ECO-FRIENDLY MANAGEMENT OF OKRA SHOOT AND FRUIT BORER USING BOTANICALS AND CHEMICAL

MD. JAHANGIR HASAN

DEPARTMENT OF ENTOMOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA -1207

DECEMBER, 2013

ECO-FRIENDLY MANAGEMENT OF OKRA SHOOT AND FRUIT BORER USING BOTANICALS AND CHEMICAL INSECTICIDE

MD. JAHANGIR HASAN

Registration No. 13-05781

A Thesis

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 (MS)
IN
ENTOMOLOGY

SEMESTER: JULY-DECEMBER, 2013

APPROVED BY

……	……
Prof. Dr. Md. Razzab Ali	**Dr. Tahmina Akter**
Supervisor	**Co-supervisor**

……..
Dr. Tahmina Akter
Chairman
Examination Committee

DEPARTMENT OF ENTOMOLOGY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

*This is to certify that the thesis entitled "**ECO-FRIENDLY MANAGEMENT OF OKRA SHOOT AND FRUIT BORER USING BOTANICALS AND CHEMICAL INSECTICIDE**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) IN ENTOMOLOGY,** embodies the result of a piece of bona fide research work carried out by **MD. JAHANGIR HASAN,** Registration no.* **13-05781** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: December, 2013
Dhaka, Bangladesh

Prof. Dr. Md. Razzab Ali
Supervisor
Department of Entomology
SAU, Dhaka

DEDICATED TO
MY
BELOVED PARENTS

ACKNOWLEDGEMENT

All praises are due to the Almighty Allah, the great, the gracious, merciful and supreme ruler of the universe to complete the research work and thesis successfully for the degree of Master of Science (MS) in Entomology.

The author expresses the deepest sense of gratitude, sincere appreciation and heartfelt indebtedness to his reverend research supervisor Prof. Dr. Md. Razzab Ali, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, innovative suggestions, constant supervision and inspiration, valuable advice and helpful criticism in carrying out the research work and preparation of this manuscript.

The author also expresses his sincere appreciation, profound sense, respect and immense indebtedness to his respected co-supervisor Dr. Tahmina Akter, Associate Professor and Chairman of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207, for extending her generous help, scholastic guidance, constructive criticism, continuous inspiration and valuable suggestions during the research work and preparation of the manuscript of the thesis.

The author would like to express his deepest respect and boundless gratitude to all respected teachers of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 for their sympathetic co-operation and inspirations throughout the course of this study and research work.

The author extends his heartiest thanks and gratefulness to many other well wishers for their inspiration, encouragement, help and active co-operation for carrying out the present study.

Cordial thanks are also due to all stuffs of the Department of Entomology and field workers of experimental field in Rampal, Munshiganj, Bangladesh for their co-operation to complete the research work in the field. Special thanks to the farmer Ripon Mollah who provided the land to conduct this experiment.

He would like to express his last but not least profound gratitude to his beloved wife Nayeema Sultana Archi and only one lovely daughter Joya who sacrificed a piece of time for author during the study period. He is grateful to all of his relatives for their inspiration, blessing and encouragement that opened the gate of her higher studies in his life.

Dated: December, 2013 **The Author**

SAU, Dhaka

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

ABBREVIATIONS AND ACRONYMS

AEZ	:	Agro-Ecological Zone
et al.	:	And associates
BBS	:	Bangladesh Bureau of Statistics
cm	:	Centimeter
CV	:	Coefficient of variation
DAS	:	Days After Sowing
DMRT	:	Duncan's Multiple Range Test
^{o}C	:	Degree Celsius
d.f	:	Degrees of freedom
etc.	:	Et cetera
FAO	:	Food and Agriculture Organization
g	:	Gram
ha	:	Hectare
J.	:	Journal
Kg	:	Kilogram
LSD	:	Least Significant Difference
L	:	Liter
m	:	Meter
MS	:	Mean sum of square
SP	:	Soluble Powder
MP	:	Murate of Potash
no.	:	Number
%	:	Percent
SAU	:	Sher-e-Bangla Agricultural University
m^2	:	Square meter
t	:	Ton
TSP	:	Triple Super Phosphate

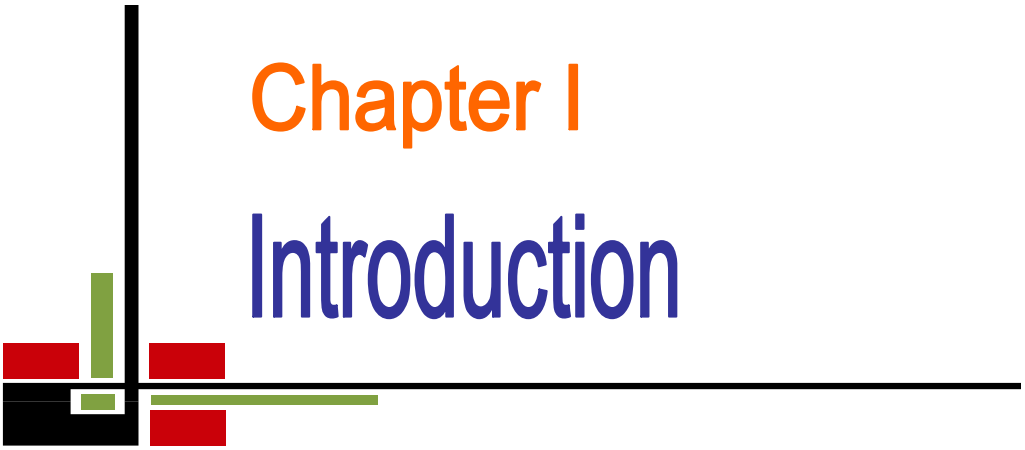
ECO-FRIENDLY MANAGEMENT OF OKRA SHOOT AND FRUIT BORER USING BOTANICALS AND CHEMICAL

By

MD. JAHANGIR HASAN

ABSTRACT

An experiment was conducted in the farmer's field at Rampal, under Munshiganj Sadar Upazila of Munsiganj, Bangladesh during the period from February'2014 to June' 2014 to study the eco-friendly management of okra shoot and fruit borer (*Earias vittella* Fab.) using botanicals and chemical. The treatments are comprised with different botanical products, one synthetic chemical insecticide and one untreated control and these are T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The data were recorded on shoot infestation; fruit infestation by number and weight at early, mid and late fruiting stages; plant and yield related attributes as well as yield of okra. Among all treatments T_6 (Suntap 50SP) showed best performance against okra shoot and fruit borer and reduced the highest percent of shoot infestation, plant infestation, flower infestation and fruit infestation by number and weight in early, mid and late stages (85.26, 93.58, 100, 100, 100 percent) over control throughout the growing period of okra respectively. Among the different botanical products, Neem oil @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval showed best performance in case of shoot infestation, fruit infestation by number and weight in early, mid and late stages, plant infestation and flower infestation. Also in case of yield, plots treated with T_3 (Neem oil @ 4 ml/Litre of water) gave highest products. On the other hand, Dholkalmi leaf extract @ 200g/Litre of water at 7 days interval showed lowest performance in case of shoot infestation, plant infestation and flower infestation and also the plots treated with this treatment showed lowest production of okra. It was revealed from the experiments, T_6= Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval showed best result and T_7= Untreated Control showed least performance in case of shoot infestation, fruit infestation by number and weight in early, mid and late stages, plant infestation and flower infestation and Yield. Okra yield was increased due to increases of number of branches/plant, number of leaf/plant and plant height on the other hand fruit yield was decreased due to increase of fruit infestation by number and by weight occurs to okra shoot and fruit borer.



Chapter I

Introduction

CHAPTER I
INTRODUCTION

Okra, *Abelmoschus esculentus* Moench locally known as '*Bhendi*' or '*Dherosh*' also known as lady's finger is a popular and most common annual vegetable crop grown from seed in Bangladesh and in other tropical and subtropical parts of the world. It belongs to the family Malvaceae and originated in tropical Africa (Purseglove, 1987). Though okra is produced mainly in the kharif season it can be grown year round (Rashid, 1976). Okra production in Bangladesh is mainly during February-July (Rashid, 1995). Okra is an important summer vegetable in Bangladesh which plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market (Ahmed, 1995 and Rashid, 1999). About 38,508 metric tons of okra is produced from 9786 hectares of land per year in Bangladesh, and its average yield is about 3.93 ton ha-^{1} (BBS, 2009). The yield is very low as compared to the yield 9.7-10 t ha-^{1} of other developed countries of the world (Thomson and Kelly, 1979).

Okra is a popular nutritious fruit vegetable. Okra provides an important source of vitamins, calcium, potassium and other mineral matters which are often lacking in the diet of developing countries (IBPGR, 1990). A 100-gram edible portion of okra fruit contains moisture 89.6 g, protein 1.9 g, fat 0.2 g, fibre 1.2 g, phosphorus 56.0 mg, sodium 6.9 mg, sulphur 30 mg, riboflavin 0.1 mg, oxalic acid 8 mg, minerals 0.7 g, carbohydrates 6.4 g, calcium 66 mg, iron 0.35 mg, potassium 103 mg, thiamine 0.07 mg, nictonic acid 0.6 mg, vitamin C 13 mg, magnesium 53 mg and copper 0.19 mg (Gopalan *et al.*, 2007). Okra is cultivated mainly for its immature fruits, which are generally cooked as vegetable.

Okra is a nutritious vegetable which plays an important role to meet the demand of vegetables of the country when vegetable are scanty in the market. Okra mucilage is suitable for medicinal and industrial application. In Bangladesh, vegetable production is not uniform round the year. Most of the vegetables are produced in the winter but very low in the summer. Around 30% of the total vegetables are produced in the kharif season (Anon., 1993) among them okra is very important. In the year 2009-2010,the total production of okra was about 42000 tons from 10121 hectors of land with an average yield of 4.15t/ha (BBS,2011).The yield is very low compared to that of other developing countries where the yield as high as 7-12 t/ha (Yamaguchi,1998).

The main causes of poor production are the attack of various pests and lack of knowledge about cultural practices. Okra is susceptible to the attack of various insects from seedling to fruiting stage such as okra shoot and fruit borer, *Earias vittella*, okra jassid, cut worm, white fly, aphids etc. Among the insect pest of okra, whitefly, *Bemisia tabaci*, okra shoot and fruit borer (OSFB), *Earias vittella* F. are the most serious pests, which cause direct damage to tender shoots and fruits. It is reported that about 69% losses in marketable yield due to attack of this insect pest. It is the most serious pest of okra in Bangladesh and both quantitative and qualitative losses happened due to its pest infestation.

According to Srinivasan *et al.* (1959) the OSFB cause up to 40-50% damage of okra fruit in some areas of South East Asian countries. Krishnaiah (1980) observed the attack of fruit borer to the extent of 35% in harvestable fruit of okra. In Madras 40-50% fruit were also found damaged by this pest (Srinivasan and Gowder 1959). The attack of fruit borer, *Earias vittella* on okra starts 4-5 weeks after the germination both in the kharif and summer seasons. The attacked top tender shoots dry up while flowers, buds and developing fruit fall down pre-maturely. Larvae of *Earias vittella* enter the shoot tips of young plants and bore into fruits. The affected fruits are unfit for human consumption.

Various control strategies have been adopted against shoot and fruit borer, one common method being the use of synthetic insecticides, which can be environmentally disruptive and can result in the accumulation of residues in the harvested produce creating health hazards (Chinniah *et al*., 1998).

Farmers always desire quick curative action for controlling pests. Since no other control measure against okra sucking pests is available, chemical insecticides have remained as the most powerful tools for controlling this pest. Insecticides are highly effective, rapid in curative action, adaptable to most situations and relatively economical. Insecticides is the only tool for pest management which is reliable for emergency action when insect pest population approach or exceed the economic threshold level (Parkash, 1988)

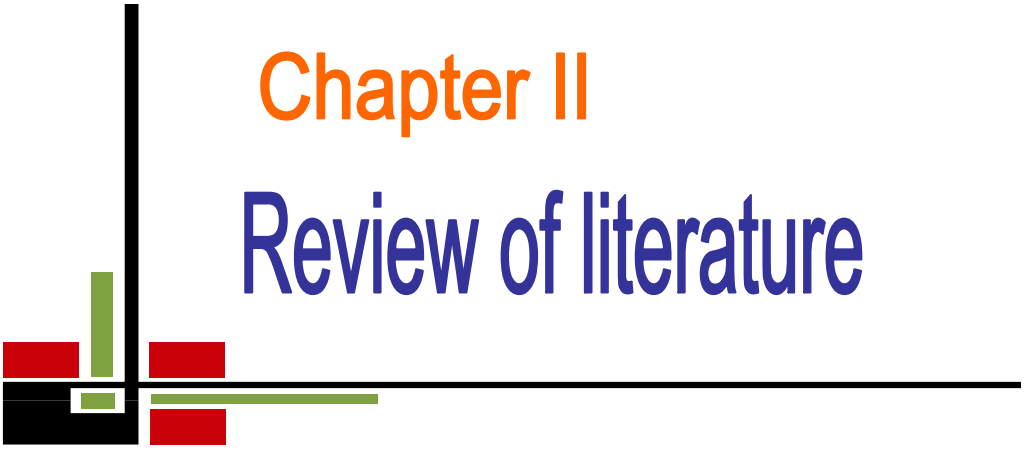
Mixtures of various plant parts such as leaf, bark, seed and vegetable oils are traditionally being practiced in Asia and Africa for the management of this insect pest.

Botanicals possess an array of properties including insecticidal activity and insect growth regulatory activity against many insect and mite pests (Prakash *et al*., 1990).

Objectives

Considering above points the experiment have been undertaken to fulfill the following objectives:

- To study the infestation level of okra shoot and fruit borer.
- To evaluate the effect of different indigenous botanicals for the management of okra shoot and fruit borer.
- To compare the effectiveness of botanicals over chemical insecticides applied against okra shoot and fruit borer.



Chapter II

Review of literature

CHAPTER II

REVIEW OF LITERATURE

An effort has been attempted to present a brief review of research in relation to ecofriendly management of okra shoot and fruit borer through botanical and chemicals. Okra *(Abelmoschus esculentus)* locally known as '*Bhendi*' or '*Dherosh*' also known as lady's finger is a popular and most common annual vegetable crop grown from seed in Bangladesh and in other tropical and subtropical parts of the world. okra shoot and fruit borer are reviewed in this chapter. In Bangladesh limited work of insect pests management of okra (*Abelmoschus esculentus* Moench) in summer or winter has been done. A brief review of the literature available in Bangladesh and elsewhere related to insect pest control of okra is discussed below:

2.1 General review of okra shoot and fruit borer

2.1.1 Nomenclature

Phylum: Arthropoda
Class: Insecta
Order: Lepidoptera
Family: Noctuidae
Genus: *Earias*
Species: *Earias vittella*

2.1.2 Distribution of okra shoot and fruit borer

Butani and Jotwani (1984) reported that okra shoot and fruit borer, *Earias vittella* (Fabricius) is widely distributed and is recorded from Pakistan, India, Sri Lanka, Bangladesh, Burma (Myanmar), Indonesia, New Guinea and Fiji. This pest is common oriental species found from India and China to North Australia (Hill, 1983). Atwal (1976) reported that *Earias vittella* is widely distributed from in North Africa, Pakistan, India, and other countries and is a serious pest of okra and cotton.

2.1.3 Biology of Okra shoot and fruit borer

Okra shoot and fruit borer is a holometabolous insect. So, it has four stages to complete its life cycle viz. egg, larva, pupa and adult.

Egg: The eggs are about 0.5 mm in diameter, spherical and bluish green in color. The egg shell (chorion) has parallel longitudinal ribs forming a crown-like structure at the top. Eggs are laid singly or in small groups on young shoots, underside of the leaves, flower buds or young pods. Depending on the species, 82-378 eggs are laid in each 4-7 days and they hatch in 3-4 days in warm weather and 8-9 days under cold weather (Rehman and ali, 1983).

