STUDY ON THE INCIDENCE OF MAJOR INSECT PESTS OF SOYBEAN AND THEIR MANAGEMENT

BY

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CERTIFICATE

*This is to certify that the thesis entitled, "**STUDY ON THE INCIDENCE OF MAJOR INSECT PEST S OF SOYBEAN AND THEIR MANAGEMEN**" submitted to the Department of Entomology, 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 bonafide research work carried out by **MASUM SHARIF SAZIDY**, Registration No. **05-1823** under my supervision and my 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.

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Dated

SAU, Dhaka


DEDICATED
TO
MY BELOVED PARENTS

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STUDY ON THE INCIDENCE OF MAJOR INSECT PESTS OF SOYBEAN AND THEIR MANAGEMENT

Abstract

The experiment was conducted at the experimental Field of Sher-e-Bangla Agricultural University, Dhaka during the *rabi* season from November, 2010 to March, 2011 to study on the major insect pest of soybean and their management. The experiment comprised with seven different insecticides including control treatment viz. Marshal 20EC @ 3ml/L water; Semcap 50EC @ 3ml/L water; Dursban 20EC @ 3ml/L water; Basathrin 10EC @ 1ml/L water, Fiter 2.5EC@ 1 ml//L water, Sobicorn 425EC @ 2 ml//L water, Aktara 5G @ 3 mg//L water, Control were used in this study. Soybean var. Shohag was included in this study. A single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Result revealed that the lowest number of aphid, jassid, whitefly, thrips and pod borer was recorded from T_1 (Marshal 20EC @ 3ml/L water) while the height number was in untreated control treatment (T_8). The height percent reduction of aphid, jassid, whitefly, thrips and pod borer population over control was also recorded from T_1 treatment (use of Marshal 20EC @ 3ml/L water) as compared to other treatment. The yield of soybean per plot was the height (1.10kg) in T_1 (Marshal 20EC @ 3ml/L water) treated plot and lowest yield controled treatment. Similarlay the yield of soybean per hectare was also the height (11.00 ton) in T_1 treated plot followed by T_7 treated plot and lowest was in controlled treatment (T_8). The findings of present study indicated that Marshal 20EC @ 3ml/L water could be used to reduce the incidence of major insect pest of soybean as well as to increase the yield of soybean.

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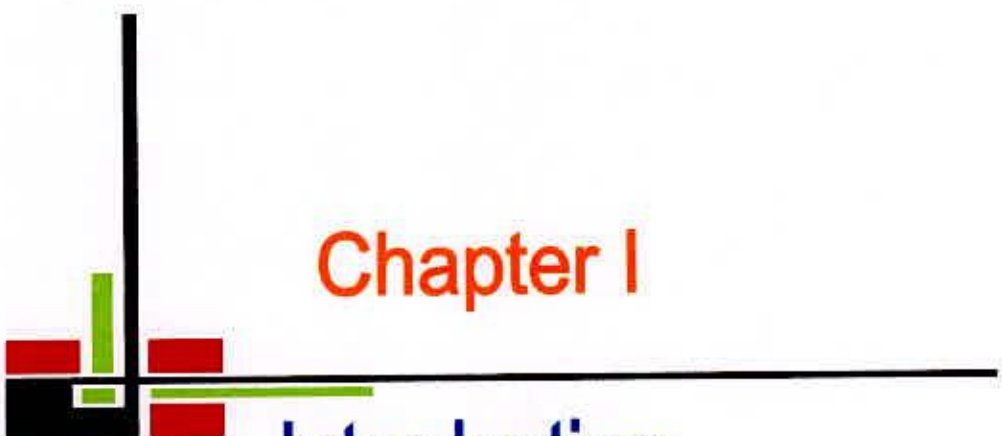
LIST OF ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
ppm	=	Parts per million
et al.	=	And others
N	=	Nitrogen
TSP	=	Triple Super Phosphate
MP	=	Muriate of Potash
RCBD	=	Randomized complete block design
DAS	=	Days after sowing
ha^{-1}	=	Per hectare
G	=	gram (s)
Kg	=	Kilogram
µg	=	Micro gram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
No.	=	Number
WUE	=	Water use efficiency
Wt.	=	Weight
LSD	=	Least Significant Difference
^0C	=	Degree Celsius
mm	=	millimeter
Max	=	Maximum
Min	=	Minimum
%	=	Percent
cv.	=	Cultivar
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of coefficient of variance
Hr	=	Hour
T	=	Ton
viz.	=	Videlicet (namely)



Chapter I

Introduction

CHAPTER I

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is a fascinating crop with innumerable possibilities of not only improving agriculture, but also supporting industries. Soybean is a major source of edible oil (20%) and high quality protein (40%). It is also a rich source of aminoacids, vitamins and minerals. Soybean oil is used as a raw material in manufacturing antibiotics, paints, varnishes, adhesives, lubricants etc. Soybean meal is used as protein supplement in human diet, cattle and poultry feeds.

Soybean is a major oil seed crop of world grown in an area of 91million ha with productivity of 2,233 kg/ha (Anon., 2006). The crop is mainly cultivated in USA, China, Brazil, Argentina and India. India contributes more than 90 per cent of world's acreage. In India it is grown over an area of 8.17 million ha with production of 9.46 mt and productivity of 1,069 $kgha^{-1}$ (Anon., 2007). Major soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh and Gujarat. In Karnataka, soybean occupies an area of 1.62 lakh ha with production of 1.53 lakh tonnes and productivity of 950 kg per ha (Anon., 2007). Belgaum, Dharwad, Bidar, Bagalkot and Haveri are the major soybean growing districts of Karnataka.

The low productivity of soybean both at national and state level is attributed to abiotic and biotic stresses like drought, weeds, insect pests and diseases. Among these, insect

pests often pose a serious threat to soybean production by increasing cost of cultivation and impairing quality of produce in many ways.

The luxuriant crop growth, soft and succulent foliage attracts many insects and provides unlimited source of food, space and shelter. Soybean crop is reported to be attacked by about 350 species of insects in many parts of the world (Luckmann, 1971). About 65 insect pests have been reported to attack soybean crop from cotyledon to harvesting stage (Rai *et al.*, 1973; Adimani, 1976; Thippaiah, 1997 and Jayappa, 2000). Among them some are fatal to this crop and have changed their severity of attack in last few years.

