INFESTATION STATUS AND MANAGEMENT OF OKRA SHOOT AND FRUIT BORER, *EARIAS VITTELLA* F.

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CERTIFICATE

This is to certify that the thesis entitled, "Infestation status and management of okra shoot and fruit borer, *Earias vittella* F." submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN ENTOMOLOGY,** embodies the result of a piece of bonafide research work carried out by Rokeya Ahmed Roll No. 00382, Registration No. 25277/00382 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 been duly acknowledged by her.

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Dedicated to
My
Beloved Parents

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ABSTRACT

A series of studies were undertaken to determine infestation status, varietal preference of okra shoot and fruit borer, *Earias vittella* and also to develop their management tactics in the Entomology Division Experimental field, BARI, Gazipur during 2005 cropping season. Shoot infestation started from 30 days after seed sowing (DAS) and infestation gradually increased thereafter. At 51 DAS the shoot infestation reached to the peak and 32.41% shoot infestation was recorded during that time. On the other hand fruit infestation started three weeks later than the shoot infestation. Fruit infestation ranged from 1.93% (51 DAS) to 17.49% (107 DAS). Shoot infestation was severe during the early part and fruit infestation during the later part of the crop cycle. Both shoot or fruit infestations of okra by OSFB were positively correlated with temperature and rainfall. This indicates that okra shoot and fruit borer like hot and humid climate for its growth and development. Among the three varieties/lines tested against OSFB, BARI Dheros 1, consistently and significantly showed higher shoot infestation than the other two okra lines, Gazipur local 1 and Gazipur local 2 in all the observations. Mean percent shoot infestation in BARI Dheros 1 was 29.81 while that was 14.93% in Gazipur local 1 and 17.29% in Gazipur local 2. Among the management treatments significantly lowest shoot infestations were observed in the neem oil and neem seed kernel extract treatments. Highest shoot infestations were recorded in untreated plots. The overall mean shoot infestations were 7.85%, 6.95%, 13.62% and 21.76% in neem seed kernel extract, neem oil, dimethoate and untreated control plots, respectively. Fruit infestation almost followed the same trends of result due to the effect of those treatments. However chemical pesticide, Dimethoate performed better in the reduction of fruit infestation than shoot infestation. Significantly lowest fruit infestations were observed in the neem oil and neem seed kernel extract and dimethoate treatments. Highest fruit infestations were recorded in untreated plots. Average reduction of 60.94%, 65.21% and 53.16% fruit infestation were happened over untreated control due to the effect of neem seed kernel extract, neem oil and Tafgor 40 EC treatments, respectively. As okra is quick harvestable vegetable so it is not wise to spray toxic pesticide at every one week interval. This study revealed that neem seed kernel extract and neem oil spray at 10 days interval can control the pest very much effectively.

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CHAPTER 1

INTRODUCTION

Bangladesh is a vegetable deficit country with an annual vegetables production of only 2.5 million tons excluding potato and sweet potato (Anonymous, 1993) against the total requirement of more than 10 million tons. Due to low production the per capita consumption of vegetables in Bangladesh is about 50g/day which is the lowest amongst the countries of South Asia and South East Asia (Rekhi, 1997). Per capita consumption in other South Asian countries, namely, Nepal 42g, Pakistan 69g, Sri Lanka 120g and India 135g are higher than that of Bangladesh. Although optimum daily requirements of vegetables for an adult person is 285g (Ramphal and Gill, 1990). As a result, chronic malnutrition is commonly evident in Bangladesh.

In Bangladesh, status of vegetable production is not uniform round the year. Vegetables are plenty in winter but are in short in summer. About 30% of total annual vegetable production of Bangladesh is limited in the kharif season and the rest is produced in the rabi season (Anon, 1993). Among the few summer vegetables okra, can get an importance due to its profuse bearing and wide coverage. Okra (*Abelmoschus esculentus* L. Moench) is an annual vegetables crop grown from seed in tropical and sub tropical parts of the world. It belongs to the family Malvaceae and locally known as 'Dherosh' or 'Bhendi'. The total acreage and production of okra in the year 1999 were 13890 acres and 17460 metric tons, respectively (BBS, 1999). Okra is cultivated mainly for its immature fruits, which are generally cooked as vegetable. Okra soups and stews are also popular dishes. When ripe, black or brown white – eyed seeds are sometimes roasted and used as a substitute for coffee. Tender green fruits of okra are generally marketed as fresh but sometimes in canned or dehydrated form. The crop may be used in paper industry and the stem of the plant is used for the extraction of the fiber (Chaudhury, 1983). Tender fruits have high mucilage content and are used in soups and gravies. Seeds are also a good source of protein and oil (Savello *et al.*, 1980). The fruits also have some medicinal value. A mucilaginous preparation from the pod can be used for plasma replacement or blood volume expansion.

Okra production in Bangladesh is effected by many factors and among them insect pest attack is the major one. Several insect pests have so far been recorded to attack okra but Okra shoot and fruit borer (OSFB), *Earias vittella*

F. is the major pest responsible for considerable damage (Butani and Jotwani, 1984). It is the most serious pest of okra in Bangladesh and both quantitative and qualitative losses happened due to this pest infestation. According to Srinivasan *et al.* (1959) 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. Fletcher and Mishra (1929) stated that the *E. vittella* is one of the most important pest among the various insect- pests of okra crop grown in different parts of India and causes 41.6% crop loss.

Despite the importance of okra and severity of OSFB problem, the management practice to combat this menacing pest is much difficult for its internal feeding behavior. Several management practices have been reported to combat this pest. But unfortunately chemical pesticides dominate the control measures of OSFB. Synthetic chemical insecticides have led to a number of problems such as development of resistance to insecticides, high insecticide residues in market produce, resurgence or increased infestation by some insect species due to the destruction of natural predators and parasitoids, changing pest status of mites and other minor insect pests, ecological imbalance and danger to health of the pesticide applicator and to consumers. Especially the residues of some of the insectidies remain on fruit and also in environment (Kavadia *et al.*, 1984), which may cause miserable consequences after consumption.

So, for the management of this pest, mixtures of various plant parts leaf, bark, seed and vegetables oils are traditionally being practiced in Asia and Africa (Rejesus *et al.*,1989). Indigenous plant materials are cheaper and non hazardous in comparison to chemical insecticides (Saxena *et al.*, 1980). Application of neem oil alone and together with endosulfan against the OSFB reduced the damaged (Samuthuiravelu and David, 1991; Sardana and Kumar, 1989). Application of cypermethrin or fenvalerate at 50gm/ha (Pawar *et al.*, 1988; Ratanpara and Bharodia, 1989; David and Kumaraswami 1991; Patil *et al.*, 1991). Endosulfan (Mote and Pokharkar, 1974; Gopalan *et al.*, 1974) were applied against the pest with partial success.

In Bangladesh few research works have so far been done on different aspects of OSFB management. Although those works were mostly oriented with the insecticides screening, loss assessment etc. Very few studies have been done on the pest status, seasonal abundance, and bio-rationale based integrated management of the pest. Especially attempt to control OSFB in summer utilizing non-chemical approaches with little reliance on insecticides and economizing the application at various growth stages are still unexploited. Moreover, the study on the seasonal abundance of the pest in Bangladesh is scanty. Determination of the peak abundance season would help for the application of management approaches to control the pest avoiding routine intervention.

So, considering the importance of okra during summer and its devastating pest, okra shoot and fruit borer series of research studies were undertaken with the following objectives:

1. To study on the infestation status of okra shoot and fruit borer, *E. vittella* on okra.
2. To study on the varietal preference of okra shoot and fruit borer, *E. vittella*.
3. To develop management packages for sustainable, economic and environmental friendly control measure of the pest.

