EVALUATION OF SOME CHEMICAL AND BOTANICAL MANAGEMENT PRACTICES IN CONTROLLING MAJOR INSECT PESTS OF SOYBEAN

MD. NAFIJUL HAQUE

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA -1207

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EVALUATION OF SOME CHEMICAL AND BOTANICAL MANAGEMENT PRACTICES IN CONTROLLING MAJOR INSECT PESTS OF SOYBEAN

BY

MD. NAFIJUL HAQUE

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Approved by:

(Ayesha Akter)	**(Prof. Dr. Mizanur Rahman)**
Assistant professor	Dept. of Entomology, SAU
Dept. of Entomology, SAU	**Co-Supervisor**
Supervisor	

(Associate Professor Dr. Tahmina Akter)
Chairman
Examination Committee

Ayesha Akter
Assistant professor
Department of Entomology
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

Ref: Date:

CERTIFICATE

This is to certify that thesis entitled, "EVALUATION OF SOME CHEMICAL AND BOTANICAL MANAGEMENT PRACTICES IN CONTROLLING MAJOR INSECT PESTS OF SOYBEAN" 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. NAFIJUL HAQUE, Registration No. 06-1887 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: June, 2013

(Ayesha Akter)
Assistant professor
Dept. of Entomology, SAU
Supervisor

DEDICATED TO
MY
BELOVED PARENTS

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SAU, Dhaka

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Md. Nafijul Haque

Abstract

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the Kharif season from April, 2012 to August, 2012 to study on evaluation of some chemical and botanical management practices in controlling major insect pests of soybean. The experiment comprised with six different insecticides and botanicals including control treatment viz. $T_{1:}$ Neem oil @ 3ml/L of water mixed with trix@10ml/L of water at 15 days interval, $T_{2:}$ Ripcord 10EC @ 2ml/L of water, $T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water, $T_{4:}$ Sumialfa 5EC @ 2ml/L of water, $T_{5:}$ Marshal 20EC@ 2ml/L of water, T_6: Control treatment; were used as treatments. Incidence of major pest of soybean var. Shohag was the main purpose of this study and their control with applied some chemicals pesticides as treatments. The experiment was laid out in Randomized Complete Block Design (RCBD) single factor with three replications. Among the major pests of soybean, maximum number of Whitefly, jassid, pod borer and leaf roller were effective than other pests on soybean research field. However, Sumialfa 5EC @ 2ml/L of water was supplementary efficient as well as the more reduction of major pests were recorded at different days after sowing. The maximum numbers of leaves, number of branches, maximum leaf length, number of flowers, minimum number of infested pod, maximum number of healthy pod per plant, were found from the treatment Sumialfa 5EC @ 2ml/L of water. Similar treatment also produced the yield plot^{-1} (3.29 kg) and yield per hectare (3.65 t/ha) of soybean. The highest benefit cost ratio (6.00) was obtained in Sumialfa 5EC @ 2ml/L of water the treated plot. Those results indicate that the Sumialfa 5EC @ 2ml/L of water showed the best performance to manage the major pests of soybean as well as on growth and yield among the all applied insecticide in this study. I also found the lady bird beetle as predator from my experimental field.

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
HRC	=	Horticulture Research Centre
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
N	=	Nitrogen
et al.	=	And others
TSP	=	Triple Super Phosphate
MOP	=	Muriate of Potash
RCBD	=	Randomized Complete Block Design
DAT	=	Days after Transplanting
ha^{-1}	=	Per hectare
g	=	gram (s)
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
wt	=	Weight
LSD	=	Least Significant Difference
^0C	=	Degree Celsius
NS	=	Not significant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of Coefficient of Variance

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 a rich source of amino acids, vitamins and minerals. Soybean is a very important recognized oil seed and protein crop in the world. It is a good source of protein, unsaturated fatty acids, minerals like Ca and P including vitamins A, B and D that meet different nutritional needs (Rahman, 1982).The seed contains about 40-45% protein, 18-20% edible oil and 20-26% carbohydrate (Gowda and Kaul, 1982).The multipurpose use of soybean is gradually increasing day by day in our country. Soybean oil is used as a raw material in manufacturing anti biotic, 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 91m ha with production of 204 mt and productivity of 2,233 kg/ha. 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 m ha with production of 9.46 mt and productivity of 1,069 kg per ha (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).

In Bangladesh, about five thousand hectares of land is under soybean cultivation and annual production is approximately 4 thousand metric tons with an average yield of 1.5-2.3 t/ha (BARI, 2006).

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 insects cause serious damage by direct feeding as well as by transmitting various diseases (Daugerty, 2009). The frequency and severity of 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 whitefly were found to damage during vegetative, flowering and pod formation stage of the crop (Biswas, *et al*. 2001). According to Rahman, *et al*. (2010) thirteen species of insect pest and three species of natural enemies were recorded in the experimental field, 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.

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.

The researchers later recognized the harmful effects of pesticides and tried to bring eco-friendly approaches to reduce pesticide load in environment by using bio-agents and bio-pesticides but these are not easily available and are costly. So it has been difficult for farmers to utilize these tools in pest management. To overcome these problems, plant based substances and indigenous practices offer safe and better alternative methods of pest management (Narayana Swamy, 1999).

