"STUDIES ON INSECT PESTS OF OKRA, *Abelmoschus esculentus(L)* MOENCH IN CHHATTISGARH WITH SPECIAL REFERENCE TO SHOOT AND FRUIT BORER, Ear/as *vittella* (Fab.)"

Thesis

Submitted to the

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by

PIYUSH KANT NETAM

IN THE PARTIAL FULFILMENT OF THE

REQUIREMENTS FOR THE

DEGREE OF

Master of **Science**

in

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Roll No. 2249 **ID No. PG/AG/2001/21**

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Dedicated to

My beloved

parents

Late Shri N. R. Netam

&

Smt. Urmila Netam

& Teacher

Dr. R. N. Ganguli

CERTIFICATE - I

This is to certify that the thesis entitled **"STUDIES ON INSECT PESTS OF OKRA, *Abelmoschus esculentus(L)* MOENCH IN CHHATTISGARH WITH SPECIAL REFERENCE TO SHOOT AND FRUIT BORER, Earlas *vittella* (Fab.)"** submitted in partial fulfilment of the requirements for the degree of **"MASTER OF SCIENCE IN AGRICULTURE"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **SHRI PIYUSH KANT NETAM** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

Chairman

Date Advisory Committee

THESIS APPROVED BY

STUDENTS ADVISORY COMMITTEE

Chairman : Dr. R. N.Ganguli

Member : Dr. D. J. Pophaly

Member : Dr. V. K. Dubey

Member : Dr. N. Mehta

Member : Dr. (Smt.) G.Chandrakar

CERTIFICATE - II

This is to certify that the thesis entitled "STUDIES ON INSECT PESTS OF OKRA, *Abelmoschus esculentus(L)* MOENCH IN CHHATTISGARH WITH SPECIAL REFERENCE TO SHOOT AND FRUIT BORER, Ear*l*as *vittella* (Fab.)" submitted by Shri PIYUSH KANT NETAM to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfilment of the requirements for the degree of **M.Sc.(Ag.)** in the **DEPARTMENT OF ENTOMOLOGY** has been approved by the Student's Advisory Committee after oral examination in collaboration with the external examiner.

Date : 29.10. **EXTERNAL EXAMINER**

MAJOR ADVISOR

HEAD OF THE DEPARTMENT

DIRECTOR OF INSTRUCTIONS

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Here space is too less to mention the name of my dear and near. Afer completing my work in future whenever. I will open

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(Piyush Kant Netam)

Department of Entomology

College of Agril., Raipur

Date :

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

CHAPTER – I

INTRODUCTION

Okra, *Abelmoschus esculentus* (L) Moench is an important vegetable crop, grown in tropical and sub tropical parts of the world. India is the world's second largest producer of vegetables next to China. The total production of vegetable in India is about 98.50 million tonnes and the total area is about 6.2 million hectare (Anonymous 2002).

The area under vegetables in Chhattisgarh is about 1,22,993 ha and the total production is about 15.007 (In lakh Mt). The area under Okra in Chhattisgarh is about 9200 ha and production is about 0.552 (In lakh Ml) (Anonymous 2002)

The area under Okra crop indicates that this crop is predominant vegetable crop in this Chhattisgarh state. In India, the present level of vegetable production can provide only 155 gm/day/capita as against recommended requirement of 285 gm/day/capita. (Anonymous 2001). The country has to double the production of vegetables to provide the minimum recommended per capita quantity of vegetables.

Okra belongs to family Malvaceae and it has multipurpose uses. Its fruit are consumed as green vegetable and mucilaginous extracts of green stem and roots are used for clarifying sugar cane juice in "Gur" manufacturing in India.

Martin (1982) has reported that its roasted and grinded seeds can used as a substitute for coffee.

Okra crop is usually heavily infested by various insects pests, which affect the crop both, quantitatively and qualitatively. In early stage of its growth considerable damage is caused by jassid, *Amrasca biguttula biguttula* resulting in discolouration, curling and deformation of leaves and deterioration of yield quantity and quality.

Rawat and Sahu (1973) estimated 22.6 per cent losses on account of jassids. In later stage Shoot and fruit borer [*Earias vittella* and *E.insulana*] causes considerable damage to okra shootsin early stage and later on to fruits-

There is a long list of insect pestson okra crop. Ewete (1983) reported 72 insectson okra in Nigeria.

Dhamdhere *et.al*, (1984) reported *Amrasca biguttulla biguttula, E. vittella, Melanagromyza hibisci*, *Aphis gossypii, Bemisia tabaci*, *Nezara viridula*, *Tetranychus telarius* Auct. *Dysderus koenigii*, *Mylabrispustaulata*, *Anomis flava, Myllocerus undecimpustulatus*, *Var Maculosus* and *Sylepta derogata*, on okra crop, in Gwalior (M.P.) Among these insect pests, shoot and fruit borer, *Earias vittella* (Fab.) is the most destructive pest causing considerable damage to okra crop in all stage of its growth.

Kumar and Urs (1988) observed about 8.4 to 53.8 per cent fruit damage by *Earias vittella.*

Shrinivasan and Gowder (1960) reported that *E.vittella* caused 40-50 per cent damage to okra crop.