Chapter 2

Review of literature

CHAPTER 2

REVIEW OF LITERATURE

2.1 Host plant

Okra (*Abelmoschus esculentus* L. Moench) is an annual vegetables crop grown from seed in tropical and sub tropical parts of the world. It belongs to the family Malvaceae and locally known as 'Dherosh' or 'Bhendi'.

2.1.1 Climate and Soils

High temperature is needed for okra cultivation. If the temperature goes below 15^0C then vegetative growth of the plants hampered. In Bangladesh it is better to grow during kharif season. Sandy loam soil is the best for okra cultivation but it can be grown in the sandy soil with the application of high organic manures. Soil should be well drained and soil pH should be within 6.0-6.8 for better okra production.

2.1.2 Varieties

There are many local varieties of okra cultivated in Bangladesh. Among them one variety with higher yield potential released by Bangladesh Agricultural Research Institute BARI named as BARI Dherosh1 became very much popular among the okra farmers as it is resistant to yellow vein mosaic virus (YVMV). Recently Bangabandhu Sheikh Mujubur Rahman Agricultural University (BSMRAU) developed an advanced line of okra which is resistant to yellow vein mosaic virus (YVMV) diseases with high yielding potential (Hossain, 1997). Generally farmers grow some unknown local cultivars or some exotic varieties with low yield potential and higher susceptibility to YVMV diseases .

2.2 The insect

Okra shoot and fruit borer, *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae) is considered as one of the major pests of okra, which reduces both the quality and quantity of fruit. It is a very common pest of okra in India and Bangladesh. The incidence of this pest occurs sporadically or in epidemic form every year throughout Bangladesh. In the favorable weather severe infestation may occur and maximum fruits may be infested. But published literature on the pest especially on it's infestation status and management are scanty in Bangladesh. However, review of the available literatures relevant to the present study is presented below under the following sub-headings.

2.2.1 Taxonomic position and Distribution

The pest Okra shoot and fruit borer, *Earias vittella* is common oriented species found from India and China to North Australia. The genus *Earias* is confined to the old world including Australia (Hill, 1983). Okra shoot and fruit borer, *Earias vittella* (Fabricius) is widely distributed and is recorded from Pakistan, India, Sri Lanka, Bangladesh, Burma, Indonesia, New Guinea, and Fiji (Butani and Jotwani 1984). Atwal (1976) reported that the species are widely distributed in North Africa, India, Pakistan and other countries and are serious pest of okra and cotton.

2.2.2 Host range

Butani and Jotwani (1984) found okra shoot and fruit borer as an oligophagous pest though 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.

Rehman *et al.*, (1983) reported that when OSFB were offered the choice of different parts of host plant they preferred okra fruit and shoot the best followed by cotton balls, buds of *Gossipium hirsutum*, ball, flowers and buds of local cotton (*G. arboreum*), buds and flower of Kenaf, flower of malvaparviflora and milky maize grains, flowers 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.

Nayar and Ananthakrishnan (1983) reported that a part from okra they also infest *Abutilon indicum*, *Abutilon hirtum*, *Althaea rosea*, *Hibiscus cannabinus*, *Hibiscus vitifolius* and *Malvastrum coromandelianum*. 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.

2.2.3 Nature of damage

Butani and Jotwani (1984) reported that OSFB lays its eggs singly on buds and flowers and occasionally on fruits as well .But in absence of these parts i.e., at the early stage of crop growth, the eggs ate laid on shoot tips. When the crop is only a few weeks old, the freshly hatched larvae bore into 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 the plants have a bushy appearance. With the formation of buds, flowers and fruits, the caterpillars bore inside those and on inner tissues. They move from bud to bud and fruit to fruit thus causing damage to a number of fruiting bodies. 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 and such fruits have hardly any market value.

Mohan *et al.*, (1983) and Atwal (1976) reported that OSFB bore into tender shoots, flower buds and fruits. As a result the attacked shoots dry up while the flower buds and developing fruits dropped prematurely. Affected fruit remain on the plants become unfit for human consumption. Karim (1992) stated that the larvae of OSFB bore into the shoots and feed inside and damage seeds. Singh and Bichoo (1989) reported that the first symptoms of attack were visible when the crop was 3 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. As soon as fruiting began, the larvae moved to the flower buds, small fruits and even mature pods, causing reduction of yield.
The damage effects due to *E. vittella* on fruit of different genotypes okra were studied by Sardana and Dutta (1989) in 1986. The results indicated that the least affected genotype (by fruit number) was IC 6653 with only 2.4%

Plate 1. Infested okra fruit by OSFB

Plate 2. Infested okra flower bud by OSFB

infestation compared to those of Bhindi 6 Dhari (2.8%) and Lam Sel-1 (3.8%) with Sel-10 showed the highest infestation (38.7%).

2.2.4 Seasonal abundance and infestation status

In general, the population of insects fluctuates from month to month, season to season, even year to year. Dash *et al*., (1987) reported that the occurrence and infestation status of noctuid *E.vittella* was maximum in shoots from July to October. The incidence of *Earias* spp on okra was studied by Dhawan and Sidhu (1984) in Panjub, India, in 1974-77. The maximum damage was counted in fruits (67.7%) and buds (52.4%) in late October. The maximum damage to shoots (1.7%) and flowers (1.5%) occurred in mid August. In the spring crop, the maximum damage to fruits (32.04%) and increased larval population (1.4/plant) were observed on late July. The population *Earias* spp. increased slowly up to mid September and rapidly there after. Heavy rainfall adversely affected its population build up. Butani and Jotwani (1984) conclude that there is no true hibernation but development and activity is considerably slowed down during winter.

Zala *et al*., (1999) found activity of shoot and fruit borer, *E. 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 *E. vittella* on shoot was started from 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 removal of crop during 1996 and 1997. The intensity of fruit damage varied from 11.11 percent (second week of August) to 40.43 percent (fourth week of September) and 10.12 percent (third week of August) to 47.37 percent (first week of October) during 1996 and 1997, respectively. The larval activity started from fifth week of August in 1996 &1997, respectively and continued till removal of the crop. The relevant observations are also reported by Mote (1977), Kadam and Khaire (1995) and Dhawan and Sidhu (1984).

The cotton plants sprouting on early spring and the fruits of okra left neglected in the field are the two important sources of early infestation and multiplication of this pest (Haque, 1993). Dutta and Saha (1990) observed the lower activity of *E. vittella* during December – January. The higher activity was observed during the increasing temperature from February and a maximum peak in May-June. Khaliq and Yousuf (1986) also reported the increased incidence of *E. vittella* with the increasing temperature and humidity.

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^{0}C and 23.2^{0}C, respectively having a mean RH of 64.8%.

Ali (1992) reported that peak abundance and intensity of OSFB /Spotted bollworm (Sbw) in cotton field were in October and 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 tended to disappear. 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.

2.2.5 Life cycle

According to Butani and Jotwani (1984) the eggs of OSFB are spherical in shape, about half mm in diameter, light bluish green in color and beautifully sculptured having 26 to 32 longitudinal ridges. The alternate ridges project upward to form a crown thus the eggs look like tiny or miniature poppy fruits. Full-grown caterpillars are 18 to 24 mm long, stout; spindle shaped having long stiff setae. Pupae are 13 to 16 mm long and chocolate-brown in color, bluntly rounded and enclosed in inverted boat shaped cocoons. Adults are medium sized moths, 13 to 15 mm long, head and thorax ochreous white; fore wings pale white with a broad wedge shaped horizontal green patch in the middle and hind wings silvery creamy in color. Wing expanse is 30 to 34 mm.

