stage and 4.75 /plot at reproductive stage) was found in Marshal 20EC treated plot. Other insecticides and plant products treated plot had significantly lower incidence of mosaic disease.

Spraying of chemical insecticides and plant products significantly influenced on growth characteristics of mungbean. The tallest plant (90.25 cm), maximum number of leaves plant^{-1} at before (31.00) and after flowering (27.50) and longest leaf (7.01 cm) were found from Marshal 20EC where the minimum number of sucking pest and mosaic disease were infected. Correspondingly, control or untreated treatment produced the shortest plant (69.25 cm), minimum number of leaf at before (22.25) and after (19.00) flowering, shortest leaf (4.37 cm).

Yield and yield contributing characters also showed significant difference due to the effect of various chemicals and botanicals treatments except plant dry weight which did not vary significantly variation. However, Marshal 20EC @ 3 ml L^{-1} gave the greater results on whole yield and yield contributing characteristics viz. number of pods plant^{-1} (26.25), pod length (7.9 cm), plant dry weight plot^{-1} (62.85 g), dry weight of husk plot^{-1} (4.06 g), number of seeds pod^{-1} (8.25), 1000-seed weight (35.50 g) and yield plot^{-1} (566.50 g). On the other hand, the minimum number of pods plant^{-1} (12.75), shortest pod (5.37 cm), lowest plant dry weight plot^{-1} (52.50 g), lowest dry weight of husk plot^{-1} (2.81 g), minimum number of seeds pod^{-1} (4.00), lowest 1000-seed weight (23.25 g) and lowest yield plot^{-1} (463.50 g) were obtained in control treatment.

From the above results, it could be concluded that among the all applied chemical chemicals and botanical extracts, Marshal 20EC showed the superior performance on managing the sucking insects as well as growth and yield characteristics of mungbean. Ripcord showed almost similar performance and plant products gave poor effect for the management of sucking insects of mungbean.

However, the following recommendations may be suggested:

1. Further study may be needed to ensuring the sucking pest incidence on mungbean and its

impact on mosaic diseases as well as the growth and yield performance.

2. More chemicals and botanical extracts should be included for future study as sole or different combination to make sure the better performance of Marshal 20EC.

REFERENCES

Ahmad, F. and Khan, F. (1995). Comparative efficacy of some traditional and noon traditional insecticides against sucking pests of cotton. *Sarhad J. Agric.* **11**(6): 733-739.

Ahmad. R, Yadava, C.P. and Lal, S. (1998). Evaluation of spray schedule for the control of insects pests of mungbean. *Indian J. Pulses Res.* **11**(2): 146-148.

Altaf Hossain, M., Prodhan, M.Z.H. & Sarkar, M.A. (2009). Sowing Dates: A Major Factor on the Incidence of Major Insect Pests and Yield of Mungbean. *J. Agric. Rural Dev.* **7**(1&2): 127-133.

Atakan, E. (2008). Thrips (Thysanoptera) species occurring in Winter vegetable crops in Çukurova region of Turkey. *Acta Phytopathologica et Entomologica Hungarica*. **43**(2): 227-234.

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

Bakr, M.A., Afzal, M.A., Hamid, A., Haque, M.M. and. Aktar, M.S. (2004). Blackgram in Bangladesh. Lentil Blackgram and Mungbean Development Pilot Project, Publication No.25, Pulses Research Centre, BARI, Gazipur, 60 p.

BARI (Bangladesh Agriculture Research Institute). (2006). Krishi Projukti Hatboi (in Bangla). 4th ed., Bangladesh Agril. Res. Inst., Gazipur, Bangladesh. p. 209-211.

Bashir, M. (2005). Studies on viral disease of major pulse crops and identification of resistant sources. Tech. Ann. Rep. (April 2004 to June 2005) of ALP. 76 pp.

Bashir, M. and Zubair, M. (2002). Identification of resistance in urdbean (*Vigna mungo*) against two different viral diseases. *Pakistan. J. Bot.* **34**(1): 49-51.

Bashir, M., Ahmad, Z. and Mansoor, S. (2006). Occurrence and distribution of viral diseases of mungbean and mashbean in Punjab, Pakistan. *Pakistan. J. Bot.* **38**(4):1341-1351.

BBS (Bangladesh Bureau of Statistics). (2009). Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the People's Republic of Bangladesh, Dhaka. pp.25.