Krishnaiah (1980) observed about 35 per cent damage of fruits by this pest, during summer season. More severe damage has been reported by the workers like Patel (1985) who stated 12.09 and 40.37 per cent damage in okra by *E.vittella* during mansoon and summer seasons respectively.

Dubey and Ganguli (1998) observed 58.90 per cent avoidable fruit losses by shoot and fruit borer, *Earias vitlella* (Fab.) on okra crop. *Earias vittella* is not only a serious pest of cotton and okra but it also causes considerable damage to other malvaceous plants (Fletcher, 1917, Cherioan and Kylasam, 1947 and Khan and Rao, 1960). Mehta and Saxena (1973) observed that okra is a belter food for ils growth and development than cotton.

Studies on the varietal resistance, biology and behaviour of the pest are very important to formulate its management strategies. Most of the work in biology and bionomics *of Earias vittella* (Fab) was on Cotton (Fletcher and Mishra, 1920, Cherian and Kylasam, 1946, Khan and Rao, 1960, and Singh and Bichoo 1989) very little information is available on its biology and bionomics on Okra.

Keeping in view the above points, the present investigation was under taken to study the varietal resistance, pest succession, population dynamics and biology of *Earias vittella* (Fab.) Okra in kharif and Rabi seasons 2002-03 at Horticulture field, College of Agriculture, Raipur (C.G.)

The present study was conducted with the following objectives : -

(1) To study the insect-pest succession in okra.

(2) Biology of shoot and fruit borer, *Earias vittella* (Fab) on okra.

(3) Population dynamics/ seasonal incidence of insect pests of okra.

Review of Literature

CHAPTER – II

REVIEW OF LITERATURE

Several workers have attempted from time to time, to study the various aspects on insect pest of okra. The available literature pertaining to various aspects of present investigation has been reviewed and grouped according to the objectives.

2.1 Insect pest Succession and correlation with weather parameters:

Ewete (1983) reported seventy two insects on okra in Nigeria.

Dhamdhere *et al.* (1984) observed the arthropod pests of okra during the kharif season of 1980 and summer 1981 at Gwalior, M.P. The Cicadellid. *Amrasca biguttula biguttula* remained active in both the seasons. Low humidity in 1980 appeared to be responsible for population build-up of shoot and fruit infestation by *Earias vittella* which was 5.5 to 23.9 and 25.93 to 40.91 per cent in kharifand summer season respectively in 1980 and 4.65 to 17.15 and 17.5 to 16.62 per cent in 1981.Temperature and humidity had no apparent effect in the activity of the pest in 1980, but in 1981 the activity increased with increased humidity. Infestation by *Melanagromyza hibisci* in 1980 and 1981 was 2.56 to 22.91 and 1.27 to 16.31 per cent respectively. Other pest recorded were *Aphis gossypii. Bemisia tabaci, Negara viridula, Tetranychus telarius* auct. (*T.urticae), Dysdercus koenigii, Mylabris pastulata Anomis flava, Myllocerus undercimpustulatus* var. *maculosus* and *Sylepta derogata.*

Dhawan and Sidhu (1984) observed the incidence of *Earias* spp. on okra in Punjab, India, during 1974 - 77. The maximum damage to shoots (1.7%) and flowers (1.5%) was in mid August. In India the spring crop, showed maximum damage to fruits (33.04%) and larval population (1.4/plants) was observed in late July. The population of *Earias* spp. increased slowly up to mid September and rapidly there after. Heavy rainfall adversely affected population build up of *E. vittella* being most abundant, while *E. cupreoviridis* was a new record for this part of the country.

Hall (1984) reported red banded blister beetles, *Mylabris designater* var. *Hacolyssa rochebrune* (Coleoptera : Meloidae) as a pest of a variety of crops, particularly okra, in the central and western provinces of Sudan.

Krishna Kumar and Srinivasan (1985) recorded high incidence (40-60%) of stem fly *Melangromyza hibisci* on winter sown okra in Karnataka (India).

Anene (1987) reported that flea beetle, *Podagrica* sp. on okra in Nigeria. The seed yield of the okra cultivar white velvet in Nigeria was reduced by 45.6 per cent and that of Jokeso by 26.7 per cent when infested with the Chrysomelid, *Podagrica* sp.

Kakar and Dogra (1988) reported the insect pest complex of okra in H.P., India in July 1985. The most important pest were the Cicadellid, *Amrasca biguttula biguttula* and the Meloid *Mylabris pastulata*.

Kumar and Urs (1988) recorded the seasonal incidence of *Earias vittella* on okra in Karnataka, India. in 1983-85. They observed the infestation on shoot and fruits started in the 2nd and 6th weeks after germination, respectively.

Oops sown in any month had infested shoots from the 3rd to 5th weeks in both year of the study. The infestation level on fruits varied from 8.4 to 33.8 and 9.2 to 73.2 per cent in different weeks during 1983-84 and 1984-85, respectively. The crop suffered heavily in the 10th week after sowing in 1984-85. Infestation was more severe in crop sown in warmer months than in those sown in rainy or cooler months. There was s significant positive correlation between the incidence of the pest and prevailing temperature. Relative humidity was found to be negatively correlated with pest incidence, whereas rainfall did not show any correlation.