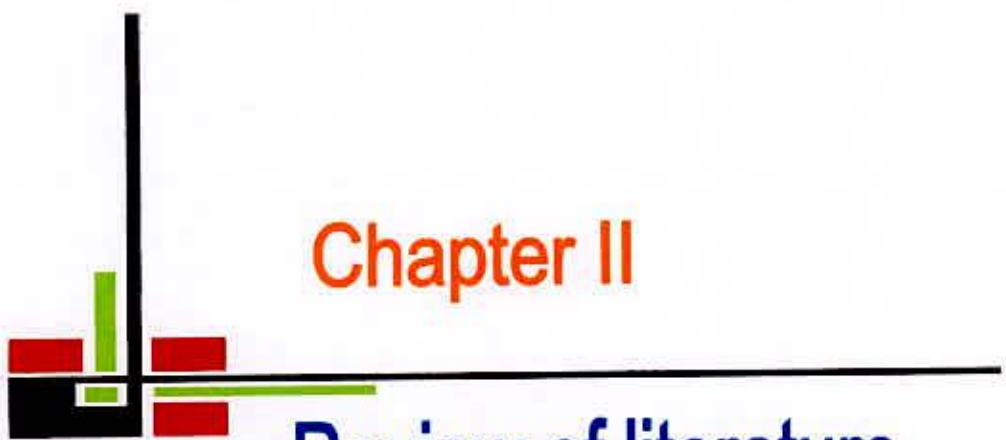
Soybean is very much susceptible to insect attack from seedling to mature stage. All parts of the plant including plant leaves, stems and pods are subjected to attack by different species of insect in Bangladesh. Different species of insect cause serious damage by direct feeding as well as by transmitting various diseases (Daugerty, 2009). The frequency and severity of insect pest damage vary considerably between the growth stages. Thirty nine species of insect pest have been recorded at the different growth stages of soybean in Noakhali region. Of these, eight species were recorded as the major pests and rests were minor importance. The most damaging insects were hairy caterpillar, leaf roller, common cutworm, pod borer, stem flies, bugs and white fly were found to damage during vegetative, flowering and pod formation stage of the crop (Biswas, 2001). There are many insect pests are found in soybean field such as soybean semilooper, soybean hairy caterpillar, soybean leaf roller, soybean fly, jassid, soybean pod borer, soybean leaf hopper, stink bug, black leaf beetle, short horned grass hopper, green leaf

hopper, brown plant hopper, cut worm and the natural enemies found were lady bird beetle, carabid beetle and spider (Rahman, 2010).

To overcome these losses caused by insect pests various control measures have been recommended. Of which chemical control measures are reported to be more effective. The investigations on synthetic organic insecticides developed during 20th century initially provided spectacular results in suppressing the insect pests which led to abandonment of traditional pest control practices (Dhaliwal and Arora, 1998). However indiscriminate use of insecticides has led to problems like insecticide resistance, pest resurgence and environmental pollution besides upsetting the natural ecosystem (Lakhansingh and Sanjeev Kumar, 1998).

Considering the facts as stated above, the present investigation was undertaken with the following objectives:

- To know the effect of different insecticide on the incidence of major insect pest of soybean.
- To explore the efficiency of different insecticides on the percent reduction over contrl of different insect pests infesting soybean.



Chapter II

Review of literature

CHAPTER II

REVIEW OF LITERATURE

2.1 Incidence of major insect pests in soybean ecosystem

Approximately 380 species of insects have been collected from soybean crop from many parts of the world (Luckmann, 1971). A total of 267 insect species were reported from soybean fields in Arkansas (Tugwell *et al.*, 1973). Fletcher (1922) was the earliest worker to report the incidence of nine species of insects occurring on soybean from India. Ramakrishna Ayyar (1963) reported two insects of soybean crop from south India.

Rawat *et al.* (1969) recorded over two dozen different species of arthropod pests of soybean from Madhya Pradesh, India. Saxena (1972) observed 32 insect pests and two non-insect pests of soybean in Madhya Pradesh. Singh (1973) reported 56 insect pests and a mite on soybean crop from Pantnagar, Uttar Pradesh.

Rai *et al.* (1973) recorded 24 insect species feeding on soybean in Karnataka, among them maximum damage was done by the larvae of *Lamprosoma indicata* F, *Stomopteryx subsecivella* Zeller, *Diacrisia oblique* Walker and the gelechid shoot borer. About 85 species of insects belonging to six different Orders and a mite on soybean were reported from Madhya Pradesh by Gangrade (1962) Adimani (1976) recorded 59 insect species belonging to six Orders occurring around Dharwad on soybean in Karnataka. The

semilooper, *Thysanoplusia orichalcea* was a pest mainly during *kharif* although it was observed in stray instances during summer also (Mundhe, 1980).

Singh *et al.* (1988) reported a higher larval populations of the noctuid, *Rivula* sp. On DS 76-1-29 and PK 472 (18.4-19.8 larvae/10 plants) than on MACS 75 and JS 76-259 (4.8-5.0 l/10 plants). PK 472 and Bragg sown on 25th June, however, gave maximum grain yield compared with the remaining cultivars and dates of sowing. Cultivars sown on 25th June had higher larval populations of *Rivula* sp. (20.5 l/10 plants).

Sontakke and Patro (1991) reported the incidence of about 20 insect pests on soybean in Western Orissa.

Field studies were carried out during 1988-89 in Chiplima, Orissa, India, and the *kharif* crop of soybeans suffered greater damage by insect pests than the *rabi* crop. Lowest pest incidence and higher yields were recorded with early sowings (20th June, 5th July and 1st 15th November) in both seasons. Three need-based applications of monocrotophos in *kharif* and two in *rabi* gave satisfactory control of all the insect pests, resulting in increased grain yield of 11.2 and 3.1 q/ha, respectively as compared to control as reported by Sontakke and Mishra (1994).

Field studies conducted in Himachal Pradesh, India, during 1993 showed that delaying the sowing date of soybeans resulted in the decrease of yields. The maximum yield (3.69

tones/ha) was obtained by sowing on 28th May and the lowest yield (1.45 tones/ha) was obtained by sowing on June 25th (Chandel and Gupta, 1995).

The studies on date of sowing carried out at Dharwad also revealed the higher incidence of *S. litura* with late sown groundnut crop (Patil, 1995).

Occurrences of 34 species of insects were observed during *kharif* and summer in Bangalore. Among them *Aproaerema modicella* (Deventer), *Liriomyza trifolii* (Burgess), *Melanagromyza sojae* (Zehntner), *T. orichalcea, Monolepta* sp. and *H. armigera* were considered as major insect pests on the crop (Venkataravanappa, 1996).

Thippaiah (1997) noticed 34 species of insects on soybean during *kharif* season and 25 species during summer season, in Bangalore, Karnataka. Among these, lepidopteran defoliators, *T. orichalcea, S. litura, Achaea janata* (Linn.) *and A. lactina* (L.) appeared only during *kharif* season where as *Spilosoma obliqua* (Walker) was noticed during both summer and *kharif* seasons.

Chaturvedi *et al.* (1998) reported that during *kharif* of 1995, 17 insect and one mite species were recorded infesting soybean variety JS 72-44 (Gaurav) sown on 15th July 1995 in Sehore, Madhya Pradesh, India. Of these, two damaged the stems, 10 defoliated the plants, five sucked the cell sap and one damaged the roots at different growth stages of the crop, immediately after the emergence of the cotyledons.

The population density of some insects associated with soybean was estimated in a field experiment in India in *kharif* 1985 by following simple random sampling and two-stage sampling techniques at three stages of plant growth, 60-64, 86-89 and 98-99 days after sowing, using the ground cloth sampling method. Population densities of *S. obliqua* Walker and *S. litura* (Fab.) during the crop growth period were maximum around the second half of October. However, density of *T. orichalcea* (Fab.) was higher during the later part of September or early October. Significant correlations were observed between population densities of some insect species as reported by Vinod Kumar *et al.* (1998).

Populations of *Biloba subsecivella* (Zuller) (*Bilobata subsecivella*), *Chrysodeixis acuta* (Walker), *S. litura* and *S. obliqua* (Walker) (*Spilarctia obliqua*) were low in early-sown (22June and 2 July) soybeans. Incidence of these pests was high in crops sown between 12 July and 1 August, (Mandal *et al.*, 1998).