Butani and Jotwani (1984) also reported that the moths emerge at dusk; mating takes place 2 to 3 days after emergence and oviposition commences after 1 to 5 days of mating. A female lays on an average 400 eggs (65 to 695). They also reported that incubation, larval and pupal periods last for 3 to 9, 9 to 20 (50 to 60 days during winter) and 80 to 12 days, respectively. A single life cycle takes

Plate 3. Larvae of OSFB

Plate 4. Pupae of OSFB

Plate 5. Adult okra shoot and fruit borer

22 to 25 days extending up to 74 days during winter and there may be 8 to 12 generations in a year. There is no true hibernation but development and activity is considerably slowed down during winter.

Rehman and Ali (1983) reported that females of *E. vittella* mated for 34-109 min for successful insemination and laid 82-378 eggs each in 4-7 days. The egg stage lasted 3-4 days, the larval stage 5-16 days, the prepupal stage 1 day, the pupal stage 6-13 days and the adult life span 8-18 days. Krishna (1987) found higher overall mean fecundity of female OSFB when larvae reared on okra seeds compared to those reared on whole fruit. Sardana *et al.*, (1990) reported on the distribution of eggs of *E. vittella* in okra field Karnataka, India, Result indicate that this border rows tended to receive more eggs than the central rows. Ovipositing female laid most of the eggs on the top of the plants.

The biology of OSFB was studied on okra in laboratory field (Singh and Bichoo, 1989). They stated that the egg, larval and pupal stages lasted 3-4, 9-17 and 6-14 days, respectively in September - October.

Tripathi and Singh (1990) reported that survival of larvae was negatively correlated with larval density. The crowding also resulted on poor development and reduced weight of larvae and pupae. Sundararaj *et al.*, (1987) stated that percentage survival of OSFB was higher on okra (68 days), followed by cotton (67 days) and Abutilon *indicum* (16.3 days). Okra and cotton has a higher reducing sugar and free amino acid and Protein. On the other hand *A. indicum* had lower non - reducing sugar.

The biology of *E. vittella* on okra was also studied by Sharma *et al.*, (1985) in the laboratory using individuals collected from the field of Bihar, India. The borer had 11 generation a year. The longest life cycle (49 days) was observed during January. While the shortest life cycle of 29 days was found during July.

2.2.6 Management

This borer is the major pest of okra, committing colossal losses to okra growers. Although various 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.

Seventy- two genotypes of okra were screened by Kashyap and Verma (1983) in Hariana, India against *Earias* spp.under field condition. Pest infestation and fruit yield were recorded on the basis both of numbers and weights. Less than 10% (on a weight basis) infestation was obtained in Parkins long green, Clemson spineless, White snow and Sel round cultivars compared to more than 50% in IC 12933, wild Bhindi and RI. The rest of the genotypes were intermediate.

Madav and Dumbre (1985) studied the reaction of 14 okra varieties against OSFB grown in the hot weather season of 1981 in Maharashtra. Varieties AE 75, Pusa sawani, Long green, Indo American hybrid and White valvet showed tolerance to shoot infestation by *E. vittella*. Indo American hybrid and Koparwadi local were found resistant to fruit infestation out of 25 varieties tested in Rabi season of 1981- 82. Bhalla *et al.*, (1989) screened some okra germplasm to find out the field resistant against this borer during the Karif seasons of 1986 and 1987. Some 1000 okra germplasm were evaluated for this purpose, of which only 50 were moderately resistant and none was completely resistant.

Atwal (1976) reported that OSFB could be suppressed by clean cultivation 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. Agarwal and Gupta (1986) reported that *Earias* spp. may be controlled by the use of resistance varieties and insecticide applications integrated with the release of natural enemies followed by cultural control with regulation of fertilizer applications. 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 was a positive correlation between nitrogen uptake by the plant and *E. vittella* infestation. But there was negative correlation between potassium uptake by the plants and its infestation.

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. Gopalan *et al.*, (1974) reported that the best result can be achieved to control *E. vittella* with two applications of sevimol 1%, monocrotophos 0.1% or endosulfan 0.9% at the 45 and 60 days after sowing the crop. Mote and Pokharkar (1974) recommended that endosulfan 0.05% at 15 days intervals starting at fruit setting stage is the safest treatment to control OSFB. Venkatanarayanan *et al.*, (1974) tried different insecticides in combination with urea in controlling OSFB and obtained that urea at 2% and 3% concentration could be safely mixed with 0.07% endosulfan, 0.1% sevimol and 0.1% nuvacron without affecting their insecticidal properties. However, urea at 4 and 6% with or without insecticides scorched the leaves.

A significant reduction in *E. vittella* incidence on okra was obtained with fenvalerate, cypermethrin and deltamethrin at 50, 30 and 10 gm/ha, respectively when applied at 25 days intervals compared to those applied at 35 days intervals. However, there were no significant differences in marketable yield among the treatments applied at 25 and 35 days intervals suggesting a possibility of extending the spray interval (KrishnaKumar and Srinivasan, 1985).

Efficacy of insecticides against the pest complex of okra was studied by Mishra and Singh (1996) in Pantnager, India. They stated that fenvalerate was most effective (2.0% damage) for borer control followed by deltamethrin where the present infestation was 3-4%. Least effective insecticide was monocrotophos granule @ 1 kg a.i. /ha applied at sowing time and furrows. Sardana and Tewari (1987) reported that dipping the pupae of OSFB in diflubenzuron suspension of 125 ppm or more for 30 second resulted in pupal mortality. The effectiveness of the chemical decreased with increase of pupal age. Dhamdhere *et al*., (1988) stated that 0.15% thiodicarp was more effective than the other carbamate tested for the control of OSFB on the basis of percent fruit infestation, yield and economic considerations and was as effective as 0.03% oxydemeton methyl.

Pawar *et al*., (1988) reported that single spray of endosulfan at 500 gm/ha at interval of 14 days were the most effective for the control of *E. vitella* of okra. Chauhan (1989) recommended 2.03% endrin as early as possible in the infested crop for the control of the noctuid OSFB and to be repeated one or twice if necessary.

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 (Malik and Lal, 1989). Sarode *et al.*, (1998) in India showed that out of 13 insecticidal treatments against *E. vittella*, endosulfan at 0.06% was the most effective. Neem seed kernel extract was relatively ineffective for controlling the pest.

Application of fenvalerate at 0.015% for the control of okra fruit and shoot borer gave lowest infestation levels and highest mortality (Ratanpara and Bharodia, 1989). Chakroborti- S (2001) conducted few experiments to contain the okra fruit borer (*Earias vittella*) through biorational integrated approach during the summer in West Bengal, India. The biorational integrated approach was very effective in checking the population builds up of the borer and recorded only a low level of infestation.

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.

Panda *et al.*, (1999) reported that Sherlone 29 EC (a combination product of phosalone 24% + cypermethrin 5%) was quite effective in controlling the fruit borers of okra, *Earias fabia* (stoll) [*Earias vittella*] and *Helicoverpa armigera* (Hubner) at 1.0, 1.25, 1.5 and 1.75 L/ha, the highest dose being the best treatment. This product was superior to phosalone (Zolone 35 EC ; 2 L/ha), cypermethrin (Shakti 25 EC; 0.25 L/ha) and spark 36 EC @ 1L/ha (a combination product of triazophos 35% and deltamethrin 1%) in restricting borer infestation and increasing fruit yield.

Sarkar and Nath (1989) conducted a field trial in Tripura, India, and indicated that decamerthrin, malathion, endosulfan and carbaryl were effective to control the OSFB but fenvalerate (0.5 ml/ha and 750ml/ha) gave the greatest reduction in number of infested fruits. David and Kumaraswami (1991) stated that cypermethrin at 0.016%, deltamethrin at 0.003% or 0.002% and fenvalerate at 0.01% were the most effective treatments for the control of *Earias* spp. on okra.