Larva: Newly hatched larva is 1-5 mm long; brownish-white has a dark head and prothoracic shield. The larvae undergo4-5 molts. Larval duration varies from9-20 days in warm weather and50-60 days in winter (Rahman and Ali1983 ,). Their main characteristics is that their body surface is irregularly spotted and spiny. Hence they are called as spiny bollworm or spotted bollworm. The fully developed (last instar) larvae are about 20 mm long, more or less spindle-shaped, greenish, dark grayish or brownish in color. The dorsal side or the back has a broad, whitish, longitudinal stripe with distinct dark spots. Two orange spots are found on the thoracic segments. Head and spiracles are black.

Pupa: Pupa is shiny yellowish brown, about 12-14 mm long and found in a firm, yellowish-white to light grayish cocoon, shaped like an inverted boat. The pod borer pupates on top of the soil layer or on the plant, often on dried shoots and pods. Dark brown Pupa is enclosed in a dirty white to buff color cocoon. The pupal period lasts from a few days to more than months depending upon the climate. The average pupal period being 1-3 weeks (Rehman and Ali, 1983).

Adult: The moth is yellowish-brown, about 12 mm long with a wingspan of about 20-25 mm. Color of fore wings is variable, depending on the season of the year (temperature), i.e. yellowish white with a pink shade or brownish-yellow and with a green (sometimes brown), more or less wedge-shaped longitudinal stripe. The dorsal side of the thorax has two green stripes. Hind wings are whitish. It has 11 generations in a year. The longest life cycle (49 days) was observed during January while the shortest life cycle (29 days) was found during July (Sharma *et al*., 1985).

2.1.4 Host range of okra shoot and fruit borer

Gautam and Goswami (2004) stated that okra shoot and fruit borer (*Earias vittella)* feeds on many species of malvaceous plants.

Satpute *et al*. (2002) studied on different hosts of *Earias vittella* and found that okra was most preferred host for the development of the pest, followed by cotton, artificial diet and mesta (*Hibiscus sp.*) based on average minimum pupal period, highest fecundity and maximum pupal and adult weight.

Dongre and Rahaller (1992) were examined the relative food plant preference and induction of preference for feeding behavior in larvae of *Earias vittella* under dual choice conditions. Out of 5 food plants, *Abelmoschus esculentus* (okra) was the most and *Hibiscus rosa-sinensis* was the least preferred.

Butani and Jotwani (1984) found okra shoot and fruit borer as an oligophagous pest although okra and cotton are its main hosts. They also found it to feed on a large number of malvaceous plants, both wild as well as cultivated.

Khan and Verma (1946); Pearson (1958); Butani and Verma (1976); Atwal (1999); David (2001) reported that this pest has been infested to okra, cotton, hollyhock, safflower, indian mallow, *Corchorus sp, Hibiscus sp, Malvas sp, Malvastrum sp, Sida sp, Theobrome sp* and *Urena sp*.

Atwal (1976) mentioned that okra and cotton is the most favorite host of OSFB. Plant species including sonchal (*Malva parviflora*), gulkhaira (*Althaea officinalis*), holly hock (*Althaea rosea*) and some other Malvaceous plants are appear to be its alternate hosts.

Rehman and Ali (1983) reported that when okra shoot and fruit borer were offered the choice of different parts of host plant they preferred okra fruit and shoot the best followed by cotton balls, ball. Flowers and buds of deshi cotton (*Gossypium arboretum*), buds and flower of kenaf and maize grains, flower of *Abutilon indicum*, flowers of *Hibiscus rosasinensis*, sarson (*Brassica campestris* var *sarson*), *Malvastrum tricuspidatum*, *Cassia fistula* and ears of pearl millet, pod of jute and soyabean.

2.1.5 Nature of damage

Okra shoot and fruit borer, *Earias vittella* (Fab.) is one of the key insect pest of okra. This pest causes 36-90 % loss in the fruit yield of okra (Misra *et al*., 2002).

Shah *et al.* (2001) observed that the caterpillars of *E. vittella* bore into the tender shoots and developing floral buds causing drop of fruiting bodies and developing fruits making them unfit for human consumption.

When the crop is only a few weeks old, the freshly hatched larvae bore into the tender shoots and tunnel downwards resulting withering of shoots and ultimately killing the growing points. As a result the apical dominance is lost and side shoots may arise and giving the plant a bushy appearance. With the formation of buds, flowers and fruits the caterpillars bore those and feed on the inner tissues. They move from bud to bud and fruit to fruit. The damaged buds and flowers wither and fall down without bearing any fruit. The affected fruits become deform in shape and remain stunted in growth (Butani and Jotwani, 1984; Acharya, 2010).

The larvae of okra shoot and fruit borer bore into the tender shoots, flower buds and fruits. As a result, the attacked shoot dries up while the flower buds and developing fruits dropped prematurely. Affected fruits remain on the plants become unfit for human consumption (Mohan *et al.,* 1983 and Atwal, 1976). The larvae of OSFB bore into the shoots and feed inside and also damage the seed (Karim, 1992).

The first symptom of attack by okra shoot and fruit borer was visible when the crop was three weeks old and the larvae bored into the shoots. Under severe attack, the top leaves wilted and the whole apex of the plant dropped down. In the reproductive stage of the crop, the larvae moved to the flower buds, small fruits and even mature pods and causing reduction of yield (Singh and Bichoo, 1989). Like other insects, the population of spotted bollworm is governed by their inherent capacity to increase, under the influence of various environmental factors.

The damage to the crop is done by two ways. First, the terminal portions of growing shoots are bored by the caterpillars, which move down by making tunnels inside. As a result, the shoots droop downward or dry up. Second, the larvae enter the fruits by making holes, rendering them unfit for human consumption (Misra *et al*., 2002).

2.1.6 Seasonal abundance of okra shoot and fruit borer

2.1.6.1 Ecology

The insect was found to occur in high population during rainy season and its number drop in summer as the temperature increases.

The development period of different stages prolonged during winter, the longevity, fecundity and coloration of the adult also fluctuate with environmental temperature and humidity (Schmutterer, 1961).

Srinivasan *et al.* (1959) reported that 40-50% okra fruit were damaged due to attack of this pest in Madras. In another study Krisnaiah (1980) observed the attack of fruit borer to the extent of 35% in the harvestable fruit of okra.

Rana (1983) observed the pick incidence of shoot and fruit borer of okra was observed in the last week of August with a range of 34 to 45% damage to fruits. The incidence of *Earias* spp. on okra was studied by Dhanwan and Sidhu (1984). He reported that the maximum damage occurred in fruits (67.7%) and buds (52.4%) in late October. The maximum in shoots (1.7%) and flowers (1.5%) occurred in mid-August. In spring, the maximum damage to fruits was 32.04% and increased larval population 1.4/plant was observed in late July. The population of *Earias spp* increased slowly upto mid September and rapidly thereafter. Dhamdhere *et al.* (1984) reported 25.9 to 40.9% damage to fruits in October.

Butani and Jotwani (1984) reported that there is no true hibernation but development and activity is considerably slowed down during winter. Khaliq and Yousuf (1986) also reported the increased incidence of *E. vittella* with the increasing temperature and humidity.

In general, the population of OSFB fluctuates from month to month, season to season, even year to year. Dash *et al.* (1987) reported that the occurrence and seasonal abundance of noctuid *E. vittella* was maximum in shoots from July to October.

Dutt and Saha (1990) observed the lower activity of *E. vittella* during December-January and the higher activity was observed during the increasing temperature from February and a maximum peak in May-June.

Khurana and Verma (1990) observed lower incidence (12.5%) of *E. vittella* during 1983 in a condition having mean maximum and minimum temperature of 34.3^0 C and 20.5^0 C, respectively with a mean RH of 73%, frequent rainfall between May and September. But they found comparatively higher incidence (20.5%) of the pest during 1987, in an environment condition with mean maximum and minimum temperatures of 36.3 C and 23.2 C, respectively having a mean RH of 64.8%.

Ali (1992) reported that the peak abundance and intensity of okra shoot and fruit borer/spotted bollworm in cotton field were in October-November and were more common during early to mid season on growing shoots, buds, pin bolls and developing bolls of cotton and during late season, particularly after January they tend to disappear.

Zala *et al.* (1999) found the activity of okra shoot and fruit borer, *Earias vittella* on shoot was started from the fifth week of July on four weeks old crop and continued till fourth week of September on twelve weeks old crop during 1996. In 1997 the infestation of *Earias vittella* on shoot was started on the first week of August on five weeks old okra crop till first week of October on thirteen weeks old crop. The maximum (26%) shoot damaged plant was observed during 1996 in second week of August on six weeks old okra crop, whereas it was 22% in the third week of August on seven weeks old okra crop during 1997.

Patel *et al.* (1999) reported the infestation of *E. vittella* on okra fruits appeared from the second week of August on six weeks old okra crop and continued till last harvest of fruit during 1996-1997. The intensity of fruit damage varied from 11.11% (second week of August) to 40.43% (fourth week of September) and 10.12% (third week of August) to 47.37% (first week of October) during 1996 and 1997, respectively. The larval activity started from fifth week of August in 1996 and 1997 and continued till the last harvest of the crop. The relevant observations were also reported by Mote (1977) and Kadam and Khaire (1995).

Pareek *et al.* (2001) reported that the incidence of okra shoot and fruit borer started in first week of September and maximum fruit infestation recorded in the third week of October. Yadvendu (2001) recorded that the peak incidence of okra shoot and fruit borer and maximum fruit infestation in first and fourth week of September, respectively.

Acharya (2002) and Dangi (2004) observed that the incidence of okra shoot and fruit borer commenced from the 4th week of August (6th week after sowing).

A field experiment was conducted by Sharma *et al.* (2010) to study the fluctuation of pest population of *Earias vittella* (Fab.) and their relation with prevailing weather condition at Horticulture Farm in Udaipur, India during Kharif 2005 and 2006. The results revealed that borer incidence commenced in the 29th standard week. The peak

infestation of plants (91.6 %) was observed in 45th standard week. The maximum numbers of larvae (7.5 larvae/l0 plants) were recorded in the 42nd standard week. Correlation between pest population and important weather parameters showed that *Earias* population was negatively correlated with the mean temperature and mean relative humidity but none significantly and negatively correlated with rainfall in terms of larval population and percentage of infested plants.

2.2 Management of okra shoot and fruit borer

Several biologically active compounds have been isolated from different parts of neem tree. Several vilasinin derivatives, salanins, salanols, salasnolactomes, vepaol, isovepaol, epoxyazadirachdone, gedunin, 7-deacetylgedunin have been isolated from neem kernels. Azadirachtin is the most potent growth regulator and antifeedant (Butterworth and Morgan, 1968; Warthen *et al.*, 1978).

The triterpenoid azadirachtin ($C_{35}H_{44}O_{16}$) was first isolated from the seeds of the tropical neem tree by Butterworth and Morgan (1968). Its definite structural formula, which resembles somewhat that of ecdysone, was finally explained in 1985 by kraus *et al*. and by Bilton *et al.* (Figure A).

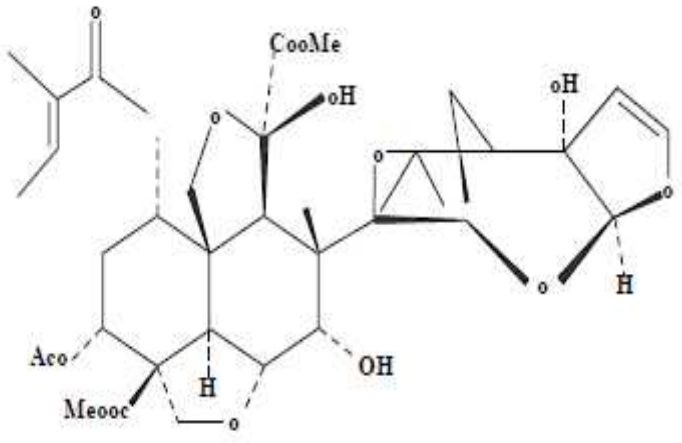


Figure A. Structural formula of azadirachtin

Azadirachtin is a limonoid alleliochemical (Butterworth and Morgan, 1968; Broughton *et al.,* 1986) present in the fruits and other tissues of the tropical neem tree (*Azadirachta indica*). The fruit is the most important aspect of neem that affects

insects in various ways. The leaves, which may also be used for pest control, may reach a length of 30 cm.

A field experiment was conducted by Patil *et al.* (1991) in India for the control of okra fruit and shoot borer (*E. vittella*) with cypermethrin (15 gm/ha), fenvalerate (50gm/ha), acephat (375 gm/ha), quinaphos (250 gm/ha) and endosulfan. (250 gm/ha). All treatments reduced pod damage but cypermethrin treated plants were the least infested gave the best yield.

Nine insecticides, cypermethrin (Cyperkill 25 EC), carbaryl (Hexavin 50 WP), deltamethrin (Decis 2.8 EC), diflubenzuron (Dimilin 25 WP), endosulfan (Thiodan 35 EC), fenvalerate (Sumicidin 20 EC), fluvalinate (Mavrik 25 EC), monocrotophos (Monocil 36 SL) and quinaiphos (Ekalux 25 EC), were tested against 1 -day-old eggs of *Earias vittella*. All treatments significantly reduced egg-hatch, although diflubenzuron had occured by far the least effect (Brickle *et al.*, 2001).

Misra (1989) studied the bio-efficacy of some insecticides against the pest complex of okra. The author reported that percent shoot infestation in insecticide treated plots varied from 1.74- 10.03% compared to 15.23% in untreated control plots.

Adult pairs of males and females of *Earias vittella*, a pest of cotton and okra, were released in breeding chambers in different sets, containing the odours of the leaves of neem, *Azadirachta indica*; tulsi, *Ocimum basilicum*; eucalyptus, *Eucalyptus rosfrata*; lantana, *Lantana camara*; bulbs of garlic, *Allium sativum* and one control set with no odour. Adult longevity did not differ significantly among the treatments. All the treatments significantly reduced the egg output as compared to the control (172 eggs). Similarly, all the odours significantfy reduced egg hatching compared to the control (90.81%). The lowest number of eggs (128) and hatching (68.15%) were recorded with *Azadirachta* leaves odour (George, 1997).

Ambekar *et al.* (2000) evaluated the efficacy of neem-based formulations and synthetic insecticides against okra shoot and fruit borer. They found that all treatments significantly reduced fruit borer infestation over the untreated control. However, cypermethrin at 0.1% was the most effective and recorded the lowest infestation of 6.57%.

Chinniah and Mohanasundaram (1999) studied the possible toxic effect or the safety of the neem derivatives to the predatory mites *Amblysieus* spp. The neem products

viz., neem cake extract (10%), neem seed kernel extract (5%) and neem oil (3%) proved safe by recording lower predator mortality.

2.2.1 Mode of action of neem

2.2.1.1 Settling Behavior

Crude neem extracts deters settling and reduces feeding in *M. persicae* (Griffiths *et al*. 1978 and 1989).

2.2.1.2 Oviposition Behavior

The females of some lepidopterous insects are repelled by neem products on treated plant parts or other substrates and will not lay eggs on them under laboratory conditions.

2.2.1.3 Feeding Behavior

Azadirachtin is a potent insect antifeedant. Antifeedancy is the result of effects on deterrent and other chemoreceptors. The antifeedant effects of azadirachtin have been reported for many species of insects. Reduction of feeding was also observed after topical application or injection of neem derivatives, including AZA and alcoholic neem seed kernel extract. This means that the reduction of food intake by insects is not only gustatory which means that sensory organs of the mouth parts but also non-gustatory regulate it. These two phagodeterrent/antifeedant effects were called primary and secondary (Schmutterer, 1985).

2.2.1.4 Metamorphosis

Azadirachtin has different influence on the metamorphosis of the insects resulting in various morphogenetic defects as well as mortality, depending on the concentration applied.The IGR effect of neem derivatives such as methanolic neem leaf extract and azadirachtin in larvae and nymphs of insects was first observed in 1972 in Heteroptera (Leuschner, 1972) and Lepidoptera.

Molting, if it occurred, was incomplete and resulted in the death of the tested insects.Botanicals possess an array of properties including insecticidal activity and insect growth regulatory activity against many insect pests and mites (Rajasekaran and Kumaraswami, 1985; Prakash and Rao, 1986 and 1987; Prakash *et al*., 1987; 1989 and 1990). Low mammalian toxicity, no reported development of resistance to their production so far, less hazardous to non-target organisms, no pest resurgence

problem, no adverse effect on plant growth, negligible application risks, low cost and easy availability are the advantages of plant products over synthetic chemicals.