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

1. To find the incidence of different insect pests in soybean.
2. To find the infestation of different insect pests at different growth stages of plant.
3. To explore the efficiency of different control options on the reduction of different insect pest infestations on soybean.

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).

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.

Rai *et al.* (1973) recorded 24 insect species feeding on soybean in Karnataka, among them maximum damage was done by the larvae of *Lamprosema indicata* F, *Stomopteryx subsecivella* Zeller, *Diacrisia obliqua* 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 to 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 (22 June 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* 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 in early sown crop (25th June), followed by mid sown crop and late sown crop which recorded 1.67 and 1.87 larvae, 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, 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.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the experimental central Field of Sher-e-Bangla Agricultural University, Dhaka during the Kharif season from April, 2012 to August, 2012 to study on evaluation of some chemical and botanical management practices in controlling major insect pests of soybean (*Glycine max* L.). Materials used and methodologies followed in the present investigations have been described in this chapter under the following headings and plates (1-2).

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.

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

There were six treatments under the present study including untreated control and they are follows:

$T_{1:}$ Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

$T_{2:}$ Ripcord 10EC @ 2ml/L of water at 15 days interval

$T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water at 15 days interval

$T_{4:}$ Sumialfa 5EC @ 2ml/L of water at 15 days interval

$T_{5:}$ Marshal 20EC@ 2ml/L of water at 15 days interval

T_6: Untreated control.

3.4 Experimental design and layout

The experiment was laid out in a one factors randomized complete block design (RCBD) having three replications. Each replication had 6 unit plots to which the treatments were assigned randomly. The unit plot size was 9 m^2 (3m ×3m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing respectively (Plate 1 & 2).

1A.

1B.

1C.

Plate 1 (A+B+C): Showing the views of experimental plot at SAU, Dhaka

2A.

2B.

2C.

Plate 2 (A+B+C): showing the views of infested leaf of soybean by white fly, Jassid and pod infested by pod borer.

3.5 Land preparation

During the study, the mainland was opened with a power tiller on 15th November, 2011. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 28th November, 2011 and was ready for sowing the seeds of soybean.

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 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 plant 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

Neem oil, Ripcord, Aktara, Sumialfa and Marshal were sprayed in assigned plots with recommended dosages by using Knapsak 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 plant of the assigned plots. Caution was taken to avoid any drift of the spray mixture to the adjacent plots at the time of the spray application. At each spray application the spray mixture was freshly prepared.

3.10 Recording of data

3.10.1 Number of insect pests and reduction percentage of plant parts

Numbers of insects pests (Whitefly, jassid, pod borer, leaf roller) were recorded at 15 days interval. Five plants were selected randomly for the collection of data. Data on number of insects were recorded at an interval of 15 days commencing from first incidence and continued up to the 5 times at morning. 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

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

3.10.2 Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at harvest time.

3.10.3 Number of leaves per plant

Number of leaves per plant was counted from each selected plant sample and then averaged at harvest.

3.10.4 Length of leaf

Length of the leaf of each sample plant was recorded and sum total of them was divided by the total number of leaves of the sample plant.

3.10.5 Number of branches per plant

Number of branches per plant data was also recorded at harvest from the randomly selected ten plants of inner rows of each plot.

3.10.6 Number of flowers per plant

Number of flowers per plant was counted from the 10 selected plant sample and then the average flower number was calculated.

3.10.7 Number of infested pods per plant

Number of infested pods per plant was counted from the 10 selected plant sample and then the average pod number was calculated.

3.10. 8 Number of healthy pods per plant

Number of healthy pods per plant was counted from the 10 selected plant sample and then the average pod number was calculated.

3.10.9 Yield of soybean per plot (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 per plot.

3.10.10 Yield of soybean (t/ ha)

Seed yield was recorded on the basis of total harvested seeds per plot and was expressed in terms of yield (t/ha). Seed yield was adjusted to 12% moisture content.

3. 11 Benefit cost ratio analysis

For benefit cost analysis, records of the costs incurred for labour, inputs, application of inputs in each treatment and that of control without insecticide were maintained. The untreated control (T_6) did not require any pest management cost. The price of the marketable healthy fruit of each treatment and that of control was calculated at market rate. The result of Benefit-Cost analysis was expressed in terms of Benefit-Cost Ratio (BCR).

Net return was calculated by subtracting treatment wise management cost from gross return. The adjusted net return was determined by subtracting the management cost involved in untreated control plot from the net return obtained from each treatment which as follows:

Adjusted net return = Net return in treated plot – Management cost in control plot.

Benefit Cost Ratio (BCR):

BCR for each treatment was calculated dividing adjusted net return to total management cost of the respective treatment which may be expressed as:

$$\text{Benefit Cost Ratio} = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

3.12 Data analysis

The collected data related to incidence of major insect pests of soybean and different yield contributing characters were analyzed statistically to observe the significant difference among the treatments. The mean values of all characters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was estimated. By 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) at 5% level of probability (Gomez & Gomez, 1986).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to evaluate performance of some chemical insecticides against the infestation of insect pests of soybean. The data were calculated on the basis of incidence of insect pests (Whitefly, jassid, pod borer, leaf roller) reduction of infestation varied significantly with different treatments. The results of the present study have been discussed and possible interpretations are furnished and presented in this chapter under the following headings:

4.1 Incidence of whitefly and reduction percentage on soybean

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 control treatment (T_6), other treatments showed less number of whitefly. Whereas, sumialfa 5EC@ 2 ml/L of water (T_4) spray on soybean plant as a insecticide produced the lowest incidence of whitefly (1.53, 2.07, 2.47, 3.93 and 1.73 at 15, 30, 45, 60, and 75 DAS, respectively) and the reduction percentage was maximum (56.33%) than other treatments. Among the treatments where the insecticides were used, the highest incidence of whitefly and their minimum reduction (37.71%) were observed in Ripcord 10EC @ 2ml/L of water (T_2) over the control (Table 1).