Jayappa (2000) reported 40 and 21 species of insects attacking soybean during *kharif* and summer seasons, respectively in Bangalore, Karnataka. 300 species of insect pests were infesting soybean, of which blue beetle, grey semilooper, green semilooper and stem fly were major insect pests in Madhya Pradesh (Singh *et al.*, 2000).

The lepidopteron defoliators like *S. litura, T. orichalcea* and *S. obliqua* were observed on the crop from 28 days after growth and caused severe defoliation in Bangalore as reported by Kamala (2000).

Negoyen Phi-Dieu Hoyen (2001) reported that lepidopteron defoliators like *S. litura,T. orichalcea* and *L. indicata* were observed from 21 DAG, of which *H. armigera* was a major pest. *S. litura* (Fab.) was seen from 21 to 49 DAG with less incidence (0.12 to 0.5 per plant), *T. orichalcea* was observed from 21 to 77 DAG and population was more at 42 and 49 DAG.

Patil (2002) reported that soybean was attacked by 48 phytophagous insect species, among these the seedling borers, *M. sojae* Zehnter, *Obereopsis brevis* Swed, leaf eating caterpillar *S. litura* (Fab.) and pod borer, *Cydia ptychora* Meyrick were key pests during *kharif*. Whereas, leaf miner, *A. modicella*, white fly, *Bemisia tabaci* Genn and leaf hopper, *Ambrasca biguttula biguttula* Ishida were major pests during summer.

An experiment was carried out at the experimental station of the University of Tocantins in Gurupi, Brazil to determine the population fluctuation of soybean pests. Among defoliating caterpillars, *A. gemmatalis* (Hub.) and *Cydia includens* were the most abundant. Among the defoliating beetle complexes, *Cerotoma arcuata* (Oliv.) was the most abundant, with population peaks near the reproductive stage as reported by Didonet *et al.* (2003).

Sastawa *et al.* (2004) reported that the number of insect defoliators and pod sucking bugs were significantly higher in soybean sown on 31st July in 2001 and on 28th August in 2002. Grain yields were higher in early sown soybean in 2001 compared to 2002.

Meena and Sharma (2006), reported the minimal larval population of 1.42 larvae per mrl in early sown crop (25th June), followed by mid sown crop and late sown crop which recorded 1.67 and 1.87 larvae per mrl, respectively at udaipur, Rajasthan. Madrap *et al.*, 2007 recorded the seasonal incidence of insect pests of soybean during *Kharif* season at Parbani. The studies revealed that the infestation of leaf miner and semilooper was less during the season. However, infestation of *S. litura* and girdle beetle was more up to 6.8 and 5.6 per cent, respectively.

Maximum larval population of *S. litura* and *T. orichalcea* (7.80, 12.00, 12.80 and 6.50, 6.20 and 8.60 larvae/mrl, respectively) were noticed on the crop sown on 08-06-06, 27-06-06 and 08-06-06 dates, respectively. Early sown crop recorded lower incidence of *S.litura, T. orichalcea* and *S. obliqua* compared to that of late sown crop as reported by Harish (2008).

Taylor (1964) observed four to five generations of the pod borer *C. ptychora* on two crops of cowpea that were grown in succession each year in Nigeria. However, the seasonal fluctuation in the population of pod borers was studied by sowing crop in different months. Highest per cent pod damage was recorded in the crop sown during the months of July and August. However, the crop sown during the months of November, December, January, February, March and April remained free from infestation (Kumar, 1978).

Olaifa and Akingbohungbe (1982) reported that the seasonal population fluctuation of cowpea moth, *C. ptychora* in black gram increased from May to September and declined during rest of the months of the year. The incidence of pod borer *C. ptychora* on green gram was observed from the month of May and the crop sown after October was free from incidence of pod borer. The highest incidence (70.80%) was noticed in the crop sown during the month of July which gradually declined in the crop sown during subsequent months. However, the crop sown during rest of the year was free from incidence (Katti, 1984).

Jagginavar *et al.* (1990) reported the seasonal abundance of pod borer complex on cowpea at Dharwad and concluded that the crop sown during the month of July recorded the highest incidence of *C. ptychora* where crops sown during subsequent months recorded reduction in the incidence.

Amarnath (2000) studied on the seasonal incidence of pod borer at Dharwad, revealed that the population of *C. ptychora* on soybean was at peak on the crop sown during the first fortnight of July, which recorded highest per cent (79.22%) pod damage. However decline in the pest population was observed on subsequent sowing. Pod borer incidence was maximum in July sown crop. The per cent incidence of stemfly was low (17.66%) on soybean sown in second week of June whereas it was high (21.70%) with girdle beetle. The per cent pod borer damage was low (21.43%) on early sown crop during June as reported by Patil (2002).

Sharanabasappa and Goud (2003) studied the incidence of *C. ptychora* on green gram involving four different sowing dates at an interval of 15 days, i.e. in the second fortnight of June, first fortnight of July, second fortnight of July and first fortnight of August in Belgaum and Dharwad Districts. The crop sown during the first fortnight of July recorded the maximum of 57.29 per cent pod and 35.74 per cent seed damage, which was significantly higher than the other dates of sowing. The pod and seed damage in case of crop sown during the second fortnight of June, second fortnight of July, and first fortnight of August were 23.37 and 13.43, 44.00 and 22.73, and 31.00 and 17.65 per cent respectively, which differed significantly from each other.

IMPACT OF SOYBEAN APHID

Soybean, *Glycine max* (L.) Merrill (Fabaceae: Phaseoleae), grown in the North-Central region of the United States have historically required a low amount of management for insect and arthropod pests (USDA 1998, Fernandez-Cornejo 1999). Following the arrival in 2000 of the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), insect management on soybean became a more common component of soybean production (Ragsdale et al. 2004). Soybean aphid activity causes yield loss in soybean from three types of injury: direct plant feeding (assimilate removal) (Myers et al. 2005a, Ragsdale et al. 2007), virus transmission

(Clark and Perry 2002, Burrows et al. 2005, Davis et al. 2005, Davis and Racliffe, 2008), and reduced light interception due to secondary pathogen development (Macedo et al.

2003). These injuries have resulted in yield reductions of up to 50 percent (Ragsdale et al. 2007, Johnson et al. 2009). The potential for soybean aphid to cause significant yield damage and economic loss (Ragsdale et al. 2007, Johnson et al. 2009, Song and Swinton 2009) has captured the attention of both the agricultural and entomological communities (Heimpel and Shelly 2004) resulting in a sizable body of research in less than ten years time. A brief review of aphid management publications include: chemical control studies (McCornack and Ragsdale 2006, Ragsdale et al. 2007, Johnson et al. 2009, Ohnesorg et al. 2009), biological control studies (Van den Berg et al. 1997, Fox et al. 2004, Heimpel et al. 2004, Rutledge et al. 2004, Fox et al. 2005, Nielson and Hajek 2005, Rutledge and O'Neil 2005, Mignault et al. 2006, Kaiser et al. 2007, Schmidt et al. 2007, 2008, Noma and Brewer 2008, Gardiner et al. 2009), and host plant resistance studies (Mensah et al. 2005, Hill et al. 2006, Hesler et al. 2007).