Ahmed (1984) enlisted 2121 plant species, possessing pest control property which include neem, sweetflag, cashew, custard apple, sugar apple, derris, lantana, tayanin, indian privet, agave, crow plant etc. 1005 species of plants having biological properties against insect pests including 384 species as antifeedants, 297 as repellents, 97 as attractants and 31 as growth inhibitors.

About 413 different species/sub-species of insect pest have been listed by (Schmutterer, 1995) found to be susceptible to neem products. The listed species/sub-species belongs to different insect orders most of them were Lepidoptera (136) and Coleopteran (79).

2.2.2 Management by botanicals

The use of neem based insecticides as a source of biologically active substances for pest control is increasing worldwide, and have recently gained popularity as components of integrated pest management (Banken and Stark, 1997).

Maximum reduction in bollworm infestation (65.7%) was observed in garlic treated plot. Garlic extract and NSKE both at 10 per cent were found to be superior. Lowest bollworm incidence was observed with NSKE (10.3%), datura and neem oil emulsion (Anon., 1987).

Mallik and Lal (1989) reported that application of neem oil cake and fertilizer (2.5 kg of each on 200 square meter plot) or of neem oil cake alone (5 kg/plot) reduced *Earias spp*. of okra infestation and increased yield.

Sardhana and Krishna Kumar (1989) studied the efficacy of neem oil, karanj oil (both at 0.5, 1.0 and 2.0%) and garlic oil (0.25, 0.5 and 1.0%) in comparison with monocrotophos (0.05%). Among the oils, neem oil and karanj oil offered effective control against okra fruit borers. It was concluded that weekly application of neem oil at two per cent concentration was effective in controlling fruit borer in okra and was safe to natural enemies.

Weekly application of neem (*Azadirachta indica*) oil at 2% was effective for controlling *E. vittella* on okra (Sardana and Kumar, 1989). They observed that the plots having lower fruit damage and increased yields in treated plots monocrotophos

at 0.05% and can therefore, be recommended for the use in an integrated control scheme for the rest.

The most probable effect of neem in Lepidopterans is the disruption of the larval-pupal molt (i.e. pupation), which has been frequently reported (Schmutterer *et al.*, 1983; Koul and Isman, 1991).

Repellent activity of neem against oviposition by Lepidopterous pests has also been reported for *Spodoptera litura* (Joshi and Sitaramaiah, 1979), *Cnaphalocrocis medinalis* (Saxena *et al*., 1981) and *E. vittella* (Sojitra and Patel, 1992). Extracts of neem and bakain caused maximum adverse effects on fecundity and hatching.

Samuthiraveiu and David, (1991) reported that application of neem oil (at 0.1, 0.3 and 0.5%) and endosulfan at (0.035 and 0.07%), alone and together against the OSFB reduced damage and maximum yield was oB. t.ained with 0.07% endosulfan

Numerous plant species have been reported to possess pest control properties but only a few seem to be ideally suited to practical utilization. Among these, neem (*Azadirachta indica* A. Juss) and bakain (*Melia azedarach* L) are the most promising plants from the entomological perspective (Schmutterer, 1990 and 1995).

Neem-based formulations have already been recommended in the management of bollworms including *E. vittella* in cotton (Gupta and Sharma, 1997 and CCSHAU, 1997).

Neem oil produced non-toxic effects after spray and acted as antifeedant, growth inhibitor and oviposition deterrent against insects pests of okra and cotton (Ahmed *et al.,* 1995).

Sasikala *et al.* (1999) studied during Rabi 1998-99 at the Agricultural College Farm, Bapatla for the management of the okra shoot and fruit borer, *Earias vittella*, involving eco-friendly methods. The treatments included 5% neem seed kernel extract (NSKE), neem oil (0.2%), *Bacillus thuringiensis* var. (B.t.) *kurstaki* (0.15%), lufenuron (0.02%), carbaryl (0.15%), their combinations (except NSKE), mechanical removal and destruction of infested shoots and fruits with larvae, and release of egg parasitoid, *Trichogramma japonicum* Ashm. Treatment by mechanical destruction of infested shoots and fruits with larvae, neem oil (0.2%) and release of the egg parasitoid, *T. japonicum* resulted in very good control of shoot and fruit borer as compared to control. The respective percentage of shoot infestation and fruit damage

(on number basis) in these treatments were 14.46, 20.24; 21.06, 23.35; and 23.36 & 28.00 vis-a-vis 52.60 & 52.55 per cent in control plots. Plots treated with neem oil (0.2%), neem oil (0.1%) + B.t. (0.075%), neem oil (0.1%) + lufenuron (0.01%), and neem oil (0.1%) + carbaryl (0.075%) gave higher fruit yield (40.76, 33.80, 31.35 and 29.07 kg/plot, respectively, compared with 17.5 kg/plot oB. t.ained from control plots).

Patil (2000) conducted an experiment with 20 indigenous plant extracts to evaluate the antifeedant property against insect pest. *A. indica* exhibited maximum of 10-51 percent antifeedant followed by *A. calamus* (15.69%) and *A. squamosa* (17.31%) against third instar larvae of *Earias vittella.*

Morale *et al.* (2000) studied the effect of plant product against *E. vittella* of cotton under laboratory condition and revealed that neem oil 1%, karanj oil 1%, cotton seed oil 1%, neem seed extract (NSE aqueous) 5% and NSE (methanolic) 1% were significantly affected the larval period, larval mortality and fecundity of *E. vittella*.

Lakshmanan (2001) reported effectiveness of neem extract alone or in combination with other plant extracts in managing lepidopteran pest's viz., *E. vittella*, *Chilo partellus* Swinhoe, *H. armigera* and *S. litura*.

Owusu *et al.* (2001) evaluated the performance of Aqueous Neem Seed Extract (ANSE) at 75 g/L of water (22.5 kg/ha) on Legon I variety of local garden egg in the field. The effect of ANSE was compared with a registered *Bacillus thuringiensis* Berl. (Biobit), a synthetic insecticide (Karate 2.5 EC) and an untreated control (water only). Karate and Biobit were applied at rate of 2.5 ml/L (800 ml/ha) and 0.8 g/L (0.24 kg/ha), respectively. The effect of each treatment on insect abundance, defoliators, shoot, bud and fruit borers were determined. Water traps were used to monitor the effect of the three products on the abundance of insect fauna associated with crop. Insects from seven major orders (Coleoptera, Lepidoptera, Odonata, Orthoptera, Diptera, Hemiptera and Hymenoptera) were found associated with the local garden egg. The major insect pests of the crop included the shoot and fruit borer, *Earias vittella*, which attacked the shoots and fruits, the bud borer (budworm) Scrobipalpa blapsigona (Meyrick), which oviposited into the buds and the feeding activities of the larvae, led to the abortion of buds, Pachnoda cordata (Drury) which scraped and chewed stem and shoot and defoliators comprising Acraea peneleos peneleos (Ward.),

Acraea pharsalus pharsalus (Ward.), *Zonocerus variegatus* L., *Eulioptera* sp., *Urentius hystericellus* (Richter) and *Phaneroptera nana* (Stal.). Karate and ANSE significantly ($p<0.05$) reduced population levels of some major pests such as *P. cordata* and *Z. variegatus* than Biobit. The mean number of *E. vitella* in the shoots and buds, respectively were significantly higher ($p>0.05$) on plots treated with ANSE and Biobit than Karate. This suggests that neem seed extract and Biobit had little or no systemic action against shoot and bud borers of the crop in the field. Significantly fewer ($p<0.05$) numbers of predators mainly ants and ladybird beetles were collected from plants treated with Karate compared to either ANSE- or Biobit- treated plots. This indicates that Karate had adverse effects on beneficial insects in the garden egg ecosystem. Karate and ANSE also significantly ($p<0.05$) reduced percentage fruit damage, number of borers per fruit and the activities of leaf feeders. Although ANSE could not effectively control the shoot and bud borers as Karate, it performed better in reducing borer damage than either Biobit or control. With proper timing and innovative methods of application, aqueous neem seed extract can be used as alternative or supplement to synthetic insecticide for the management of vegetable pests of local garden eggs by resource poor farmers.

Rosaiah (2001) reported that neem oil 0.5% was significantly superior in reducing the whitefly population and shoot and fruit borer damage on okra followed by NSKE (5%).

Antifeedant effect of neem in combination with sweetflag and pongam extracts on okra shoot and fruit borer was studied by the Rao *et al.* (2002) which gave 43.12 to 80.00 percent mortality protection over control.

Mishra and Mishra (2002) conducted a field experiment during the wet season of 1995 and 1996 in Udayagiri, Orissa, India, to evaluate the efficacy of some biopesticides against the insect pests (*Amrasca biguttula biguttula* and *Aphis gossypii*) and defenders of okra. The botanical insecticides Neemax (neem seed kernel extract) at 1.0 kg/ha and Multineem (neem oil) at 2.5 litres/ha; and bioinsecticides Biotox (*Bacillus thuringiensis* subsp. *thuringiensis* serotype) at 1.0 kg/ha alternated with Malathion at 0.5 kg a.i./ha in different combinations were sprayed thrice over the crop at 20 days interval, starting from 20 days after germination. The results revealed lowest fruit borer incidence (8.6% fruit bored on weight basis) when Biotox was applied to the crop 2 times alternated with one Malathion application, followed by the

treatment where Malathion was applied twice alternated with one Biotox application (10.6%). Multineem and Neemax combined with Malathion or sole Malathion application also lowered the fruit borer incidence (11.7-13.3%) compared to the untreated control, which had the highest incidence of 16.9%. The aphid population remained very low (50.7/top 3 leaves) in treatment where Biotox, Neemax and Multineem were applied once in succession, which was at par (52.2) with treatment where Multineem was applied in between 2 Malathion applications. The control plants maintained the highest aphid population (125). The predatory coccinellids and spiders were the main defenders existed in the field in both years. The predatory coccinellids were active in the biopesticide-treated plants and in the untreated plants. Their population remained extremely low in Malathion-treated plot. The spider population was found unaffected by the treatments. The application of Multineem and Neemax alternated with Malathion was as remunerative as the 3 applications of Malathion (7.83-8.67 thousand rupees/ha), except in Biotox application where the yield was found low due to higher aphid population. The untreated plot was the least remunerative (2.65 thousand rupees/ha).

Patil *et al.* (2002) carried out a field experiment in okra (cv. Arka Anamika) field, grown during the summer season of 1995 in Rahuri, Maharashtra, India, was sprayed with neem seed extract (2% NSE), *Bacillus thuringiensis* (0.03% B. t.) and cypermethrin 25 EC (0.0075%), applied alone, in combination or alternately, to control the fruit borers *Earias vittella* and *E. insulana*. Cypermethrin 25 EC was highly effective against okra fruit borers, recording only 15.55% fruit damage and resulting in a yield of 42.11 q/ha (compared with 52.82% damage and a yield of 22.88 q/ha in untreated control plants). The combination treatment NSE+cypermethrin controlled okra fruit borers effectively and recorded the lowest fruit damage of 14.48% and highest pod yield (67.22 q/ha). The cypermethrin-NSE-B. t.-cypermethrin sequence treatment recorded 15.33% fruit damage and a 50.77 q/ha fruit yield.

Sumathi and Balasubramanian (2002) conducted two field experiment during 1998 and 1999 to test the efficacy of different treatments viz., the egg parasitoid *Trichogramma chilonis* (TC), neem oil (NO), Palmarosa oil (PRO), neem seed kernel extract (NSKE) and endosulfan at varying economic threshold levels to reduce the fruit borers, *Earias vittella* Fabricius and *E. insulana* Boisduval damage. In both the experiments, spraying of endosulfan 0.07% was significantly superior in reducing the fruit borer damage on weight basis and the order of efficacy of different treatments in

reducing the fruit damage was with endosulfan 0.07% (67.55 and 63.90%)>NSKE 5% (47.56 and 44.60%)>PRO 5% (42.40 and 37.15%)>NO (C) 3% (28.91 and 31.29%)>release of *Trichogramma chilonis* (T. C.) at 50 000/ha at 100% ETL i. e. 10.0% fruit damage (29.90 and 29.40%)>NO (A) 3% (28.91 and 31.29%)>T. C. at 7.5% fruit damage (24.65 and 22.62%)>T. C. at 5.0% fruit damage (20.63 and 17.96%)>T. C. at 2.5% fruit damage (15.26 and 13.33%). The cost:benefit ratio was maximum in endosulfan treatment and minimum with release of *T. chilonis* at 2.5% fruit damage.

Mudathir and Basedow (2004) found that different preparations of neem significantly reduced okra shoot and fruit borer infestation in okra.Singh *et al.* (2005) tested the efficacy of two botanicals and insecticides and reported that NSKE @ 1.5% was found superior after fenvalerate with respect to yield. NSKE (1.5%), NSKE (1%), karanj seed kernel extract (KSKE) (1.5%) and NSKE (1%) were superior by recording 58.27, 47.32, 44.25 and 41.5 q/ha yield, respectively as against 29.17 q/ha in untreated control.

2.2.3 Cultural control

Atwal (1976) reported that OSFB can be suppressed by clean cultivation and destruction of alternate host plants. Kashyap and Verma (1987) suggested that control of OSFB may be achieved through field sanitation, early sowing and resistant varieties when cotton is not growing in a locality.

The effect of nitrogen, phosphorus and potassium fertilizers on the incidence of noctuid *E. vittella* on okra was studied by Kumar and Urs (1988) in the field in Karnataka, India. The highest infestations were recorded in the plots treated with 250 and 30 kg of nitrogen and potassium per hectare, respectively. There were positive correlations between nitrogen uptake by the plant and E. vittella infestation. But there was negative correlation between potassium uptake by the plants and its infestation.

2.2.4 Management by chemical

Borer is the major pest of okra, committing colossal losses to okra growers. Although varies measures have been reported for controlling the pests, there is not a single such method that successfully be adopted to suppress the incidence and damage of the pests. This perhaps, is mainly due to the oligophagous nature of this pest that helps their year round population build up. However, a thorough search of review reveals

that the approaches that had ever been made in controlling this pest comprise mainly the use of chemicals. Though various management approaches are practiced for this pest suggested by different workers, insecticides are found very effective which are cited below.

Brickle *et al.* (2001) tested nine insecticides, cypermethrin (Cyperkill 25 EC) carbaryl (Hexavin 50 WP), deltamethrin (decis 2.8 EC), diflubenzuron (Dimilin) 25 WP), endosulfan (Thiodan 35 EC), fenvalerate (Sumicidin 20 EC), fluvalinate (Mavrik 25 EC), monocrotophos (Monocil 36 SL) and quinaiphos (Ekalux25 EC) against 1 –day-old eggs of *Earias vittella*. All treatments significantly reduced egg-hatch, although diflubenzuron had occurred by far the least effect.

Efficacy of different pesticides and their combination against jassid and borer of okra was studied by Satpathy and Rai (1999). The result indicates that among the treatments in vegetative phase, Monocrotophps + cypermethrin combination reduced the shoot borer damage, significantly to 2.06% and 4.08% during 1996 and 1997 respectively. In the reproductive stage, protection with monocrotophos, cypermethrin, combination of these two insecticides in half doses and combination of neem (2.5 ml/litre) and endosulfan (350 g a.i./ha) were equally effective against fruit borer.

Badaya *et al*. (1999) studied the efficacy and economics of different insecticides for the control okra fruit and shoot borer, *Earias vittella* Fab. They found that among several insecticides against *Earias vittella* on okra Madhya Pradesh, India, fenvalerate at 0.02% was the most effective and profitable treatment, while dimethoate at 0.05% was relatively ineffective.