Table 1: Effect of different treatments on the incidence and reduction of whitefly on soybean

Treatments	Number of Whitefly						% Reduction over control
	15DAS	30DAS	45DAS	60DAS	75DAS	Mean	
T_1	1.73b	2.33b	2.93b	5.07bcd	2.93bc	3.00	44.17
T_2	2.07b	2.40b	2.73b	5.87bc	3.67ab	3.35	37.71
T_3	1.80b	2.40b	2.73b	4.27cd	2.40bc	2.72	49.38
T_4	1.53b	2.07b	2.47b	3.93d	1.73c	2.35	56.33
T_5	1.58b	2.33b	2.53b	6.60b	2.60bc	3.13	41.76
T_6	3.53a	4.40a	5.43a	8.63a	4.87a	5.37	
$LSD_{(0.05)}$	0.88	0.65	0.83	1.74	1.45	1.11	
CV (%)	23.89	13.52	14.50	16.73	23.92		

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

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

T_2: Ripcord 10EC @ 2ml/L of water

T_3: Aktara 25 WG @ 0.3 mg/L of water

T_4: Sumialfa 5EC @ 2ml/L of water

T_5: Marshal 20EC@ 2ml/L of water

T_6: Untreated control

Above results indicate that the incidence of whitefly and their management by the botanical and chemicals, it was found that the chemical pesticide Sumialfa 5EC @ 2ml/L of water was more effective to manage the whitefly on soybean research field. Chemicals pesticides Sumialfa 5EC @ 2ml/L of water showed the superior performance as insecticide against whitefly.

4.2 Incidence of jassid and reduction percentage on soybean

Table 2 shown, the incidence of jassid where Different insecticides was used to suppress the pest. The maximum number of jassid was found in (T_5) (1.87, 3.20, 2.67, 4.53 and 3.33 at 15, 30, 45, 60 and 75 DAS, respectively) when the soybean plant treated by Marshal 20EC@ 3 ml/L of water while was found in the untreated treatment.

It was observed from the Table 2, incidence of jassid was (0.87, 1.80, 0.93, 2.40 and 0.93 at 15, 30, 45, 60 and 75 DAS, respectively) which had reduction (55.56%) of jassid as compared to control treatment. Among the treatments, (T_4) (Sumialfa 5EC @ 2ml/L water) was more effective against jassid controlled as well as the jassid number was the lowest (0.60, 1.20, 0.73, 1.60 and 0.80 at 15, 30, 45, 60 and 75 DAS, respectively) on soybean research field which increased the natural growth and maximizing the yield of soybean. The treatment showed the highest reduction (68.38%) over control treatment (Table 2).

Table 2: Effect of different treatments on the incidence and reduction of jassid on soybean

Treatments	Number of Jassid						% Reduction over control
	15 DAS	30DAS	45DAS	60 DAS	75 DAS	Mean	
T_1	1.00 b	1.53 b	1.27 b	1.73 b	1.67 ab	1.44	53.85
T_2	1.07 ab	1.40 b	1.80 ab	2.73 ab	1.93 ab	1.79	42.74
T_3	1.07 ab	1.53 b	1.80 ab	2.07 b	1.13 b	1.52	51.28
T_4	0.60 b	1.20 b	0.73 b	1.60 b	0.80 b	0.99	68.38
T_5	0.87 b	1.80 b	0.93 b	2.40 b	0.93 b	1.39	55.56
T_6	1.87 a	3.20 a	2.67 a	4.53 a	3.33 a	3.12	
$LSD_{(0.05)}$	0.81	1.07	1.22	1.83	1.71	1.33	
CV(%)	41.17	33.16	33.72	39.95	27.56		

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

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval
T_2: Ripcord 10EC @ 2ml/L of water
T_3: Aktara 25 WG @ 0.3 mg/L of water
T_4: Sumialfa 5EC @ 2ml/L of water
T_5: Marshal 20EC@ 2ml/L of water
T_6: Untreated control

From the above results observation on incidence of jassid and their controlled by different treatment, it was found that the controlled agent Sumialfa 5EC @ 2ml/L water on soybean research field decrease the number of jassid . Whereas all entire chemical insecticide reduce the number of jassid from all production stage whereas Sumialfa 5EC @ 2ml/L of water 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 pod borer and reduction percentage on soybean