Gurnam *et al.*, (1998) conducted an experiment to determine the efficacy of insecticides (endosulfan, malathion, neem seed oil, fenvalerate and *Bacillus* *thuringiensis* sub. sp. *Kurstaki*) for the control of *Earias vittella*. The results showed that the most effective level of control was achieved by adopting a spraying schedule consisting of fenvalerate 5 weeks, endosulfan 7 weeks and fenvalerate 9 weeks after crop germination.

Mathur *et al.*, (1998) reported that the combined application of monocrotophos 36 SL (1.0 litre/ha), followed by two sprays of *Bacillus thuringiensis* sub-sp. kurstaki (Btk) (Dipel- 8L, 1.0 litre/ha) + methomyl 40 sp (0.625kg/ha) produced the lowest fruit damage (4.21%) and highest fruit yield (4.07 t/ha).

Praveen *et al.*, (2001) conducted an experiment during January- March at Coimbatore, Tamil Nadu, India to evaluate the effectiveness of different biological control agents against the major pests of okra. The results revealed that release/ application of the predator, *Chrysoperla carnea* (2500 larvae ha-1 release -1) + Econeem 0.3% (0.5 L/ha) for three times at 15 day intervals starting from fruit borer infestation occurred. The percent fruit damage by *E. vittella* (9.21%) was reduced. Fruit damage in untreated control was recorded as 22.56 and 22.6%, respectively. The fruit yield (10326 kg/ha) and cost benefit ratio (CBR) (1: 2.60) was also higher when *C. carnea* and Econeem

0.3% were combined, compared with either *C. carnea* (9643 kg fruit/ha and 1: 2.39) or Econeem 0.3% (9533 kg fruit/ha and 1: 2.44) alone.

A field experiment was conducted by Patil *et al.*, (1991) in India for the control of the okra fruit and shoot borer (*E. vitalla*). They treated okra plants with cypermethrin (15 gm/ha), fenvalerate (50 gm/ ha), acephat (375gm/ha), quinaphos (250gm/ha) and endosulfan (250gm/ha). All treatments reduced pod damage but cypermethrin treated plants were least infested and gave the best yield. Treatment with Endosulfan (0.035% EC) had considerably lower fruit damage by *Earias vittella* than rest of the insecticides except endosulfan (wp 0.035%) chlorpyriphos (0.02%) and NSKS (3%) [(Neem seed kernel suspension)] were found equally effective as chlorpyriphos (0.04%) triazophos(0.04%) and quinalphos(0.025%) is giving protection to okra fruits against *E. vittella* (Patel *et al.*,1997).

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 obtained with 0.07% endosulfan (Samuthiravelu and David, 1991). Treatment with endosulfan at 500 g/ha sprayed 15 days after germination followed by 3 applications of fenvalerate at 50 g/ha 40, 55 and 70 days after germination were most cost effective is controlling borer of okra during both summer and winter (KrishnaKumar and Srinivasan, 1987). Chaudhury *et al.*, (1989) reported that if the insecticidal protection was not given the OSFB 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% endosulfan provided yield of 15.65 kg/plot with 10% fruit infestation.

Tomar (1998) carried out a field experiment in Bilaspur, India to evaluate the biopesticide, Dipel a commercial formulation of *Bacillus thuringiensis* var. *Kurstaki* at concentration 0.1 percent combined with insecticides endosulfan 35 EC (0.35%) and Dipel + fenvalerate 20EC (0.0025%) were comparability and more effective compared to their single use.

The economics of pest management of OSFB were studied by Srinivasan and Krishnakumar(1983) in Karnataka, India, for 3 growing seasons. Disulfoton granules at 1 kg ai /ha applied at the time of sowing, followed by 0.1% carbaryl sprays at 40,50 and 60 days after germination in the rainy and late summer growing seasons, or 40 and 55 days germination in the winter season, gave the maximum crop yield and net income .

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

The present study on "Infestation status and management of okra shoot and fruit borer, *Earias vittella* F." was carried out at the experimental field of the Entomology Division, Bangladesh Agricultural Research Institute (BARI) Gazipur, Bangladesh during April 2005 to July 2005. The materials and methods adopted in the study are discussed in the following sub-heading:

3.1 Location

The study area is situated at 24.09° North latitude and 90.26° East Longitudes with an elevation of 8.4 meter from the sea level.

3.2 Climates

The climatic condition of Gazipur has unimodal rainfall pattern; most of the rainfall occurs during the months of May to September. The average rainfall is usually higher than 200 mm during November to March. The warmer months are April, May and June with mean maximum temperature of 31-34°C and the cold months are November, December and January when the temperature ranges from 10-19°C.

3.3 Soil

The area belongs to the Madhupur tract (AEZ-28), clay loam in texture having low organic matter (1.12%) moderately slow permeability and deficient in nitrogen, potassium and sulphur in comparison with the standard nutrient status. The soil is acidic in nature having pH between 5.9 to 6.1.

3.4 Land preparation

A tractor drawn disc plough followed by harrowing opened the land. For ensuring good tilth, power tiller was used. Tractor drawn labeler was use to level the land. The plots were raised by 10 cm from the soil surface keeping the drain around the plots.

3.5 Fertilization and manuring

In all the studies, cow dung and other chemical fertilizers were applied as recommended by Haque (1993) and are shown in Table 1. 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, 40 days after seed sowing.

Table 1. Doses of manures and fertilizers and their methods of application used for different studies

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

3.6 Seed sowing

Seeds were sown directly in the pits. Two seeds were sown per pit. Before sowing the seed were soaked in fresh water for 24 hours. Pit to pit distance 40 cm and line to line distance 50 cm were maintained. The plots were watered just after sowing and irrigated when needed.

3.7 Cultural practices

After seed germination, a light irrigation was applied. Subsequent irrigation was done as when needed. Single healthy seedling with luxuriant growth per pit was allowed discarding others. Propping of each plant by bamboo sticks was provided to avoid their lodging. Necessary intercultural operations were done through out the cropping season for proper growth and development of the plants. Weeds and mulching were done to break the soil crust and to keep the plots free from weeds. Stagnant water was effectively drained put at the time of heavy rain.

3.8 Study on infestation status

3.8.1 Seed sowing

Okra seeds of BARI Dharos-1 were sown on third week of April 2005 following the above described methods in the chapter 3.4, 3.5, 3.6 & 3.8 at Entomology Division Experimental field, BARI, Gazipur. There were three plots (5x5 m) and each plot was considered as one treatment replicated.

3.8.2 Data collection

Infestation of okra plants by okra shoot and fruit borer were monitored during both vegetative and reproductive stages. Infested shoots from 10 randomly selected plants were counted and recorded at weekly interval after careful examination on the presence of bores and excreta at both vegetative and reproductive stage. Moreover, at reproductive stage, the infested fruits from 10 randomly selected plants were also checked for OSFB infestation and recorded at 3 days interval (during the time of harvesting). The percent infestation of shoot and fruit was calculated with the following procedures.

$$\%\ \text{Infestation of shoot} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

$$\% \text{ Infestation of fruit} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

The correlation of different weather parameter especially temperature and rainfall with the infestation of OSFB on shoot and fruit were also calculated to determine their effect on the pest population.

3.9 Varietal preference study

3.9.1 Seed sowing

Okra seeds of three variety/lines viz. Gazipur Local 1, Gazipur local 2 & BARI Dharos-1 were sown on 4^{th} week of April 2005 following the above described methods in the chapter 3.4, 3.5, 3.6 & 3.8 at Entomology Division Experimental field, BARI, Gazipur. The plot size of this study was 5x5 m. RCB design was followed in this experiment with four replications.

