COMPARATIVE EFFICACY AND ECONOMICS OF SYNTHETIC AND BOTANICAL INSECTICIDES FOR THE MANAGEMENT OF STEM FLY, THRIPS AND WHITE FLY OF MUNGBEAN

BY

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CERTIFICATE

This is to certify that thesis entitled, **"COMPARATIVE EFFICACY AND ECONOMICS OF SYNTHETIC AND BOTANICAL INSECTICIDES FOR THE MANAGEMENT OF STEM FLY, THRIPS AND WHITE FLY OF MUNGBEAN "** 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. GOLAM AZAM**, Registration No. **22913/00106** 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:
Place: Gazipur, Bangladesh

(Dr. Kamal Humayun Kabir)
Supervisor

DEDICATED

TO

MY BELOVED PARENTS

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ABSTRACT

The study was conducted at Bangladesh Agricultural Research Institute (BARI) farm during March 2005 to August 2005 to find out the most appropriate management practices against three major insect pests of mungbean. The experiment consisted of seven treatments of various management practices viz. i) Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing ii) Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing iii) spraying of Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop iv) Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS v) Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS vi) Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and vii) Untreated (Control). The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications.

The stem fly, trips and white fly were found to attack mungbean field. The highest stem tunneling (22.52 %) was recorded from the untreated control and lowest (14.50 %) from the application of Furadan 5G (Carbofuran) @ 4% before sowing. The highest reduction of infestation in case of stem tunneling by stem fly over control was recorded from application of Furadan 5G (Carbofuran) @ 4% before sowing. The lowest number of whitefly (1.95 white fly/5 leaves) was recorded from application of Furadan 5G which also ensured the highest population reduction of 62.87% over control followed by Shobicorm 425 EC treatments (2.02 whitefly/5 leaves) which was equivalent to a reduction of 61.53 % successively over control. Spraying of Shobicorm 425 EC @ 20 ml/L of water at 20DAS and at 35 DAS (57.92%) treatment had the lowest number of thrips (2.5 per 5 leaves) where as the highest number of thrips (5.2 per 5 leaves) was recorded from untreated control.

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LIST OF ABBREVIATIONS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
FAO	=	Food and Agriculture Organization
ppm	=	parts per million
TSP	=	Triple Super Phosphate
MP	=	Muriate of Potash
RCBD	=	Randomized Complete Block Design
DAS	=	Days After Sowing
Kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
No.	=	Number
DMRT	=	Duncan's Multiple Range Test
LSD	=	Least Significant Difference
^0C	=	Degree centigrade
NS	=	Not Significant
cv.	=	Cultivar(s)
CV%	=	Percentage of Coefficient of Variance
meq	=	miliequivalent
µg	=	microgram

CHAPTER I

INTRODUCTION

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INTRODUCTION

Mungbean (*Vigna radiate* L. Wilczek) is one of the most important pulse crops in tropics and subtropics belonging to the family Leguminosae and sub family Papilionaceae. It is one of the important sources of protein for both men and domestic animals. It has good digestibility and flavour. The global mungbean growing area has increased during the last 20 years at an annual growth rate of 2.5%. The crop has various advantages in cropping system because of its rapid growth, early maturation, atmospheric nitrogen fixation through symbiotic relationship with soil bacteria and improve the soil fertility (Yadav *et al.,* 1994). It ranks fifth both in acreage and production and contributes 6.5% of the total pulse production in Bangladesh (Anon.1998). Mungbean is considered as a poor man's meat because it is a good source of protein (Miah, 1990). It contains 51% carbohydrate, 26% protein, 10% water, 4% minerals and 3% vitamins (Peterson, 1965). It is a popular crop in Bangladesh not only as a food crop but also as a fodder crop.

Several insect pests have been reported to infest mungbean and damage the seedlings, leaves, stems, flowers, buds, pods causing considerable losses (Sehgal and Ujagir, 1988; Rahman, 1988; Husain, 1993). The most damaging insect pests of mungbean recorded so far are stemfly (Rahman, 1987; Lal, 1985; Agrarwal and Pandey, 1961), whitefly (Rahman *et al.,* 1981; Srivastava and Singh, 1976) and thrips (Rahman *et al.,* 1981). Stemfly mainly damage the crop by feeding tender stems at seedling stage although it may attack at any stage of the crop. Infested seedlings frequently wilt and subsequently die. Such damage causes stunted growth of older plants. In mungbean, upto 97% plants were found to be infested by stemfly (Rahman, 1988).

Thrips is associated mostly with the damage of tender buds and flowers of mungbean (Lal, 1985). Chhabra and Kooner (1985) have reported extensive damage to the summer mungbean due to flower shedding caused by thrips. The average yield loss of mungbean due to different insect pests has been estimated to be 22 percent.

Whitefly transmits mungbean yellow mosaic virus (MYMV), which is a serious disease of the crop. Heavily infected crop exhibits a sickly black appearance. Females lay eggs singly on the underside of the leaves. On emergence, the nymphs start feeding on the cell sap and pupate within 9-14 days. The pupae become adult whiteflies in 2-8 days (Daughtrey *et al. 1998*).

Chemical control is generally being advocated for the management of insect pests of mungbean. Soil application of Furadan 3G @ 1.5 g a.i. ha^{-1} just prior to sowing followed by foliar application of Azodrin 40 EC @ 0.07% at 50% flowering protected the crop and ensured higher yield (Rahman, 1988).

The control of these insect pests in Bangladesh is principally carried out by the conventional use of insecticides. Many workers have tried to control these pests with varying degrees of success by frequent application of insecticides as foliar treatments (Chowdhury and Roy, 1975). It is difficult to emphasize the effectiveness of particular synthetic insecticides out of many commercially available ones against a certain insect pest. These chemicals should be applied at appropriate dose and at right time against the target pests. For controlling the pests successfully and to save biological agents, judicious application of insecticides is essential. In this study, an effort was taken to find out the most effective insecticide in controlling the stem fly, white fly and thrips of mungbean.

Controlling insect pests is very important to reduce losses. If chemical means are used, concern on environmental pollution should be addressed. Botanical insecticide, now-a-days gains some confidence and become the topic of world wide discussion. Because, the botanical pesticide is eco friendly.

Under the above perspective, the effective control of these pests in mungbean demands new approach, which is safe guard the environment and ensure economical and social acceptance. The present study has been undertaken to fulfill the following objectives:

i) To document the abundance and damage severity of stemfly, thrips and whitefly in mungbean.

ii) To find out the most economical package for the management of these pests in mungbean.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Pulses play a vital role in the diet of the people of Bangladesh. Nutritionally, they are two to three times richer in protein than cereal grains and have remained the least expensive source of protein for people since the dawn of civilization. In fact, till today, pulses serve as the only high protein component of the average diet of the vast majority of the people of Bangladesh (Rahman *et al.,* 1981). About 73 million hectares of land are used in pulse production, which is 5.3% of the total cropped area of Bangladesh. It is a tropical and sub-tropical crop, resistant to high temperature and in many countries grown as a summer crop and can be cultivated in a wide range of soil. It is sensitive to cloudy weather and can not tolerate frost. The average yield of mungbean is 617. 50 kg/ha in Bangladesh, which is far low as compared to the potential yield of this crop and to the average yield of other pulse growing countries (Anon., 1998). There are many constrains responsible for the low yield of mungbean. The poor yield is largely due to varietal aspect, climatic factors, management practices, insect pests and diseases (Rahman *et al.,* 1981). Among the constrains of mungbean cultivation, the attack of insect pests is considered as the important one (Rahman *et al.* 1981).

Insect pests of mungbean are listed below with their scientific name and order-

Common name	Scientific name	Order
Stemfly	*Ophiomya phaseoli*	Diptera
Thrips	*Megalurothrips distalis*	Thysanoptera
White fly	*Bemicia tabaci*	Homoptera

2.1 Stemfly

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

2.2 Thrips

Thrips is another important insect pest in mungbean. They are small, slim-bodied insects with piercing-sucking mouthparts that puncture plant cells and suck out their contents. Thrips feed on flowers, petioles and stigmas, causing deformity of the inflorescence and premature flower shedding. Sachan (1986) has reported widespread thrips damage to mungbean flowers. Thrips feed by rasping the leaves and other tissues of plants to release the sap, which they then consume. This feeding reduces the plant's ability to produce food and interferes with transportation of foliar nutrients. Weed destruction in the field and surrounding margins can help to reduce thrips populations, since these areas serve as over wintering and re-infestation sites.