From the results in (Table 3) showed significant variations due to the effect of chemicals and botanical management on incidence and percent of reduction of pod borer. Among the chemicals on management of pod borer, chemical insecticide Sumialfa 5EC @ 2ml/L of water showed highest control against pod borer and Neem oil @ 3ml/L of water showed lowest performance on restricted the pod borer. Pod borer is the also major pest to a large amount destructive on soybean production. Whereas, Sumialfa 5EC @ 2ml/L of water reduce the maximum pod borer attack (0.20 and 00.00 at 60, and 75 DAS, respectively) which showed more reduction (96.10%) of pod borer and supported to make sure the more yield of soybean. In the similar trend, Aktara 25 WG @ 0.3 mg/L of water showed lower performance to manage the pod borer while minimum reduction (90.91%) 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 3: Effect of different treatments on the incidence and reduction of pod borer on soybean

Treatments	Number of Pod borer			% Reduction over control
	60 DAS	75 DAS	Mean	
T_1	1.27 ab	0.33 b	0.80	68.82
T_2	1.13 ab	0.07 b	0.60	76.56
T_3	0.13 b	0.33 b	0.23	90.91
T_4	0.20 b	0.00 b	0.10	96.10
T_5	1.20 ab	0.13 b	0.67	74.02
T_6	3.13 a	2.00 a	2.57	
$LSD_{(0.05)}$	2.03	0.46	1.25	
CV(%)	17.94	14.26		

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

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval
T_2: Ripcord 10EC @ 2ml/L of water
T_3: Aktara 25 WG @ 0.3 mg/L of water
T_4: Sumialfa 5EC @ 2ml/L of water
T_5: Marshal 20EC@ 2ml/L of water
T_6: Untreated control

4.4 Incidence of leaf roller and reduction percentage on soybean

From the results in (Table 4) showed significant variations due to the effect of chemicals and botanical management on incidence and percent of reduction of leaf roller. Among the chemicals on management of leaf roller, chemical insecticide Sumialfa 5EC @ 2ml/L of water showed highest control against leaf roller and Ripcord 10EC @ 2ml/L of water showed lowest performance on restricted the leaf roller. Whereas, Sumialfa 5EC @ 2ml/L of water reduce the maximum leaf roller attack (0.12 and 45.00 at 60, and 75 DAS, respectively)

which showed more reduction (78.89%) of leaf roller and supported to make sure the more yield of soybean. In the similar trend, Neem oil @ 3ml/L of water showed lower performance to manage the leaf roller while minimum reduction (77.78%) was recorded on soybean research field (Table 4). It was observed that the maximum number of leaf roller occurrence was found in the untreated or control treatment. According to Rahman, *et al*. (2010) more or less thirteen species of insect pests and three species of natural enemies were recorded in the experimental field, 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.

Table 4: Effect of different treatments on the incidence and reduction of leaf roller on soybean

Treatments	Number of leaf roller			% Reduction over control
	60 DAS	75 DAS	Mean	
T_1	0.13 b	0.47 b	0.30	77.78
T_2	0.14 b	0.87 b	0.51	62.59
T_3	0.13 b	0.73 ab	0.43	68.03
T_4	0.12 b	0.45 b	0.29	78.89
T_5	0.33 b	0.47 b	0.40	70.37
T_6	1.30 a	1.40 a	1.35	
LSD (0.05)	0.51	0.59	0.55	
CV(%)	14.94	22.77		

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

Treatments:

$T_{1:}$ Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval
$T_{2:}$ Ripcord 10EC @ 2ml/L of water
$T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water
$T_{4:}$ Sumialfa 5EC @ 2ml/L of water
$T_{5:}$ Marshal 20EC@ 2ml/L of water
T_6: Untreated control

4.5 Effect of chemicals and botanical control on growth of soybean

4.5.1 Plant height

Plant height was significantly affected by the application of chemicals and botanical used as treatment at harvest level. Among the treatments, the tallest plant (89.67 cm) was observed at chemicals pesticide Sumialfa 5EC @ 2ml/L of water where minimum number of pest was recorded which was closely followed by Marshal 20EC@ 2ml/L of water (84.00 cm). On the other hand, the shortest plant (72.67) was recorded from control treatment (Fig. 1). Sumialfa 5EC @ 2ml/L of water the most effective insecticide for controlling against soybean pests.

4.5.2 Number of leaves per plant

Effect of chemicals and botanical (Neem oil) showed significant variation in respect of number of leaves per plant at harvest. Among the treatments, the maximum number of leaves (17.33) was found from the treatment Sumialfa 5EC @ 2ml/L of water. The lowest results were obtained by control treatment (Fig. 2).

4.5.3 Number of branch per plant

A significant variation was also observed due to the effect of different chemicals and botanical management of pest on soybean plant in respect of number of branch per plant at harvest. The maximum number of branches (4.33) were found at Sumialfa 5EC @ 2ml/L of water where the pests were not more effective in case of highest control was obtained by Sumialfa 5EC @ 2ml/L of water. On the other hand, the minimum number of branches (1.83) was recorded from control treatment (Fig. 3). Sumialfa 5EC @ 2ml/L of water was the most effective insecticide against soybean insect pests.