3.9.2 Data collection

OSFB infestations on the three varieties/lines were monitored during both vegetative and reproductive stages. Infested shoots from 10 randomly selected plants were counted and recorded at weekly interval after careful examination on the presence of bores and excreta at both vegetative and reproductive stage. Moreover, at reproductive stage, the infested fruits from

10 randomly selected plants were also checked for OSFB infestation and recorded at 3 days interval (during the time of harvesting). The percent infestation of shoot and fruit was calculated following the procedures described in the chapter 3.8.2.

3.9.3 Statistical analysis

All the data were analysed statistically followed by MSTAT programming and the mean values were judged by LSD (P>0.05).

3.10 Management with bio-rationales /chemical

Management of OSFB with different bio-rational and chemical pesticides was carried out at the experimental field of the Entomology Division, Bangladesh Agricultural Research Institute (BARI) Gazipur, Bangladesh during April-July 2005.

3.10.1 Seed sowing & Experimental design

Okra seeds of BARI Dharos-1 were sown on 4^{th} week of April 2005 following the above described methods in the chapter 3.4, 3.5, 3.6 & 3.8. The plot size of this study was 5x5 m. RCB design was followed in this experiment with four replications. There were four treatments. They were as follows:

T1 = Neem seed kernel extract @ 500 gm crushed kernel dissolved in 10 liters of water for 24 hours. The filtered water with dissolved Azadirachtin was sprayed. Spraying was started with high volume knapsack sprayer from 30 days after seed sowing (DAS) at 10 days interval. A total of 4 spraying were done.

T2 = Neem oil @ 5 ml /liter of water mixed with 1 ml trix was sprayed. Spraying of neem oil was done with high volume knapsack sprayer from 30 days after seed sowing (DAS) at 10 days interval. A total of 4 spraying were done.

T3= Spraying of Dimethoate (Tafgore 40 EC @ 2.5 ml / liter of water) was also done with high volume knapsack sprayer from 30 days after seed sowing (DAS) at 10 days interval. A total of 4 spraying were also done with chemical pesticides.

T4= Untreated control. No pesticide or bio-rationales were applied in this treatment.

3.10.2 Data collection

OSFB infestations on different management treatments were recorded during both vegetative and reproductive stages. Infested shoots from 10 randomly selected plants were counted and recorded at weekly interval after careful examination on the presence of bores and excreta at both vegetative and reproductive stage. Moreover, at reproductive stage, the infested fruits from 10 randomly selected plants were also checked for OSFB infestation and recorded at 3 days interval (during the time of harvesting). The percent infestation of shoot and fruit was calculated following the procedures described in the chapter 3.8.2.

3.10.3 Statistical analysis

All the data were analysed statistically followed by MSTAT programming and the mean value were judged by LSD ($P>0.05$).

3.11 Meteorological data

Different metrological data viz. daily maximum, minimum and average temperature, relative humidity and rainfall were recorded from the Meteorological Department situated at Bangladesh Agricultural Research Institute, Gazipur campus about 500m away from the experimental field. Weekly mean temperature and rainfall were calculated and presented in Appendix I.

Chapter 4

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

Results of different studies on infestation status and management of okra shoot and fruit borer, *Earias vittella* have been presented and discussed under the following sub-heading:

4.1 Study on infestation status

Shoot infestation started from 30 days after seed sowing (DAS) and infestation gradually increased thereafter. At 51 DAS the shoot infestation reached to the peak and 32.41% shoot infestation was recorded during that time (Fig. 1). It is also revealed from the Figure 1 that shoot infestation declined after that and became almost zero during the time of senescence of the plants (121 DAS). On the other hand fruit infestation started three weeks later than the shoot infestation. During the early weeks fruit infestation ranged from 1.93% (51 DAS) to 5.73 (86 DAS). From 93 DAS the fruit infestation increased rapidly and reached to its peak within two weeks, when 17.49% of the fruits of okra were infested by OSFB. Infestation declined thereafter and at 121 DAS it was declined to 8.57%. Shoot infestation was severe during the early part and fruit infestation during the later part of the crop cycle.

However, OSFB damaged more shoots than the fruits.

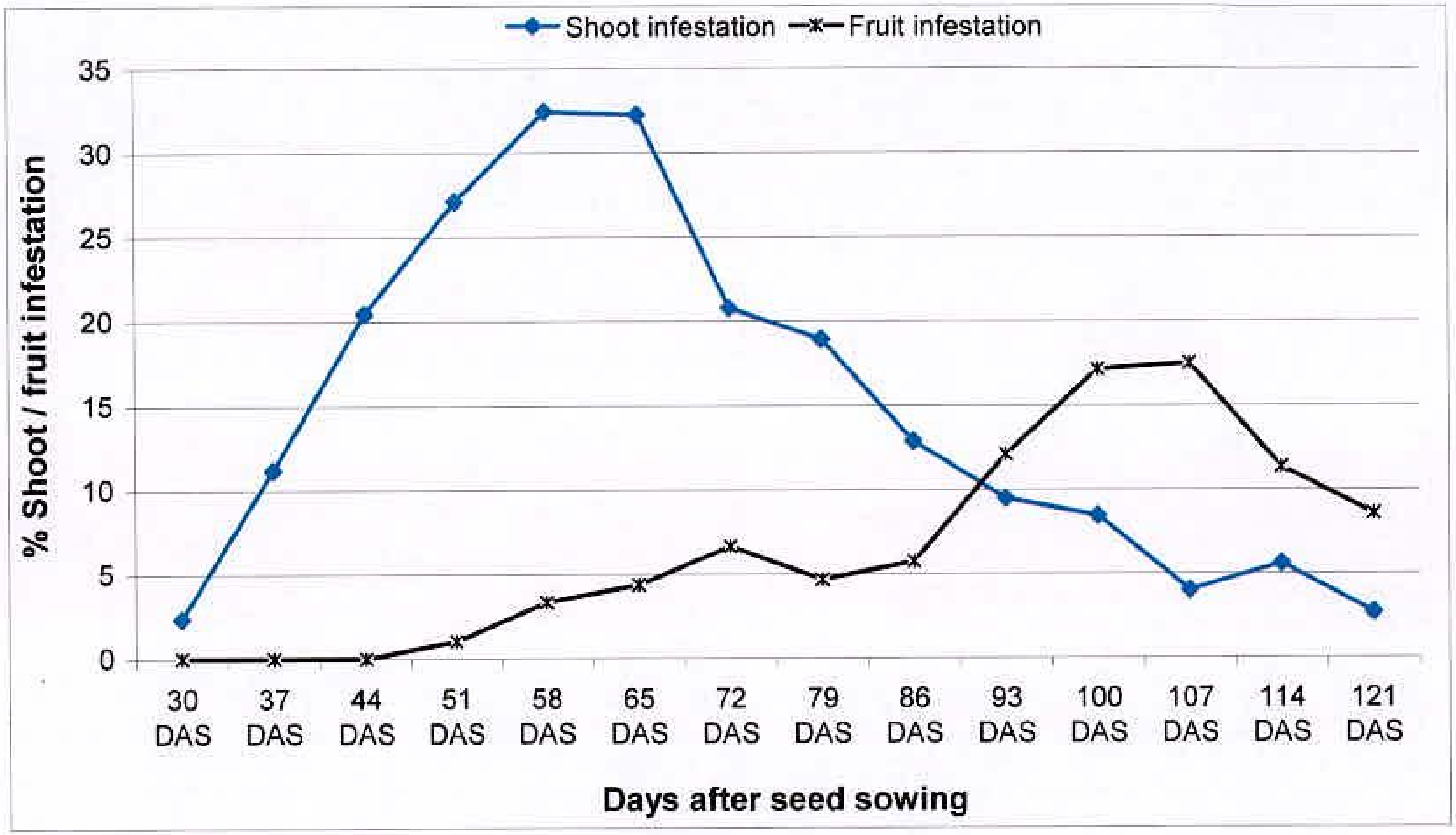

Fig. 1. Percent shoot and fruit infestation of okra plants (BARI Dheros-1) at different days after seed sowing at Entomology Division Experimental field, BARI, Gazipur during 2005 cropping season