2.3 Whitefly

The adult whitefly is a tiny soft bodied and pale yellow insects which, change to white within a few hours due to wax on the body and wings (Haider *et al.,* 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves. Eggs are pear shaped and 0.2mm long. One female can lay upto 136 eggs in its life time in mungbean . The nymphs are pale, translucent white, oval, with convex dorsum and flat elongated ventral side. The whitefly adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus thus reducing the photosynthetic area. The infested plants became weakened due to sucking of the plant sap from the leaves and also due to the reduction of photosynthesis of the infested plant parts. Young plant may even be killed in case of severe whitely infestation in mungbean (Srivastava and

Singh, 1976). The infested parts become yellowish, the leaves become wrinkle, curl downwards and eventually fallen off. This happens mainly due to viral infection where the whitefly acts as a mechanical vector of many viral diseases.

2.4 Management of insect pests of mungbean

The available techniques for controlling insect pests are conveniently categorized in order of complexity as cultural, mechanical, physical, biological, chemical, genetic, regulatory and biotechnological methods. Among these techniques, chemical method is widely and frequently used.

Chemical control is one of the widely practiced methods of controlling insect pests. Modern insecticides are both effective and reliable and almost all the countries of the world are relying to them more and more for the solution of insect problem. But their excessive and indiscriminate use has resulted in the development of insecticide resistance against the pests and causing environmental pollution (Babu, 1988).

Four granular insecticides (Carbofuran, Phorate, Quinalphos applied at 0.75 and 1.0 kg a.i. /ha each, and Cartap hydrochloride applied at 0.75, 1.0 and 1.5 kg a.i./ha) were evaluated for the control of semfly *(Ophiomyia phaseoli)* of mungbean. All of the tested insecticides were found effective (Dhiman *et al.,* 1993). Ahmad (1987) observed that pre sowing soil application of Carbofuran or Furadan 3G, Aldicarb 10G or Phroate 10G at 1 kg a.i./ha gave significant control of stemfly damage. Gupta and Singh (1984) obtained the largest increase in grain yield by controlling stemfly of mungbean with Aldeicarb and Desulfoton

Chhabra and Kooner (1985) reported that treatments with Aldicarb and Monocrotophs, Dimethoate, Malathion or Endosulfan gave significant control of thrips.

Prhorate or Carbofuran granules at the rate of 1 to 2 kg a.i./ha and foliar sprays of Dimethoate, Fenithion, Phosphamidon were effective in reducing whitefly and jassid population of mungbean (Yadav *et al.*, 1979). Ahmad (1987) stated that two applications of Dimethoate or monocrotophos at 45 and 60 DAS gave effective control of pod borer damage.

Nayak *et al,*(2004) conducted a field experiments in Pantnagar, Uttar Pradesh, India, to evaluate the efficacy of different combinations of insecticides, i.e. Carbofuran as basal at 1 kg/ha, Imidacloprid as seed treatment at 0.008 kg a.i./ha and Thiamethoxam sprayed 7 days after germination (DAG) at 0.025 kg a.i./ha, along with the application of neem seed kernel extract (25 kg/ha), *Bacillus thuringiensis* (Bt) (1.25 kg/ha), Dichlorvos (0.2 kg a.i./ha), Monocrotophos (0.2 kg/ha) and Endosulfan (0.35 kg a.i./ha) at flowering and podding stages, against thrips and white fly infesting black gram during summer and kharif 2002. The treatment differences were statistically significant. Application of Monocrotophos and Endosulfan at the flowering and podding stages of the crop effectively controlled white fly and thrips populations and increased the yield of black gram.

Different insecticides (Carbosulfan, Thiamethoxam, Phorate, Carbofuran and Chlorpyrifos) were evaluated as seed treatments, soil application and as spray against insect pests (leaf miner, *Aproaerema modicella*; stem fly, *Melanagromyza sojae*;

girdle beetle, *Obereopsis brevis*; whiteflies, *Bemisia tabaci*; and jassids) of soyabean seedlings in Parbhani, Maharashtra, India, during the 1998-99 kharif season by Salunke *et al.*, (2004). All the treatments were significantly superior over the control. Carbosulfan 25 DS at 30 g/kg seed recorded the lowest number of leaf miner larvae and consequently the leaf damage. Percent stem tunnelling was lowest in Phorate 10 G at 10 kg/ha whereas the lowest infestation of girdle beetle was recorded in Carbofuran 3 G at 30 kg/ha. The most effective treatment against whitefly was Thiamethoxam 70 WS at 3 g/kg seed and Chlorpyrifos 20 EC at 1.5 litres/ha against the jassids. The highest yield (27.57 q/ha) was recorded with the treatment carbosulfan 25 DS at 30 g/kg seed followed by thiamethoxam 70 WS at 3 g/kg seed (25.54 q/ha).

Rai and Solanki (2002) reported that leaf curl in chilli due to thrips, *Scirtothrips dorsalis* (upward curling) and mite, *Polyphagotarsonemus latus* (downward curling) is one of the important limiting factors in the cultivation of chilli in India. Mites and thrips are mainly congregated on the top canopy of the plant i.e. mites on the lower surface and thrips on the upper surface of the leaf for feeding and multiplication, and aphids (*Myzus persicae*) mostly on the bottom canopy preferring lower leaf surface. The pests were active from October to December, causing leaf curling in the plant. Application of carbofuran 3G at 1 kg a.i./ha 15 days after transplanting (DAT) followed by dicofol 0.04% 45, 60, 75 and 90 DAT was most effective against the mite. Neemectin 0.15 at 0.0006% azadirachtin followed by endosulfan 0.075% and neem product followed by microbial pesticide (*Bacillus thuringiensis subsp. kurstaki* (Bt)) at 1 kg/ha were highly effective against the thrips.

Pheromone traps and light traps are effective to control insect pests. Summer ploughing destroys the eggs of gram cutworm, grasshopper and pupae of red hairy caterpillar. Mungbean, intercropped with sorghum or bajra, decreases the incidence of jassids. Setting up of yellow sticky trap reduces the incidence of white fly. Digging trenches around the infested field controls the gram cut worm. The sucking pest can be controlled spraying by Dimethoate 0.03 per cent, Metasystox 0.025 per cent and Monocrotophos 0.04 per cent (Yadav *et al.*, 1979).

An experiment was conducted by Sinha *et al* (1992) in India during 1982-83 to determine the efficacy of sprays of the pyrethroid insecticides Deltamethrin, Permethin, Cypermethrin and Fenvalerate, and the organophosphorus insecticides Fenitrothion, Methyl-demeton [demeton-methyl] and Dimethoate to control infestations of *Thrips tabaci* on onions. Cypermethrin applied at 60 and 120 g/ha, and Deltamethrin applied at 24 g/ha reduced pest numbers effectively for up to 8 days after application. Fenitrothion applied at 600 g/ha was as effective as the pyrethroid insecticides. None of the chemicals had any effect after 15 days. There were no phytotoxic effects on onions and no residues were detected.

Field studies were conducted by Eapen (1994) in Karnataka, India, during 1989-93 to determine the efficacy of 3 granular pesticides, alone and in combination with neem oil to control various soil-borne pests of cardamom. Among the pesticides, Phorate applied at 5 and 2.5 g a.i./clump gave the highest reduction in damage by *Sciothrip cardamomi* (32.9 and 29.2%), followed by Quinalphos (18.6 and 15.4%). Carbofuran was effective only at 5 g a.i./clump. The reduction in damage due to *S.*

cardamomi was attributed to the protection of tender capsules by the pre-monsoon application of pesticides. Therefore, a single application of a broad spectrum pesticide, such as Phorate, was more convenient and economical than the usual recommendation of 6-7 applications of spray.