BBS (Bangladesh Bureau of Statistics). (2010). Statistics Pocket Book of Bangladesh (2009-10). Bangladesh Bureau of Statistics Division, Govt. of the People's Republic of Bangladesh. pp.38.

Biswas, P.K. (1987). A study on the relative merits of mixed cropping under two levels of irrigations. MS Thesis, Dept. Agron. Bangladesh Agric. Univ. Mymensingh. p. 38-40.

Biswass, K.K., Malathi, V.G. and Varma, A. (2008). Diagnosis of symptoless yellow mosaic begomovirus infection in pigeon pea by using cloned mungbean yellow mosaic India virus a probe. *J. Plant Biochem. Biotech.* **17**(1): 9-14.

Bos, L. (1999). Plant Viruses: Unique and Intriguing Pathogens: A Text Book of Plant Virology, Backhuys Publishers, the Netherlands. pp: 305-306.

Brier, H. (2010). Integrated pest management in Australian mungbeans and soybeans-swings, roundabouts and conundrums. Proceedings of the 1st Australian Summer Grains Conference, Gold Coast, Australia, 21-24th June 2010. pp. 1-10.

Bundy, C.S. and McPherson, R.M. (2000). Dynamics and seasonal abundance of stink bug (*Heteroptera:* Pentatomidae) in a cotton mungbean ecosystem. *J. Econ. Entomol.* **93**(3): 697-706.

Camargo, A.J.A. (2001). Insect diversity in cultivated areas and nature reserves: consideration and recommendation. *J. Res.* **4**(2): 167-169.

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

Chand, R, Lal, M. and Chaurasia, S. (2003). Phytotonic effect of carbendazim on greengram (*Phaseolus radiatus*) and control of cercospora leaf spot (*Cercospora canescens*). *Indian J. Agril. Sci.* **73**(1):572–573.

Chandrasekharan, M. and Balasubramanian, G. (2002), Evaluation of plant products and insecticides against sucking pests of greengram. Pestol. **26**(1): 48-50.

Chi, Y.C., Sakamaki, Y. and Kushigemochi, K. (2003). The seasonal abundance of the legume pod borer, *Maruca vitrata*, in Kayoshima, Japan. Memories, Faculty of Agriculture, Kagoshima University. **38**(2): 41-44.

FAO. (1999). Food and Agriculture Organization. Production Year Book. Rome, Italy. pp. 45-48

FAO. (1988). Food and Agriculture Organization. Land resources appraisal of Bangladesh for agricultural development. Rep. 2. Agro-ecological regions of Bangladesh, UNDP, FAO, Rome. p. 116.

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

Ganapathy, T., Kuruppiah, R. and Gunasekaran, K. (2003). Identifying the source of resistance for mungbean yellow mosaic virus (MYMV), urd bean leaf crinkle virus and leaf curl virus disease in urd bean (*Vigna mungo* (L.) Hepper). In Annual Meeting and Symposium on recent Developments in the diagnosis and Management of Plant Diseases for Meeting Global Challenges, December 18-20, 2003, University of Agricultural Sciences, Dharwad, p.30.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for Agricultural Research. A Wiley Int. Sci. Publ. John Wiley and Sons. New York, Brisbane, Singapore. pp. 139-240

Gumber, R., Sarvjeet, S., Kular, J.S., Kuldip, S., Singh, S. and Singh, J. (2000). Screening chickpea genotypes for resistance to *Helicoverpa armigera*. Int. Chickpea Pigeonpea Newsl. **7**: 20-21.

Gupta, M.P. and Pathak, R.K. (2009). Bioefficacy of neem products and insecticides against the incidence of whitefly, yellow mosaic virus and pod borer in Black gram. *Natural product radiance,* **8**(2): 133-136.

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

Hossain, M.A., Islam, K.M.S. and Mondal, A.T.M.A.I. (2000). Effect of sowing date on lentil aphid, aphis craccivora koch infestation nd yield contributing characters of lengtil (*Lens culinaris* Medik). *J. Bio. Sci.* **8**: 115-117.

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

Hull, R, (2004). Mathew’s Plant Virology, Fourth Edition, Elsevier Publishers, India. pp.180-182.

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

Islam, B.N. (2004). Use of some extract from meliaceae and annonaceae for control of rice hispa, *Dicladispa armigera* and the pulse beetle, *Callosobruchus chinensis*. pp. 217-242. In: proc. 3rd Intl. Neem Conf. Nirobi, 1986.