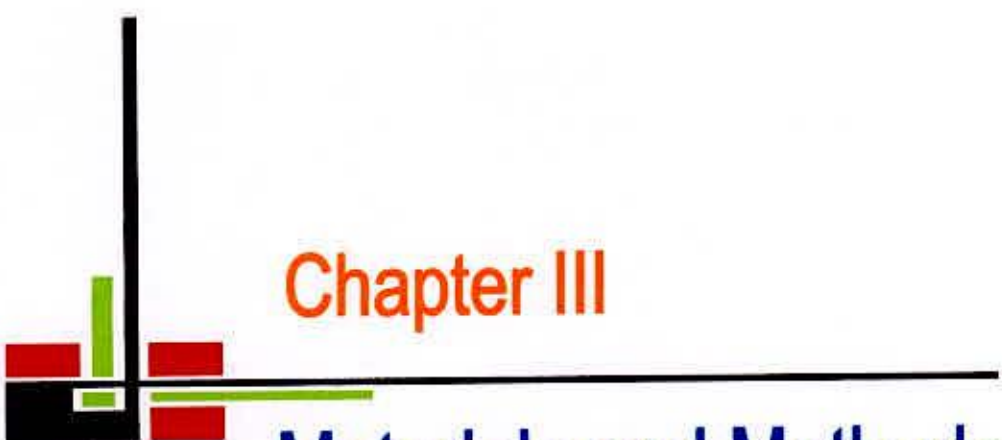
BIOLOGY OF SOYBEAN APHID

The soybean aphid is an invasive species which is native to Southeast Asia. The soybean aphid was first discovered in North America (Wisconsin) in July of 2000 (Hodgson et al. 2004, Ragsdale et al. 2004). By July 2002 soybean aphids were found in every county of Iowa (Lang 2003), and by 2004, soybean aphids were reported in 24 states and three provinces of Canada (Losey et al. 2002, Ragsdale et al. 2004, Voegtlin et al. 2004a,).

The importance of understanding soybean aphid biology in North America was so great that *the Annals of the Entomological Society of America* dedicated a special issue to the

biology of soybean aphid in North America and its management (Heimpel and Shelly 2004). Prior to the arrival of soybean aphid in the Midwestern United States, no aphids were known to colonize soybean fields, or cause yield losses in soybean due to feeding injury (Kogan and Turnipseed 1987, Higley and Boethel 1994). Only the cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) could be found and reproduce on soybean in the Midwestern United States. However, the cotton aphid did not cause yield damage (Blackman and Eastop 2000). The fact that cotton aphid was the only aphid in North American known to feed on soybean partially explains why initial reports of aphids colonizing soybean were incorrectly identified as the cotton aphid (Voegtlin et al. 2004b). In addition to having a common summer host, there are many morphological similarities between the two species.

Cotton aphid and soybean aphid are approximately the same size and shape (0.9 mm to 1.9 mm for apterous (wingless) females and 1.1 mm to 1.9 mm for alate (winged) females). They have similar coloration and patterns (Blackman and Eastop 2000). The morphological similarities are so similar that, "It may not be possible to determine every specimen collected on soybean with complete certainty" (Voegtlin *et al.* 2004b).



Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The study was conducted at the experimental Field of Sher-e-Bangla Agricultural University, Dhaka during the *rabi* season from November 2010 to March 2011 to study the effect of chemical onsecticide on the incidence of major insect pests of soybean.

3.1 Description of the experimental site

3.1.1 Site and soil

Geographically the experimental field was located at 23^0 77' latitude and 90^0 33' E longitudes at an altitude of 9 m above the mean sea level. The soil belonged to the Agro-ecological Zone – Modhupur Tract (AEZ 28). The land topography was medium high and soil texture was silt clay with pH 8.0. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix-1.

Experimental site

3.1.2 Climate and weather

The climate of the locality is subtropical which is characterized by high temperature and heavy rainfall during *Kharif* season (April-September) and scanty rainfall during *Rabi* season (October-March) associated with moderately low temperature. The prevailing weather conditions during the study period have been presented in Appendix-II.

3.2 Plant materials

The experiment was carried out with soybean variety "Shohag". Seeds of shohag were collected from siddique bazar, Dhaka.

3.3 Treatments under investigation

A single factor experiment was carried out with the following treatments :

T_1: Marshal 20EC @ 3ml/L water

T_2: Semcap 50EC @ 3ml/L water

T_3: Dursban 20EC @ 3ml/L water

T_4: Basathrin 10EC @ 1ml/L water

T_5: Fiter 2.5EC@ 1 ml//L water

T_6: Sobicom 425EC @ 2 ml//L water

T_7: Aktara 25 WG @ 0.5 mg//L water and

T_8: Control

3.4 Experimental design and layout

The experiment was laid out in a one factor randomized complete block design (RCBD) design having three replications. Each replication had 8 unit plots to which the treatment combinations were assigned randomly. The unit plot size was 5 m^2 (2.5m ×2m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing respectively.

3.5 Land preparation

The experimental land was opened with a power tiller on 14th November 2010. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 29th November 2010 and was ready for sowing seeds.

3.6 Fertilizer application

The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5 Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil.

3.7 Sowing of seeds

Seeds were sown at the rate of 60 kg ha^{-1} in the furrow and the furrows were covered with the soils soon after seeding. The line to line (furrow to furrow) distance was maintained treatment arrangements with continuous sowing of seeds in the line.

3.8 Germination of seeds

Seed germination occurred from 3rd day of sowing. On the 4th day the percentage of germination was more than 85% and on the 5th day nearly all baby plants (seedlings) came out of the soil.

3.9 Intercultural operations

3.9.1 Weed control

Weeding was done once in all the unit plots with care so as to maintain a uniform plat population as per treatment in each plot at 15 DAS.

3.9.2 Thinning

Thinning was done at 20 days after sowing (DAS) and 35 DAS. Plant to plant distance was maintained at 10 cm.

3.9.3 Irrigation and drainage

Irrigation was done as needed. During experimental period, there was heavy rainfall for several times. So it was essential to remove the excess water from the field.

3.9.4 Insect and pest control

Application of pesticide as per treatment

3.10 Data collection

3.10.1 Number of major insect pests of soybean and percentage of reduction over control

Numbers of major pests (aphid, jassid, whitefly, thrips and pod borer) were recorded at 7 days interval. Five plants were selected randomly 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 9 weeks (9 times). Reduction percentage was also recorded on the basis of control treated plant where the maximum number of major pest was attack. The following formula were used for taking the reduction percentage

$$\text{Reduction (\%)} = \frac{\text{No. of pests as per treatments - No. of pests of control}}{\text{No. of pests of control}} \times 100$$

3.10.2 Yield plot^{-1} (g)

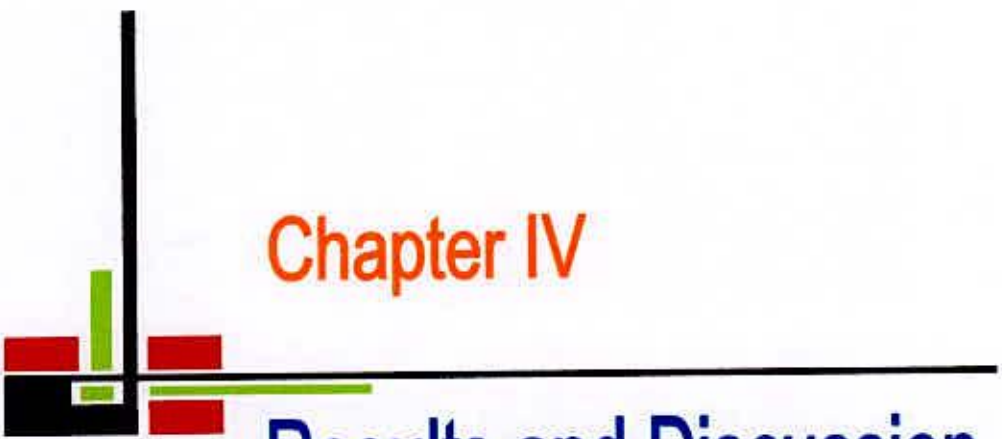
Seed yield were recorded from randomly selected ten pods. After harvesting the plant was sun-dried and threshed by pedal thresher. Seed were properly sun-dried and their weights recorded. Seed yield was then converted to kg plot^{-1}.