Granular formulations of Phorate, Mephosfolan, Disulfoton, Carbofuran and Aldicarb were tested in the field by Gupta and Singh (1992) in India as soil applications against *Megalurothrips distalis* on green gram (*Vigna radiata*). Up to 3 applications at up to 2.0 kg a.i./ha were made, and all treatments reduced infestation. Yields and benefit: cost ratios were greatest for one application at 2.0 kg a.i./ha.

A field trial was conducted by Mohite *et al.*(1994) in Maharashtra, India, in 1983-85, the following insecticides are recommended for controlling *Thrips tabaci* on onion: 0.03% Quinalphos (Ekalux), 0.02% Dichlorvos (Nuvan), 0.02% Methyl-demeton [demeton-S-methyl] (Metasystox), 0.03% Monocrotophos (Nuvacron), 0.02% Dimethoate (Rogor), 0.02% Phosphamidon (Dimecron), 0.03% Bromophos-methyl (Nexion methyl) and 0.02% Endosulfan (Endocel).

A field trial was conducted by Srivastrava and Gupta (1992) during the kharif seasons of 1988, 1989 and 1990 at the Regional Research Station, Nashik, to control *Thrips tabaci* using systemic insecticides. Four systemic insecticides (Monocrotophos at 0.05% and 0.1% Phorate at 0.5 kg a.i./ha and 1.0 kg a.i./ha, Carbofuran at 0.5 kg a.i./ha and 1.0 kg a.i./ha and Dimethoate at 0.05% and 0.1%) were assessed. Monocrotophos and dimethoate were sprayed 3 times at fortnightly intervals 30 days after transplanting and the rest were side-dressed 30 days after transplanting. The data on thrips infestation were recorded. Three years' pooled data were analyzed and it was found that minimum incidence and thrips population were in the treatment with Monocrotophos at 0.1%. The maximum bulb yield and cost-benefit ratio were also obtained in this treatment.

A field trials on the control of *Thrips tabaci* in onions grown for seed were carried out in 1989 and 1990 by Hoekstra and Hoek (1993). One to two sprays with synthetic pyrethroids such as Cypermethrin, Deltamethrin and Permethrin reduced suction damage to the crop compared with standard treatment with parathion. No reduction in yield as a result of suction damage was observed.

Field experiments carried out by Brar *et al.* (1993) in Ludhiana, Indian Punjab, during 1989-91 showed that out of 6 insecticidal treatments, Carbofuran and Phorate (both at doses of 0.75 and 1 kg a.i./ha) were the most effective insecticides against *Ophiomyia phaseoli* in peas.

Borah (1995) carried out an experiment to evolve a cheaper and effective control of *Bemisia tabaci* and minimizing the incidence of yellow mosaic virus [mungbean yellow mosaic bigeminivirus] in green gram [*Vigna radiata*], Cypermethrin (0.01, 0.015%), Deltamethrin (0.0028, 0.0042%), Dimethoate (0.03, 0.045%) and Malathion (0.05, 0.075%) were tested as foliar sprays during summer 1993 and 1994 in field trials in Assam, India. Foliar application with Cypermethrin, Deltamethrin and Dimethoate 50 days after sowing proved quite effective in reducing the incidence of *B. tabaci* and the virus.

Studies on relative toxicity and persistence of Folidol-M 50 EC [parathion-methyl], Azodrin 40 EC [monocrotophos], Sumicidin 20 EC [fenvalerate] and Ripcord 10 EC [cypermethrin] against *Bemisia tabaci* on soyabeans were carried out by Hussain *et al.*(1994) in Pakistan. After 24 h all the insecticides were effective, but toxicity decreased with time.

Four granular insecticides (Carbofuran, Phorate and Quinalphos applied at 0.75 and 1.0 kg a.i./ha each, and Cartap hydrochloride applied at 0.75, 1.0 and 1.5 kg a.i./ha) were evaluated by Dhiman *et al.* (1993) for the control of *Ophiomyia phaseoli* in field studies conducted in India. Carbofuran and phorate at both conchs were the most effective in reducing plant mortality and increasing the crop yield. The insecticide-treated plots also showed less incidence of wilt and *Aschochyta* blight on the foliage. The plots treated with phorate and quinalphos (at 1.0 kg) and sprayed twice with Bavistin [carbendazim] (0.05%) gave the maximum level of control of the disease.

An experiment was carried out by Tanzini *et al.*(1993) in Sao Paulo, Brazil, in 1991-92 to evaluate the influence of potassium fertilizer on the effectiveness of carbofuran for the control of *Thrips tabaci* on groundnut (*Arachis hypogaea*). The treatments consisted of NP with 150 kg of ammonium sulfate and 445 kg of superphosphate per ha; NPK with 52 or 104 or 156 kg of potassium chloride per ha; NP2K ; NP3K; NP + Carbofuran; NPK + Carbofuran; NP2K + Carbofuran; and NP3K + Carbofuran. The number of nymphs and adults found in 20 leaflets per plot and yields were determined. The results showed that large and normal dosages of K caused an increase in the effect of carbofuran for the control of the pest. Lowest efficiency of the insecticide occurred in plots without K. Highest yield was obtained in treatments with double dosage of K and it was lowest in the absence of this macronutrient.

Experiments were conducted by Azam *et al*. (2002) with leaves and seeds extracts of eight sub-tropical plants, namely, *Acacia nilotica, Annona squamosa, Azadirachta indica, Boswellia sacra, Crotolaria juncea, Jatropa dhofarica, Myrtus communis* and *Sueda aegyptica* by steeping 12.5 g of shaded dried leaf/seed powder of the plants in 62.5 ml water-ethanol (1 : 4 v/v) for 24 h. The extracts were suction filtered. Required quantity of filtrate was diluted with water to get 1, 1.5, 2 and 2.5% spray solutions, respectively. Tomato leaves with whitefly nymphs were used to test the insecticidal properties of the extracts. The leaves were kept in contact on filter papers for 2 h just before spraying and for 24 h after spraying of extracts. The filter papers were sprayed with ninhydrin (0.4% in ethanol) and kept in oven at a temperature of 80°C for 2 min, which developed purple spots due to honeydew secreted by whitefly nymphs. The difference between the number of spots before and after spray gave the mortality of nymphs. Data were analyzed by analysis of variance using statistical analysis system for the mortality of nymphs for all the extracts including control. The mortality of nymphs in different plant extracts at different concentrations was significant (<0.05) and there was no interaction among plant extracts with varying concentrations.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This chapter deals with details of the materials and methods used during the study period. It includes a brief description of the site of experiment, soil and climatic condition of the experimental site, materials used for experiments, treatments, design of experiment, method of cultivation, method of data collection, statistical analysis etc.

3.1 Experimental site

The experiment was conducted at the experiment farm of the Entomology Division of Bangladesh Agricultural research Institute (BARI), Gazipur, Bangladesh during February 2005 to June 2005.

3.2 Climate

During experimentation maximum and minimum temperature, relative humidity and rainfall were recorded at an interval of 10 days and presented in Appendix 1.

3.3 Soil

The soil of the experimental land was clay loam texture, pH range from 5.2 to 5.7, organic matter 1.12% and belongs to the Grey Terrace soils (AEZ-28).

3.4 Design of experiment

The experiment was laid out in a randomized Complete Block Design (RCBD) with four replications.

3.5 Land preparation

A tractor drawn disc plough followed by harrowing opened the land. Tractor drawn labeler was used to level the land. Urea, TSP and MP fertilizers were applied @ 45 kg Urea, 100 kg TSP and 60 kg MP, respectively per hectare during land preparation as recommended by Anon. (1997) for mungbean cultivation.

The whole field was divided into four equal blocks having 1 m space between the blocks and each block was again sub-divided into 7 plots (3m × 3m each) as treatment plots with 0.6 m space between them. The spacing was 30 cm between rows and 10 cm between plants.

3.6 Seed source and sowing

The mungbean seeds (Barimug-5) were collected from Pulse Research Centre, BARI, Joydebpur, Gazipur. All the seeds were subjected to germination test before sowing. In all cases, the rate of germination was found to be more than 90%. Seeds of mungbean were sown on 8 March of 2003.

3.7 Cultural practices

After sowing, a light irrigation was given. Subsequent irrigations were applied in all the plots and whenever required. Thinning, weeding in the plots were done at regular interval upto the flowering stage.