Islam, B.N. (2006). Pesticidal action or neem and certain indigenous plants and weeds of Bangladesh. In: proc. 2nd Neem conf. Rauischholzhausen. F.R. Germany, May 25-28, 1983.

Islam, M.S., Latif, M.A., Ali, M. and Hossain, M.S. (2008). Population dynamics of white fly on some recommended mungbean varieties in Bangladesh and its impact on incidence of mungbean yellow mosaic virus disease and yield. *Int. J. Sustain. Agril. Tech.* **5**(4):41-46

Jahangir Shah, M., Ahmad, A., Hussain, M., Malik, M. Yousaf and Ahmad, B. (2007). Efficiency of different insecticides against sucking insect-pest complex and effect on the growth and yield of mungbean (*Vigna radiata* L.). *Pakistan Entomol.* **29**(2): 83-86.

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

Jost, D.J. and Pitre, H.N. (2002). Mungbean looper and cabbage lopper (*Lepidoptera:* Noctuidae) population in cotton and mungbean cropping systems in *Mississippi. J. Entomol. Sci.* **37**(3): 227-238.

Kabir, K.H., Baksh, M.E., Rouf, F.M.A., Karim, M.A. and Ahmed, A. (1996). Insecticide usage pattern of vegetables at farmers' level of Jessore region in Bangladesh: A survey findings. *Bangladesh J. Agril. Res*. **21**(2): 241-254

Khan, N.A., Ansari, H.R. and Samiullah. (1997). Effect of gibberellic acid spray and basal nitrogen and phosphorus on productivity and fatty acid composition of rapeseed-mustard. *J. Agron. Crop Sci*. **179**:29-33.

Khatri, N.K, Nanda, U.S., Kakani, R.K., Henry, A., Kumar, D. and Singh, N.B. (2003). Extent of Yellow mosaic virus disease of moth bean in Bikaner Region. Proceedings of the National Symposium on arid legumes, for food nutrition security and promotion of trade, Hisar, India. 15-16 May, 2002.

Khattak, G.S.S., Saeed, I. and Shah, S.A. (2008). Breeding high yielding and disease resistant mungbean (*Vigna radiata* (L.)Wilczek) genotypes. *Pakistan J. Bot.* **40**: 1411-1417.

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

Khattak, M.K., Ali, S., Chishti, J.I, Saljiki, A.R. and Hussain, A.S. (2004). Efficacy of certain insecticides against some sucking insect pests of mungbean (*Vigna radiata* L.). *Pakistan Entomol.* **26**(1): 75-80.

Khunti, J.P., Bhoraniya, M.F. and Vora, V.D. (2002). Management of powdery mildew and cercospora leaf spot of mungbean by some systemic fungicides. *J. Mycol. Plant Pathol.* **32**: 103–105.

Kidiavai, E.L. (2009). International Centre for Insect Physiology and Ecology (IIPE), Nairobi, Kenya.

Kyamanywa, K. (2009). Damage-yield relationship of common beans infected by the bean thrips. *Nigerian J. Entomol*. **5**(1): 45-48.

Lal, S.S. (2008). A review of insect pests of mungbean and their control in India. *Tropical Pest Mange*. **31**(2): 105-114.

Latif, M., Aslam, T.S. and Naeem, M. (2001). Comparative efficacy of different insecticides against whitefly, *Bemisia tabaci* (Gemn) on two cotton varieties. *Pakistan J. Biol. Sci.* **1**: 26-29 (Supplementary Issue).

Marimuthu, T., Subramanian, C.L. and Mohan. (1981). Assessment of yield losses due to yellow mosaic virus in mungbean. Pulse Crop Newsl. **1**: 104.

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

Mishra, H.P. (2002). Field evaluation of some newer insecticides against aphids (Aphis gossypii) and jassids (*Amrasca biguttula biguttula*) on okra. *Indian J. Entomol.* **64**:80–84.

Mohan, M. and Katiyar, K.N. (2000). Impact of different insecticides used for bollworm control on the population of jassids and whitefly on cotton. *J. Pestic. Res.* **12** (1): 99 -102

Muhammad Yaqoob, Haqqani, A.M. and Najibullah. (2007). Genetic resistance and selection response in mothbean against yellow mosaic virus disease. *Pakistan J. Bot.* **39**(7): 2373-2377.