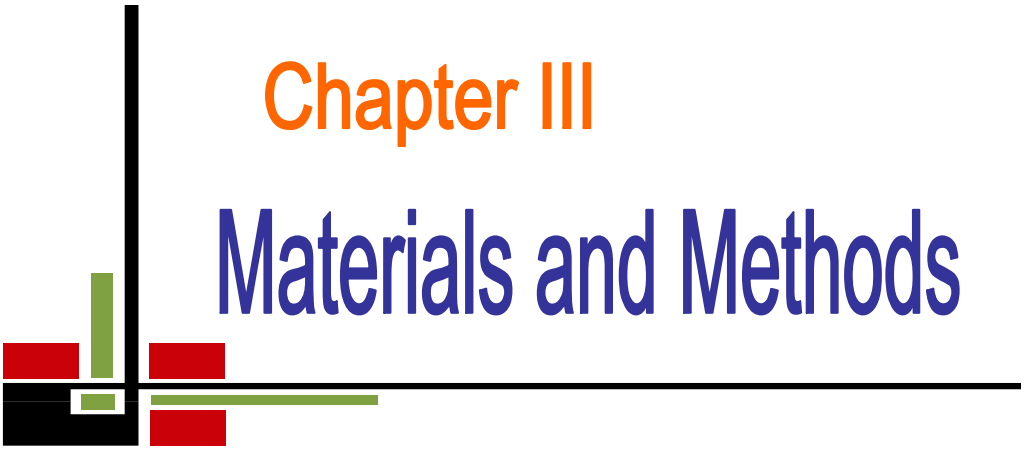
A field experiment was conducted by Patil *et al*. (1991) in India for the control of okra fruit and shoot borer (*E. vittella*) with cypermethrin (15 gm/ha), fenvalerate (50 gm/ha), acephat (375 gm/ha), quinalphos (250gm/ha) and endosulfan (250 gm/ha). All treatments reduced pod damage but cypermethrin treated plants were the least infested gave the best yield.

Chaudhury and Dadheech (1989) reported that if the insecticidal protection was not given the okra shoot and fruit borer infested fruits were as much as 57.1% with a yield of 9.83 kg/plot. But the plots protected with alternate weekly sprays of 0.03% phosphamidon and 0.05% endosulphan provided yield of 15.65 kg/plot with 10% fruit infestation.

Misra (1989) studied the bio-efficacy of some insecticides against the pest complex of okra. The athor reported that percent shoot infestation in insecticide treated plots varied from 1.74-10.03% compared to 15.23% in untreated control plots.

Sarkar and Nath (1989) conducted a field trial in Tripura, India, and indicated that decamethrin, malathion, endosulfan and carbaryl were effective to control okra shoot and fruit borer but fenvalerate (0.5 ml/L and 750 ml/ha) gave the greatest reduction in number of infected fruits.

Borah (1995) tested several insecticides against *Earias vittella* on okra in Assam, India, in 1993, Malathion 0.05% applied 15 days after germination in combination with Dimethoate 0.03% applied 25 and 30 days after germination was the most effective treatment against the pest and also gave the maximum yield, followed Dimethoate 0.03% 15 and 30 days after germination.



Chapter III

Materials and Methods

CHAPTER III
MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in conducting the experiment.

3.1 Location of the experimental

The experiment was conducted farmer's field located in Rampal under Munshiganj sadar upazila of Munshiganj district, Bangladesh, during the period from February' 2014 to June' 2014.

3.2 Climate

The climate of the experimental site is sub-tropical characterized by heavy rainfall during February' 2014 to June' 2014 and sporadic during the rest of the year. The weather condition of the experimental site was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during kharif season and scantly in the Rabi season.

3.3 Design, layout of the experiment and land preparation

The experiment was conducted using five botanical products, one chemical insecticide and an untreated control and laid out in a Randomized Complete Block Design (RCBD). The selected land for the experiment was first opened on February' 2014 by power tiller. The main land in the experimental field was prepared with good tilth mixed with recommended doses of cowdung and chemical fertilizers and expose to the sun for a week. After one week the land was ploughed and cross-ploughed several times with a power tiller and laddering to obtain good tilth followed each ploughing. The stubbles of the crops and uprooted weeds were removed from the field and the land was properly leveled. The field layout was done on accordance to the design, immediately after land preparation. The whole land was divided into three blocks maintaining 0.5m block to block distance. Then each block was sub-divided into 7 plots considering a plot size 1.5 m x 1m maintaining and plot to plot distance 0.5m. Each treatment was replicated three times.

Plate 1. The experimental field of okra

Plate 2. Growing okra plants in the experimental field

3.4 Manure and fertilizer application

Manures and fertilizers with their doses and their methods of application followed in this study were recommended by Haque (1993) and are shown in below Table:

Table 3.1.Doses of manures and fertilizer and their methods of application used for this experiment

Manure/Fertilizer	Dose per ha (kg)	Basal dose (kg/ha)	Top dressing(kg/ha)	
			First*	Second**
Cow dung	5000	Entire amount	-	-
Urea	150	-	75	75
TSP	120	Entire amount	-	-
MP	110	Entire amount	-	-

*25 days after sowing, **45 days after sowing

Entire amount of cow dung, TSP and MP were applied during final land preparation. The entire amounts of urea were applied as top dressing in two equal splits at 25, 45 days after seed sowing.

3.5 Collection, sowing of seeds and seedling raising

Seeds of Orka variety shurovi-1 were collected from local market, Rampal, Munshiganj, Bangladesh. The seeds of okra were sown directly in the main field on March, 2014. The intensive care and all necessary intercultural operations including irrigation, weeding, thinning etc was done in proper time to obtain healthy seedlings. The seed was germinated within 3-7 days. The row to row and plant to plant spacing was maintained at 60 cm x 50 cm respectively. The field was irrigated lightly immediately after sowing.

3.6 Intercultural operations

The seedlings were always-kept under close observation. Necessary intercultural operations were done throughout the cropping season to obtain proper growth and development of the plants.

3.7 Cultural practices

3.7.1 Gap filling: Dead, injured and weak seedlings were replaced by new vigour seedling from the stock on the border line of the experiment.

3.7.2 Thinning: When the seedlings got established, one healthy seedling in each location was kept and other seedlings were removed.

3.7.3 Irrigation: Light overhead irrigation was provided with a watering can to the plots once immediately after sowing of seed and then it was continued at 3 days interval after seedling emergence for proper growth and development of the seedlings. When the soil moisture level was very low. Wherever the plants of a plot had shown the symptoms of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet.

3.7.4 Drainage: Stagnant water effectively drained out at the time of heavy rains.

3.8 Harvesting: As the seeds were sown in the field at times, the crops were harvested at different times. Green pods were harvested at every alternate day when they attained edible stage.

3.9 Treatments: The comparative effectiveness of the following seven treatments for okra shoot and fruit borer management and evaluated on the basis of reduction of this pest.

T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval.

T_2 = Neem seed kernel extract @200g/Litre of water at 7days interval.

T_3 =Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval.

T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval.

T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval

T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval

T_7 = Untreated control

3.10. Preparation of extract

Preparation of neem leaf extract

The fresh neem leaves were collected from the Rampal College premises before the day in spraying into the field. According to the treatment schedule, 200 gram of freshly collected neem leaves were pasted with the help of mortar. The pasted neem leaves were put into 1 litre of water in a grass beaker and kept for overnight and waited for spraying in the field. In the next day morning the wetted aqueous materials were sieved with the help of filter paper to get the desired aqueous neem leaf extract and immediate after sieving the extract was sprayed in the pre-selected and designed plot of main field. This procedure was repeated for every spraying interval.

Neem seed kernel extract

The neem seed kernels were collected from the Siddik bazaar, Dhaka. According to the treatment schedule, 200 gram of neem seed kernel was grinded with the help of mortar and put into 1 litre of water in a grass beaker and kept for overnight and waited for spraying in the field. In the next day morning, the wetted aqueous materials were sieved with the help of filter paper to get the desired aqueous neem seed leaf kernel extract and immediate after sieving the extract was sprayed in the pre-selected and designed plot of main field. This procedure was repeated for every spraying interval.

Dholkalmi and Mahogany leaf extract

Both Dholkalmi and Mahogany leaves were collected from the road side of Rampal area. According to the treatment scheduled, 200 gram of freshly collected *dholkalmi* and *mahogany* leaves were pasted separately with the help of mortar. The pasted *dholkalmi* and *mahogany* leaves each was put into 1 litre of water in a grass beaker separately and kept for overnight and waited for spraying in the field. In the next day morning the wetted aqueous materials of *dholkalmi* and *mahogany* were sieved separately with the help of filter paper to get the desired aqueous *dholkalmi* and *mahogany* leaf extract and immediate after sieving the extracts were sprayed in the pre-selected and designed plots of main field. These procedures were repeated for every spraying interval.

Preparation of neem oil aqueous solution

The neem oil was collected from the Siddik bazaar, Dhaka. According to the treatment schedule, 4 ml neem oil was mixed with one litre water in a grass beaker. Then 10 trix (detergent) was poured in the beaker to dissolve the neem oil with the water. Just after mixing, the aqueous mixture of neem oil was sprayed in the pre-selected and designed plot of main field. This procedure was repeated for every spraying interval.

3.11 Application of the treatments

Spraying for all treatments was done at 12.00 pm to avoid moisture on leaves. The spraying of different treatments was started to apply in their respective plots at 55 days after sowing of seeds in the field. Treatments were applied at 7 days interval with the help of knapsack sprayer. To get complete coverage of plant spraying was done uniformly on the entire plant with special care. In case of untreated control, only fresh water sprayed for respective plots.

3.12 Data collection

Data on infestation by okra shoot and fruit borer under different management treatments were recorded during both vegetative and reproductive stages. Infested shoots from 5 randomly selected plants were counted and recorded at seven days interval by the presence of bores and excreta on flower bud, shoot and fruit at stages respectively.

3.13 Collection of data on yield and yield contributing character:

3.13.1 Infestation level

Infestation caused by okra shoot & fruit borer was monitored during both vegetative and reproductive stages of the okra plants. Five plants per plot was selected randomly and tagged. Infested shoots and fruits was counted and recorded at 7 days intervals after observing the bores and excreta in both vegetative and reproductive stage of the plants. The data was recorded on different parameters throughout the growing period of the crops such as number of infested shoot per 5 tagged plants per plot, Number total shoots per 5 tagged plants per plot, Total number of infested plants per plot, Total number of plants per plot, Number of infested flower/5 tagged plants per plot, Total number of flower per 5 tagged plants per plot , Number of infested fruit per 5 tagged plants per plot, Total number of fruits per 5 tagged plants per plot, Weight of infested fruits per 5 tagged plants per plot, Weight of total fruits per 5 tagged plants per plot.

3.13.2. Yield attributes and yield

The data was also recorded on different parameters to observe the yield performance throughout the growing period of okra such as number of branch/ 5 selected plants/ plot, number of leaves/ 5 selected plants/ plot, length of 10 randomly selected fruits per 5 tagged plants per plot, girth of 10 randomly selected fruits per 5 tagged plants per plot, height of 5 tagged plants per plot, single fruit weight, total weight of fruits per plot.

3.14. Data calculation

The percent infestation of the shoot and fruit on the basis of recorded data was calculated with the following procedure:

3.14.1. Shoot infestation

$$\% \text{ infestation of shoot} = \frac{\text{Number of infestation shoots/5 plants}}{\text{Total number of shoots/5 plants}} \times 100$$

3.14.2. Fruit infestation

$$\% \text{ infestation of fruit by number} = \frac{\text{Number of infestation fruits/ 5 plants}}{\text{Total number of fruits/5 plants}} \times 100$$

$$\% \text{ infestation of fruit by weight} = \frac{\text{Weight of infested fruit/ 5selected plants/ plot}}{\text{Weight of total fruits/5 plants}} \times 100$$

3.14.3. Flower infestation

$$\%\text{infestation of flower} = \frac{\text{Number of infested flower/5 selected plants/plot}}{\text{Total number of flowers/5 selected plants}} \times 100$$

Plate 03: Healthy Okra Shoot with flower and fruit

Plate 04: Okra fruit showing infestation symptom caused by OSFB larvae

3.14.4 Height of plant

Height of plant from randomly selected 5 plants were taken and then averaged for each treatment separately. The percent increase of fruit length and girth over control was calculated using the above mentioned formula.

3.14.5 Weight of single fruit

Mean weight of fruits from randomly selected 5 plants were measured for each plot of the experiment for each treatment separately. The percent increase of single fruit over control was calculated using the above mentioned formula.

Plate 05: Healthy okra fruits

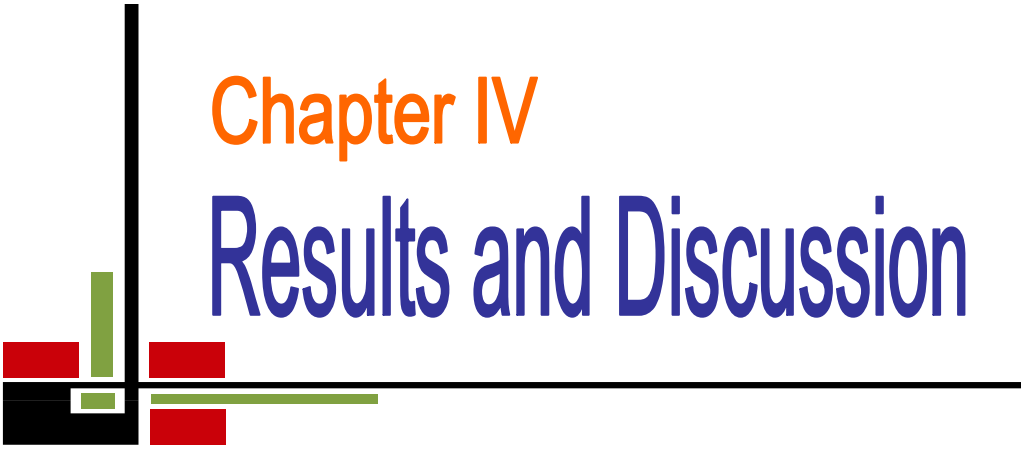
3.14.6 Yield per hectare

Total yield of okra per hectare for each treatment was calculated in tons from cumulative fruit production in a plot. Effect of different treatments on the increase and decrease of okra yield over control was also calculated by the following formula:

$$\% \text{ increase of yield over control} = \frac{\text{Yield of treated plot- Yield of control plot}}{\text{Yield of control plot}}$$

3.15 Statistical analysis

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT program (Gomez and Gomez, 1976). The treatment means were separated by Duncan's Multiple Range Test (DMRT).



Chapter IV
Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted in the farmer's field at Rampal area under Munshiganj sadar upazila of Munshiganj district, Bangladesh, during the period from February'2014 to June' 2014 to study the eco-friendly management of okra shoot and fruit borer using botanicals and chemical. The results have been presented and discussed and possible explanations have been given under the following sub-headings:

4.1. Effect of management practices on the shoot infestation

Effect of management practices using botanicals and chemical in controlling okra shoot and fruit borer in the present study showed a statistically significant difference in term of % shoot infestation throughout the growing period of okra at different days after sowing (DAS). Highest % of shoot infestation (23.93%) was recorded in T_7 (untreated control treatment) at different days after sowing (DAS), which was significantly similar from all other treatments. On the other hand the lowest % of shoot infestation (3.53) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was followed by T_3 (spraying of Neem oil @ @ 4 ml/Litre of water mixed with 10 ml of trix liquid sprayed at 7 days interval) and T_2 (spraying of neem seed karnel extract @200g/Litre of water at 7days interval) treatments respectively (Table 4.1).

Among different management practices on management of okra shoot and fruit borer, chemical insecticide Suntap 50SP @ 1.5 ml/L of water showed highest control against okra shoot and fruit borer and botanical T_4 treatment (Dholkalmi leaf extract @ 200g/Litre of water) showed lower performance on restricted the okra shoot and fruit borer. Okra shoot and fruit borer cause large amount destruction on okra production. Whereas, Suntap 50SP @ 1.5 ml/L of water reduce the maximum okra shoot and fruit borer attack (0,00, 0.00, 0.00,0.00, 6.06 and 11.57at 45, 52, 59, 66, 73 and 80 DAS respectively) which showed more reduction (85.26%) of okra shoot and fruit borer and supported to make sure the more yield of okra (Table 4.1). In the similar trend, T_4 treatment (Dholkalmi leaf extract @ 200g/Litre of water) showed lower performance to control the okra shoot and fruit borer while minimum over reduction (32.01%) was recorded on okra research field (Table 4.1). About similar results were also observed by different researchers. Islam *et al.* (1999) observed the minimum acceptable level of shoot infestation reduction over control was 80%.