3.8 Treatment of the Experiments

The treatments of the present study were assigned as follows:

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing

T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing

T_3: Neem seed oil @ 10 mL of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop.

T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS

T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS

T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS

T_7: Untreated (Control)

Insecticides were procured from local market. Neem seed oil was collected from the Division of Entomology, Bangladesh Agriculture Research Institute (BARI).

3.9 Procedure of spray application

Furadan, Cruiser, Neem seed oil, Cymbush, Ekalux and Shobicorm were sprayed in assigned plots and dosages by using Knapsack sprayer. The spraying was always done in the afternoon to avoid bright sunlight. The spray materials were applied uniformly to obtain complete coverage of whole plants of the assigned plots. Caution was taken to avoid any drift of the spray mixture to the adjacent plots at the time of spray application. At each spray application the spray mixture was freshly prepared.

3.10 Data collection

- **Stemfly:**

At 15 days after germination (DAG), 10 randomly selected plants from each plot were uprooted considering the density of plant and brought to the laboratory. Plant stems were splitted open by a scalpel for recording the number of infested plant, the length of larval tunnel, total length of the stem and larvae or pupae per plant. The same procedure was followed upto 45 DAG at an interval of 10 days. The percentage of stemfly infested plant and stem tunneling were calculated using the following formulae:

$$\text{Percent stemfly infested plant (by number)} = \frac{\textit{Number of infested plants}}{\textit{Total number of plants}} \times 100$$

$$\text{Percent stemfly tunneling (by length)} = \frac{\textit{Length of stem tunneling}}{\textit{Total length of plant stem}} \times 100$$

- **whitefly and thrips**

Ten plants per plot were tagged randomly from 6 inner rows leaving 15cm from the corner. These plants were used for taking data on whitefly and thrips. Whitefly and thrips were counted insito from five fully unfolded top leaves of the plant. Data on these insects were recorded at an interval of 10 days commencing from first incidence and continued up to the maturity of the crop. Overall, percentage of population reduction over control was calculated by following formula:

$$\text{Percent population reduction over control} = \frac{X_2 - X_1}{X_2} \times 100$$

Where, X_1 is the mean of treated plots

X_2 is the mean of untreated plots

- **Yield**

The yield data (kg/ha) were recorded from treated and untreated plots. The difference between the seed yield in treated and untreated plots was considered as loss. The avoidable losses or percent increase in yield over untreated control were calculated on the basis of following by formula:

$$\text{Percent Avoidable loss/ Percent increase in yield} = \frac{X_1 - X_2}{X_1} \times 100$$

Where, X_1 is the mean yield of treated plots.

X_2 is the mean yield of untreated plots.

- **BCR**:

Benefit cost ratio (BCR) for each treatment and that of control was calculated on the basis of the current market price, cost of each treatment and cost of cultivation BCR was calculated by using following formula:

$$BCR = \frac{\textit{Net income (Benefit over control)}}{\textit{Management cost}}$$

3.11 Statistical analysis

All data were analyzed by MSTAT software for analysis of variance (ANOVA). The percent data were transformed into square root wherever needed. Treatment means were separated by applying Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the experiment. The study was conducted to document the abundance, damage severity of three major pests of mungbean and find out the most beneficial management practices of these pests. The rate of infestation and abundance has been presented in Tables 1- 4 and Figures 1-5. The analysis of variance on different plant growth and yield characteristics obtained from the present investigation are presented in Appendices III.

The results have been discussed and possible interpretations whenever necessary have been made under the following headings.

4.1 Effect of different treatments on the intensity of stem fly infestation

The intensity of stem fly infestation significantly varied between the treatments. Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing (T_1) had the lowest infestation (12.5%) which was statistically identical with T_2 (Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing), T_3 (Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop), T_4 (Spraying of Symbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS) and T_6 (Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at

35 DAS) (Table 1). On the other hand, the highest plant infestation (28.50%) was recorded from T_7 (Untreated Control), which was statistically different with others. The results also revealed that application of Furadan 5G @ 4% before sowing seed provided the maximum protection from the stem fly infestation resulting the highest reduction of stem fly infestation (56.16%) in mungbean over control. This result is in conformity with the findings of Singh and Gupta (1984). They reported that Furadan was the most effective granular insecticide against the control of stem fly. The highest reduction of infestation in case of stem tunneling by stem fly over control was recorded from Seed treatment by Furadan 5G (35.56%) followed by Spraying of Shobicorm 425 EC (26.66%).

Results of stem tunneling are also shown in Table 1. The highest stem tunneling (22.52 %) was recorded from the T_7 (untreated control) which was statistically different with other treatments. On the other hand, significantly lowest (14.50 %) stem tunneling was obtained from application of Furadan 5G (Carbofuran) @ 4% before sowing (T_1). The highest reduction of infestation in case of stem tunneling by stem fly over control was recorded from application of Furadan 5G (Carbofuran) @ 4% before sowing (T_1) . Anon. (2001) obtained similar reduction of stem tunneling through Furadan application. Kundu and Mehra (1989) reported the percent stem tunneling in soybean as the most suitable parameter for determining economic threshold.

Table 1. Effect of different treatments on the damage severity of stem fly by infesting plant and stem tunneling of mungbean during Kharif 2005 at Gazipur.

Treatments	Stem fly infested plants (%)	Stem tunneling (%)	Reduction of infestation over control (%)	
			Stem fly infested plant	Stem tunneling
T_1	12.5c	14.50d	56.16	35.56
T_2	17.5bc	18.75bc	38.61	16.67
T_3	16.75bc	18.50bc	41.24	17.78
T_4	16.30bc	17.25bc	42.82	23.33
T_5	19.00b	19.25b	33.35	14.44
T_6	14.20bc	16.50cd	50.14	26.66
T_7	28.50a	22.50a		
$LSD_{0.05}$	4.59	2.29	-	-
$LSD_{0.01}$	6.28	2.31		
CV (%)	17.32	8.49		

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing;
T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing;
T_3: Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop;
T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS;
T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS;
T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and
T_7: Untreated (Control).

4.1.1 Seasonal abundance of stem fly

The results of the seasonal fluctuation of stem fly infestation are shown in Figure 1. Stem fly infestation started from March 09, 2005 and showed an increasing trend with the progress of the season and reached at the peak on 13 April 2005 and then slightly decreased up to the end of the season. This might be due to prevailing high temperature and rainfall (Appendix 1). The present findings are agreement with Sharma *et al.* (1997). They stated that temperature and sunshine were significantly and positively correlated with stem fly infestation while negatively correlated with rainfall. Gupta and Singh (1984) also recorded the maximum stem fly infestation during April, May and June but it was less during Febuary-March. A similar trend of stem fly infestation was also observed by Prodhan *et al.* (2000).

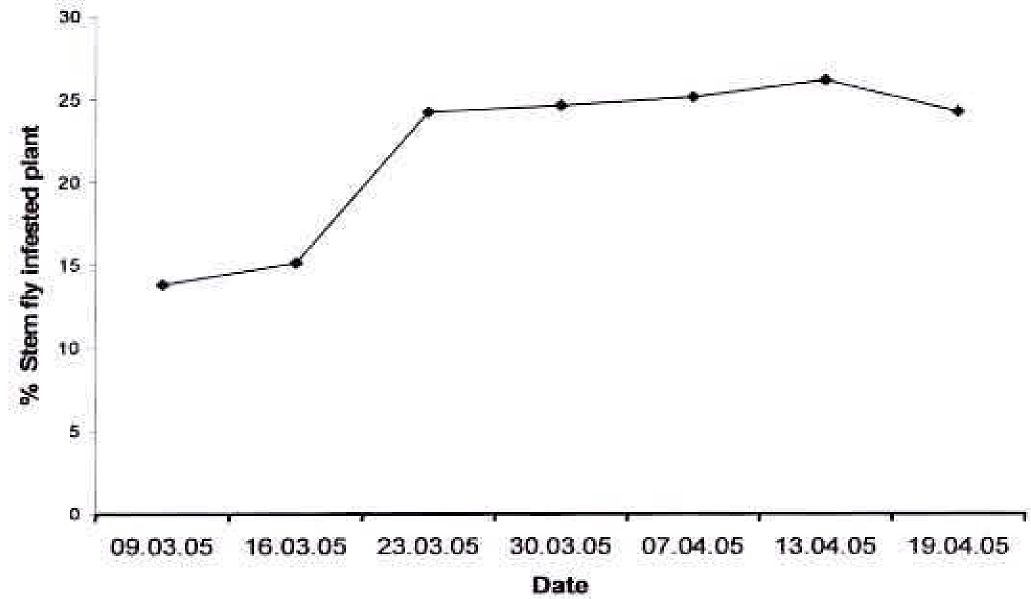

Fig 1. Seasonal variation in the abundance of stem fly infestation over the mungbean growing season during March-May, 2005.