3.10.3 Seed yield (t ha^{-1})

Seed yield was recorded on the basis of total harvested seeds plot^{-1} and was expressed in terms of yield (t ha^{-1}). Seed yield was adjusted to 12% moisture content.

3.11 Data analysis

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Duncan's Multiple Range Test (DMRT) test (Gomez & Gomez, 1986).



Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experimental results were studied on the major insect pest of soybean and their management. The results obtained from the present study for incidence of soybean pest. Beside different crop characters have been also present and discussed in this chapter with some tables and figures as follows:

4.1 Effect of different treatments on the incidence of aphid

Incidence of aphid and their reduction percentage on soybean showed significant difference. Those significant variation results were also present in Table 1. Different chemicals were used to suppress the incidence of aphid and to test the effectiveness of their control whereas the maximum incidence of aphid (7.00, 6.93, 4.80, 4.33, 3.80, 3.13, 2.47, 2.87, 2.97 and 4.26 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) was found under the untreated treatment (control treatment) on soybean. Among the chemicals using Marshal 20EC @ 3 ml L^{-1} of water gave the maximum control of aphid (4.13, 4.07, 1.77, 1.47, 1.00, 1.27, 1.87, 1.67, 1.33 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) and it was maximum percent of reduction over control (51.52%). But compare to other treatments, use of Basathrin 10EC @ 1ml/L of water showed less effectiveness to suppress the aphid (4.87, 4.40, 3.07, 1.80, 1.73, 1.60, 2.47, 1.80 and 1.80 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) which was minimum percent of reduction over control (38.55%).

Table 1: Effect of different treatments on the incidence and percent reduction of aphid on soybean at differrent days after swoing (DAS)

Treatment	Number of aphid at different days sowing (DAS)										% Reduction over control
	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean	
T_1	4.13 b	4.07 b	1.77c	1.47c	1.00s	1.27 b	1.87b	1.67 b	1.33b	2.06	51.52
T_2	4.20b	4.33 b	2.53bc	1.87c	1.27cd	1.33 b	2.27ab	1.73 b	1.53b	2.34	45.00
T_3	4.14b	4.40 b	2.73bc	2.07bc	1.80b	1.73 b	2.20ab	1.73 b	1.93b	2.53	40.62
T_4	4.87 b	4.40 b	3.07 b	1.80c	1.73b	1.60 b	2.47a	1.80 b	1.80b	2.61	38.55
T_5	4.33 b	4.40 b	2.47bc	2.53b	1.07d	1.60 b	2.07ab	1.81 b	1.93b	2.47	42.01
T_6	4.53 b	4.33 b	2.53bc	2.07bc	1.53bc	1.27 b	2.00b	1.87 b	1.87b	2.44	42.56
T_7	4.67b	4.27 b	3.13b	2.00bc	1.27cd	1.67 b	2.20ab	2.20 b	1.73b	2.57	39.60
T_8	7.00a	6.93a	4.80a	4.33a	3.80a	3.13a	2.47a	2.87a	2.97a	4.26	
LSD 0.05	0.96	0.76	0.90	0.59	0.36	0.65	0.41	0.65	0.78	0.67	
CV%	11.59	15.03	34.14	28.34	29.28	21.95	25.23	18.96	23.48	23.11	

In a column, means having similar letter(s) are statistically identical at 5% level of significance.

T_1: Marshal 20EC @ 3ml/L water
T_2: Semcap 50EC @ 3ml/L water
T_3: Dursban20EC @ 3ml/L water
T_4: Basathrin 10EC @ 1ml/L water
T_5: Fiter 2.5EC@ 1 ml//L water
T_6: Sobicorn 425EC @ 2 ml//L water
T_7: Aktara 25 WG @ 0.5 mg//L water
T_8: Control

Table 1 shows the mean incidence of aphid at different duration by using chemical treatments. The highest mean incidence of aphid was observed in control soybean (4.26) and the best performance was noticed in Marshal 20EC @ 3 ml L^{-1} water (2.06).

From the above results, it was found that the Marshal 20EC @ 3 ml L^{-1} water treated was more effective to reduce the incidence of aphid (*Aphis craccivora*) as well as maximum percent of reduction over control. Marshal 20EC @ 3 ml L^{-1} water was more effective to control aphid as compared to other treatments which might ensure the greater yield. A heavy aphid infestation becomes readily visible when they spread to the upper leaves and pods. There are no set thresholds for aphid in soybeans. Aphids inject toxins into the plant while feeding. Severe infestations most likely reduce soybean vigour and yield. Aphid feeding produces honeydew making harvesting difficult. Honeydew produced by aphids promotes sooty mould which reduces photosynthesis.

4.2 Effect of Different treatments on the incidence and percentage reduction of jassid

Pestjassidjad significant affected on soybean at weekly observation which results are present in table 2. Incidence of jassid and their reduction percentage on soybean showed significant difference. Different insecticides were used to suppress the incidence of jassid and to test their effectiveness whereas the maximum incidence of jassid (6.6, 52.7, 6.27, 3.53, 4.4, 3.00, 2.8, 3.6, and 4.27 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) was found in the untreated treatment (control treatment) on soybean.

From the table 2, it was found that the soybean plant when treated by Sobicorn 425EC @ 2 ml/L of water, incidence of jassid was (4.27, 2.67, 2.87, 2.13, 3.00, 2.13, 1.93, 2.2, 1.73 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) which had reduction (40.28%) of jassid as compared to control treatment. Among the treatments , T_1 (marshal 20EC@3 ml L^{-1} of water) was more effective against jassid controlled as well as the jassid number was the lowest (2.4, 2.6, 2.2, 2.0, 1.73, 0.93, 1.2 and 1.8 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) on soybean research field which increased the natural growth and maximizing the yield of soybean. The treatment showed the highest reduction (58.34%) over control treatment (Table 2).

Table 2: Effect of different treatments the on incidence and percent reduction of jassid on soybean at different days after sowing (DAS)

Treatment	Number of Jassid at different days sowing (DAS)										% Reduction over control
	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean	
T_1	2.40c	2.60d	2.20d	2.00c	1.73d	0.93b	1.20b	1.80b	1.13c	1.78	58.34
T_2	3.40bc	3.20b	3.20b	2.13bc	2.60bc	1.73ab	2.10 ab	1.87b	1.93b	2.46	42.28
T_3	3.67bc	3.07bc	2.60bcd	2.43bc	2.47bc	1.33 ab	2.07 ab	1.87b	1.67bc	2.35	44.88
T_4	4.07b	2.67cd	2.27cd	2.20bc	2.40bc	1.87 ab	1.93 ab	2.27b	1.53bc	2.36	44.79
T_5	4.40b	2.73cd	2.40cd	2.40b	2.73bc	1.47 ab	2.00 ab	2.53b	1.73bc	2.49	41.67
T_6	4.27b	2.67cd	2.87bc	2.13bc	3.00b	2.13 ab	1.93 ab	2.20b	1.73bc	2.55	40.28
T_7	4.33b	2.87bcd	2.73bcd	2.13bc	2.20cd	1.60 ab	1.87 ab	2.20b	1.87bc	2.42	43.23
T_8	6.60a	5.27a	6.27a	3.53a	4.40a	3.00 ab	2.80a	3.60a	2.93a	4.27	
LSD 0.05	1.28	0.42	0.59	0.29	0.58	1.78	0.89	0.70	0.67	0.80	
CV %	24.60	22.72	20.94	20.13	12.35	23.03	25.18	17.51	21.01	20.83	

In a column, means having similar letter(s) are statistically identical at 5% level of significance.