Tables 4.1 Percent shoot infestation throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	% shoot infestation at different DAS							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	%reduction over control
T_1	4.08 bc	8.59 bc	9.42 bc	9.413 b	12.50 bc	15.83 bc	10.06 c	57.96
T_2	0.00 c	7.21 bc	5.90 bc	10.06 b	11.77 bc	12.73 bc	8.36 cd	65.05
T_3	0.00 c	5.34 cd	7.40 bc	7.40 bc	7.867 c	9.467 c	6.03 de	74.81
T_4	9.69 ab	13.03 b	14.90 ab	14.90 b	20.40 ab	23.33 ab	16.27 b	32.01
T_5	5.29 bc	10.10 bc	9.88 bc	12.23 b	11.46 bc	15.57 bc	10.91 c	54.41
T_6	0.00 c	0.00 d	0.00 c	0.00 c	6.060 c	11.57 bc	3.53 e	85.26
T_7	14.93 a	21.07 a	23.00 a	25.57 a	28.50 a	29.67 a	23.93 a	-
LSD $_{(0.01)}$	5.534	5.612	10.16	8.672	9.694	11.77	3.621	-
CV (%)	45.69%	24.11%	40.46%	30.59%	27.61%	27.97%	12.85%	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

4.2. Effect of management practices on the plant infestation

A significant difference was found in terms of plant infestation at different days after sowing (DAS) among different control methods for the management okra shoot and fruit borer. The highest % of plant infestation (20.40 %) was recorded inT_7 (untreated control) treatment which was closely followed by T_4 (14.70 %) treatment. On the other hand the lowest % of Plant infestation (1.31%) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was closely followed by T_3 (spraying of Neem oil @ @ 4 ml/Litre of water mixed with 10 ml of trix liquid sprayed at 7 days interval) and T_2 (spraying of neem seed karnel extract @ 200g/Litre of water at 7days interval) treatments respectively (Table 4.2).

From the results in Table 4.2, showed significant variation due to the effect of different management practices using botanicals and chemical in controlling okra shoot and fruit borer, in term of % plant infestation throughout the growing period of okra at different days after sowing (DAS). Among different management practices on

management of okra shoot and fruit borer, chemical insecticide Suntap 50SP @ 1.5 ml/L of water showed hightest control against okra shoot and fruit borer and botanical T_4 treatment (Dholkalmi leaf extract @ 200g/Litre of water) showed lower performance on restricted the okra shoot and fruit borer. Okra shoot and fruit borer cause large amount destruction on okra production. Whereas, Suntap 50SP @ 1.5 ml/L of water reduce the maximum okra shoot and fruit borer attack (0,00, 0.00, 0.00,0.00, 0.00 and 7.87 at 45, 52, 59, 66, 73 and 80 DAS respectively) which showed more reduction (93.58%) of okra shoot and fruit borer and supported to make sure the more yield of okra (Table 4.2).

In the similar trend, T_4 treatment (Dholkalmi leaf extract @ 200g/Litre of water) showed lower performance to control the okra shoot and fruit borer while minimum over reduction (27.94%) was recorded on okra research field (Table 4.2). About similar results were also observed by different researchers. Shukla *et al.* (1997) reported that before fruiting stage plant infestation reached a peak of 8.5%. Choi *et al.* (2004) reported 87% plant infestation reduction.

Table 4.2 Percent plant infestation throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	% plant infestation at different DAS							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	%reduction over control
T_1	3.70 ab	3.70 ab	7.40 abc	11.57 b	15.27ab	18.97abc	10.10bcd	50.49
T_2	0.00 ab	3.70 ab	7.40 abc	7.40 bc	11.10bc	14.80 bc	7.410cde	63.68
T_3	0.00 b	0.00 b	3.70 bc	3.70 bc	7.87 bc	11.57 bc	4.48 de	78.04
T_4	3.70 ab	11.57 a	15.27 ab	15.27ab	19.43ab	23.13 ab	14.70 ab	27.94
T_5	3.70 ab	7.40 ab	11.57abc	15.27ab	18.97ab	23.13 ab	13.30 bc	34.80
T_6	0.00 ab	0.00 b	0.00 c	0.00 c	0.00 c	7.87 c	1.31 e	93.58
T_7	11.57 a	11.57 a	18.97 a	23.13 a	26.83 a	30.53 a	20.40 a	-
LSD $_{(0.01)}$	10.49	9.254	13.20	10.69	13.60	11.41	6.769	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

4.3. Effect of management practices on flower infestation of okra

A significant difference was found in terms of flower infestation at different days after sowing (DAS) among different control methods for the management okra shoot and fruit borer. The highest % of flower infestation (21.62%) was recorded in T_7 (untreated control) treatment which was followed by T_4 (13.21 %) treatment. On the other hand, no flower infestation (0.00%) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was closely followed by T_3 (spraying of Neem oil @ @ 4 ml/Litre of water mixed with 10 ml of trix liquid sprayed at 7 days interval) treatments (3.06%) (Table 4.3).

Table 4.3 Percent flower infestation throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	% Flower infestation at different DAS							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	% reduction over control
T_1	8.33 b	11.00 a	10.32 d	15.00 b	16.40 b	7.65 b	11.45b	47.04
T_2	7.00 b	6.667 b	19.44 b	13.33 b	14.44 b	6.54 c	11.24b	48.03
T_3	0.00 c	0.00 c	0.00 e	7.33 c	8.00 c	3.00 e	3.06 c	85.87
T_4	11.67 a	9.33 ab	16.43 c	13.89 b	17.43 b	10.53 b	13.21b	38.88
T_5	5.33 b	10.00 a	12.50cd	15.56 b	15.50 b	9.50 b	11.40b	47.28
T_6	0.00 c	0.00c	0.00 e	0.00 d	0.00 d	0.00 e	0.00 d	100.00
T_7	13.67 a	12.67 a	28.89 a	26.11 a	29.79 a	18.56 a	21.62a	-
LSD $_{(0.01)}$	2.914	3.189	3.93	2.75	3.81	3.53	3.29	-
CV(%)	17.78	18.02	16.70	15.31	14.50	16.70	10.45	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

Among different management practices on management of okra shoot and fruit borer, chemical insecticide Suntap 50SP @ 1.5 ml/L of water showed highest control against okra shoot and fruit borer and botanical T_4 treatment (Dholkalmi leaf extract @ 200g/Litre of water) showed lower performance on restricted the okra shoot and fruit borer. Okra shoot and fruit borer cause large amount destruction on okra

production. Whereas, Suntap 50SP @ 1.5 ml/L of water reduce the maximum okra shoot and fruit borer attack (0,00, 0.00, 0.00,0.00, 0.00 and 0.00 at 45, 52, 59, 66, 73 and 80 DAS respectively) which showed more reduction (100%) of okra shoot and fruit borer and supported to make sure the more yield of okra (Table 4.3). In the similar trend, T_3 treatment (spraying of Neem oil @4 ml/Litre of water mixed with 10 ml of trix liquid sprayed at 7 days interval) showed highest performance to control the okra shoot and fruit borer while minimum over reduction (85.87%) was recorded on okra research field (Table 4.3).

4.4 Effect of management practices on the fruit infestation by number

Effect of management practices using botanicals and chemical in controlling okra shoot and fruit borer in the present study showed a statistically significant difference in term of % fruit infestation by number throughout the growing period of okra at different stages. In early fruiting stage, highest % of fruit infestation by number (6.00 a) was recorded in T_5 (spraying of mahogani leaf extract@200g/litre of water at 7 days interval), which was statistically similar from all other treatments. On the other hand the lowest % of fruit infestation by number (0.00 b) was recorded in T_3 (spraying of Neem oil@4 ml/litre of water at 7 days interval) and T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was closely followed by T_4 (spraying of Dholkalmi leaf extract @ 200 g/Litre of water at 7 days interval) and T_2 (spraying of neem seed karnel extract @200g/Litre of water at 7days interval) treatments respectively. In mid fruiting stage, highest % of fruit infestation by number (8.20 a) was recorded in T_7 (untreated control) which was statistically similar with T_5 (spraying of mahogani leaf extract@200g/litre of water at 7 days interval), On the other hand the lowest % of fruit infestation by number (0.00 c) was recorded in T_3 (spraying of Neem oil@4 ml/litre of water at 7 days interval) and T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment followed by T_2 (spraying of neem seed karnel extract@200 gm/litre of water at 7 days interval) and T_4 (spraying of Dholkalmi leaf extract @ 200 g/Litre of water at 7 days interval). In late fruiting stage, highest % of fruit infestation by number (15.02 a) was recorded in T_7 (untreated control) followed by T_5 (spraying of mahogani leaf extract@200g/litre of water at 7 days interval), On the other hand the lowest % of fruit infestation by number (0.00 c) was recorded in T_6 (spraying of Suntap 50SP @

1.5 ml/L of water at 7 days interval) followed by (3.42 d) which was recorded in T_3 (spraying of Neem oil@4 ml/litre of water at 7 days interval).

Among different management practices on management of okra shoot and fruit borer, chemical insecticide T_6 (Suntap 50SP @ 1.5 ml/L of water) showed highest control against okra shoot and fruit borer followed by T_4 (Dholkalmi leaf extract @ 200g/Litre of water) which was closely related to T_2 (neem seed karnel extract@200 gm/litre of water at 7 days interval). On the other hand, T_5 (mahogani leaf extract@200g/litre of water at 7 days interval) showed lowest control against okra shoot and fruit borer. Okra shoot and fruit borer cause large amount destruction on okra production. Whereas, T_6 (Suntap 50SP @ 1.5 ml/L of water) reduce the maximum okra shoot and fruit borer attack (early, mid and late fruiting stage respectively) which showed more reduction (100%) of okra shoot and fruit borer and supported to make sure the more yield of okra (Table 4.4). In the similar trend, T_5 treatment (Mahogani leaf extract@200g/litre of water at 7 days interval) showed lower performance to control the okra shoot and fruit borer while minimum over reduction (16.55%) was recorded on okra research field (Table 4.4).

Table 4.4 Percent fruit infestation by number throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	% fruit infestation by number				
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean	%reduction over control
T_1	5.08 a	6.08 b	6.59 c	5.92 b	39.16
T_2	4.48 a	5.67 b	7.12 c	5.75 b	40.90
T_3	0.00 b	0.00 c	3.42 d	1.14 c	88.28
T_4	4.17 a	5.75 b	6.97 c	5.63 b	42.14
T_5	6.00 a	7.47 ab	10.88 b	8.12 a	16.55
T_6	0.00 b	0.00 c	0.00 e	0.00 c	100.00
T_7	5.96 a	8.20 a	15.02 a	9.73 a	-
$LSD_{(0.01)}$	2.131	1.774	2.537	1.713	-
CV(%)	23.28	15.02	14.24	13.25	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

4.5 Effect of management practice on the fruit infestation by weight

Effect of management practices using botanicals and chemical in controlling okra shoot and fruit borer in the present study showed a statistically significant difference in term of % fruit infestation by weight throughout the growing period of okra at different stages. In early fruiting stage, highest percent of fruit infestation by weight (3.75 a) was recorded in T_7 (untreated control), which was significantly different from all other treatments. On the other hand, the lowest percent of fruit infestation by weight (0.00 d) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) followed by T_2 (spraying of neem seed karnel extract @200 gm/litre of water at 7 days interval) treatment. In mid fruiting stage, highest percent of fruit infestation by weight (5.95 a) was recorded in T_7 (untreated control) which was statistically significant to all other treatments. On the other hand, the lowest percent of fruit infestation by weight (0.00 d) was recorded in T_4 (Dholkalmi leaf extract @ 200g/Litre of water at 7 days interval) and T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) respectively.

Table 4.5 Percent fruit infestation by weight throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	% fruit infestation by weight				
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean	%reduction over control
T_1	2.08 bc	2.67 c	5.82 bc	3.53 c	50.42
T_2	0.83 cd	2.73 c	3.75 cd	2.44 d	65.73
T_3	2.08 bc	3.58 bc	6.17 b	3.94 c	44.66
T_4	0.00 d	0.00 d	3.17 d	1.06 c	85.11
T_5	2.92 ab	4.60 b	7.75 b	5.09 b	28.51
T_6	0.00 d	0.00 d	0.00 e	0.00 e	100.00
T_7	3.75 a	5.95 a	11.65 a	7.12 a	-
LSD $_{(0.01)}$	1.224	1.178	2.265	1.058	-
CV (%)	29.49	16.94	16.60	12.03	-

In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

In late fruiting stage, highest percent of fruit infestation by weight (11.65 a) was recorded in T_7 (untreated control) which was significantly different from all other treatments. On the other hand the lowest percent of fruit infestation by weight (0.00 e)

was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) which was also significantly different from other treatments.

Among different management practices on management of okra shoot and fruit borer, chemical insecticide Suntap 50SP @ 1.5 ml/L of water showed highest control against okra shoot and fruit borer followed by T_4 (Dholkalmi leaf extract @ 200g/Litre of water). On the other hand, T_5 (mahogani leaf extract@200g/litre of water at 7 days interval) showed lowest control against okra shoot and fruit borer. Okra shoot and fruit borer cause large amount destruction on okra production. Whereas, Suntap 50SP @ 1.5 ml/L of water reduce the maximum okra shoot and fruit borer attack (early, mid and late fruiting stage respectively) which showed more reduction (100%) of okra shoot and fruit borer and supported to make sure the more yield of okra (Table 4.5). In the similar trend, T_3 treatment (Neem oil@4 ml/litre of water at 7 days interval) showed lower performance to control the okra shoot and fruit borer while minimum over reduction (44.66%) was recorded on okra research field (Table 4.5).

4.6. Effect of management practices on the number of branch of okra

A significant difference was found in terms number of branch /plant throughout the growing period of okra at different days (45, 52, 59, 66, 73 and 80 days) after sowing (DAS) among different control methods for the management okra shoot and fruit borer. The highest % number of branch/plant (4.72 %) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was statistically identical among the all other treatments. On the other hand the lowest number of branch/plant (1.93%) was recorded in T_7 (untreated control) treatment (Table 4.6).

Table 4.6 Number of branch per plant throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	Number of branch/plant at different DAS							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	% increase over control
T_1	2.57 c	5.07 a	2.67 c	3.13 ab	2.80 b	3.53 a	3.02 a	56.48
T_2	5.23 a	3.27 a	8.00 a	2.93 ab	4.60 ab	3.87 a	3.83 a	98.45
T_3	2.73 bc	4.00 a	1.67 c	3.67 ab	4.67 ab	3.13 a	3.31 a	71.50
T_4	3.20 bc	5.67 a	3.93 bc	2.80 ab	7.00 a	5.33 a	3.66 a	89.64
T_5	2.80 bc	3.33 a	6.33 ab	3.67 ab	2.53 b	2.67 a	3.56 a	84.46
T_6	4.67 ab	3.53 a	3.67 bc	5.20 b	5.53 b	5.73 a	4.72 a	144.56
T_7	1.40 c	2.80 a	3.07 bc	6.00 a	2.20 b	2.73 a	1.93 b	-
LSD $_{(0.01)}$	1.922	3.399	3.137	3.144	2.982	2.097	2.309	-
CV(%)	23.87	32.01	30.01	36.16	30.63	53.65	34.42	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

4.7. Effect of management practices on the number of leaf

From Table no. 4.7, a significant difference was found in terms number of leaf /plant throughout the growing period of okra at different days (45, 52, 59, 66, 73 and 80 days) after sowing (DAS) among different control methods for the management okra shoot and fruit borer. The highest % number of leaf /plant (29.30 %) was recorded in T_6 (spraying of Suntap 50SP @ 1.5 ml/L of water at 7 days interval) treatment which was statistically identical among the all other treatments. On the other hand the lowest number of leaf /plant was recorded in T_7 (untreated control) treatment (21.63%) which was closely followed by T_5 (Mahogany leaf extract @ 200g/Litre of water at 7 days interval) treatment (23.03%) and T_1 (Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval) treatment (21.83%).