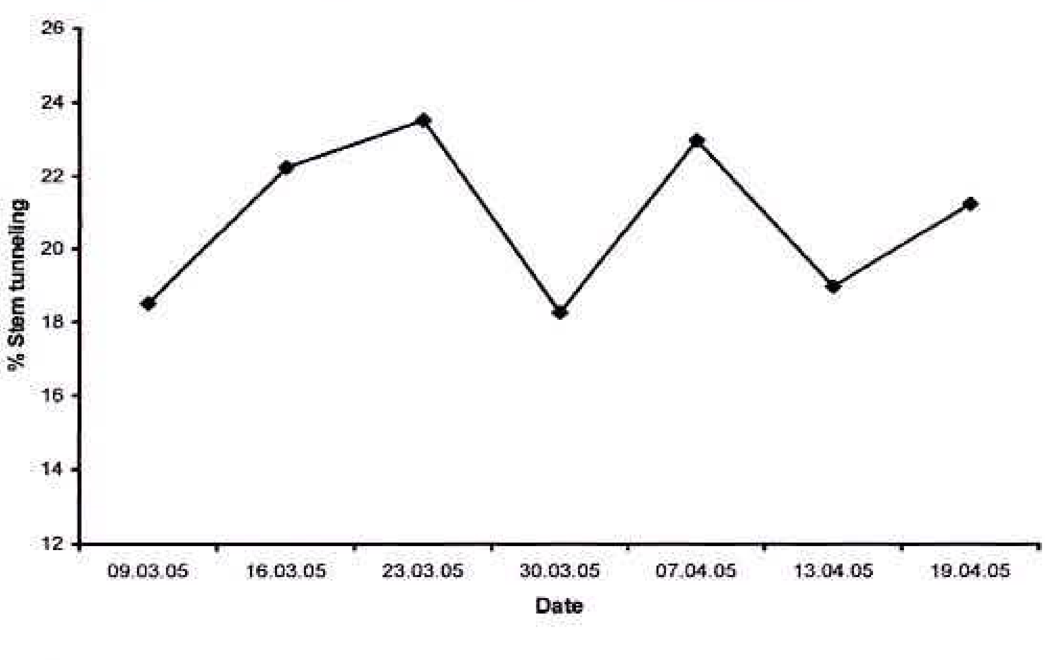

Fig 2. Seasonal variation of stem tunneling of stem fly over the mungbean growing season during March-May,2005.

Figure 2 shows the seasonal fluctuation of stem tunneling by stem fly. The results revealed that the stem tunneling started on March 09, 2005 with a peak on 23 March, 2005. After that the stem tunneling was decreased, again stem tunneling increased on 07 April and slightly decreased on 13 April 2005. Then an increasing trend was observed up to the end of the season.

4.1.2 Effect of different treatments on the incidence of stem fly larvae/pupae

Number of stem fly larvae/pupae per plant significantly varied among treatments (Table 2). The lowest number (0.75 larvae or pupae/ plant) was observed from T_1 (Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing) while Untreated control had the highest larvae or a pupa (1.45/plant).

The highest number of stem fly larvae or pupae reduction over control was also obtained from the application Furadan 5G (75.86%) followed by Shobicorm 425 EC (68.47%).

Table 2. Effect of different treatments on the incidence of stem fly larvae/pupae attacking mungbean during kharif 2005 (March-June) at gazipur.

Treatments	Number of larvae/pupae per plant	Population reduction over control (%)
T_1	0.35e	75.86
T_2	0.75b	48.28
T_3	0.65bc	55.18
T_4	0.55cd	62.07
T_5	0.80b	44.83
T_6	0.45de	68.97
T_7	1.45a	-
$LSD_{0.05}$	0.1819	
$LSD_{0.01}$	0.249	
CV (%)	17.28	

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing;

T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing;

T_3: Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop;

T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS;

T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS;

T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and

T_7: Untreated (Control).

4.1.3 Seasonal abundance of stem fly larvae or pupae

Seasonal abundance of stem fly larvae or pupae (by number) per plant is shown in Figure 3. It is revealed from the figure that larvae or pupae of stem fly were first noticed on 09 March, 2005 and the prevalence was continued up to the April 19, 2005. At the beginning of the season, a slightly increasing trend was found and then declined on 23 March. After that, abundance of larvae or pupae was suddenly increased up to 07 April. Then again slightly decreased and afterwards, an increasing trend was observed at the end of the season, which was to some extent similar to the results observed by Prodhan *et al.* (2000). They recorded that incidence of stem fly larvae or pupae were increased with the progress of the season.

4.2 Effect of different treatments on the incidence of white fly

The effect of various treatments of the incidence of white fly are presented in Table 3. There was a significant difference among the treatments in respect of whitefly population (Table 3). The lowest number of whitefly (1.95) was recorded from application Furadan 5G (T_1) which also ensured the highest population reduction of 62.87% over control followed by application of Shobicorm 425 EC (T_6) (2.02 whitefly/5 leaves) which was equivalent to a reduction of 61.53 % successively over control. The lower infestation of whitefly in Furadan 5G is in agreement with the findings of Gupta and Singh (1983).

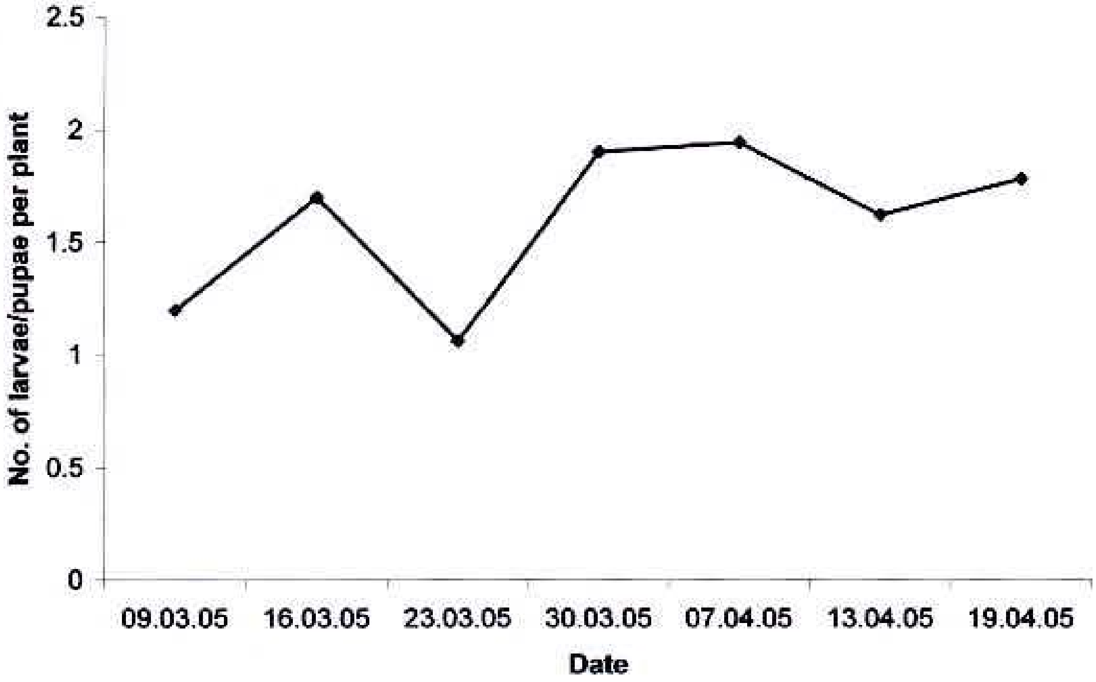

Fig.3 Seasonal variation in the abundance of stem fly larvae/pupae per plant over the mungbean growing season during March-May, 2005.