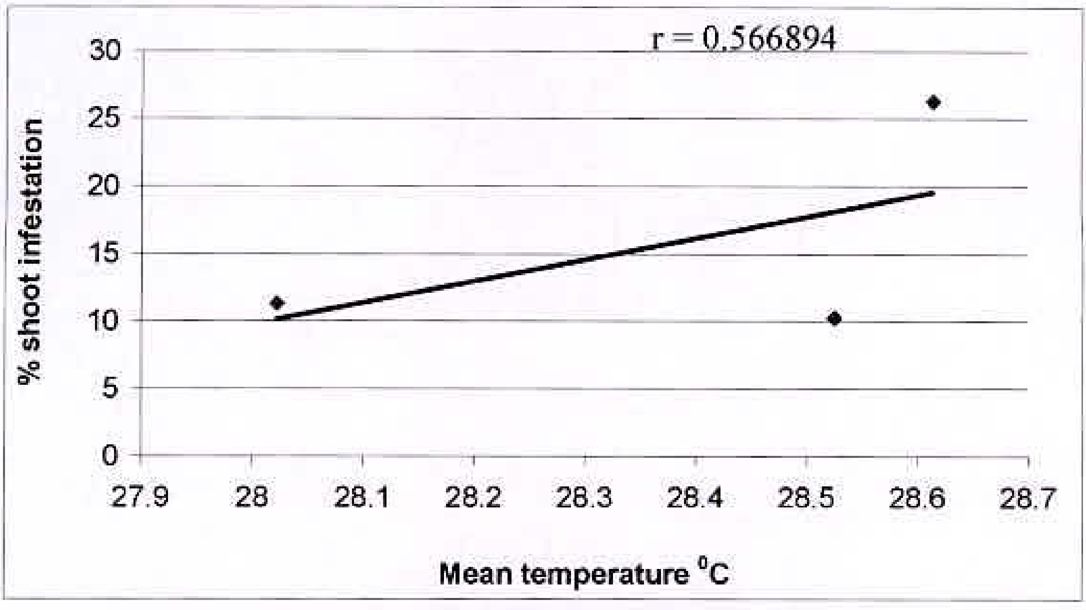

Fig. 2. Correlation of the infestation status of shoot infestation by OSFB with the corresponding temperature

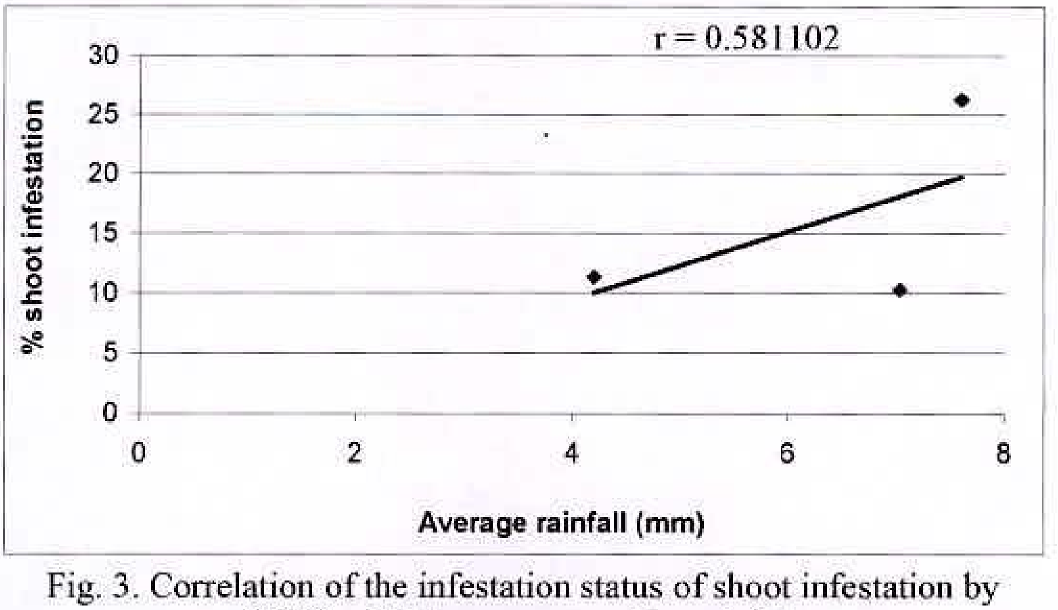

Fig. 3. Correlation of the infestation status of shoot infestation by OSFB with the corresponding rainfall

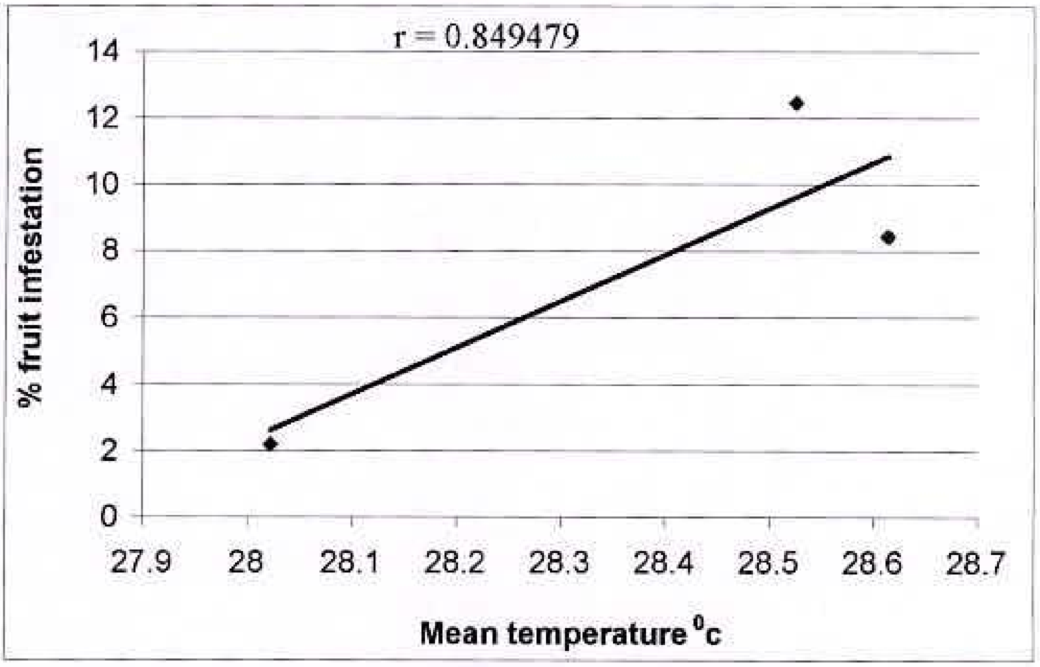

Fig. 4. Correlation of the infestation status of fruit infestation by OSFB with the corresponding temperature