Table 4.7 Number of leaf per plant throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	Number of leaf per plant							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	% increase over control
T_1	23.00abc	29.07ab	24.53a	31.73 a	29.80ab	25.43 a	21.83 b	0.92
T_2	27.33 ab	31.40 a	22.40ab	30.47 a	31.60 a	21.00 b	27.37ab	26.54
T_3	21.20 bc	21.33 b	15.27 b	14.93 d	17.07 c	14.90 c	24.73ab	14.33
T_4	30.53 a	28.07ab	22.73ab	25.77bc	29.40ab	23.27ab	26.63ab	23.12
T_5	18.33 c	32.67 a	25.07 a	26.33bc	27.10ab	23.40ab	23.03 b	6.47
T_6	30.83 a	25.80ab	28.40 a	29.17ab	25.07 b	19.50 b	29.30 a	35.46
T_7	20.87 bc	25.27ab	20.80ab	23.60 c	24.40 b	27.00 a	21.63 b	-
LSD $_{(0.01)}$	7.592	7.756	7.366	3.295	5.177	3.776	5.241	-
CV(%)	12.38	11.24	12.99	5.08	7.88	6.86	8.43	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

4.8. Effect of management practices on the plant height of okra during the management of okra shoot and fruit borer at different fruiting stage

Statistically significant variation in plant height among different management practices in controlling okra shoot and fruit borer under the present trail. In case of per plot it was releaved that the highest height (66.00 cm) was recorded in T_6 (spraying Suntap 50SP @1.5ml/L of water at 7 days interval) treatment which was closely followed by (62.33 cm and 61.82 cm) was recorded in T_2 (Neem seed karnel extract @ 200g/Litre of water at 7 days interval) and T_1 (Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval) treatment respectively. On the other hand the lowest height (53.70 cm) was recorded in T_7 (untreated control) treatment, which was closely followed by (58.16 cm) was recorded in T_5 (Mahogany leaf extract @200g/Litre of water at 7 days interval) treatment (Table-4.8).

Table 4.8 Plant height per plot throughout the growing period of okra during the management of okra shoot and fruit borer

Treatment	Single plant height (cm)							
	45 DAS	52 DAS	59 DAS	66 DAS	73 DAS	80 DAS	Mean	%reduction over control
T_1	42.53bc	49.87 ab	58.20b	68.20bc	74.67a	77.47a	61.82ab	15.12
T_2	45.33ab	50.20 ab	56.33b	69.87ab	73.33a	78.93a	62.33ab	16.07
T_3	38.53 c	43.47 bc	58.00b	63.73 c	74.00a	79.53a	59.54abc	10.88
T_4	43.10 b	52.30 a	66.67 a	74.93 a	77.73a	83.67a	61.59 ab	14.69
T_5	42.47bc	50.53ab	56.33b	63.30 c	71.87a	75.33a	58.16 bc	8.31
T_6	48.67 a	45.20abc	62.67ab	56.13 d	77.20a	82.63a	66.00 a	22.91
T_7	26.33 d	42.07 c	45.13 c	47.40 e	69.53a	75.47a	53.70 c	-
LSD $_{(0.01)}$	4.101	7.243	7.084	5.513	8.22	8.56	6.171	-
CV(%)	4.01	6.09	4.93	3.49	9.87	9.42	4.09	-

DAS=Days after sowing. In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

Table 4.9 Effect of management practices on the fruit yield of okra

Significant variations were observed among the treatments in terms of fruit yield of okra. In case of fruit yield (kg/plot) , the highest yield (2.42 kg/plot) was recorded in T_6 , which was statistically different from all other treatments followed by T_3 (2.12 kg/plot). This was statistically similar with T_1 and T_2 . On the other hand, the lowest yield was recorded in T_7 (1.78 kg/ plot) which was statistically similar with T_4 and T_5 . more or less similar trend was observed in case of yield of fruits in ton per hectare where the highest yield was recorded in T_6 (16.13 ton/ha) and lowest yield was recorded in T_7 (11.87 ton/ha).

Considering the percent yield increased over control, the highest increase was recorded in T_6, which was 35.92% followed by T_3 (18.51%), T_1 (14.01%) and T_2 (13.45%). on the other hand the lowest yield increase was observed in T_4 that was only 1.66%, which was identical with T_5. as a result, the order of the trends of results in terms of increasing the yield of okra yield over control is $T_6 > T_3 > T_1 > T_2 > T_4, T_5$.

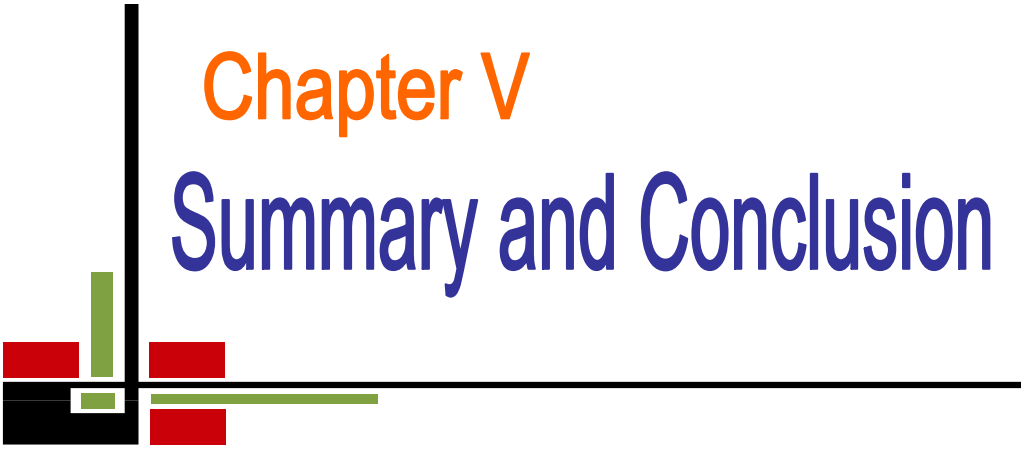
Table 4.9 Average yield of okra for different management practices

Treatment	Fruit yield		
	Yield (kg/plot)	Yield (ton/ha)	% increase over control
T_1	2.030 b	13.53 c	14.01
T_2	2.02 b	13.47 c	13.45
T_3	2.12 b	14.07 b	18.51
T_4	1.81 c	12.07 d	1.66
T_5	1.81 c	12.07 d	1.66
T_6	2.420 a	16.13 a	35.92
T_7	1.780 c	11.87 d	-
$LSD_{(0.01)}$	0.2021	0.2298	-
CV(%)	7.72%	2.89%	-

In a column, means having similar letter(s) are statistically similar at 1% level of significance. The numerical figure within column indicates the mean of three replicates.

[T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control]

From the above findings, it was revealed that the T_6 comprising Suntap 50SP @ 1.5 ml/litre of water sprayed at 7 days interval performed the best result in increasing the fruit yield of okra that was followed by T_3 comprising neem oil @ 4ml/litre of water sprayed at 7 days interval.



Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the field in Rampal, Munshiganj, Bangladesh, during the period from February'2014 to June' 2014 to study the eco-friendly management of okra shoot and fruit borer (*Earias vittella* Fab.) using botanicals and chemical. The treatments are comprised with different botanical products, one synthetic chemical insecticides and one untreated control and these are T_1 = Neem leaf extract @ 200g/Litre of water sprayed at 7 days interval; T_2 = Neem seed karnel extract @200g/Litre of water at 7days interval; T_3 = Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval; T_4 = Dholkalmi leaf extract @200g/Litre of water at 7 days interval; T_5 = Mahogany leaf extract @200g/Litre of water at 7 days interval; T_6 = Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval; T_7 = Untreated control .The experiment was laid out in single factor Randomized Complete Block Design (RCBD) with three replications.

SUMMARY

Considering the efficiency of different management practices, the findings of the results have been summarized as follows:

In terms of percent shoot infestation by number at the early fruiting stages, T_6 comprising Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval (T_6) performed best result in terms of percent shoot infestation reduction (85.26%) over control followed by T_3 (74.81%) Neem oil @ @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval and T_2 (65.05%) comprising Spraying of Neem seed karnel extract @200g/Litre of water at 7days interval, whereas T_4 (32.01)comprising Spraying Dholkalmi leaf extract @200g/Litre of water at 7 days interval was showed the least performance in reducing percent shoot infestation throughout the growing period of okra during the management of okra shoot and fruit borer at the different days after sowing by over control. As a result, in order of the trend of different management practices in terms of present shoot infestation reduction was T_6 (Suntap 50SP)> T_3 (Neem oil) > T_2 (Neem seed karnel extract)> T_1 (Neem leaf extract) >T_5 (Mahogany leaf extract) > T_4 (Dholkalmi leaf extract) > T_7 (Untreated control).

In term of percent plant infestation throughout the growing period of okra during the management of okra shoot and fruit borer at the different days after sowing by over control, comprising Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days

interval (T_6) performed best result in terms of percent plant infestation reduction (93.58%) over control followed by T_3 (78.04%) comprising Spraying of Neem oil @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval and T_2 (63.68%) comprising Spraying of Neem seed karnel extract @ 200g/Litre of water at 7days interval, whereas T_4 (27.94%) comprising Spraying Dholkalmi leaf extract @200g/Litre of water at 7 days interval was showed the least performance in reducing percent plant infestation at over control. As a result, order the trend of different management practices in terms of present Plant infestation reduction was T_6 (Suntap 50SP)> T_3 (Neem oil) > T_2 (Neem seed karnel extract)> T_1 (Neem leaf extract) >T_5 (Mahogany leaf extract) > T_4 (Dholkalmi leaf extract) > T_7 (Untreated control).

In term of percent flower infestation throughout the growing period of okra during the management of okra shoot and fruit borer at the different days after sowing by over control, comprising Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval (T_6) performed best result in terms of percent flower infestation reduction (100%) over control followed by T_3 (85.87%) and T_2 (48.03%) treatments respectively, whereas T_4 (38.88%) comprising Spraying Dholkalmi leaf extract @200g/Litre of water at 7 days interval was showed the least performance in reducing percent flower infestation at over control. As a result, order the trend of different management practices in terms of percent flower infestation reduction was T_6 (Suntap 50SP)> T_3 (Neem oil) > T_2 (Neem seed karnel extract)> T_1 (Neem leaf extract) >T_5 (Mahogany leaf extract) > T_4 (Dholkalmi leaf extract) > T_7 (Untreated control).

In case of fruit infestation by number due to okra shoot and fruit borer at the early fruiting stages, T_6 comprising Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval (T_6) performed best result in terms of percent fruit infestation by number reduction (100.00%) over control followed by T_3 (88.28%) %) comprising Spraying of Neem oil @ 4 ml/Litre of water mixed with 10ml of trix liquid sprayed at 7 days interval and T_4 (42.14%) comprising Spraying Dholkalmi leaf extract @200g/Litre of water at 7 days interval, whereas T_5 (16.55) comprising Spraying of Mahogany leaf extract @200g/Litre of water at 7 days interval was showed the least performance in reducing percent the fruit infestation by number due to okra shoot and fruit borer at the early fruiting stage over control. As a result, order the trend of different management practices in terms of present fruit infestation reduction by number was T_6 (Suntap 50SP)> T_3 (Neem oil) > T_4 (Dholkalmi leaf extract) > T_2 (Neem seed karnel extract) > T_1 (Neem leaf extract) >T_5 (Mahogany leaf extract) > T_7 (Untreated control).

In case of fruit infestation by weight due to okra shoot and fruit borer at the different fruiting stage, T_6 comprising Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval (T_6) performed best result in terms of percent fruit infestation by weight reduction (100.00%) over control followed by T_4 (85.11%) and T_2 (65.73%) treatments respectively, whereas T_5 (28.51%) treatment was showed the least performance in reducing percent the fruit infestation by weight due to okra shoot and fruit borer at the early fruiting stage over control. As a result, in order of the trend of different management practices in terms of present fruit infestation reduction by weight was T_6 (Suntap 50SP)>T_3 (Neem oil)>T_4 (Dholkalmi leaf extract)> T_2 (Neem seed karnel extract) > T_1 (Neem leaf extract)> T_3 (Neem oil)>T_5 (Mahogany leaf extract) >T_7 (Untreated control).

Incase of branch per plant throughout the growing period of okra, T_6 comprising of Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval performed the best result. As a result, order the trend of different management practices in terms of percent reduction over control in terms of branch per plant throughout the growing period of okra during the management of okra shoot and fruit borer was T_6 (Suntap 50SP) > T_2 (Neem seed karnel extract) >T_4 (Dholkalmi leaf extract)>T_5 (Mahogany leaf extract) > T_3 (Neem oil)>T_1 (Neem leaf extract)>T_7 (Untreated control).

Incase of leaf per plant throughout the growing period of okra, T_6 comprising of Spraying of Suntrap 50SP @ 1.5ml/ Litre of water at 7 days interval performed the best result. As a result, order the trend of different management practices in terms of percent reduction over control in terms of leaf per plant throughout the growing period of okra during the management of okra shoot and fruit borer was T_6 (Suntap 50SP)>T_2 (Neem seed karnel extract) >T_4 (Dholkalmi leaf extract)> >T_3 (Neem oil)>T_5 (Mahogany leaf extract) >T_1 (Neem leaf extract)>T_7 (Untreated control).

Incase of, height per plant throughout the growing period of okra, T_6 comprising of Spraying of Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval performed the best result. Highest percentage of reduction over control has been reported in case of this treatment T_6 22.91 followed by T_2 (16.07) and T_1 (15.12 treatments respectively, on the other hand T_5 (8.31) treatment showed least performance. As a result, order the trend of different management practices in terms of percent reduction over control in terms of leaf per plant throughout the growing period of okra during the management of okra shoot and fruit borer was T_6 (Suntap 50SP)>T_2 (Neem seed karnel extract) >T_1 (Neem leaf extract) >T_4 (Dholkalmi leaf extract) >T_3 (Neem oil)> T_5 (Mahogany leaf extract)>T_7 (Untreated control).

In case of yield of okra due to application of different management practices T_6 35.92 comprising suntap 50SP @ 1.5 ml/litre of water sprayed at 7 days interval performed the best result in increasing the fruit yield of okra that was followed by T_3 (18.51) treatment, whereas T_4 (1.66) and T_5 (1.66) treatments respectively showed least performance. As a result, order the trend of different management practices in terms of percent reduction over control in terms of leaf per plant throughout the growing period of okra during the management of okra shoot and fruit borer was T_6 (Suntap 50SP) > T_3 (Neem oil) > T_1 (Neem leaf extract) > T_2 (Neem seed kernel extract) > T_4 (Dholkalmi leaf extract) > T_5 (Mahogany leaf extract) > T_7 (Untreated control).

CONCLUSION

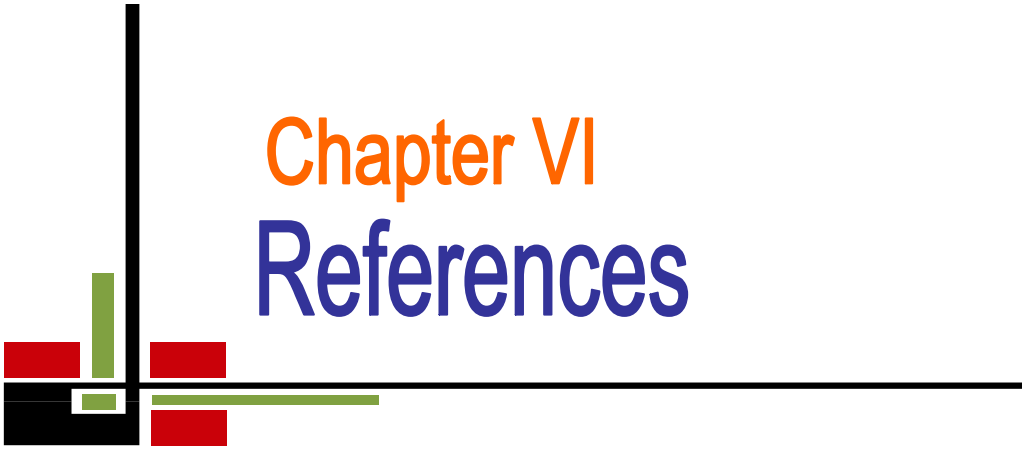
The findings of the study were concluded as follows:

- The synthetic chemical insecticides Suntap 50SP @ 1.5ml/ Litre of water at 7 days interval showed best performance in reducing the percent infestation of shoot, plant, flower, as well as fruit infestation caused by OSFB.
- Among botanical products, Neem oil @ 4 ml/Litre of water sprayed at 7 days interval showed best performance in reducing the percent infestation of shoot, plant, flower, as well as fruit infestation caused by OSFB.
- Maximum yield was produced by Suntap 50SP treated plots followed by Neem oil treated plots.
- But in consideration of eco-friendly management aspects, neem oil based treatment produced the best results in producing maximum yield of okra.