Chaudhary and Dadheech (1989) observed the occurrence and economic importance of insects pest on okra in Rajasthan, India. The summer crop was attacked by *Aphis gossypii* (with a peak of 2.89 individuals / leaf), the Cicadellid, *Amrasca biguttula biguttula* (4.78 / leaf), the aleyrodid, *Bemisia tabaci* (0.78 / leaf) and the Noctuid, *Eariaxfabia (E. vittella)* (57.5% infested fruits).

Singh and Bichoo (1989) observed the injuriousness *of Earias fabia (E. vittella)* on okra in the laboratory and field in Madhya Pradesh, India. The first symptoms of attack were visible when the crop was 3 week old and the larvae bore into the shoots. Under severe attack, the top leaves wilted and the whole apex of the plant drooped down. As soon as fruiting began, the larvae migrated to the flowers buds, small fruits and even mature pods causing reduction in yield.

Mahmood *et al*. (1990) reported no significant relationship between jassids population and relative humidity.

Lal *et al.* (1990) reported that a high relative humidity (>78%) drastically reduced the jassid population on the different varieties of Okra.

Tripathi and Singh (1990a) found okra to be the most suitable food plant in terms of development, growth and reproduction of *E. vittella.*

Nasu and Yasudu (1993) observed *Crocidosena plebejana* (Lcpidoptera : Tortricidae) to be newly record from Ishigaki Island (Okinawa, Prefecture, Japan), where its larva is injurious to commercial okra fruits.

Srinivasan (1993) reported shoot and fruit borer, *(E. vittella* Fab. and *E. insulana* Boisd), leaf hopper *(Amrasca biguttula biguttula* Ishrda), okra stem fly. (*Melonagromyza hibisci* Spencer), mites (*Tetranychus neocaledonicus* Andre) and *(T. cinnabarinces* Boisd). Ants *(Monomosium* sp.) white fly *(Bemisia tabaci* Genn). Aphid *(Aphis gossypii* Glower), Blister beetles (*Mylabris pastulata*) and few species of ash weevils (*Myllocerus maculosus* Deb, *M. variegatus* Boheman and *M. viridanus*) as pest on okra.

Bhagat (1996) observed twelve insects infestation on okra, i.e. cotton leaf miner *(Acrocercrops bifasciata Wlsm*), onion thrips (*Thrips tabaci* Lind) jassid *(Amrasca biguttula biguttula*), shoot and fruits borer *(Earias vittella* Fab.), aphid *(Aphis gossypii* Glover), flea beetle *(Podagrica* sp.), white fly *(Bemisia tabaci* Genn.), semilooper (*Anomi flava*), leaf folder *(Sylepta derogeta*).

Red cotton bug *(Dysdercus koenigii*) gram pod borer (*Heliothis armigera* Hubned), green stink bug *(Nezara viridula*) were observed during summer season of 1996 at Raipur.

2.2 Biology of Earias vitella (Fab.) on okra :

2.2.1 Host plants

This pest was reported to cause serious damage on cotton in Australia (Frrogatt 1920; Donald 1940; Tasi and Yu. 1962) and China (Chang *el al*., 1975, and Yu and Li, 1966). This pest was also observed on *Hibiscus esculentus* in Egypt (Dadgeon 1916), Peradengya (Austin, 1926) and Philipines (Wood worth 1922).

Monteil (1924) reported it from Africa and in Irag by Walker (1953) who also observed this pest on hollyhock and *Abutition avieennae*. Stock (1925-26) reported that, this pest occurs extensively on *Abutition indica* and *Hibiscus panduriformis* on which it persists through out the year.

Chao *el al*. (1965) stated that this pest was noticed feeding on *Malva verticullata* and *Althea rosea* in China.

2.2.2 Nature and extent of damage :

Burt (1916) stated that in the United Province, bhindi was attacked by this insect in much greater extent than cotton. Jhaveri (1921) observed in Gujrat, that 50 per cent of the young cotton plants were bored .

Fletcher and Mishra (1920) reported that the young larvae bore into the buds, bolls and top shoots of cotton plants. According to Jhaveri (1921) Cotton crop is attacked in all stages and particularly damaged by boring into young shoots in seedling stage and later on bore in to young buds, floweiy and small bolls causing

shedding of buds and flowers. Woodworth (1922) observed that the caterpillars enter okra pods at the tip or from sides and feed on seeds.

Tryon (1923) reported that the caterpillars feed on the pith of young green wood, especially at the base of shoots of the cotton plants and the second generation mines in to the developing bolls, penetrate the seeds and eat through the developing lint.

Richard (1924) also observed that the larvae first attack the young seedling than the flowers, buds, young bolls and finally the larvae of later generations eat their way into well developed bolls, devour the seeds and thus destroy the lint and thereby the yield and quality of cotton in deteriorated.