T_1: Marshal 20EC @ 3ml/L water
T_2:Semcap 50EC @ 3ml/L water
T_3: Dursban20EC @ 3ml/L water
T_4:Basathrin 10EC @ 1ml/L water
T_5:Fiter 2.5EC@ 1 ml//L water
T_6: Sobicorn 425EC @ 2 ml//L water
T_7:Aktara 25 WG @ 0.5 mg//L water
T_8: Control

From the above results observation on incidence of jassid and their controlled by different treatment, it was found that the controlled agent marshal 20EC@3 ml L^{-1} on soybean research field decrease the number of jassid at vegetative and reproductive stage. Whereas all entire chemical insecticide reduce the number of jassid from vegetative to reproductive stage whereas marshal 20EC@3 ml L^{-1} showed the best performance against jassid. The results obtained from other treatments showed intermediate percent incidence of jassid compared to highest and lowest incidence.

4.3 Incidence of whitefly and percent reduction over control as influenced by different treatments

Whitefly is also very destructive for soybean production. The collecting results during the experiment significantly influenced in respect on number of incidence whitefly and their percent reduction over control at all production stage. It was observed that the maximum number of whitefly occurrence was found in the untreated or control treatment, other treatments showed less number of whitefly. Whereas, marshal 20EC@3 ml L^{-1} of water spray on soybean plant as a insecticide produced the lowest incidence of whitefly (2.27, 2.87, 1.4, 1.67, 1.13, 1.2, 0.33, 1.13 and 1.07 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) and the reduction percentage was maximum (63.47%) than other treatments. Among the treatments where the insecticides were used, the highest incidence of whitefly and their minimum reduction (44.83%) were observed in Dursban 20EC @ 3ml/L of water over the control (Table 3).

Table 3: Effect of different treatment on the incidence and percent reduction of whitefly on soybean at different days after sowing(DAS)

Treatment	Number of white fly at different days sowing (DAS)										% Reduction over control
	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean	
T_1	2.27b	2.87c	1.40d	1.67c	1.13d	1.20d	0.33b	1.13b	1.07b	1.45	63.47
T_2	3.33b	3.47b	1.60cd	2.33bc	1.80bc	2.13bc	1.20ab	1.47ab	1.67ab	2.11	46.88
T_3	3.00b	3.20bc	2.20b	2.53b	2.00b	2.53b	1.33ab	1.40ab	1.53ab	2.19	44.83
T_4	3.13b	3.33bc	2.07bc	1.80bc	1.27cd	1.67cd	1.80a	1.47ab	1.27b	1.98	50.23
T_5	3.07b	3.07bc	1.93bc	1.87bc	1.73bc	1.67cd	1.47ab	1.40ab	1.27b	1.94	51.16
T_6	2.87b	3.00bc	1.67cd	2.47b	1.93b	1.73cd	1.53ab	1.87ab	1.67ab	2.08	47.62
T_7	3.20b	3.33bc	1.73bcd	2.33bc	1.73bc	2.40b	1.13ab	1.33ab	1.53ab	2.08	47.63
T_8	5.00a	6.53a	4.87a	4.53	3.80a	4.27a	2.07a	2.20a	2.50a	3.97	
LSD	0.96	0.48	0.46	0.71	0.55	0.57	1.14	0.79	0.93	0.73	
CV%	16.96	19.12	27.78	27.96	28.36	32.32	47.82	29.58	33.84	29.30	

In a column, means having similar letter(s) are statistically identical at 5% level of significance.

T_1: Marshal 20EC @ 3ml/L water
T_2 Semcap 50EC @ 3ml/L water
T_3 Dursban20EC @ 3ml/L water
T_4 Basathrin 10EC @ 1ml/L water
T_5 Fiter 2.5EC@ 1 ml//L water
T_6: Sobicorn 425EC @ 2 ml//L water
T_7 Aktara 25 WG @ 0.5 mg//L water
T_8: Control

Above results indicate that the incidence of whitefly and their management by the chemicals, it was found that the chemical pesticide marshal 20EC@3 ml L^{-1} was more effective to manage the whitefly on soybean research field and it was observed that the number of whitefly decrease at vegetative and reproductive stage. Chemicals pesticides marshal 20EC@3 ml L^{-1} showed the superior performance as insecticide against whitefly.

4.4 Incidence of thirps and percent reduction over control on soybean

From the results in table 4 showed significant variation due to the effect of chemicals management on incidence and percent of reduction of thirps. Among the chemicals on management of thirps, chemical insecticide marshal 20EC @ 3 ml L^{1} showed greatest control against thirps and Dursban 20EC @ 3ml/L showed lower performance on restricted the thirps. Thirps is the also major sucking pest to a large amount destructive on soybean production. Whereas, marshal 20EC @ 3 ml L^{1} reduce the maximum thirps attack (1.33, 2.13, 2.2, 2.0, 1.8, 1.73, 1.87, 2.07 and 1.13 at 7, 14, 21, 28, 35, 42, 49, 56 and 63 DAS, respectively) which showed more reduction (56.04%) of thirps and supported to make sure the more yield of soybean. In the similar trend, Dursban 20EC @ 3ml/L of water showed lower performance to manage the thirps while minimum reduction (43.60%) was recorded on soybean research field (Table 4).

Table 4: Effect of different treatments on the incidence and percent reduction of thirps on soybean at different days after sowing(DAS)

Treatment	Number of Thirpsat different days sowing (DAS)										% Reduction over control
	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean	
T_1	1.33b	2.13c	2.20c	2.00b	1.80d	1.73f	1.87b	2.07b	1.13c	1.81	56.04
T_2	1.73b	2.33c	2.80b	2.47ab	2.27bc	1.93cf	2.13ab	2.67b	1.93b	2.25	45.23
T_3	1.87b	2.67bc	2.93b	2.27ab	2.40b	2.53b	2.00ab	2.53b	1.67bc	2.32	43.60
T_4	1.40b	2.07c	2.47bc	2.80ab	2.07bcd	2.27cd	1.87b	2.47b	1.53bc	2.10	48.82
T_5	1.67b	3.07b	2.73bc	2.27b	2.13bcd	2.40bc	2.20ab	2.33b	1.73bc	2.28	44.51
T_6	1.53b	2.20c	2.53bc	2.20b	1.93cd	2.07de	2.27ab	2.67b	1.73bc	2.13	48.29
T_7	1.53b	2.53bc	2.40bc	2.33b	2.33b	2.00e	2.40ab	2.20b	1.87bc	2.18	47.03
T_8	3.53a	5.47a	5.60a	3.53a	4.27a	3.27a	2.53a	4.20a	4.60a	4.11	
LSD 0.05	0.53	0.60	0.52	1.04	0.33	0.24	0.58	1.21	0.70	0.64	
CV %	23.96	20.11	25.94	23.90	24.12	21.37	29.64	26.10	19.83	23.89	

In a column, means having similar letter(s) are statistically identical at 5% level of significance.