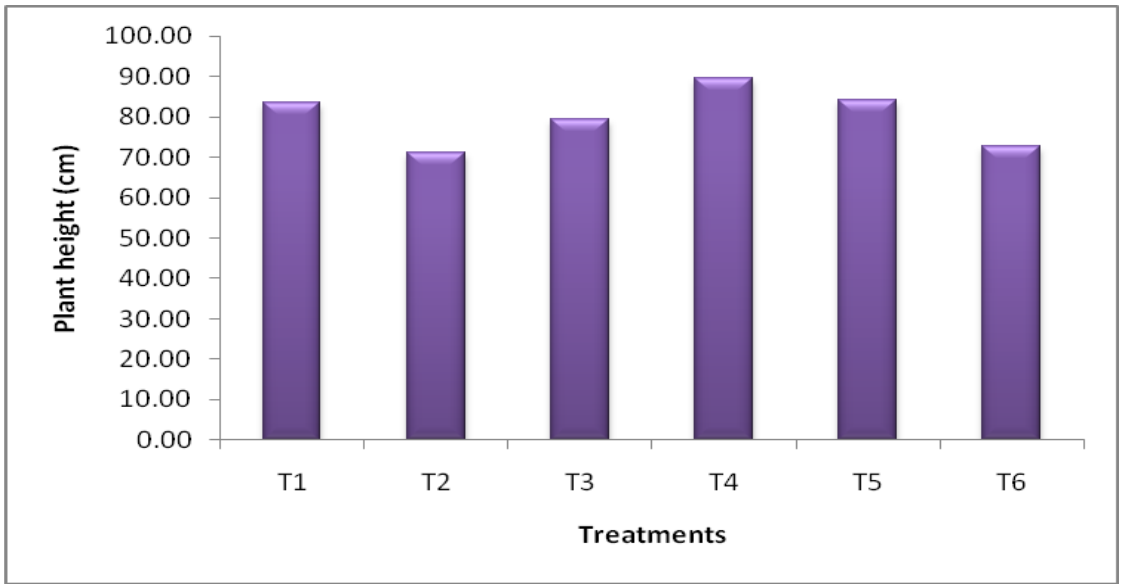

Fig.1 Effect on different management practices on the plant height of soybean

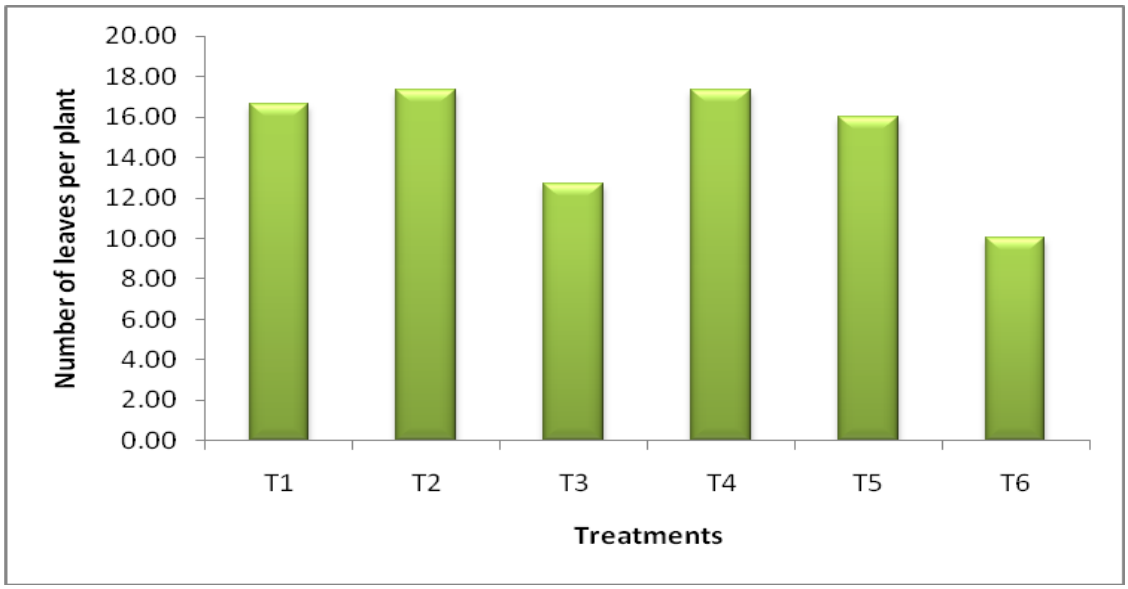

Fig.2 Effect on different management practices on the number of leaves per plant of soybean

Treatments:

$T_{1:}$ Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

$T_{2:}$ Ripcord 10EC @ 2ml/L of water

$T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water

$T_{4:}$ Sumialfa 5EC @ 2ml/L of water

$T_{5:}$ Marshal 20EC@ 2ml/L of water

T_{6}: Untreated control

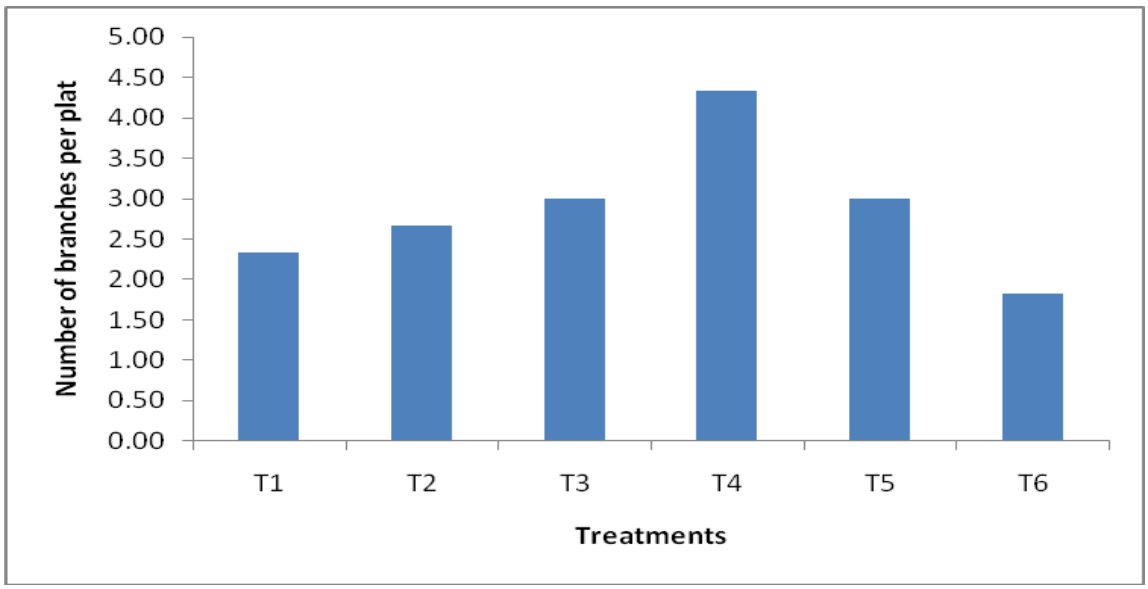

Fig.3 Effect on different management practices on the number of branches per plant of soybean

Treatments:

$T_{1:}$ Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval
$T_{2:}$ Ripcord 10EC @ 2ml/L of water
$T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water
$T_{4:}$ Sumialfa 5EC @ 2ml/L of water
$T_{5:}$ Marshal 20EC@ 2ml/L of water
T_{6}: Untreated control

4.5.4 Leaf length (cm)

A significant variation was also observed due to the effect of different chemicals and botanical management of pest on soybean plant in respect of leaf length. The maximum leaf length (15.27) was found at Sumialfa 5EC @ 2ml/L of water. On the other hand, the minimum leaf length (10.53) was recorded from control treatment (Fig. 4). Probably, control measures ensure optimum photosynthesis as well as maximum accumulation of nutrients which ultimately contributed to increase the length of the leaf.

It also observed from the results that the maximum pest attack reduce the plant growth but pesticide using reduce the pests and maximum the plant growth as well as plant height, number of leaves, number of branches etc.

4.6 Effect of chemicals and botanical control on yield of soybean

4.6.1 Number of flowers per plant

A significant variation was also observed due to the effect of different chemicals and botanical management of pests on soybean plant in respect of number of flower per plant. The maximum number of flowers (19.33) was found at Sumialfa 5EC @ 2ml/L of water. On the other hand, the minimum number of flowers (10.00) was recorded from control treatment (Table 5).

Probably, control measures ensure optimum photosynthesis as well as maximum accumulation of nutrients which ultimately contributed to increase the number of flower per plant.

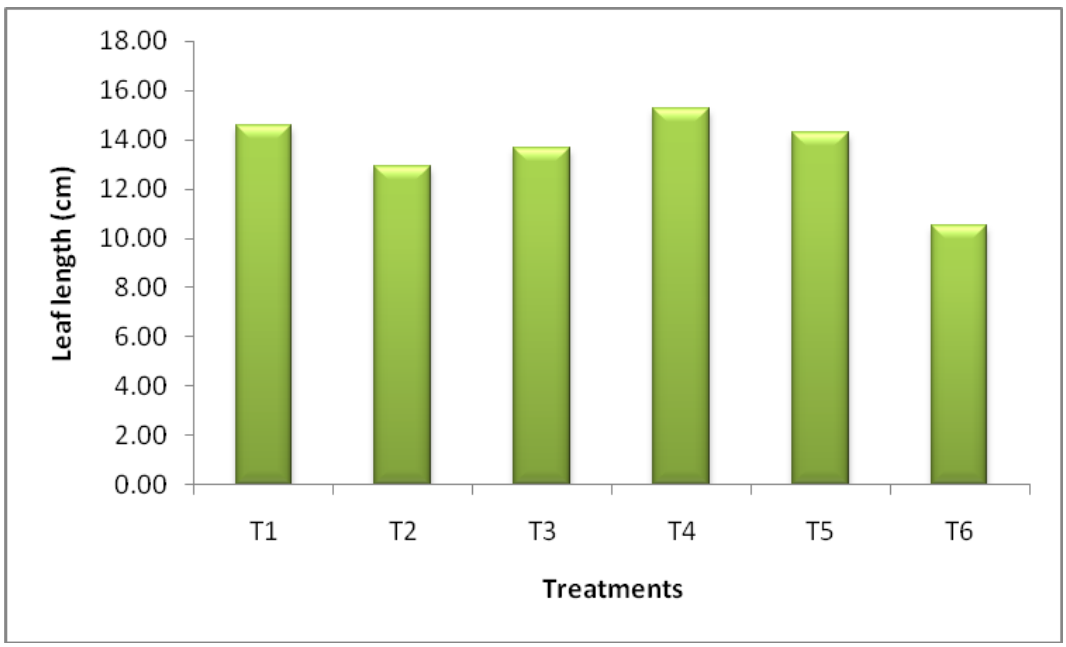

Fig.4 Effect on different management practices on the leaf length of soybean

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

T_2: Ripcord 10EC @ 2ml/L of water

T_3: Aktara 25 WG @ 0.3 mg/L of water

T_4: Sumialfa 5EC @ 2ml/L of water

T_5: Marshal 20EC@ 2ml/L of water

T_6: Untreated control

Table 5: Effect of chemicals and botanical (neem oil) to manage the pest and its impact on yield characteristics of soybean