Musatafa, G. (2000). Annul Rept. Emtomol. Section, Ayub Agric, Res. Institute, Faisalabad. pp. 1-14.

Mustafa, G. (1996). Ann. Rept. Entomol. section, Ayub Agric. Res. Institute, Faisalabad. pp. 12-13.

Nazrussalam., Ansari, M.S., Haidar, A and Tufail, A. (2008). Efficacy of multineem and NSKE with insecticides for management of *Amrasca biguttula biguttula* and *Earas vittella* on okra. *Annals Plant Protec. Sci.* **16**(1): 17-20.

Omo-Ikerodah. (2010). International Institute of Tropical Agricultue, Ibadan, Nigeria. Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria.

Oparaeke, A.M., Dike M.C. and Amatobi, C.I. (2005).Botanical pesticide mixtures for insect pest management on cowpea, *Vigna unguiculata* (L.) walp plants-2. The pod borer, *Maruca vitrata* Fab. (Lepidoptera: Pyralidae) and pod sucking bug, *Clavigralla tomentosicollis* stal (Heteroptera: *coreidae*). Agricultura tropica et subtropica. **38**(2): 33.

Pathak, A.K. and Jhamaria, S.L. (2004). Evaluation of mungbean (*Vigna radiata* L.) varieties to yellow mosaic virus. *J. Mycol. and Plant Path.* **34**(1): 64-65.

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

Qazi, J., Ilyas, M., Mansoor, S. and Briddon, R.W. (2007). Legume yellow mosaic viruses: genetically isolated begomoviruses. *Mole. Plant Pathol*. **8**(4): 343-348.

Rajnish, K., Ali, S. and Rizvi, S.M.A. (2006). Efficacy of insecticides and neem against *Bemisia tabaci* genn and yellow mosaic virus in mungbean. *Annals Plant Protec*. *Sci.* **14**(2): 431-434.

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

Russell, D.F. (1986). MSTAT-C package programme. Dept. Crop Soil Sci. Michigian State Univ. USA. p. 59-60.

Sachan. J.N., Yadava, C.P., Ahmad, R. and Katti, G. (1994). Insect Pest Management in Pulse Crop. In: Dhaliwal, G.S. and Arora, R. (eds.) Agricultural Insect Pest Management. Common Wealth Publishers, New Delhi, India. pp. 45-48.

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

Sethuraman, K.N., Manivannan and Natarajan, S. (2001). Management of yellow mosaic diseases of urdbean using neem products. *Legume Res.* **24** (3): 197-199.

Shad, N., Mughal, S.M. and Bashir, M. (2005). Transmission of mungbean yellow mosaic Begomovirus (MYMV). *Pakistan J. Phytopathol.* **17**(2): 141-143.

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

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

Singh, K., Sharma, U.S., Swaminathan, R. and Dashora, P.K. (2009). Management of insect pests of *Vigna radiata* (L.) wilczek. *Appl. Ecol. Environ. Res*. **7**(2): 99-109.

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

Sunil, C.D. and Singh, B. (2010). Seed treatment and foliar application of insecticides and fungicides for management of cercospora leaf spots and yellow mosaic of mungbean (*Vigna radiata*). *Intl. J. Pest Mange.* **56**(4): 309–314.

Tufail, M., Rasheed, A. and Bari, S. (1996). The comparative efficacy of some latest spray schedules against the whitefly, Bemisia tabaci (Gen.) on FH-682. *Pakistan Entomal.* **18** (1-2): 67-69.

UNDP and FAO. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development. Report 2. Agroecological Regions of Bangladesh. United Nations Development Programme and Food and Agriculture Organization. pp. 212-221.