T_1: Marshal 20EC @ 3ml/L water
T_2: Semcap 50EC @ 3ml/L water
T_3: Dursban20EC @ 3ml/L water
T_4: Basathrin 10EC @ 1ml/L water
T_5: Fiter 2.5EC@ 1 ml//L water
T_6: Sobicorn 425EC @ 2 ml//L water
T_7: Aktara 25 WG @ 0.5 mg//L water
T_8: Control

Above indicating results on sucking pests on soybean chemical pesticide marshal 20EC @ 3 ml L^{-1} was more effective than other chemicals to manage the sucking pests.

4.5 Incidence of pod borer and percent reduction over control on soybean

From the results in table 5 showed significant variation due to the effect of chemicals management on incidence and percent of reduction of pod borer. Among the chemicals on management of pod borer, chemical insecticide marshal 20EC @ 3 ml L^{1} showed greatest control against pod borer and Dursban 20EC @ 3ml/L showed lower performance on restricted the pod borer. Pod borer is the also major pest to a large amount destructive on soybean production. Whereas, marshal 20EC @ 3 ml L^{1} reduce the maximum pod borer attack (0.13, 1.87, 2.67, 2.67 and 2.47 at 35, 42, 49, 56 and 63 DAS, respectively) which showed more reduction (68.25%) of pod borer and supported to make sure the more yield of soybean. In the similar trend, Dursban 20EC @ 3ml/L of water showed lower performance to manage the pod borer while minimum reduction (42.76%) was recorded on soybean research field (Table 5). It was observed that the maximum number of pod borer occurrence was found in the untreated or control treatment.

Table 5: Effect of different treatments on the incidence and percent reduction of pod borer on soybean at different days after sowing(DAS)

Treatments	Number of pod borer						% Reduction over control
	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean	
T_1	0.13 b	1.87 b	2.67 c	2.67 d	2.47 c	1.96	68.25
T_2	0.13 b	3.07 ab	6.33 ab	4.67 c	3.07 bc	3.45b	44.06
T_3	0.33 b	2.47 b	5.33 bc	3.33 cd	3.27 b	2.95b	52.27
T_4	0.20 b	2.67 b	3.67 bc	8.00 b	3.13 bc	3.53b	42.76
T_5	0.27 b	3.00 ab	4.33 bc	3.00 cd	2.67 bc	2.65c	57.02
T_6	0.33 b	2.93 ab	4.00 bc	4.67 c	2.87 bc	2.96b	52.05
T_7	0.40 b	2.60 b	4.33 bc	4.67 c	3.07 bc	3.01b	51.19
T_8	1.67 a	4.00 a	9.33 a	11.00 a	4.87 a	6.17a	
LSD $_{0.05}$	0.42	1.21	3.58	1.52	0.61	1.47	
CV %	55.74	22.39	40.85	31.62	20.42	34.20	

In a column, means having similar letter(s) are statistically identical at 5% level of significance.

T_1: Marshal 20EC @ 3ml/L water
T_2: Semcap 50EC @ 3ml/L water
T_3: Dursban20EC @ 3ml/L water
T_4: Basathrin 10EC @ 1ml/L water
T_5: Fiter 2.5EC@ 1 ml//L water
T_6: Sobicorn 425EC @ 2 ml//L water
T_7: Aktara 25 WG @ 0.5 mg//L water
T_8: Control

4.6 Yield plot^{-1} (g)

The yield per plot of soybean was affected by the application of different insecticidal treatments. The highest yield per plot was obtained by the application of Marshal 20EC @ 3mlL^{-1} of water followed by Actara 25WG @ 0.5mg/L of water and the lowest yield (0.66 kg/plot) was obtained from untreated control plot.

From the figure 1, it was observed that Marshal 20EC @ 3mlL^{-1} of water showed the best performence to increase per plot yield of soybean.

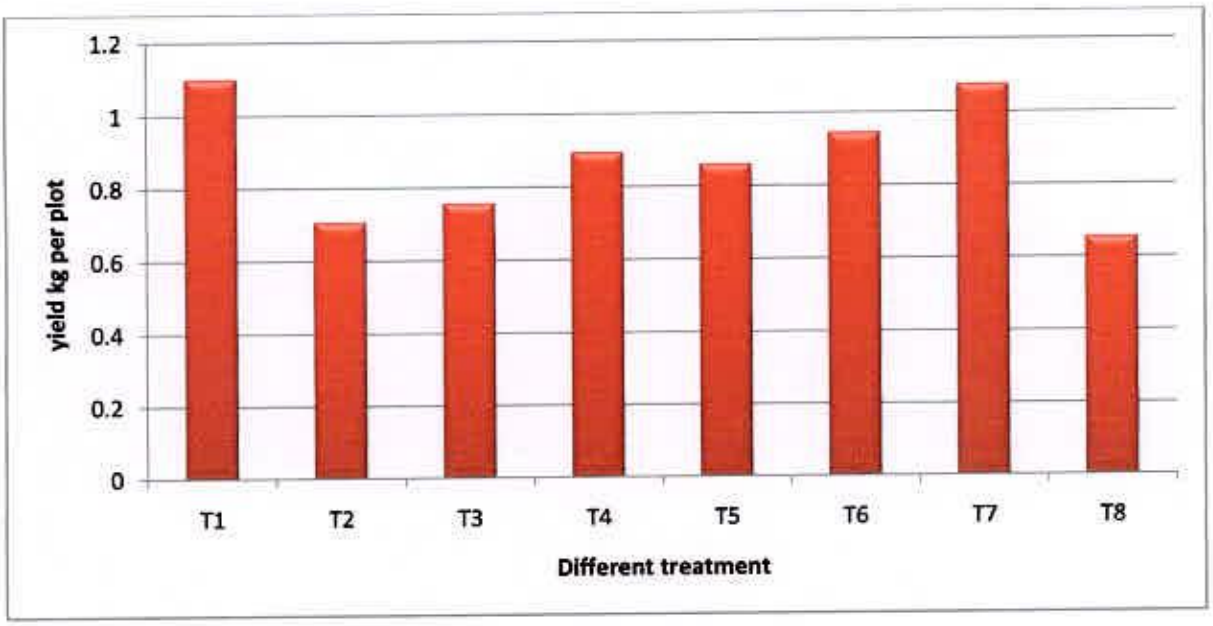


Fig.1. Effect of different treatments on yield per plot of soybean

4.7 Yield of soybean per hectare

Yield of soybean per hectare was significantly affected by the application of different insecticide. As a result, marshal 20EC @ 3 ml L^{-1} of water showed the highest yield (11.00 t/ha). On the other hand, the lowest yield (6.56 t/ha) was found control treatment (Fig. 2).

From the above results, it was found that the among all applied insecticide treatments in this study, marshal 20EC @ 3 ml L^{-1} of water showed the better performance in reducing the pest as well as on increasing yield of soybean.