Treatments	No. of flowers	No. of infested pods	No. of healthy pods
T_1	17.67 ab	9.27 b	20.53 ab
T_2	14.67 ab	10.20 ab	21.33 ab
T_3	14.00 ab	5.80 c	19.53 b
T_4	19.33 a	5.53 c	22.60 a
T_5	14.00 ab	5.87 c	20.60 ab
T_6	10.00 b	11.07 a	16.07 c
LSD (0.05)	7.08	1.40	2.28
CV(%)	26.05	9.65	6.23

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

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

T_2: Ripcord 10EC @ 2ml/L of water

T_3: Aktara 25 WG @ 0.3 mg/L of water

T_4: Sumialfa 5EC @ 2ml/L of water

T_5: Marshal 20EC@ 2ml/L of water

T_6: Untreated control

4.6.2 Number of infested pod per plant

The effect of different chemicals and botanical management of insect pests on soybean were significantly influenced due to number of infested pod per plant. The minimum number of infested pod (5.53) were found at Sumialfa 5EC @ 2ml/L of water. On the other hand, the maximum number of infested pod

(11.07) were recorded from control treatment (Table 5). Sumialfa 5EC @ 2ml/L of water the most effective insecticide against soybean pest.

4.6.3 Number of healthy pod per plant

A significant variation was found due to the effect of different chemicals and botanical control agent against insect pests on soybean in respect of number of healthy pod per plant. Among the treatment, Sumialfa 5EC @ 2ml/L of water to ensure produced the maximum number of healthy pod per plant (22.60) where as the minimum number of pest was effective on soybean. Similarly, the minimum number of healthy pod per plant (16.07) were recorded from control (Table 5).

4.7 Yield of soybean per plot

Yield per plot was significantly affected by the application of different treatments as a control agent of major insect pests of soybean. Different insecticides and botanical were used as control agent to manage the insect pests of soybean in this study. As a result, Sumialfa 5EC @ 2ml/L (T_4) of water showed the highest yield per plot (3.29 kg). On the other hand, the lowest yield per plot (2.54 kg) was found from the control treatment (T_6) (Table 6).

From the above results investigate, it was found that the among all applied different treatments in this study, Sumialfa 5EC @ 2ml/L of water showed the superior performance on control the pests as to ensure the optimum vegetative growth and highest number of flowers and healthy fruits per plot as well as maximum yield per plot.

4.8 Yield of soybean per hectare

Yield was significantly affected by the application of different insecticides and botanicals. Different insecticides were used to manage the pest in this study. As a result, Sumialfa 5EC @ 2ml/L of water (T_4) showed the highest yield (3.65 t/ha). On the other hand, the lowest yield (2.82 t/ha) was found control treatment (Table 6).

From the above results investigate, it was found that the among all applied insecticide treatments in this study, Sumialfa 5EC @ 2ml/L of water showed the superior performance on control the pest to ensure the optimum vegetative growth and highest number of flowers and healthy fruits per plot as well as maximum yield per hectare.

Table 6: Effect of chemicals and botanical (neem oil) to manage the pest and its impact on yield of soybean

Treatment	Yield (kg/plot)	Yield (t/ha)
T_1	2.97 b	3.30 b
T_2	2.79 c	3.10 c
T_3	2.94 b	3.27 b
T_4	3.29 a	3.65 a
T_5	3.19 a	3.55 a
T_6	2.54 d	2.82 d
LSD (0.05)	0.141	0.15
CV(%)	5.89	6.78

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

Treatments:

T_1: Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

T_2: Ripcord 10EC @ 2ml/L of water

T_3: Aktara 25 WG @ 0.3 mg/L of water

T_4: Sumialfa 5EC @ 2ml/L of water
T_5: Marshal 20EC@ 2ml/L of water
T_6: Untreated control

4. 9 Benefit cost ratio analysis

The highest benefit cost ratio (6.00) was obtained in T_4 (Sumialfa 5EC @ 2ml/L water) the treated plot. The second highest benefit cost ratio (5.40) was found in T_5 (Marshal 20EC@ 2ml/L water) treated plot. More or less similar benefit cost ratio was observed in T_1 (3.20) comprising of releasing of Neem oil @ 3ml/L of water. The lowest benefit cost ratio (1.30) found in T_2 (Ripcord 10EC @ 2ml/L of water) treated plot followed by T_3 (2.90) comprising of spraying of Aktara 25 WG @ 0.3 mg/L of water (Table 7).

Similarly the net return was also the highest in T_4 treated plot i.e. Tk. 262235/ha followed by T_5 treated plot which is Tk. 252760/ha. On the other hand, the lowest net return found in T_2 treatment which includes Tk. 206860 followed by T_3 (224310 Tk.).