Table 3. Effect of different treatments on the incidence of white fly attacking mungbean during kharif 2005 (March-June) at Gazipur.

Treatments	Number of white fly per 5 leaves	Population reduction over control (%)
T_1	1.95	62.87
T_2	3.1	40.96
T_3	2.75	47.63
T_4	2.25	57.25
T_5	3.70	29.53
T_6	2.02	61.53
T_7	5.25	-
$LSD_{0.05}$	0.917	
$LSD_{0.01}$	1.256	
CV (%)	20.55	

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing;

T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing;

T_3: Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop;

T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS;

T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS and

T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS

The result of the present study indicated that seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing was found to be the best for controlling from the attack of whitefly.

4.2.1 Seasonal abundance of whitefly

The result of the seasonal abundance of whitefly is presented in Figure 5. Whitefly incidence started from 08 April, 2005 and showed an increasing trend with the progress of the season, but after May 28, a sudden decline of population was found which might be due to rainfall (Appendix I). The activity of this pest decreases with the on set of rain. At the reproductive stage, an increasing trend was again found which continued upto the end of the season due to the temperature and relative humidity (Appendix I). Alam (2001) reported that temperature and relative humidity had positive effect on the abundance of whitefly population.

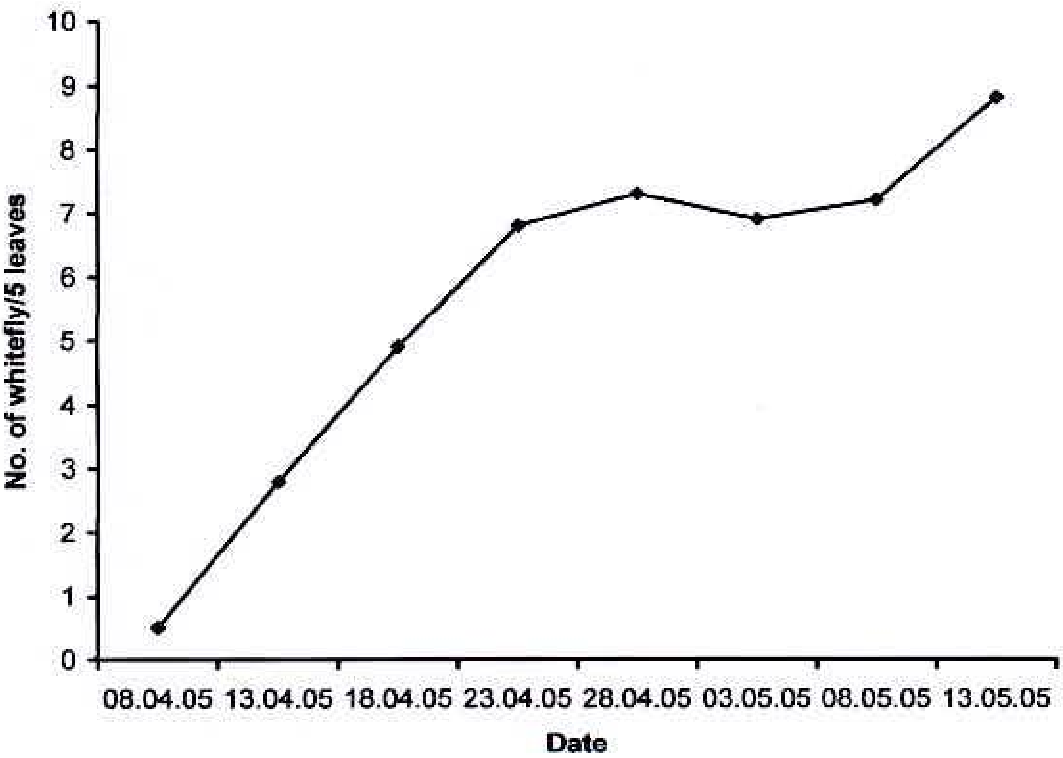

Fig.4. Seasonal abundance of white fly over the mungbean growing season during March-May, 2005

4.3 Effect of different treatments on the incidence of Thrips

The assigned treatments showed the significant influence on the incidence of thrips (Table 4). The results indicated that the T_6 (Spraying of Shobicorm 425 EC had the lowest number of thrips (2.5 per 5 leaves) where as the highest number of thrips (5.2 per 5 leaves) was recorded from untreated control which was statistically different from other treatments. Similarly, T_6 (Spraying of Shobicorm 425 EC treatment ensured the highest reduction of thrips infestation (57.42%) over control followed by T_1 (seed treatment by Furadan 5G @ 4% before sowing) (46.15%) over. Similar performance of Furadan 5G against thrips was reported by Olowe *et al.*(1987). They reported the lowest number of thrips from Furadan treated plots and also 46% population reduction over control. Annon. (2000) also found the reduction of thrips infestation (40.72%) from spraying of Cymbush 10 EC over control.

4.3.1 Seasonal abundance of thrips

The population fluctuation of thrips throughout the Kharif season under untreated control plots is shown in Figure 6. The results revealed that the incidence of thrips started on 08 April, 2005. From April 26-29 at the reproductive stage, the thrips incidence started to increase and reached at the peak on May 13 and it was continued up to the end of the season. Chhabra and Kooner (1985) reported similar observation.

4.4 Effect of different treatments on seed yield of mungbean

Seed yield of mungbean also differ significantly due to the application of different treatments (Table 5). It is evident from the table that the highest seed yield (950.50 kg/ha) was recorded from T_1 (Seed treatment by @ 4% before sowing) which was statistically similar with T_6 (Spraying of Shobicorm 425 EC @ 20 ml/L of water at 20DAS and at 35 DAS) (915.20 kg/ha). The lowest seed yield was recorded from the untreated control and it was statistically different from other treatments. The highest rate of yield increase (60.87%) over control was obtained from T_1 (Furadan 5G) followed by T_6 (Shobicorm 425 EC) and T_3 (Neem seed oil @ 10 ml of water + Trix, respectively. Gupta and Singh (1984) obtained similar results where Furadan applied twice and yielded the highest. On the other hand, spraying of Cymbush 10 EC also provided better yield of mungbean (Annon., 2001).

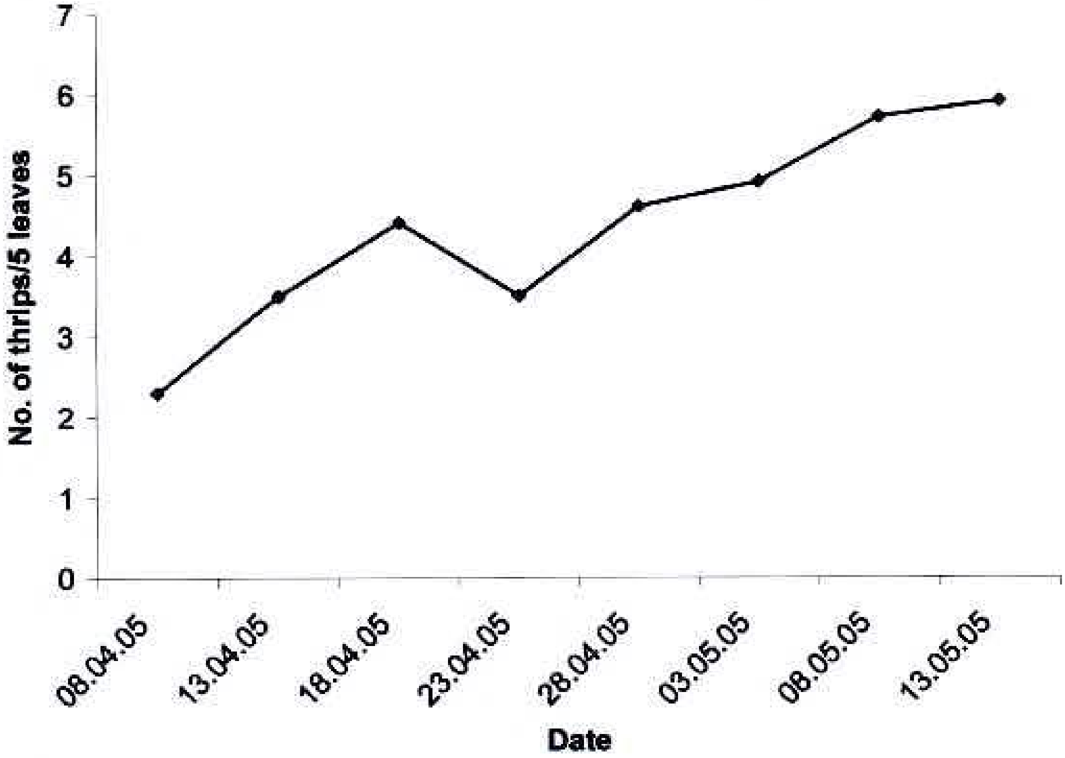

Fig.5. Seasonal abundance of thrips over the mungbean growing season during March-May, 2005.