Ahmad and Ullah (1938) found *Earias vittella* as a serious pest in Madhya Pradesh, Bombay, Mysore and Madras with moderate climate, whereas *Earias insulana* was found in North West India with extreme climatic conditions.

Butac (1939) in Philippines reported that the larvae bore into the stems and branches of young plants of cotton from the buds, moving from shoot to shoot, but preferred flower buds, flowers or bolls when available. They hollowed out the buds, fed only on the anthers in open flowers, the seeds in the bolls and incidentally damage the lint.

Ankersmit (1951) in Java described the larva entering into the shoots, buds, flowers, bolls and stem of cotton plants. Yazdani (1971) reported that the spotted boll worm, *Earias fabia* continuously breed in the field through out the year on cotton, okra, holly hock and *Hibiscus* spp. caused considerable economic

losses to okra and cotton every year. Krishnaiah *el al.* (1996) reported that the pest cause 49-74 per cent damage to marketable fruits of okra.

2.2.3 **Life history :**

Dadgeon (1916) in Egypt stated that the egg stage of *E. fabia* lasts for 3-4 days, larval stage for 14 days, pupal and adult periods for more than a month in summer and in winter egg period was from 10-12 days.

Fletcher (1917) stated that during July to middle of October the pest *E. fabia* was predominant in the field but the population reduced to the end of January at Pusa.

Fletcher and Mishra (1920) worked out the life history of *E. fabia* under Pusa conditions. Life cycle of the pest lasted form 21 to 32 days. The female moth flew after dusk and oviposited on the flowers, leaves, buds, tender top leaves, capsules and flower bracts of cotton. Both larvae and adults were present throughout the year and there was no trace of hibernation, though activity was considerably reduced during the winter months. Oviposition began with the warmer temperature. Egg and larval period lasted for about 3, 9 to 20 days respectively.

Hussain (1923) reported that the larvae of the pest (*E. fahici)* were collected on holly hock in July, on bhindi from April to June and on cotton buds, flower during September in Punjab.

Stock (1925-26) reported that the adult moth of *Earias fabia* breeds throughout the year and the total life cycle occupies about 4 weeks in Rangoon.

Butac (1939) reported in Phillipines that the eggs *E. fabia* were laid singly on or near the terminal buds or on flowers or bolls, at night. The egg, larval and pupal stage were completed in 2 to 4, 11 to 17 and 8 to 1 I days, respectively. The adult lived upto 4 weeks. Pupation took place in cocoons attached to the petioles and branches of the plant or to the bracts of the bolls.

Babbington and Mckinstry (1944) observed that in Tanganyikal the pest was present throughout the season on cotton plants, some times considerably numerous. Mekinday (1957) stated that the attack of *Earias fabia* (stall) on cotton tend to increases at the end of the season.

Haroon Khan *el al.* (1946) described that this pest (*Earias fabia)* was very common on bhindi during July to October when pods were plentiful on the plants and might attack cotton when population have build up.

Cherian and Kylasam (1947) noticed high level population from middle of May to July with heavy shedding of bolls and buds in South India. The egg, larval, prepupal and pupal stages lasted 2.5 to 3, 10-12, 1-5 and 7-10 days, respectively. Adults were found to live for upto 15 days and deposited upto 385 eggs all over the plant. Female predominated slightly over males. The months were not attracted to bright light or the usual chemical attractants but were slightly attracted to sesamum oil cake when it was soaked in water or exposed in shallow trays in cotton fields.

Ankersmit (1951) studied its life history in Java on cotton. The eggs hatched in 3 to 4 days. They become full fed in 16 to 17 days in shoots, 10 days in flowers and about 12 days in bolls. Pupation took place on the plant and the pupal

stage lasted form 8 to 9 days. The adult lived from 8 to 23 days and upto 357 eggs were deposited per female.

Pant and Gupta (1959) described a method for the rearing of spotted bollworm, *Earias* spp. By this technique 33-48 per cent normal adults can be obtained from the newly hatched larvae in the laboratory.

Pant (1960) studied the bionomics of the *Earias* spp. in laboratory and as well as in field in cages at Kanpur. According to him after a preoviposition period of 2 to 4 days, the eggs were laid singly at night on the lower surface of the leaves. Egg hatched in 3 to 4 days in January to February and the larvae pupated on plants but these in soil were estimated to number 9680 per acre. The pupal stages was from 4 to 15 days with an average of 28 in November to December. The adult lived for 8 to 10 days in September to October and for 25-28 days in January and February. Female survived longer than males. This pest passed through 6 to 8 generation in a year and hibernated as full fed larvae.

Tasi and Yu (1962) made laboratory and field observations on the life history of the pest in Formasa where its out break occurred from July to December and when cotton was sown in June, it was severely infested from September to December. Infestation was continuous when cotton was grown through out the year. The egg, larval, pupal stages lasted for 3 to 6, 10 to 28, 5 to 25 days respectively, the periods were even longer when the temperature dropped. They observed that the larvae migrate to fresh food 4 to 14 times during development depending on the type of food. When feeding on buds and small bolls or on longer

bolls, they migrated once in 2 to 4 or 2 to 7 days, but this had no relation to instar.