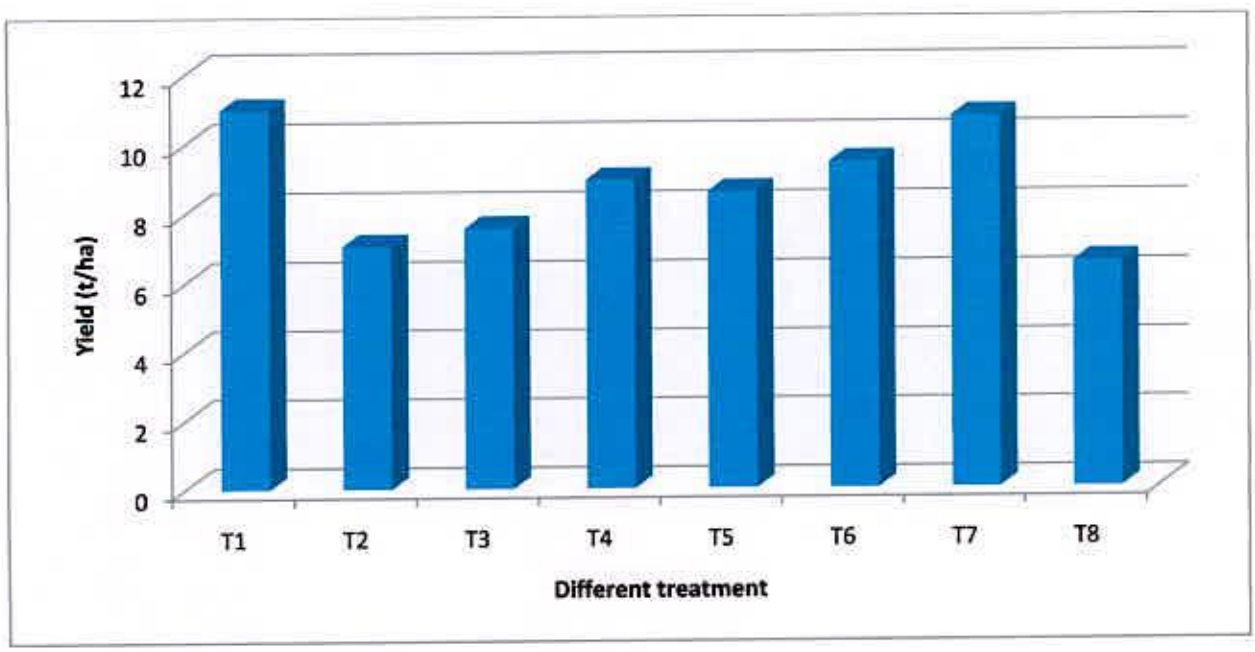
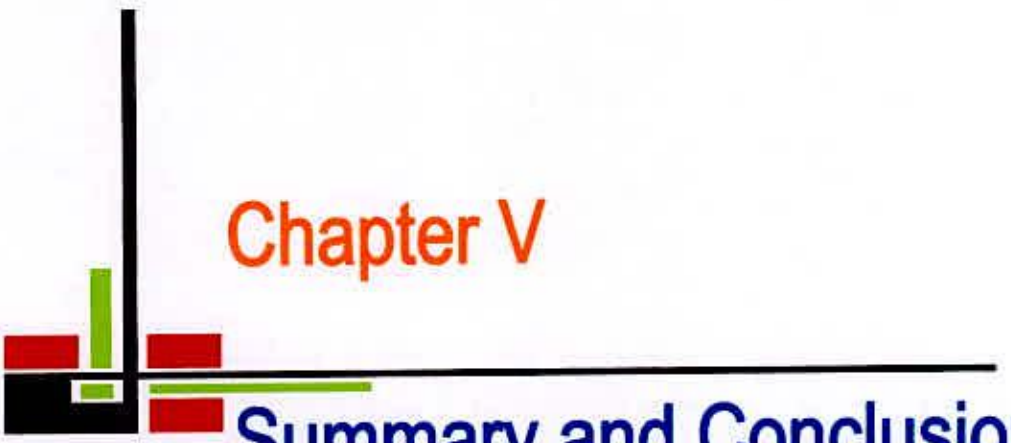


Fig.2. Effect of different treatments on yield per hectare of soybean



Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The study was conducted at the experimental Field of Sher-e-Bangla Agricultural University, Dhaka during the *rabi* season from November 2010 to March 2011 to know the effect of different insecticides on the incidence of the major insect pests of soybean. The experiment comprised with seven different insecticides including control treatment viz. T_1: Marshal 20EC @ 3ml/L water; T_2: Semcap 50EC @ 3ml/L water; T_3: Dursban 20EC @ 3ml/L water; T_4: Basathrin 10EC @ 1ml/L water, T_5: Fiter 2.5EC@ 1 ml//L water, T_6: Sobicorn 425EC @ 2 ml//L water, T_7: Aktara 5G @ 3 mg//L water, and control as treatments. Soybean var. Shohag was used as the target crop. A single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

Incidence of major pests viz. aphid, jassid, whitefly, thrips and pod borer showed significant variation due to the effect of various chemicals pesticides. Among the treatments, marshal 20EC @ 3 ml L^{-1} was found more effective on pests as well as the minimum number of aphid) and reduction (51.52%), number of jassid and reduction (58.34%), number of whitefly and reduction (63.47%) and number of thrips and reduction (56.04%) were recorded at all growth and reproductive stage, respectively on the basis of control treatment.

The Marshal 20EC @ 3 ml L^{-1} of water showed the highest yield $plot^{-1}$ (1.10 kg). The Marshal 20EC @ 3 ml L^{-1} of water showed the highest yield (11.00 t/ha). On the other hand, the lowest yield (6.56 t/ha) was found control treatment.

From the above results, it can be concluded that among all insecticidal treatments, Marshal 20EC @ 3 ml L^{-1} of water showed the best performance for suppressing the major pests of soybean as well as on soybean yield.

Further study may be conducted to develop an IPM package using Marshal 20EC @ 3 ml L^{-1} of water as chemical component of Integrated Pest Management.

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APPENDIES

Appendix I: Soil characteristics of experimental farm of Sher-e-Bangla Agricultural University are analyzed by soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture garden, SAU, Dhaka
AEZ	Modhupur tract (28)
General soil type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	N/A

Source: SRDI

B. Physical and chemical properties of the initial soil

Characteristics	Value
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
pH	5.56
Organic matter (%)	0.25
Total N (%)	0.02
Available P (µgm/gm soil)	53.64
Available K (me/100g soil)	0.13
Available S (µgm/gm soil)	9.40
Available B (µgm/gm soil)	0.13
Available Zn (µgm/gm soil)	0.94
Available Cu (µgm/gm soil)	1.93
Available Fe (µgm/gm soil)	240.9
Available Mn (µgm/gm soil)	50.6

Source: SRDI

Appendix II. Monthly air temperature, Rainfall and Relative humidity of the experimental site during the study period (October, 2010 to Aril, 2011)

Year	Month	Air temperature (^{0}C)			Rainfall** (mm)	* Relative humidity (%)
		Max.	Min.	Mean		
2010	October	36.6	18.5	27.455	320	74.5
	November	30.8	15.8	24.3	14	68.0
	December	27.2	11.3	19.75	0.00	66.0
2011	January	28.0	12.8	19.75	0	17.5
	February	28.9	16.2	22.55	48	56
	March	34.4	23.3	28.85	22	59
	April	35.5	24.4	29.95	37	67

* Monthly average

** Monthly total

Source: The Meteorological Department (Weather division) of Bangladesh, Agargoan, Dhaka