Table 4. Effect of different treatments on the incidence of thrips attacking mungbean during kharif 2005 (March-June) at Gazipur.

Treatments	Number of thrips per 5 leaves	Population reduction over control (%)
T_1	2.8b	46.15
T_2	3.36b	35.38
T_3	3.25b	37.50
T_4	2.95b	43.27
T_5	3.60b	30.77
T_6	2.50b	57.42
T_7	5.20b	-
$LSD_{0.05}$	1.375	
$LSD_{0.01}$	1.884	
CV (%)	27.39	

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing;

T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing;

T_3: Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop;

T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS;

T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS;

T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and

T_7: Untreated (Control).

4.5 Relationship between stem fly infestation and yield

Results clearly indicated that there was a strong negative correlation between percent stem fly infestation and yield, which indicated that with the increase of stem fly infestation there was a progressive fall in the yield. A linear regression was fitted between yield and percent plant infested with stem fly (Fig.6). The correlation coefficient (r) was – 0.924 and the contribution of the regression (R^2) were 0.854.

4.6 Relationship between stem fly tunneling and yield

The results revealed that there was a strong negative correlation between percent stem fly tunneling and yield, which suggested that with the increase of stem fly infestation there was a decline of influenced on yield. A linear regression was fitted between yield and percent plant infested with stem fly (Fig.7). The correlation coefficient (r) was – 0.699 and the contribution of the regression (R^2) was 0.488.In the present study, it was observed that maggot gnawed the xylem and phloem tissue in tunnel that passively prevented plants to transport nutrient and water. The plants became stunted resulting reduced yield.

Table 5. Effect of different treatments on the seed yield of mungbean

Treatments	Seed yield of Mungbean (kg/ha)
T_1	950.5a
T_2	772.8b
T_3	800.3b
T_4	820.2b
T_5	712.3c
T_6	915.2a
T_7	590.3d
$LSD_{0.05}$	45.85
$LSD_{0.01}$	62.81
CV (%)	3.88

T_1: Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing;

T_2: Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing;

T_3: Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop;

T_4: Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS;

T_5: Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS;

T_6: Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and

T_7: Untreated (Control).

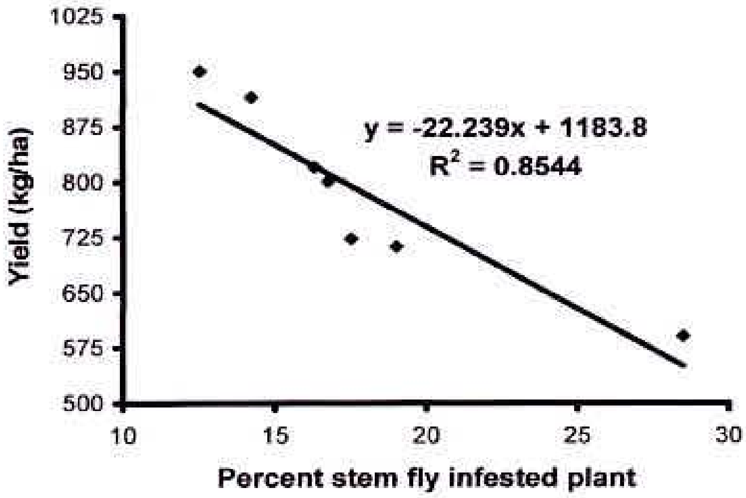

Fig. 6 Relationship between stem fly infestation and yield of mungbean obtained from different treatments.

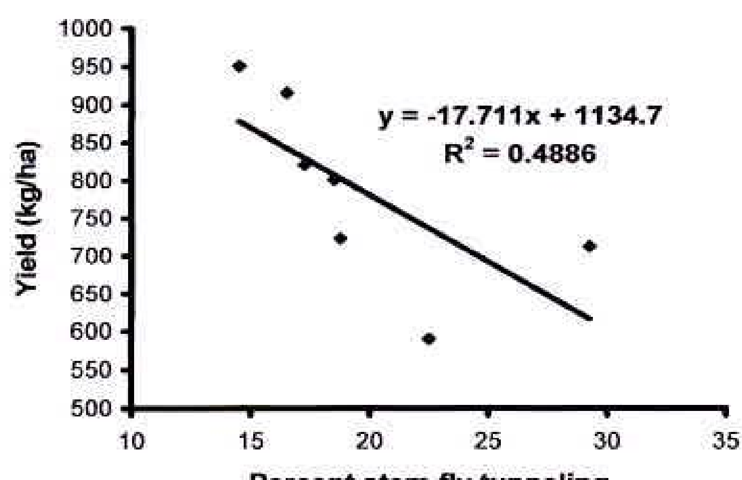

Fig. 7 Relationship between stem tunneling and yield of mungbean obtained from different treatments.

4.7 Relationship between incidence of white fly and yield

There was a strong negative correlation between incidence of white fly and yield, which indicated that higher number of white fly conversely lower the total yield. A linear regression was fitted between yield and percent plant infested with stemfly (Fig. 8). The correlation coefficiernt (r) was – 0.945 and the contribution of the regression (R^2) were 0.8927.

4.8 Relationship between incidence of thrips and yield

Similar to stemfly and trip fly, there was strong negative linear regression was found between the number of thrips and yield for different treatments, which indicated that higher number of trips conversely lower the total yield. A linear regression was fitted between yield and percent plant infested with stem fly (Fig.9). The correlation coefficient (r) was – 0.906 and the contribution of the regression (R^2) were 0.8209.

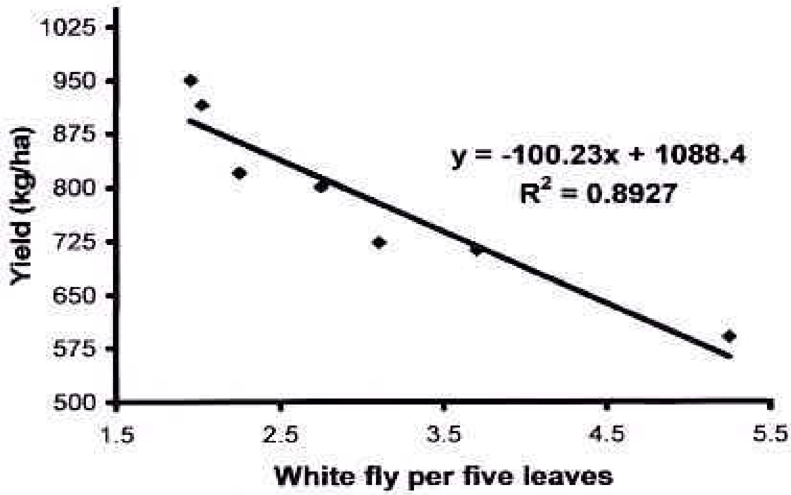

Fig. 8 Relationship between white fly infestation and yield of mungbean obtained from different treatments.