Yu and Li (1966) reported the pest *(E. fabia)* increasing rapidly after late August and reaching even greater population level in China. They have observed that the over wintering stage of the pest in unknown and all individuals are dead by the end of December. It had 4 to 5 generations a year and the third and fourth instar were most injurious.

Sharma (1979) conducted an experiment to find out the influence of chemical component in Gossypium on the behaviour and biology of spotted bollworm on the biochemical mechanism of resistance in different varieties of cotton. It was observed that gossypol and tannin were the principal components responsible for the degree of resistance in a variety. High gossypol content acted as oviposition suppressant. Gossypol and tannin content of bolls were responsible for first instar larval mortality. Larvae penetrated through the thalamic region containing very low amount of gossypol as compared to pericarpic region.

Hiremath (1984) tested six host plants viz., cotton *(Gossypium hirsutum)*, bhindi (*Abelmoschus esculentus*), Hollyhock (*Althoea rosea*), pundi *(Hibiscus cannabinus)*, *H. pandureformis* and *Abutilon indicum* for oviposition, preference and also for determining fecundity and longevity. Under natural infestation maximum damage was (60-68%) in bhindi followed by cotton (5.74%) and hollyhock (2.90%). Under laboratory conditions development period was found to be 23.50 days in bhindi, followed by cotton (25.40 days) and hollyhock (27.50 days). Highest fecundity (4.68 eggs per female) was recorded from moth

which emerged from larvae reared on bhindi, followed by cotton (303.20 eggs) and pundi (208.00 eggs) under free choice oviposition receiving 35.33 eggs followed by cotton (28.00 eggs) *H. panduraeformis* (20.66 eggs) and *A. indicum* (18.00 eggs).

Singh and Bichoo (1989), studied the biology and injuriousness of *E. fabia (E. vittella)* on okra in the laboratory and field in M.P., India. The egg, larval and pupal stages lasted for 3-4, 9-17 and 6-14 days, respectively in September-October. The first symptom of attack as visible when the crop was 3 weeks old and the larvae bored into the shoots under severe attack, the top leaves wilted and the flower buds, small fruits and even mature pods with reduction in yield.

Tripathi and Singh (1990b) studied the effect of different levels of larval density (1, 5, 10, 15, 20 and 25 / beaker) on development, growth and reduction of *Earias vittella*, in the laboratory at 22°-23°C and 87-91% R.H. Survival of larvae was negatively correlated with larval density. Crowding also resulted in lower development, reduced weight of larvae and pupa and number of eggs produced. The per centage of egg hatching was un affected.

Kamaluddin (1994), the noticed, *E. vittella* as a pest of cotton (*Gossypium)*as serious pest of lady finger (*Abelmoschusesculentus*) in Pakistan.

Kain (1998) reported the life history of *E. vittella* under laboratory conditions. According to him the egg, larval, pupal periods were 3.5, 14.0 and 9 days, respectively. The longevity of adult female and male was 6 to 8 and 3 to 4 days, respectively. The total life of female and male moth was 33.50 and 31.50

ays, respectively. He also reported that the female moths survived longer than the male.

2.3 **Population dynamics/seasonal incidence of insect pests of okra :**

Krishnaiah and Tandon (1975) reported *Tetranychus neocaledonicus* Andre and *T. cinnabarinus* (Biosd) as important pest of okra.

Abraham and Ramaswami (1978) recorded *Myrmecine* auto viz. *Myrmicaria brunnea* Sound, *Pheidolgetion diversus Jera* and *Teramorium smithi* Mayer as pest on okra at Mannuthy, Kerala. They also reported that these ants fed on the petals, ovarian tissuses, pollen grains in buds and flowers. Ewete (1983) has reported 72 insect on okra in Nigeria.

Srinivasan *et.al* (1988) recorded the seasonal patterns of the cicadellid *Amrasca biguttula biguttula* on okra in Karnataka, India from 1981-83. Time series analyses were adopted for working out the weekly seasonal index of the pest. There was a low incidence of *Amrasca biguttula biguttula* from June to mid January. On various weather parameters analysed, only minimum temperature had a significant positive correlation with the population.

Singh and Kaushik (1990) compared the five different techniques for sampling population of cicadellid *Amrasca biguttula buguttula* on okra. The best method was to take samples from three leaves, one each from the top, middle and bottom canopy of five randomly selected plants.

Borad *et.al* (1993) observed the population of *Bemisia tabaci* in orka fields in Maharashtra, India and the incidence of yellow vein mosaic virus

(YVMV) was low in August-October 1988-89. In both years the population reached to a maximum size during the first week of October symptoms of yellow vein mosaic virus (YVMV) appeared I week after infestation with *B. tabaci.* Both adults and nymphs of*B.tabaci* observed 16 and 20 day after seed sowing.

Dubey *et.al.* (1993) observed the population dynamics of *Helicoverpa armigera* in M.P.India over 2 years (1983-84 and 1984-85). The pest fed on various crops (Chickpea, pigeonpea, lentil and tomato in the cropping seasons and bhindi [okra])

Singh *et.al,* (1993) reported the noctuid, *Helicoverpa armigera*, the cicadellid, *Amrasca biguttula biguttula* (*A.devastans*) the aleyrodid, *Bemisia tabaci* and their predator *chrysoperlacarnea* on okra.