From the above mentioned findings it was revealed that the T_4 performed as the best treatment in terms of benefit cost ratio (6.00) followed by T_5 (5.40). On other hand, the lowest benefit cost ratio was recorded in T_2 (1.30) followed (2.90) by T_3 (Table 7).

Table 7. Economic analysis of different management practices for managing soybean pest.

Treatments	Cost of pest management (TK)			Yield (t/ha)	Gross return (Tk.)	Net return (Tk.)	Adjusted return (Tk.)	Benefit cost ratio (BCR)
	Insecticides (Tk.)	Labour	Total					
T_1	9000	2520	11520	3.30	330000	227610	36780	3.2
T_2	9750	2520	12270	3.10	310000	206860	16030	1.3
T_3	9000	2520	11520	3.27	326700	224310	33480	2.9
T_4	9375	2520	11895	3.65	365000	262235	71405	6.0
T_5	8850	2520	11370	3.55	355000	252760	61930	5.4
T_6	0	0	0	2.82	281700	190830		

Price of Soybean seed=TK100.00/kg

Cost of insecticide

Neem oil =TK600.00/L

$T_{2:}$ Ripcord 10EC=Tk 1300.00/L

$T_{3:}$ Aktara 25 WG=TK 800/L

$T_{4:}$ Sumialfa 5EC =TK. 1250.00/L

$T_{5:}$ Marshal 20EC=Tk 1180.00/L

Cost of lobour-TK 180.00/manday

Treatments:

$T_{1:}$ Neem oil @ 3ml/L of water mixed with trix @ 10ml/L of water at 15 days interval

$T_{2:}$ Ripcord 10EC @ 2ml/L of water

$T_{3:}$ Aktara 25 WG @ 0.3 mg/L of water

$T_{4:}$ Sumialfa 5EC @ 2ml/L of water

$T_{5:}$ Marshal 20EC@ 2ml/L of water

T_6: Untreated control

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the experimental Field of Sher-e-Bangla Agricultural University, Dhaka during the kharif season from April, 2012 to August, 2012 to study some chemical and botanical management practices in controlling major insect pests of soybean (*Glycine max* L.). The experiment comprised with six different insecticides and botanicals including control treatment viz. $T_{1:}$ Neem oil @ 3ml/L water with trix @ 10ml/L of water at 15 days interval, $T_{2:}$ Ripcord 10EC @ 2ml/L water, $T_{3:}$ Aktara 25 WG @ 0.3 mg/L water, $T_{4:}$ Sumialfa 5EC @ 2ml/L water, $T_{5:}$ Marshal 20EC@ 2ml/L water, T_6: Control, treatment were used as treatments. Incidence of major pest of soybean var. Shohag was the main purpose of this study and their control with applied some chemicals pesticides as treatments. The experiment was laid out in Randomized Complete Block Design (RCBD) single factor with three replications.

Incidence of major pests viz. Whitefly, jassid, pod borer and leaf roller showed significant variation due to the effect of various chemical pesticides. I also found the lady bird beetle as predator from my experimental field. Among the treatments, Sumialfa 5EC @ 2ml/L of water was more effective on pests as well as the minimum number of whitefly and reduction (56.33%), number of jassid and reduction (68.38%), number of pod borer and reduction (96.10%) and number of leaf roller and reduction (78.89%) were recorded at all growth and reproductive stage, respectively on the basis of control treatment.

All growth and yield character were significantly affected by the application of chemicals and botanical extract uses as treatment. The tallest plant (89.67 cm) was observed at chemicals pesticide Sumialfa 5EC @ 2ml/L of water. the maximum number of leaves (17.33) and number of branches (4.33), maximum leaf length (15.27), minimum number of flowers (10.00), minimum number of infected pod (5.53), maximum number of healthy pod per plant (22.60), were found from the treatment Sumialfa 5EC @ 2ml/L of water. Sumialfa 5EC @ 2ml/L of water showed the highest yield per plot (3.29 kg). Sumialfa 5EC @ 2ml/L of water showed the highest yield (3.65 t/ha). On the other hand, the lowest yield (2.82 t/ha) was found control treatment. It is also revealed that (T_4) performed as the best treatment in terms of benefit cost ratio (6.00) followed by T_5 (5.40). On other hand, the lowest benefit cost ratio was recorded in T_2 (1.30) which was very close to T_3 treatment (2.90).

From the above results investigation, it could be concluded that among the all applied insecticidal and botanical treatments in this study, Sumialfa 5EC @ 2ml/L of water showed the pest performance to manage the major pest of soybean as well as on growth and yield characteristics. The following recommendation may be suggested below-

1. Further study may be needed to ensuring the major pest incidence on soybean as well as the growth and yield performance.
2. More chemical treatments may be needed to include for future study as sole or different combination to make sure the better performance of Sumialfa 5EC @ 2ml/L of water.

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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	Farm, 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 (March-August, 2012)

Year	Month	Air temperature (^{0}C)			Rainfall** (mm)	* Relative humidity (%)
		Max.	Min.	Mean		
2012	April	34.1	26.4	30.25	37	59
	May	35.5	25.9	30.7	177	67
	June	34.2	26.9	30.55	308	71
	July	33.0	27.4	30.2	167	79
	August	31.3	27.0	29.15	340	77

* Monthly average

** Monthly total

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