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

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

APPENDICES

Appendix I. Physiological properties of the initial soil

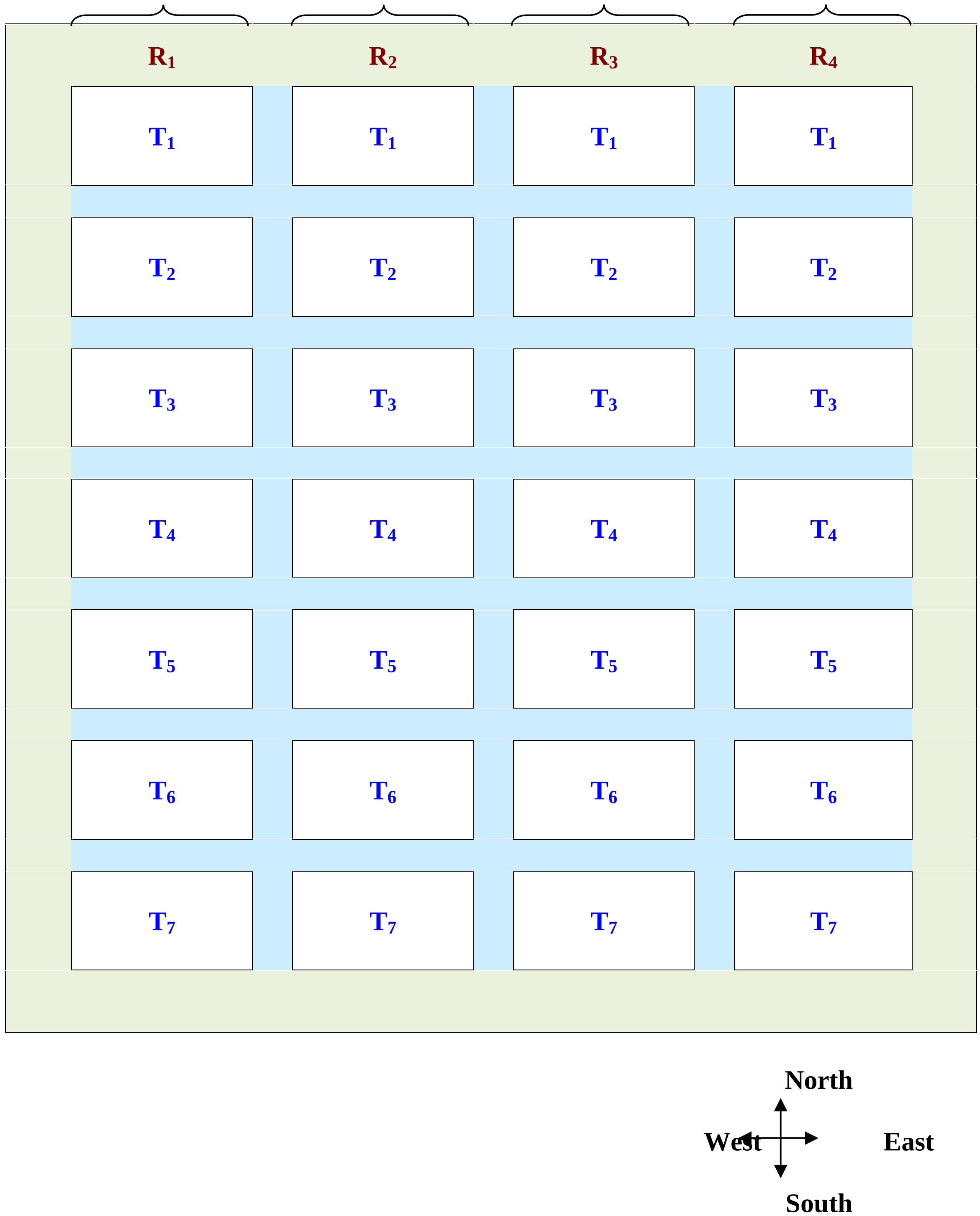
Characteristics	Value	Critical value
Partical size analysis		
% sand	26	-
% silt	45	-
% clay	29	-
Textural class	Silty clay	-
pH	5.6	Acidic
Organic carbon (%)	0.45	-
Organic matter (%)	0.78	-
Total N (%)	0.03	0.12
Available P (ppm)	20.00	27.12
Exchangeable K (me 100^{-1} g soil)	0.10	0.12
Available S (ppm)	45	-

Appendix II: Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from March 2011 to November 2011

Date/Week	Temperature		Relative humidity (%)	Rainfall (mm) (Total)
	Maximum	Minimum		
March	32.1	21.5	57	20
April	33.5	23.2	64	123
May	33.4	24.6	76	235
June	32.6	26.3	80	314
July	32.3	26.7	79	356
August	31.1	26.5	82	409
September	32.4	26.4	77	207
October	32.7	24.7	73	112
November	29.7	19.2	67	0

Source: Bangladesh Meteorological Department (Climate and Weather Division), Agargoan, Dhaka- 1207