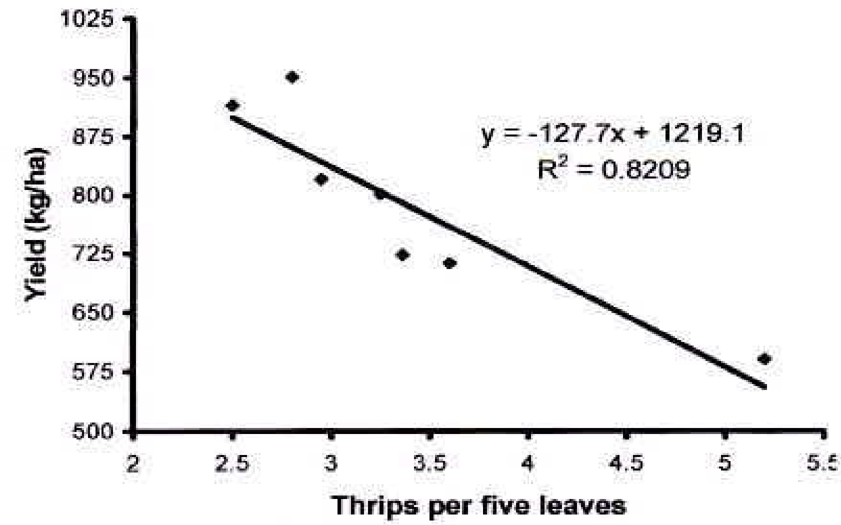

Fig. 9 Relationship between thrips infestation and yield of mungbean obtained from different treatments.

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the experiment farm of the Entomology Division of Bangladesh Agricultural research Institute (RARI), Gazipur, Bangladesh during February 2005 to June 2005. The experiment was laid out in a randomized Complete Block Design (RCBD) with four replications in the field. The whole field was divided into four equal blocks having 1 m space between the blocks and each block was again sub-divided into 7 plots (3m × 3m each) as treatment plots with 0.6 m space between them. The spacing was 30 cm between rows and 10 cm between plants. The treatments of the present study were assigned as i) Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing; ii) Seed treatment by Cruisar 70 WS (Imidacloprid) @ 4% before sowing; iii) Neem seed oil @ 10 ml of water + Trix @ 5 ml/L of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop iv) Spraying of Cymbush 10 EC (Cypermethrin) @ 1 ml/L of water at 20DAS and at 35 DAS; v) Spraying of Ekalux 25 EC (Quinalphos) @ 2 ml/L of water at 20DAS and at 35 DAS; vi) Spraying of Shobicorm 425 EC (Propenphos + Cypermethrin) @ 20 ml/L of water at 20DAS and at 35 DAS and vii) Untreated (Control).

Result revealed that the intensity of stem fly infestation was significantly different with different treatments. Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing had the lowest infestation (12.5%). The result also revealed that application of Furadan 5G 4% before sowing seed provided the maximum protection from the stem fly infestation resulting the highest reduction of stem fly infestation (56.16%) in mungbean over control.

The highest stem tunneling (22.52 %) was recorded from the untreated control and lowest (14.50 %) stem tunneling was obtained from application of Furadan 5G (Carbofuran) @ 4% before sowing. The highest reduction of infestation in case of stem tunneling by stem fly over control was recorded from application of Furadan 5G (Carbofuran) @ 4% before sowing.

Stem fly infestation started from March 09, 2005 and showed an increasing trend with the progress of the season and reached at the peak on 13 April 2005 and then slightly decreased up to the end of the season. The results revealed that the stem tunneling started on March 09, 2005 with a peak on 23 March, 2005. After that the stem tunneling was decreased, again stem tunneling increased on 07 April and slightly decreased on 13 April 2005. Then an increasing trend was observed up to the end of the season.

The lowest number shoot fly (0.75 larvae/ pupae plant) was observed from Seed treatment by Furadan 5G (Carbofuran) @ 4% before sowing. Untreated control had the highest larvae or pupae (1.45).

Stem fly larvae/ pupae were first noticed on 09 March, 2005 and the prevalence was continued up to the April 19, 2005. At the beginning of the season, a slightly increasing trend was found and then declined on 23 March, After that, abundance of larvae or pupae was suddenly increased up to the 07 April.

The lowest number of whitefly (1.95/5 leaves) was recorded from the application of Furadan 5G which also ensured the highest population reduction of 62.87% over control followed by Shobicorm 425 EC treatments (2.02 whitefly/5 leaves) which was equivalent to a reduction of 61.53 % successively over control.

Whitefly incidence started from 08 April, 2005 and showed an increasing trend with the progress of the season, but after May 28, a sudden decline of population was noticed.

The results indicated that the Spraying of Shobicorm 425 EC @ 20 ml/L of water at 20DAS and at 35 DAS (57.92%) had the lowest number of thrips (2.5 per 5 leaves) where as the highest number of thrips (5.2 per 5 leaves) was recorded from untreated control which was statistically different from other treatments.

The results indicated that the highest seed yield of Mungbean was found under T_1 treatment (950.5 kg/ha) and the lowest was found under T_7 treatment (590.3 kg/ha).

The results revealed that the incidence of thrips started on 08 April, 2005. From April 26-29 at the reproductive stage, the thrips incidence started to increase and reached at the peak on May 13 and it was continued up to the end of the season.

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APPENDICES

APPENDICES

Appendix I. Monthly recorded of temperature, relative humidity, rainfall and sunshine during the period from February, 2005 to June, 2005

Year	Month	Air temperature (^0C)			Relative humidity (%)	Rainfall (mm)	Sunshine (hours)
		Maximum	Minimum	Average			
2005	February	28.92	18.40	23.66	82.03	00.3	172.45
	March	31.28	19.10	25.19	75.29	01.7	236.89
	April	30.98	21.92	26.45	80.23	146.6	194.22
	May	32.04	24.14	28.09	82.55	413.2	187.67
	June	31.13	25.75	28.44	87.67	335.5	189.79

Appendix II: Analysis of variance (ANOVA) for the damage severity of stem fly by infesting plants and stem tunneling of mungbean during Kharif 2005 at Gazipur.

Sources of variation (SV)	Degree of Freedom (DF)	Mean square value	
		Stem fly infesting plants (%)	Stem tunneling (%)
Replication	3	9.524	2.381
Factor A	6	106.946**	24.976**
Error	18	9.524	2.381
CV(%)		17.32	8.49

Means followed by common letters do not differ significantly

NS = Not significant

** = Significant at 1% level of probability

* = Significant at 5% level of probability

Appendix III: Analysis of variance (ANOVA) for the incidence of stem fly larvae/pupae attacking mungbean during Kharif 2005 (March-June) at Gazipur.

Sources of variation (SV)	Degree of Freedom (DF)	Mean square value
		Number of larvae/pupae per plant
Replication	3	0.015
Factor A	6	0.522**
Error	18	0.015
CV(%)		17.28

Means followed by common letters do not differ significantly

NS = Not significant

** = Significant at 1% level of probability

* = Significant at 5% level of probability

Appendix IV: Analysis of variance (ANOVA) for the incidence of white fly attacking mungbean during Kharif 2005 (March-June) at Gazipur.

Sources of variation (SV)	Degree of Freedom (DF)	Mean square value
		Number of larvae/pupae per plant
Replication	3	0.381
Factor A	6	5.500**
Error	18	0.381
CV(%)		20.55

Means followed by common letters do not differ significantly

NS = Not significant

** = Significant at 1% level of probability

* = Significant at 5% level of probability

Appendix V: Analysis of variance (ANOVA) for the incidence of trips attacking mungbean during Kharif 2005 (March-June) at Gazipur.

Sources of variation (SV)	Degree of Freedom (DF)	Mean square value
		Number of larvae/pupae per plant
Replication	3	0.857
Factor A	6	3.116*
Error	18	0.857
CV(%)		27.39

Means followed by common letters do not differ significantly

NS = Not significant

** = Significant at 1% level of probability

* = Significant at 5% level of probability

Appendix VI: Analysis of variance (ANOVA) for effect of different treatments on the seed yield of mungbean

Sources of variation (SV)	Degree of Freedom (DF)	Mean square value
		Seed yield of Mungbean (kg/ha)
Replication	3	952.382
Factor A	6	59023.768*
Error	18	952.382
CV(%)		3.88

Means followed by common letters do not differ significantly

NS = Not significant

** = Significant at 1% level of probability

* = Significant at 5% level of probability