Singh and Brar (1994) reported that the okra sown on May 15 harboured the highest mean population *of Amrasca biguttula biguttula* and *Earias* sp. followed by the crop sown on May 30. Maximum damage by *Earias* sp. was observed on okra sown on July 30. The highest fruit yield was obtained by sowing the crop on May 15. Crop protection from the insect pests gave a greater fruit yield than control and the losses in yield varied from 32.06 to 40.48 per cent.

Gurbinder *et.al:* (1995) observed in 1992 at Punjab, India the effect of different plant spacing on the incidence of *Amrasca biguttula biguttula* and *Earias sp.*on okra revealed that the highest yield (19.91 q/ha) was obtained at spacing of 30 X 15 cm and lowest yield (4.77 q/ha) at 60 X 30 cm.

Patel *et.al,* (1997) found a significant relationship between population of *Aphis gossypii* and *Earias vittella* (Fab.) with weather parameters. A

significant relationship was observed between *Amrasca biguttula biguttula* population level and maximum temperature (r=0.76). The population *of Amrasca biguttula biguttula* increased during the monsoon when temperature remained around 37°C along with at least ten (10) hours of bright sunshine.

Shriramula and Ravi (1997) reported jassid population to be maximum in the crop sown during June and July, November and December-[illegible]. Negative correlation was observed with temperature whereas positive correlation was observed with relative humidity.

Dhawan *et.al,* (1998) reported cotton white fly *Bemisia tabaci* had gained the status of economic pest of upland cotton in the northern cotton belt of India, they observed the population build-up of this pest during 1992-96 which indicates that population remained comparatively low until 1994, followed by a severe outbreak in 1995 and declining population during 1996. Weather played a significant role in population build-up during 1995.

Jaydeb *et.al,* (1999) conducted field studies at Pundibari, Cooch Behar, India during 1997 and 1998 to determine the seasonal incidence of insect pest. Peak population of Aphid *(Aphis gossypii* Glover), white fly *(Bemisia tabaci* Germ) and fruit borer *(Earias insulana* Boisd. *E.vittella* Fab.), were observed at the and of the crop growth period i.e. , 4[1] week of July (30[th] standard week), where as Jassid *(Amrasca biguttula biguttula* Ishda) and leaf roller (*Syleptaderogata*) peak in the middle of June (24[th] standard week) and the 2[nd] week of July (28[th] standard week) respectively.

2.4 Varietal resistance on local varieties of okra against shoot and fruit borer :

Uthamasamy *et.al,* (1972) reported data on insect development and reproduction which showed variation among the three varieties observed.

Malik and Nandal (1986) reported infestation *by Amrasca biguttula biguttula* and *Pectinophora gossypiella*,on 5 line of *Gossypium arboreum* and 35 of *G.hirsutum* in 1981-82. The incidence *of Amrasca devastans* was less in the *G. arboreum* lines (12.4 to 16.2). None of the entries was highly resistant to *P.gossypiella* but the *G.hirsutum* cultivars, Paymaster, Cook and Super okra had 13.3, 15.4 and 17.8% infested loculi, respectively, and were more resistant than H777 (23.0%), G27(20.4% infested loculi) of the *G.orboreum* lines.

Roy (1990) tested 5 varieties of okra in the field in Orissa, India during March - June 1985. Selection 2-2 was the least susceptible to *Aphis gossypii*(because of its thick leaves) and selection–1 was the most susceptible.

Mahal *et.al,* (1993) observed the ovipositional preference of adults of *Amrasca biguttula biguttula* on different plant ages of 2 varieties of okra in India, during 1986. Result revealed that fewer nymphs emerged from the leaves of the resistant variety 1C 7194 (9.83) as compared to 13.23 nymphs for the susceptible variety Pusa sawani.

Mahal *el.al,* (1993) observed the response of 13 okra varieties to the cicadellid, *Amrasca bigultula biguttula* at different crop under field conditions in the Punjab, India, in 1986. Differences in nymphal population and cicadellid injury index were evident in the 7^{th} and 8^{th} week of crop age, respectively. The

response of different varieties during this period was almost the same as that of the overall response for the season.

Brar *et.al*, (1995) assessed some 35 genotypes of okra under condition of natural infestation for resistance to *Atnrasca biguttula biguttula*. Populations of the jassid nymphs were recorded twice at 8 days interval at the peak period of infestation and plants were rated according to the number of nymphs per leaf. Five crosses and one genotype were found resistant.

Khambete and Desai (1996) screened 26 okra cultivars for resistance to jassid (*Amrasca biguttula biguttula),* and shoot and fruit borer *(Earias vittella)* in naturally infested fields. 20-30% infestation was recorded by shoot and fruit borer damage.