Appendix III: Lay out of the experiment



Legend:

Treatments: 7 (Seven); **Replication:** 4 (Four); **Number of pot:** 28
Length of plot: 3 m; **Width of a plot:** 2.0 m; **Area of a plot:** 6.0 m^2
Row to row distance: 35 cm; **plant to plant distance:** 15 cm

Appendix IV: Mean square on incidence reduction of aphid at vegetative and reproductive stage

Source of variation	Degrees of freedom	Mean square of					
		Vegetative stage		Reproductive stage		Total	
		No. of	Reduction	No. of	Reduction	No. of	Reduction

		Aphid	(%)	Aphid	(%)	Aphid	(%)
Replication	3	3.057	37.825	2.302	116.197	10.661	51.902
Treatments	6	21.096**	1961.194**	13.249**	1877.396**	66.439**	1947.413**
Error	18	0.007	3.234	0.018	7.173	0.019	3.385

Appendix V: Mean square on incidence reduction of jassid at vegetative and reproductive stage

Source of variation	Degrees of freedom	Mean square of					
		Vegetative stage		Reproductive stage		Total	
		No. of Jassid	Reduction (%)	No. of Jassid	Reduction (%)	No. of Jassid	Reduction (%)
Replication	3	1.941	76.732	1.586	196.845	7.007	117.973
Treatments	6	2.205**	1413.609**	2.361**	1931.596**	9.046**	1644.366**
Error	18	0.005	10.308	0.008	12.686	0.017	8.814

Appendix VI: Mean square on incidence reduction of whitefly at vegetative and reproductive stage

Source of variation	Degrees of freedom	Mean square of					
		Vegetative stage		Reproductive stage		Total	
		No. of Whitefly	Reduction (%)	No. of Whitefly	Reduction (%)	No. of Whitefly	Reduction (%)
Replication	3	2.920	22.360	2.238	22.713	10.250	28.630
Treatments	6	19.098**	1462.363**	14.366**	1711.526 **	65.866**	1569.755**
Error	18	0.012	1.817	0.009	3.507	0.025	2.067

Appendix VII: Mean square on incidence reduction of white leaf hopper at vegetative and reproductive stage

Source of variation	Degrees of freedom	Mean square of					
		Vegetative stage		Reproductive stage		Total	
		No. of white Leaf Hopper	Reduction (%)	No. of white Leaf Hopper	Reduction (%)	No. of whiteLeaf Hopper	Reduction (%)
Replication	3	1.869	320.655	0.850	254.442	5.232	286.536
Treatments	6	2.353**	1719.909**	1.096**	2460.027**	6.350**	1878.858**
Error	18	0.013	17.477	0.003	20.681	0.017	14.872

**= significant at 1% level of probability

Appendix VIII: Mean square on mosaic disease infested at before and after flowering

Source of variation	Degrees of freedom	Mean square of Mosaic infested plant plot^{-1}	
		Before flowering	After flowering
Replication	3	30.79	21.845
Treatments	6	20.06**	20.405**

Error	18	0.853	1.262

Appendix IX: Mean square on plant height, number of leaves at before and after flowering and length of leaf

Source of variation	Degrees of freedom	Mean square of			
		Plant height (cm)	No of leaves/plant		Length of leaf (cm)
			Before flowering	After flowering	
Replication	3	52.893	13.571	12.476	1.607
Treatments	6	224.060**	52.060**	48.655**	3.065**
Error	18	3.504	6.821	6.560	0.394

Appendix X: Mean square on pod length, no. of pods plant^{-1}, plant and husk dry weight

Source of variation	Degrees of freedom	Mean square of			
		Pod length (cm)	No. of pods plant^{-1}	Plant dry weight (g)	Dry weight of husk (g)
Replication	3	3.379	12.798	49.197	3.457
Treatments	6	1.440**	109.238**	74.672NS	0.823**
Error	18	0.244	0.270	83.412	0.163

Appendix XI: Mean square on no. of seed pod^{-1}, 1000-seed weight and yield plot^{-1}

Source of variation	Degrees of freedom	Mean square of		
		No. of seed pod^{-1}	1000-seed weight (g)	Yield plot^{-1}
Replication	3	5.048	37.429	5509.560
Treatments	6	10.643**	70.393**	5578.619**
Error	18	0.103	0.345	154.476

**= significant at 1% level of probability   ns= non significant