RECOMMENDATIONS

Considering the findings of the study the following recommendations can be drawn:

- In the context of total yield production, the chemical insecticide Suntap 50SP may be recommended as an effective control measure applied against okra shoot and fruit borer (OSFB) on okra.
- But in the context of hazards free okra production, neem oil and other neem based products may be recommended for eco-friendly management okra shoot and fruit borer by sacrificing some yield of okra.
- Further intensive studies based on different doses of Suntap and Neem oil should be conducted.
- More chemicals and botanicals with their derivatives should be included in further elaborative research for controlling okra shoot and fruit borer.



Chapter VI
References

CHAPTER VI

REFERENCES

Abdullah, N.M.M. and Singh, J. (2004). Effect of insecticides on longevity of the whitefly, *Bemisia tabaci* Gennadius on cotton. *University Aden J. Natural Appl. Sci*. **8**(2):261-268.

Acharya, M.C. (2002). Determination of economic threshold levels and integrated management of fruit borer, *Earias vittella* (Fab.) on okra, *Abelmoschus esculentus* (L.) Moench. M.Sc. Thesis, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Acharya, M.C. (2010). Determination of Economic Threshold level and Integrated Management of Okra Fruit Borer *Earias vittella* (Fab.). *J. Prot. Society*. **2**: 47-61.

Ahmed, S.S. (1984). Some promising plant species for use as pest control agent under traditional farming system. In: Proceedings on 2nd Neem Conference Reschhdzhouson FRG. pp. 565-580.

Ahmed, K.U. (1995). Pal-Phul O Shak-Shabji (In Bengali) 5th ed. Mirpur, Dhaka, Bangladesh. p. 400.

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

Ahmed, H., Ali, S., Khan, M.A. and Habib, A. (1995). Efficacy of neem oil and synthetic growth regulators on control of okra insect pests as compared to chemical pesticides. *J. Sustan. Agric Environ.* **5**(1-2): 232-245.

Ali, M.I. (1992). Seasonal occurrence of different cotton bollworms on cotton in Bangladesh. *Bangladesh J. Entomol*. **2**(1 & 2).

Ambekar, J.S., Pawar, A.S. and Sakhare, M.V. (2000). Bio-efficacy of certain neem products against okra fruit borer. *J. Maharashtra Agril. Uni*. **25**(1): 42-43.

Anonymous. (1987). Annual Report for (1986-87). Central Institute for Cotton Research, Nagpur. P. 27.

Anonymous. (1993).Research and development of vegetable crops. Paper presented in the workshop on importance of okra as summer vegetable on March 9-10, IPSA, Gazipur.pp.1-07.

Anonymous, 2005, Horticultural Information Service, *Monthly Bull.* pp. 60-62.

Atiri, G.I., Ivbijaro, M.F. and Oladele, A.D. (1991). Effects of natural synthetic chemicals on the incidence severity of okra mosaic virus in okra. *Tropical Agril*. **68** (2):178-180.

Atwal, A.S. (1976). Agricultural Pest of India and South-East Asia. Kalayani Publishers, New Delhi. pp. 283-285.

Atwal, A.S. (1999). Pests of Cotton. 4 th Edn., Kalyani Publishers, New Delhi. pp. 224-234.

Avidov, Z. (1956). Bionomics of the tobacco whitefly (*Bemisia tabaci* Gennad.) in Israel. 7: 25-41.

Azab, A.K., M.M. Megahed and D.H. El-Mirsawi. (1971). On the Biology of *Bemisia tabaci* (Genn.). *Societe Entomol. D'Egypte Bull*. **55**: 305-315.

Azam, K.M., Razvil, Z. and Al-Raeesi, A.A. (1997). Management of whitefly *Bemisia tabaci* Gennadius and tomato leaf curl virus in tomato crops. *Arab and Near East Plant Protect. Newsl.* No. 25, 27.

BBS (Bangladesh Bureau of Statistics). (2009). Ministry of Planning, Government of Peoples Republic of Bangladesh. Yearbook of Agric. Statistics of Bangladesh. Dhaka.

Badaya, A.K., Deshpande, R.R. and Ali, S.A. (1999). Efficacy and economics of different insecticides for the control of okra fruit and shoot borer, *Earias vittella* Fab. *Bhartiya Krishi Anusandhan Patrika.* **6**(3-4): 181-185.

Basu, A. N. (1995). *Bemisia tabaci* Gennadius-Crop pest and principal whitefly vector of plant viruses. Oxford &IBH Pub. Co. Pvt. Ltd. New Delhi. pp. 183.

Banken, J.A.O. and Stark, J.D. (1997). Stage and age influence on the susceptibility of *Coccinella septempunctata* after direct exposure to neemix, a neem insecticide. *J. Eco. Entomol.* **90**(5): 1102-1105.

Begum, M.A. (2002). Prevalence and spread of *Okra yellow vein clearing mosaic virus (*OkYVCMV*)* in the field and its impact on growth and yield of okra. M.S. Thesis. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. pp 135.

Berlinger, M.J. (1986). Host Plant Resistance to *Bemisia tabaci*. *Agric. Ecosystems Environ*. **17**: 69-82.

Berlinger, M.J., Taylor, R.A.J. Lebiush-Mordechi, S., Shalhevet, S. and Spharim, I. (2002). Efficacy of exclusion screens for preventing whitefly transmission of tomato yellow leaf curl virus of tomatoes in Israel. *Bull. Entomol. Res*. **92**(5):367-373.

Bilton, J.N., Broughton, H.B., Ley, S.V., Lidert, Z., Morgan, E.D., Rzepa, H.S. and Sheppard, R.N. (1985). Structural reappraisal of the limonoid insect antifeedant azadirachtin. *J. Chem. Soc. Chem. Commun*. pp. 968-971.

Borah, R.K. and Nath, P.D.(1995).Evaluation of an insecticide schedule on the incidence of whitefly, *Bemisia tabaci* Genn. and yellow vein mosaic in okra. *Indian J. Virol*. **11**(2):65-67.

Brickle, D.S., Tumiseed, S.G. and Sullivan, M.J. (2001). Ovicidal effects of insecticides on eggs of gram podborer (*Helicoverpa armigera*) and spotted bollworm (*Earias vittella*). *Indian J. Agril. Sci*. **63**(12):853-855.

Broughton, H.B., Bilton, J.N., Ley, S.V., Lidert, Z., Morgan, E.D., Rzepa, H.S. and Sheppard, R.N. (1986). Structural reappraisal of the limonoid insect antifeedant azadirachtin. *J. Chem. Soc. Chem. Commun*. pp. 968-971.

Brown, J.K., Frohilch, D.R. and Rossel, R.C. (1995). The sweet potato or silverleaf whiteflies: Biotype of *Bemisia tabaci* or a species complex. *Ann. Rev. Entomol*. **40**:511-34.

Butani, D.K. and Jotwani, M.G. (1984). Insects in vegetables. Perodical Expert Book Agency. Vivek-Vihar, Delhi. pp: 45-66.

Butani, Dhomo K. and Jotwani, M.G. (1984). Insects in vegetables. Periodical expert Book Agercy, India. pp: 356.

Butler,G.D.Jr.,T.J. Henneberry and T.E. Clayton. (1983). *Bemisia tabaci* (Homoptera: Aleyrodidae): Development, Oviposition, and Longevity in Relation to Temperature. *Ann. Entomol. Soc. America*. **76**(2): 310-313.

Butterworth, J.H. and Morgan, E.D. (1968). Isolation of substance that suppresses feeding in locusts. *J. Chem. Commun*. pp. 23-24.

CCSHAU. (1997). The Package of Practices for Kharif Crops. Hisar: India. CCS Haryana Agricultural University.

Cahill, M., Byrne, F.J., Gorman, K., Denholm, I., and Devonshire, A.L. (1995). Pyrethoid and Organophosphate resistance in tobacco whitefly, *Bemisia tabaci* (Homoptera:Aleyrodidae). *Bull. Entomol. Res*. **85:** 181-187.

Chaudhury, D.S. (2001). Evalution of synthetic and bio-pesticides against OSFB. Current Research Report. *Mahatama Phula Agril. Univ.* **2**(1): 256-261.

Chauhan, D.V.S. (1972). Vegetable production in India. 3rd Edition. Published by Ram Prasad Sons, Agra. pp. 28-30.

Chinniah and Mohanasundaram, M., (1999). Evaluation of neem derivatives for their toxic effect on safety to predatory mites, *Amblyseius* spp. (Acarina : Phytoseidae) in cotton ecosystem. *Pestology*, 123 : 45-48. cotton aphid (*Aphis gossypii*). *Indian J. Agric. Sci.* **63** : 134- 135.

Choi In Hu, Jang YongSeok, Kim GilHah and Kim JeongWha, (2004). Control effects of some insecticides on different stages of the stone leek leafininer , *Liriomyza chinensis* Kato (Diptera:Agromyzidae). *Korean Appl. Entomol*. **43**(2): 169-173.

Cock, M.J.W.Ed. (1986). *Bemisia tabaci*, A Literature Survey on the Cotton Whitefly with an Annotated Bibliography. Food and Agriculture Organization of the U.N., C.A.B. Int. Inst. Biol. Cont. 121 pages.

Cohen, S. and M.J. Berlinger. (1986). Transmission and Cultural Control of Whitefly-borne Viruses. *Agric. Ecosystems Environ*. **17**: 89-97.

Dangi, P.R. (2004). Incidence of *Earias vittella* (Fabricius) and its management in okra, *Abelmoschus esculentus* (L.) Moench. M.Sc. Thesis, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Dash, A.N., Mahapatra, H., Pradhan, A.C. and Patnaik, N.C. (1987). Effect of mixed and inter cropping on occurrence of some pest in Orissa. *Environ. Ecol.* **5**(3): 526-530.

David, B.R. (2001). Elements of Economic Entomology. Population Book Report, Chennai. pp: 198-207.

De Barro, P.J. (1995). *Bemisia tabaci* Biotype B: a review of its biology, distribution and control. Division of Entomol. Technical paper no. 33. *Common. Sci. Indus. Res. Org*., Canberra, Australia.

Dhamdhere, S.V., Bhadur, I. and Mishra, U.S. (1984). Studies on occurrence and succession of pests of okra at Gwalior. *Indian J. Plant Prot.* **12**: 9-12.

Dhawan, A.K. and Sidhu, A.S. (1984). Incidence and relative abundance of different species of spotted bollworms on okra at Ludhiana, Punjab. *J. Res. Punjab Agric.Univ.* **21**: 533-542.

Dongre, T.K. and Rahalkar, G.W. (1992). Relative host plant preference and induction of preference for feeding behavior in spotted bollworm. *Indian Ecol*. **19**(1): 61-64.

Dutt, A.K. and Saha, J.L. (1990). Insect pest management of winter planted cotton in coastal rice fallow of West Bengal. *Tropical Pest Manage.* **36**(2): Pp. 89-92.

El-Helaly, M.S., A.Y.El-Shazil, and F.H. El-Gayar. (1971). Biological studies on *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae) attacking cotton in the coastal plain of Israel. *Bull. Entomol. Res.* **70**: 213-219.

Gautam, R.K. and Goswami, N. (2004). Different food varies for amino acids in moth larvae. *Uttar Pradesh Zool*. **24**(2):183-186.

Gennadious, P. (1889). Disease of the tobacco plantation in the Triconia. The aleurodid of tobacco. *Ellenike Ga*. **5**:1-3.

George, P.J.E. (1997) Effect of some plant odours in the breeding environment on fecundity and hatching of okra shoot and fruit borer, *Earias vittella* Fab. Under laboratory conditions. *Crop Res. Hisar*. **13**(3):157-161.

Gomez, K.A. and Gomez, A.A. (1976). Statistical Procedure for Agricultural Research (2nd Ed). A Willey Inter science Publication, New York. P. 680.

Gopal an, C., Rama Sastri, B.V. and Balasubramanian, S. (2007). Nutritive Value of Indian Foods, published by National Institute of Nutrition (NIN), ICMR.

Greathead, A.H. (1986). Host Plants. Chapter 3, pp. 17-25. In: *Bemisia tabaci* - a literature survey on the cotton whitefly with an annotated bibliography (Ed. M.J.W. Cock). CAB International Institute of Biological Control, Ascot, UK. p. 121.

Griffiths, D.C., Greenway, A.R. and Lioyd, S.L. (1978). The influence of repellent materials and aphid extracts on settling behavior and larviposition of *Myzus piersicae* (Sulzer) (Hemiptera: Aphididae). *Bull. Ent. Res.* **68:** 613-619.

Griffiths, D.C., Pickett, J.A., Smart, L.E. and Woodcock C.M. (1989). Use of insect antifeedant against aphid vectors of plant virus disease. *Pestic. Sci*. **27**: 269-276.

Gupta, G.P. and Sharma, K. (1997). Neem-based pest management strategy in cotton system. *Pestic. Res. J*. **9**: 190–197.

Haider, M.Z. (1996). Effectiveness of some IPM packages for the management of virus-disseminating whitefly on tomato. M.S. thesis in Entomology, IPSA, Salna, Gazipur, Bangladesh. 1-65 pp.

Harender, R. Bhardwaj, M. L. and Sharma, N.K. (1993). Performance of commercial okra(*Hibiscus esculentus*) varieties in relation to disease and insect pests. *Indian J. Agric. Sci*. **63**(11): 747-748.

Haque, M.M. (1993). Tomato, Brinjal and Okra. In: Ahmed and Sahajahan, M. (ed). Homestead vegetable production, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. p. 61.

Hill, D.S. (1983). Agricultural Pests of the Tropics and their control. Cambridge University press. Cambridge, New York. pp. 64-367.

Husain, M.A., Trehan K.N. and Verma, P.N. (1939). Eonomics of field scale spraying against the whitefly of cotton (*Bemisia gossypiperda*, M. and L.). *Indian J. Agric. Sci*. **9**: 109-126.

International Board for Plant Genetic Resources IBPGR. (1990). Report on International Workshop on Okra Genetic resources held at the National bureau for Plant Genetic Resources, New Delhi, India

Islam, M.N., Kumar, N.K. and Karim, M.A. (1999). Efficacy of different insecticides for the control of okra shoot and fruit borer , *Earias vittella* F. Annual Report.(1998-99). BARI, Joydevpur, Gazipur, Bangladesh: pp. 33-34.

Jayaraj, S., Rangarajan, G.A.V., Murugesan, S., Santharam, G. Vijayaraghavan, S. And Thangaraj, D., (1986), Outbreak of whitefly *Bemisia tabaci* (G.) on cotton in Tamil Nadu and its management. *All Indian Group Discussion on Whitefly in Cotton,* Guntur, April 29-30, (1986).

Joshi, B.G. and Sitaramaiah, S. (1979). Seed kernel as an oviposition repellent for *Spodoptera litura* (F.) moths. **7**: 199–202.

Kabir, K.H., Rouf, F.M.A., Islam, M.N. and Malakar, P.K. (1994). Efficacy of different insecticides in controlling brinjal shoot and fruit borer, Leucinodes orbonalis Guen. Univ. 3. Zool., Rajshahi Univ. 13: 1-8.

Kadam, J.R. and Khaire, V.M. (1995). Raining and relative humidity: key factors to suppress *Earias vittella* Fab infestation on Okra crop. *J. Ento. Res.* **19**(3): 201-205.