Patil *et.al,* (1996) evaluated 151 exotic and 20 indigenous genotypes of okra during kharif 1991 for resistance to podborer under field condition at Dharwad, India data ranged between 0 and 80.8% and 0 and 63.4% for per centage of infestation and weight loss, respectively.

Abhishek *et.al,* (1998) observed that on field trails conducted at two different locations in Madhya Pradesh during summer 1993 to test seven okra varieties/hybrids for resistance to *Earias vittella* (Fab.), varieties Ankur 35 and Parabhani Kranti registered significantly higher shoot damage (7.5 and 8%) but produced higher healthy fruit yield of 72.81 and 62.06 q/ha.

Srinivasa and Sugectha (2001) evaluated nine (9) cultivars of okra for resistance against major pests including *Ainrasca biguttula, biguttula*, *Dysdercus spp. Earias* sp. and spider mite *(Tetranycus macfarlanei)* in an

experiment in Karnataka, India during the kharif season of 1997 and summer of 1998. No cultivar was completely free from infestation.

Manish and Singh (2002) tested 22 okra cultivars for their resistance to *Amrasca biguttula biguttula* in a field experiment conducted in Faizabad (U.P.) India, during the summer of 1999. *Amrasca buguttula biguttula* was observed 14 days after transplanting of okra cultivars. The lowest leaf injury was observed on "Arka Anamika" (12.61%) and highest in "Pusa sawani" (61.06%).

Materials and Methods

CHAPTER - III

MATERIAL AND METHOD

The present investigations entitled "Studies on insect pests of Okra *Abelmoschus esculentus* (L.) Moench in Chhattisgarh with special reference to shoot and fruit borer. *Earias vittella* (Fab.)" were conducted during kharif and Rabi seasons of 2002-03, at the Horticulture experimental field of IGAU, Raipur (C.G.). The details of the materials used and the methods adopted during the course of study are given below :

Geographical location :

Raipur is situated in the South Eastern part of Chhattisgarh and lies at 21-16°N latitude and 81.36° E longitude with an altitude of 298 m above mean sea level.

Climate :

Rapier, the place of investigation, comes under dry moist, sub-humid region. It has an annual average rainfall of 1200-1400 mm, out of which about 85 per cent is received from third week of June to mid-September and very little during October to February. May is the hottest and December is the coldest months of the year. The pattern of rainfall, particularly during June to September months has great variation from year to year. The maximum temperature goes to as high as 46°C during summer and minimum as low as 6°C during the winter months. The atmospheric humidity is high from June to October. The weather conditions during the crop growth period are given in Table 3.1.

Table 3.1 Weekly meteorological data during the cropping season of okra (kharif 2002) for the period 1st October to 23rd December

Week No.	Month/year	Date	Max.temp.	Min.Temp	Rain fall	R.H.-I	R.H.-II	Wind Velocity	Sunshine
40	Oct-02	01-07	33.60	21.90	0	90	48	1.60	10.00
41	Oct-02	08-14	32.20	23.10	0	86	60	3.90	8.90
42	Oct-02	15-21	30.90	21.30	23.2	93	60	3.20	7.10
43	Oct-02	22-28	31.50	18.40	0	92	42	2.00	9.20
44	Oct-02	29-04	31.90	15.90	0	90	36	1.70	9.40
45	Nov-02	05-11	30.10	16.20	0	90	41	2.70	8.00
46	Nov-02	12-18	29.80	14.40	0	89	36	2.80	9.10
47	Nov-02	19-25	29.80	11.90	0	89	30	1.70	9.30
48	Nov-02	26-02	30.00	10.90	0	87	25	2.00	9.60
49	Dec-02	03-09	29.80	12.90	0	90	34	1.40	7.80
50	Dec-02	10-16	29.70	12.40	0	89	31	1.70	8.80
51	Dec-02	17-23	30.90	12.40	0	85	26	2.50	9.20