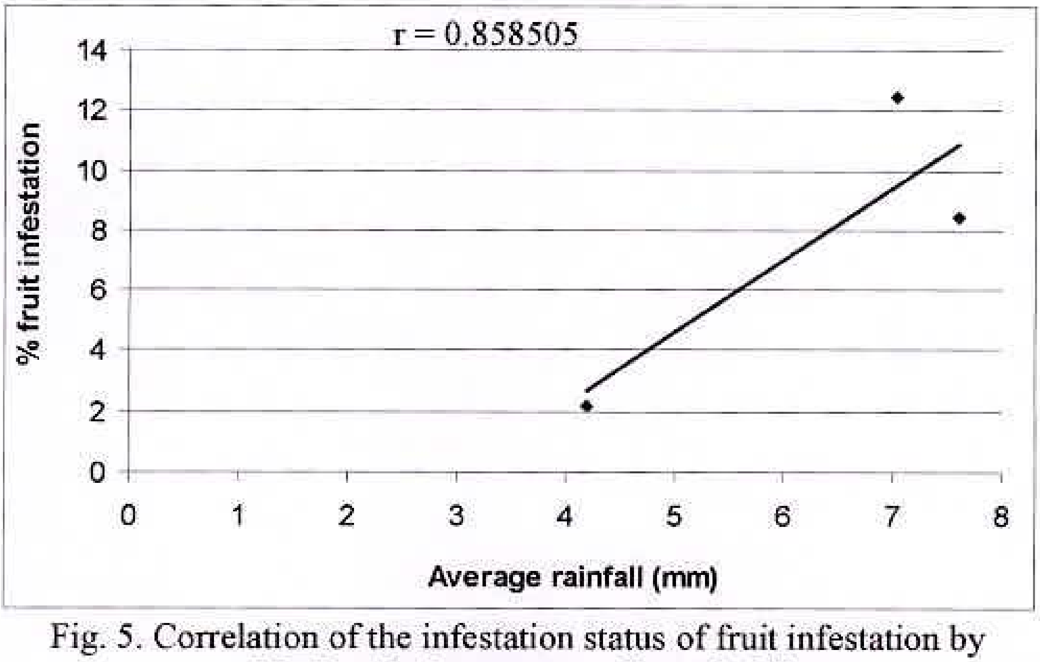

Fig. 5. Correlation of the infestation status of fruit infestation by OSFB with the corresponding rainfall

Both shoot or fruit infestations of okra by OSFB were positively correlated with temperature and rainfall. Figure 2 and Figure 3 shows the correlation of shoot infestation of okra with that of temperature and rainfall. In both the cases positive correlations were observed. Same results were also observed in case of fruit infestation by OSFB (Fig. 4 and Fig. 5). This indicates that okra shoot and fruit borer like hot and humid climate for its growth and development.

4.2 Varietal preference study

Among the three varieties/lines tested against OSFB, BARI Dherosh 1, consistently and significantly showed higher shoot infestation than the other two okra lines, Gazipur local 1 and Gazipur local 2 in all the observations (Table 2). Mean percent shoot infestation in BARI Dheros 1 was 29.81 while that was 14.93% in Gazipur local 1 and 17.29% in Gazipur local 2. Same trend of results were also observed in case of fruit infestation by OSFB (Table 3). Higher numbers of fruits of BARI Dherosh 1 were consistently and significantly infested with okra shoot and fruit borer. Mean percent fruit infestation in BARI Dheros 1 was 12.15 while that was 6.92% in Gazipur local 1 and 8.23% in Gazipur local 2. So, it is revealed from this study that BARI Dherosh 1, which is a high yielding and virus free okra variety is susceptibleto okra shoot and fruit borer. On the other hand some local germplasms like Gazipur Local 1 or Gazipur Local 2 have the resistant potentiality against OSFB.

Table 2. Mean percent shoot infestation by OSFB on different okra varieties /lines recorded at Entomology Experimental field, BARI, Gazipur during 2005 cropping season

Variety / Lines	Percent shoot infestation at different date of observations								Overall Mean
	5/26/2005	6/2/2005	6/9/2005	6/16/2005	6/23/2005	6/30/2005	7/7/2005	7/14/2005	
Gazipur Local 1	0.00	12.91	17.67	15.41	23.67	23.67	14.01	12.15	14.93 c
Gazipur Local 2	1.25	3.74	20.41	22.17	24.83	32.12	17.08	16.77	17.29 bc
BARI Dharos 1	5.75	16.83	23.33	43.75	48.75	40.91	31.25	27.88	29.81 a

Means followed by the same letter are not significantly different (P>0.05, LSD test)

Table 3. Mean percent fruit infestation by OSFB on different okra varieties /lines recorded at Entomology Experimental field, BARI, Gazipur during 2005 cropping season

Variety / Lines	Percent fruit infestation at different date of observations											Overall Mean
	6/4/05	6/7/05	6/10/05	6/13/05	6/16/05	6/19/05	6/22/05	6/25/05	6/28/05	7/1/05	7/4/05	
Gazipur Local 1	0.00	2.01	4.35	6.64	4.66	5.73	8.96	12.09	15.43	8.67	7.65	6.92 c
Gazipur Local 2	1.03	3.35	5.36	7.37	6.34	8.35	7.56	14.26	16.45	11.43	8.96	8.23 bc
BARI Dharos 1	2.05	4.54	6.35	8.34	7.98	11.68	14.36	17.13	23.49	21.76	15.97	12.15 a

Means followed by the same letter are not significantly different (P>0.05, LSD test)

4.3 Management with bio-rationales /chemical

Study on the okra shoot and fruit borer management was done at Entomology Division experimental field, BARI, Gazipur during 2005 cropping season. Three treatments, viz. neem seed kernel extract (500 gm crushed kernel dissolved in 10 liters of water for 24 hours. The filtered water with dissolved Azadirachtin was sprayed), neem oil (5 ml /liter of water mixed with 1 ml trix was sprayed), Dimethoate (Tafgore 40 EC @ 2.5 ml / liter of water) were evaluated for OSFB control along with a untreated control.

It is revealed from the Table 4 that significantly lowest shoot infestations were observed in the neem oil and neem seed kernel extract treatments. Shoot infestation from 40 days after seed sowing to 89 DAS was significantly less in those two treatments than the diamethoate treated plots as well as untreated plots. During the initial periods (40 DAS to 54 DAS) no significant difference in shoot infestation by OSFB was observed between the diamethoate (Tafgor 40 EC) treated plots and that of untreated ones. However, after 54 DAS shoot infestation in the dimethoate treated plots became significantly lower than the untreated ones. Highest shoot infestations were found in untreated plots. The overall mean shoot infestations were 7.85%, 6.95%, 13.62% and 21.76% in neem seed kernel extract, neem oil, dimethoate and untreated control treated plots, respectively. It is also revealed from the Table 5 that average reduction of 63.92%, 68.06% and 37.40% shoot infestations were happened over untreated control due to the intervention of neem seed kernel extract, neem oil and Tafgor 40 EC treatments, respectively.

Fruit infestation almost followed the same trends of result due to the effect of those treatments. However, chemical pesticide, dimethoate performed better in the reduction of fruit infestation than shoot infestation. It is revealed from the Table 6 that significantly lowest fruit infestations were observed in the neem oil and neem seed kernel extract and dimethoate treatments. Fruit infestation from 47 days after seed sowing to 89 DAS was significantly less in those three treatments than untreated plots. Highest fruit infestations were recorded in untreated plots. The overall mean fruit infestations were 3.49%, 3.11%, 4.18% and 8.93% in neem seed kernel extract, neem oil, dimethoate and untreated control treated plots, respectively. It is also revealed from the Table 7 that average reduction of 60.94%, 65.21% and 53.16% fruit infestation were happened over untreated control due to the effect of neem seed kernel extract, neem oil and Tafgor 40 EC treatments, respectively.