Karim, M.A. 26-29 January (1992). Vegetable production and marketing. Proceedings of a national review of planning workshop hold at BARI, Gazipur, Bangladesh.

Khaliq, A. and Yousuf, M. (1986). Effect of weather on the light-trap captures of some insect pests of cotton. *J. Agric. Res. Lahore.* **24**(4): 313-319.

Khan, M.A. and Mukhopadhyay, S. (1985). Effect of different pesticide combinations on the incidence of yollow vein mosaic virus of okra (*Abelmoschus esculentus*) and its whitefly vector *Bemisia tabaci* Genn. *Indian J. Virol.* **1**(2):147-151.

Khan, M.H. and Verma, P.M. (1946). Studies on *Earias spp* (the spotted bollworm of cotton) in the Punjub. The biology of the common parasites of *Earias fabia* stoll, *E. insulana* (Boisd) and *E. cupreoviridis* (WK). *Indian J. Entomol.* **7**: 41-63.

Khurana, A.D. and Verma, A.N. (1990). Comparative damage caused by bollworms and yield of seed cotton during a dry and wet year in Haryana. *J. Insect Sci.* **3**(2): 180-182.

Koul, O. and Isman, M.B. (1991). Effects of azadirachtin on the dietary utilization and the development of the variegated cutworm *Performa saucier*. *J. Insect. Physiol.* **37**: 591-598.

Kraus, W., Bokel, R., Klenk, A. and Pohnl, H. (1985). Constituents of neem and related species: A reversed structure of azadirachtin. Third Int. Conf. of

Chemistry and Biotechnology of Biologically Active Natural products (Sofia, Bulgaria, 1985), Abstr. pp. 446-450.

Krishna, S.S. (1987). Nutritional modulation of reproduction in two phytophagous insect pests. **96**(3): 153-169.

Krishnaiah, K. (1980). Methodology for assessing crop losses due to pests of vegetables "Assessment of crop losses due to pest and diseases". USA Tech. Series no. **33**: 259-267.

Lakshmanan, K.K. (2001). Neem a natural pesticide. *The Hindu, March* 1. P.8.

Leuschner, K. (1972). Effects of an unknown substance on a shield bug. *Naturwissenshaften*. **59**: 217.

Maleque, M.A. (1998). Judicious application of insecticides for the management of Brinjal shoot and fruit borer. M.S. Thesis, BSMRAU, Salna, Gazipur, Bangladesh. management of fruit borer, *Earias vittella* (Fab.) on okra, *Abelmoschus esculentus* (L.) Moench. M.Sc. Thesis, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Mandahar, C.L. and Singh, J.S. (1972). Effect of bhendi yellow vein mosaic on its host. *Acta. Acad. Sci. Hungaricae* **7**: 187-191.

Marcano, R. and Gonzalez, E. (1993). Evaluation of insecticides for the control of the whitefly *Bemisia tabaci* (Gennadius) in tomato. *Bio.Entomol. Venezolana*. **8** (2): 123-132.

Mau, Ronald F.L. and Dick Tsuda. (1991). Sweetpotato whitefly *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae).

Miah, M.A.S. (1988). Effect of date of planting and insecticidal spray on control of yellow vein mosaic of Lady`s finger (*Hibiscus esculenturs* L.) *Maharashtra Agric. Univ.* **2**(2): 175.

Misra, P.N. (1989). Bio-efficacy of some newer insecticides against the pest complex of okra. *Bangladesh Hort*. **17**(1):1-4.

Misra, H.P., Dash, D.D. and Mahapatro, D. (2002). Efficacy of some insecticide against okra fruit borer and leaf roller. *Ann. Pl. Proect. Sci.* **10**: 51-54.

Mohan, J., Krishnaiah, K. and Prasead, V.G. (1983). Chemical control of insect pest of okra. *Indian J. Entomol.* **45**(2): 252-258.

Morale, R.S., Sarnaik, D.N., Satpute, U.S. and Sadawarte, A.K. (2000). Effect of plant products on growth and development of *Helicoverpa armigera* on cotton. *Pestology*. **24**(6): 50-55.

Mound L.A. and S.H. Halsey. (1978). *Bemisia tabaci* (Gennadius). pp. 118-124. In Whitefly of the World, A Systematic Catalog of the Aleyrodidae (Homoptera) with Host Plant and Natural Enemy Data. British Museum (Natural History) and John Wiley & Sons, Chichester, New York, Brisbane, Toronto. 340 pages.

Mudathir, M. and Basedow, T**.** (2004). Field experiments on the effects of neem products on pests and yields of okra *Abelmoschus esculentus* in the Sudan. *Mitteil. Deutsch. Gesellsch. allgem. angew. Entomol*. **14**: 407-410.

Ngo, N., Moore, S., Lawson, S., Dugger, P. and Richter, D. (1999). Ovicidal research with emamectin benzoate against tobacco budworm eggs. Conferences,

Orlando, Florida, USA, 3-7 January, (1999):1090-109. (1988). Schedule of insecticidal application against insect pest complex of brinjal with special reference to brinjal shoot & fruit borer,- *Leucinodes orbonalis* Guen. *Indian J.* **50** (1): 16-19.

Nandihalli, B.S., Parameshwara Hugar And Patil, B.V. (1990). Evaluation of neem and neem products against cotton whitefly, *B. tabaci* (Genadius). *Karnataka J. Agril. Sci.* **3** : 58-61.

Natarajan, K. Prasad, R. And Sundaramurthy, V.T. (1986). Effect of neem oil on cotton whitefly (*Bemisia tabaci*). *Indian J. Agril. Sci.*, **60** : 290- 291.

Nath, P. and Saikia, A.K. (1993). Assessment of yield loss due to yellow vein mosaic of okra (Abelmoschus esculentus L.) in Assam, India. *J. Agric. Sci. Soc*. **6** (4): 87-88.

Pareek, B.L., Kumawat, R.L. and Patni, S.K. (2001). Effect of abiotic factors on the incidence of okra insect pests in semi-arid conditions. Proceeding of the National Conference on plant protection- New Horizons in the Millennium, Feb. 23-25, Udaipur. pp. 1-8.

Patel, M.S., Yadav, D.N. And Rai, A.B., 1994, Neemark (Azadirachtin) as ovipositional deterrent against cotton pests. *Pestology.* **18** : 17-19.

Patel, N.C., Zala, S.P. and Patel, J.R. (1999). Impact of weather on magnitude of *Earias vittella* infesting okra. *Indian J. Ento*. **61**(4): 351-355.

Patil, C.S., Pawer, S.A., Mote, U.N. and Khaire, V.M. (1991). Evaluation of cypermethrin (SIRcis and RIS-cis isomers) against okra fruit borer. *Ann. AppI. Biol*. **118** (suppl.):20-21.

Patil, R.S. (2000). Utilization of plant products in the management of okra shoot and fruit borer *Earias vittella* in okra crop. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Pearson, E.O. (1958). The insect pests of cotton in tropical Africa. *Intl. J. Appl. Entomol.* **12**: 71-74.

Prakash, A., Rao, J., Pasalu, I.C. and Mathur, K.C. (1987). Rice Storage and Insect Management. B.R. Publishing Corporation, New Delhi. p.337.

Parkash, O. (1988). Schedule of Insecticidal Application against insect pest complex of brinjal with special reference to brinjal shoot and fruit borer , *Leucinodes orbonalis* Guen. *Indian J. Entomol*. **50(1)** :16-19.

Prakash, A., Rao, J., Jevari, S.N. and Gupta, S.P. (1990). Rice agro ecosystem management by pesticides and its consequences. *Nat con. Publ. in Growth Develop.Natural Res. Conservations*. pp. 131-137.

Pruthi, H.S. (1946). Report of the Imperial Entomologist. Abridged science Reports, Agricultural Research Institute, New Delhi. (1941-44). **99**: 64-71.

Rahman , M.H. and H. Ali. 1983.Biology of spotted bollworm of cotton, *Earias vittella* Fab. *Pakistan J. Biol*. **13**(1-2): 105-110.

Rai, S. (1985). Chemical control of Bhindi pests. *Indian J. Entomol.* **7** (2): 173-178.

Rajasekaran, B. and Kumarswami, Y. (1985). Antifeedent properties of certain plant products against *Spodoptera litura* (F.). In: Proceedings of National Seminar

on Behavioral Physiology Appr. Mrmt. Crop pests, Tamil Nadu Agricultural University. pp. 25-28.

Ramiah, M., Vidhyasekaran, P. and Kandaswamy, T.K. (1972). Changes in photosynthetic pigments of bhendi infected by yellow vein mosaic disease. *Madras Agril. J.* **59**:402-404.

Rana, B.S. (1983). Studies in the effectiveness of some insecticides against insect pests of bhendi, *Abelmoschus esculentus* (L.) Moench. M.Sc. Thesis, Udaipur University, Rajasthan.

Rao, S.N., Rajendran, R. and Raguraman, S. (2002). Antifeedant and growth inhibitory effects of neem in combination with sweet-flag and pungam extracts on Okra shoot and fruit borer, *Earias vittella* (Fab.). *J. Entomol. Res*. **26** (3): 233-238.

Rashid, M.M. (1976). Vegetables of Bangladesh (in Bengli), Bangla Academy, Dhaka. P.494.

Rashid, M. M. (1999). Shabjibiggayan (In Bengali). Rashid Publishing House, 94 Old DOHS, Dhaka-1206. P. 49.

Rosaiah, R., (2001), Performance of different botanicals against the pests complex in bhendi. *Pestology*, **25** : 17-19.

Sardana, H.R. and Krishnakumar, N.K. (1989). Effectiveness of plant oils against leafhopper, shoot and fruit borer in okra. *Indian J. Entomol*. **51** (2): 167- 171.

Sarkar, B.B. and Nath, B.C. (1989). Field evaluation of various insecticides against fruit borer and effect on yield of lady's finger seed. *Pestology*. **13**(4): 19-21.

Satpathy. S and Rai, S. (1999). Efficacy of different pesticides and combination against jassid borer of okra. *Vege. Sd*. **26**(1):78-81.

Satpute, N.S., Deshmukh, S.D., Mane, P.N., Rao, N.G.V. and Nimbalkar, S.A.(2002). Growth and development of spotted bollworm, *Earias vittella* (Fab.) reared on different hosts under laboratory conditions. *PKV. Res.* **26**(1/2):47-50.

Savello, P.A., Mortin, F.W. and Hill, J.M. (1980). Nutritional composition of okra seed meal. *Agril. Food Chem.* **28**: 1163-1166.

Saxena, R.C., Waldbauer, G.P., Liquido, N.J. and Puma, B.C. (1981). Effects of neem seed oil to the rice leaf folder, *Cnaphalocrocis medinalis*. In: Natural Pesticides from the Neem Tree (*Azadirachta indica* A. Juss) and Other Tropical Plants. Ed. by Schmutterer, H.; Ascher, K. R. S. Rottach-Egern, Germany: Eschborn: GTZ, 189–204.

Schmutterer, H. (1961). The most important pests of crops in the central rainlands of the Sudan and their control. *Anz. Schadlinge.* **34**: 177-180.

Schmutterer, H., Saxena, R.C. and Heyde, V.D.J. (1983). Morphogenetic effects of some partially-purified fractions and methanolic extracts of neem seeds on *Mythimna separata* (Walker) and *Ccaphalocrotrocis medinalis* (Guenenee). *J. Angew. Entomol*. **95**: 230-237.

Schmutterer, H. (1985). Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. *Annu. Rev. Entomol*. **35**: 271-297.

Schmutterer, H. (1990). Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. *Ann. Rev. Entomol*. **35**: 271–290.

Schmutterer, H. (1995). The neem tree, *Azadirachta indica* A. Juss and other eliaceous plants Sources of unique natural products for integrated pest management, medicines, industry and other purposes. VCH Publishers Inc., New York, USA. P. 253.

Shah, B.R., Vyas, H.N. and Jhala, R.C. (2001). Population dynamics of major insect pests of okra *Abelmoschus esculentus* (L.) in relation to weather parameters. *In:* Abstracts National conference: Plant Protection –New Horizons in the Millennium (NCPP). Udaipur (Raj.) p^4.

Sharma, I.N., Lall, B.S., Sinha, R.P. and Singh, B.N. (1985). Biology of spotted bollworm *Earias vittella. Bull. Entomol*. **26**(1): 38-41.

Sharma, R.P., Swaminathan, R. and Bhati, K.K. (2010). Seasonal incidence of fruit and shoot borer of Okra along with climatic factors in Udaipur region of India. *Asia J. Agril. Res.* **4**(4): 232-236.

Shukla, A., Pathak, S.C. and Agrawal, R.K. (1997). Seasonal incidence of okra shoot and fruit borer, *Earias vittella* and effect of temperature on its infestation level. *Plant Sci.* **10**(1): 169-172.

Singh, Y. and Bichoo, S.L. (1989). Some biological and bionomical observation of *Earias* spp. *Bull. Entomol. New-Delhi*. **30**(1): 84-91.

Singh, M.P., Sharma, D. P. And Mishra, H.P., (1999), Efficacy of plant extracts against cotton whitefly, *Bemisia tabaci* (genn.). *Annals of Plant Protection Sciences*, **26**: 46-48.Singh, B.K., Singh, A.K. and Singh, H.M. (2005). Efficacy of certain synthetic insecticides and two botanicals against the okra fruit and shoot borer, *Earias vittella* (Fab.). *Pest Manage. Economic Zool*. **13**(1): 99-103.

Sojitra, I.R. and Patel, J.R. (1992). Effects of plant extracts (including Azadirachta indica, Ricinus communis and Pongamia pinnata) on ovipositional behaviour of spotted bollworm (*Earias vittella*) infesting okra (*Abelmoschus esculentus*). *Indian J. Agric. Sci.* **62**: 848–849.

Srabani, Debnath, Nath, P. S. and Denath, S. (2002). Management of yellow vein mosaic disease of okra through insecticides, plant products and suitable varieties. *Ann. Plant Protect. Sci*. **10**(ii):340-342.

Srinivasan, P.M. and Gowder, R.B. (1959). A preliminary note on the control of the okra shoot and fruit borer, *Earias fabia* and *E. insulana. Indian J. Agric. Sci.* **30**(1): 55-57.

Srinivasan Murthy, K. And Sharma, D.P., (1997), Traditional pest management in cotton. *Insect Environ.*, **3** : 73-74.

Thakur, M.R., Arora, S.K., Bose, T.K. and Son, M.G. (1986). Vegetable crops in India. 6^{th} edition. Calcutta, India. p. 678.

Thomas, R. (1932). Periodic failure of the Punjab-American Cotton Crop *Acric. Livestock in India*. **2** (3):243-274.

Thomson, H.C. and Kelly, W.C. 1979. (3rd ed.) Vegetable crops. Mcgraw Hill Co. New York. P. 562.

Tindall, H.D. (1986). Vegetables in the Tropics. 1st edition, Macmillan Publishers, Hong kong. pp. 325-327.

Torres, J.B. Ruberson, J.R. (2004). Toxicity of thiamethoxam and imidacloprid to *Podisus nigrispinus* (Dallas) (Heteroptera:Pentatomidae) nymphs associated to aphid and whitefly control in cotton. *Neotropic. Entomol*. **33**(i):99-106.

Verma, S, Gupta, R.S., Vishwa nath, S.P., Kawal, D. and Sing, R. (1980). Control of pests of okra. *Indian J. Entomol*. **42**: 822-823.

Warthen, J.D., Uebel, J., Dutky, E.C., Luspy, S.R. and Finegold, W.R. (1978). Adult house fly feeding deterrent from neem seeds. *USDA/SEA Agric. Res. Results, Northeast.* **2**: 1-11.

Yadvendu, T.C. (2001). Evaluation of newer insecticides against insect pests of okra (*Abelmoschus esculentus*). M.Sc. Thesis, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan

Yamaguchi, M. (1998). World Vegetables Principles, Production and Nutritive Values. Van Nostrand Reiduction. New York, USA. pp. 415.

Zala, S.P., Patel, J.R. and Patel, N.C. (1999). Impact of weather on magnitude of *Earias vittella* infesting okra. *Indian J. Entomol.* **61**(4): 351-355.