Table 4. Effect of different management treatments on the shoot infestation by OSFB at Entomology Division experimental field, BARI, Gazipur during May-July, 2005

Treatment	Percent shoot infestation								Mean
	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	
Neem kernel extract	3.08 a	3.77 a	8.54 a	10.25 a	6.87 a	12.34 a	8.34 a	9.64 a	7.85 a
Neem oil	2.68 a	3.55 a	6.79 a	8.69 a	7.34 a	9.38 a	8.37 a	8.69 a	6.95 a
Tafgor 40 EC	4.11 a	6.88 b	11.11 b	18.33 b	16.33 b	18.33 b	17.65 b	16.24 b	13.62 b
Untreated control	3.88 a	7.89 b	13.22 b	27.78 c	31.24 c	36.79 c	31.56 c	29.35 c	21.76 c

Means followed by the same letter are not significantly different (P>0.05, LSD test)

Table 5. Percent reduction / increase of the shoot infestation by OSFB over untreated control due to the effect of different treatments in okra at Entomology Division experimental field, BARI, Gazipur during May-July, 2005.

Treatments	Percent reduction of shoot infestation over untreated control								Mean
	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	
Neem kernel extract	20.62	52.22	35.40	63.11	78.01	66.45	73.57	67.15	63.92
Neem oil	30.92	55.01	48.64	68.71	76.51	74.51	73.47	70.39	68.06
Tafgor 40 EC	-05.92	12.81	15.96	34.01	47.72	50.17	44.07	44.67	37.40
Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6. Effect of different management treatments on the fruit infestation by OSFB at Entomology Division experimental field, BARI, Gazipur during May-July, 2005

Treatment	Percent fruit infestation								Mean
	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	
Neem kernel extract	1.87 a	2.34 a	2.46 a	3.54 a	3.78 a	4.68 a	4.25 a	4.98 a	3.49 a
Neem oil	2.31 a	2.64 a	2.25 a	2.98 a	3.32 a	3.66 a	3.58 a	4.12 a	3.11 a
Tafgor 40 EC	1.24 a	2.39 a	3.44 a	3.97 ab	4.68 ab	4.52 a	5.98 a	7.24 ab	4.18 a
Untreated control	3.35 a	4.35 b	6.64 b	4.66 b	5.73 b	12.09 b	17.13 b	17.49 b	8.93 b

Means followed by the same letter are not significantly different (P>0.05, LSD test)

Table 7. Percent reduction / increase of the fruit infestation by OSFB over untreated control due to the effect of different treatments in okra at Entomology Division experimental field, BARI, Gazipur during May-July, 2005.

Treatment	Percent reduction of fruit infestation over untreated control								Mean
	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	
Neem kernel extract	44.17	46.21	62.95	24.03	34.03	61.29	75.18	71.52	60.94
Neem oil	31.04	39.31	66.11	36.05	42.06	69.73	79.11	76.44	65.21
Tafgor 40 EC	62.98	45.06	48.19	14.81	18.32	62.61	65.09	58.61	53.16
Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

As okra is quick harvestable vegetable so it is not wise to spray at every one week interval. On the other hand okra matures very quickly, so it must be ready for harvest within the retention period of toxic pesticide. In this study it was revealed that neem seed kernel extract and neem oil spray at 10 days interval can control the pest very much effectively. So it will be better to use those environmental friendly bio-pesticides for the management of okra shoot and fruit borer.

Chapter 5

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

Several experiments have been undertaken to determine infestation status, varietal preference of okra shoot and fruit borer, *Earias vittella* and also to develop their management tactics in the Entomology Division Experimental field, BARI, Gazipur during 2005 cropping season.

Shoot infestation started from 30 days after seed sowing (DAS) and infestation gradually increased thereafter. At 51 DAS the shoot infestation reached to the peak and 32.41% shoot infestation was recorded during that time. Shoot infestation declined after that and became almost zero during the time of senescence of the plants (121 DAS). On the other hand fruit infestation started three weeks later than the shoot infestation. During the early weeks fruit infestation ranged from 1.93% (51 DAS) to 5.73 (86 DAS). From 93 DAS the fruit infestation increased rapidly and reached to its peak within two weeks, when 17.49% of the fruits of okra were infested by OSFB. Infestation declined thereafter and at 121 DAS it was declined to 8.57%. Shoot infestation was severe during the early part and fruit infestation during the later part of the crop cycle.

Both shoot or fruit infestations of okra by OSFB were positively correlated with temperature and rainfall. This indicates that okra shoot and fruit borer like hot and humid climate for its growth and development.

Among the three varieties/lines tested against OSFB, BARI Dherosh 1, consistently and significantly showed higher shoot infestation than the other two okra lines, Gazipur local 1 and Gazipur local 2 in all the observations. Mean percent shoot infestation in BARI Dheros 1 was 29.81 while that was 14.93% in Gazipur local 1 and 17.29% in Gazipur local 2. Same trend of results were also observed in case of fruit infestation by OSFB. Mean percent fruit infestation in BARI Dherosh 1 was 12.15 while that was 6.92% in Gazipur local 1 and 8.23% in Gazipur local 2. So, it is revealed from this study that BARI Dharosh 1is susceptible to okra shoot and fruit borer. On the other hand some local germplasms have the resistant potentiality against OSFB.

Among the management treatments significantly lowest shoot infestations were observed in the neem oil and neem seed kernel extract treatments. Shoot infestation from 40 days after seed sowing to 89 DAS was significantly less in those two treatments than the diamethoate treated plots as well as untreated plots. During the initial periods (40 DAS to 54 DAS) no significant difference in shoot infestation by OSFB was recorded between the diamethoate (Tafgor 40 EC) treated plots and that of untreated ones. However, after 54 DAS shoot infestation in the dimethoate treated plots became significantly lower than the untreated ones. Highest shoot infestations were recorded in untreated plots. The overall mean shoot infestations were 7.85%, 6.95%, 13.62% and 21.76% in neem seed kernel extract, neem oil, dimethoate and untreated control treated plots, respectively. Average reduction of 63.92%, 68.06% and 37.40% shoot infestations were happened over untreated control due to the intervention of neem seed kernel extract, neem oil and Tafgor 40 EC treatments, respectively.

Fruit infestation almost followed the same trends of result due to the effect of those treatments. However chemical pesticide, dimethoate performed better in the reduction of fruit infestation than shoot infestation. Significantly lowest fruit infestations were observed in the neem oil and neem seed kernel extract and dimethoate treatments. Highest fruit infestations were recorded in untreated plots. Average reduction of 60.94%, 65.21% and 53.16% fruit infestation were happened over untreated control due to the effect of neem seed kernel extract, neem oil and Tafgor 40 EC treatments, respectively. As okra is quick harvestable vegetable so it is not wise to spray toxic pesticide at every one week interval. This study revealed that neem seed kernel extract and neem oil spray at 10 days interval can control the pest very much effectively. So it will be better to use those environmental friendly bio-pesticides for the management of okra shoot and fruit borer.

References

CHAPTER 6

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Appendix 1.Weekly mean daily maximum and minimum temperature (^{0} C) and rainfall (mm) during the period of May '05 to July '05 recorded at meteorological station, BARI (Bangladesh Agricultural Research Institute)

Month	Week	Mean Temperature (^{0} C)		Rain fall(mm)
		Maximum	Minimum	
May	1st	32.20	18.30	2.86
	2nd	33.59	23.56	4.57
	3rd	32.13	23.30	3.57
	4th	32.47	24.01	7.86
	5th	35.20	27.70	0.00
June	1st	35.20	26.53	2.00
	2nd	35.19	27.34	0.43
	3rd	30.96	26.51	4.29
	4th	31.53	26.34	5.57
	5th	29.05	25.60	2.00
July	1st	30.63	25.33	20.29
	2nd	30.81	26.22	18.43
	3rd	31.71	25.84	8.57
	4th	33.37	26.73	12.43
	5th	33.50	27.37	0.00