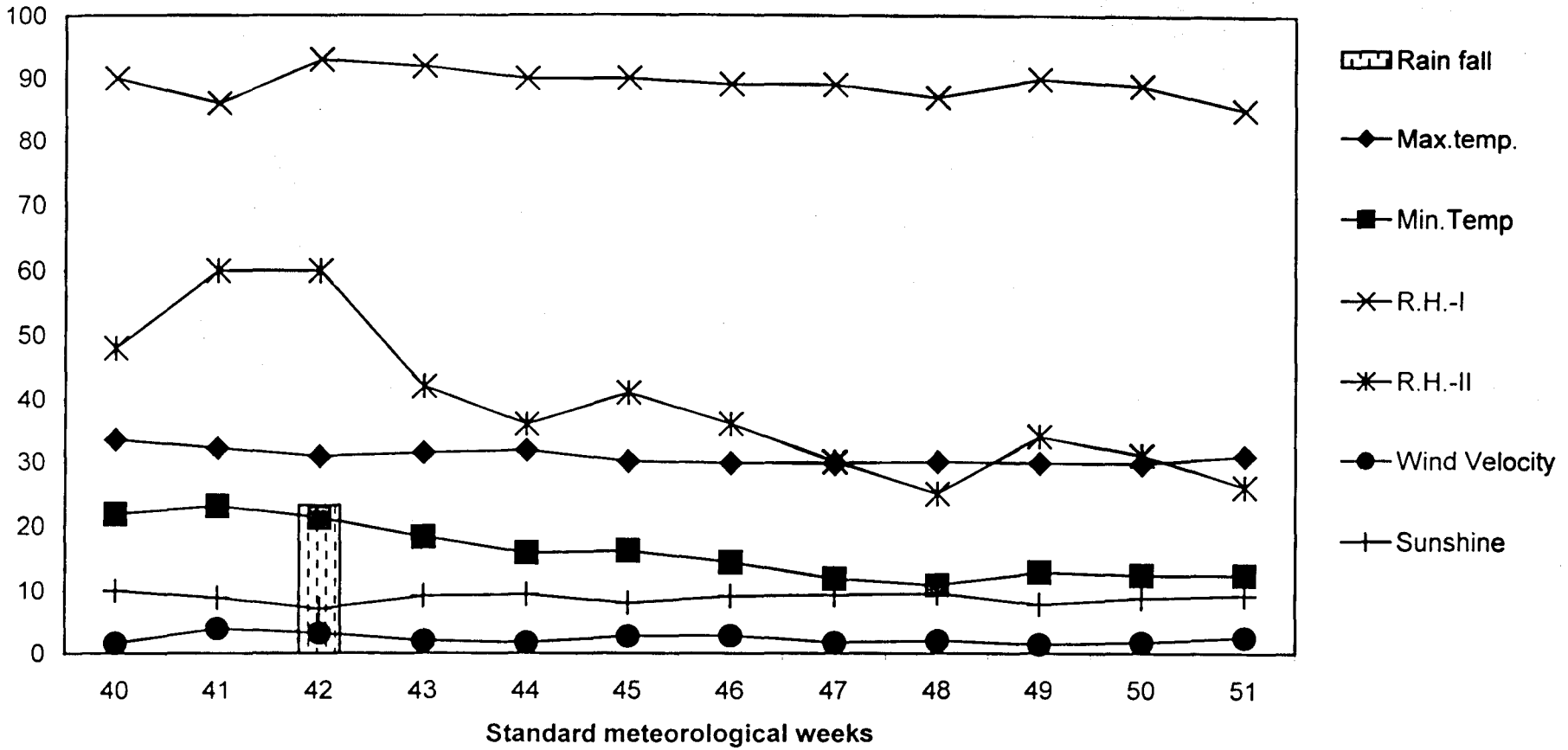

Fig. 3.1 Weekly meteorological data during the crop growth during Kharif 2002 period (1st October to 23rd December)

3.1 Insect pest succession :

Studies on insect pest succession in okra were under taken at Raipur (C.G.) during kharif and Rabi season of 2002-03.

3.1.2 Experimental details :

3.1.2.1 Field preparation :

The experimental field was ploughed well with the help of mould board plough. After ploughing the tractor drawn cultivator was operated, followed by removal of crop residues and grasses from the field.

3.1.2.2 Layout details :

The experiment was conducted with 24 varieties during kharif 2002 and 20 varieties during Rabi 2003. Three lines of each varieties were sown.

During kharif season 2002

(1) Net area - $2.4m^2$ x 24 = 57.6 m^2

(2) Per plot area size - 0.8 x 3 = 2.4 m^2

(3) Spacing - 40 x 30 cm (Row to row x plant to plant)

(4) Date of sowing - 24^{th} September 2002

(5) Varieties - 24 varieties

During Rabi season 2003

(1) Net area - 2.4m x 20 = 48 m^2

(2) Per plot area size - 0.8 x 3 = 2.4 m^2

(3) Spacing - 40 x 30 cm (Row to row x plant to plant)

(4) Date of sowing - 8th February 2003

(5) Varieties - 20 varieties

Table 3.2 Weekly meteorological data during the cropping season of okra (Rabi 2003) for the period 26th February to 20th May)

Week No.	Month /year	Date	Max.temp.	Min.Temp	Rain fall	R.H.-I	R.H.-II	Wind Velocity	Sunshine
9		26-04	34.70	18.60	0.00	74	29	3.60	8.90
10	Mar-03	05-11	32.30	12.00	0.00	71	17	3.30	9.40
11	Mar-03	12-18	33.40	18.00	14.50	78	39	4.70	8.00
12	Mar-03	19-25	33.90	18.00	2.80	79	33	3.50	8.50
13	Mar-03	26-01	37.30	20.00	0.40	72	23	5.10	8.80
14	Apr-03	02-08	38.80	22.40	12.40	60	25	4.90	9.10
15	Apr-03	09-15	29.50	23.30	0.00	63	23	5.10	7.80
16	Apr-03	16-22	41.80	25.70	0.00	51	26	6.60	10.60
17	Apr-03	23-29	41.50	25.20	0.00	40	17	6.80	8.60
18	Apr-03	30-6	41.00	24.00	7.60	46	18	7.80	9.90
19	May-03	7-13	42.40	24.20	0.00	32	11	4.70	7.30
20	May-03	14-20	43.30	28.30	0.00	35	15	6.00	6.90

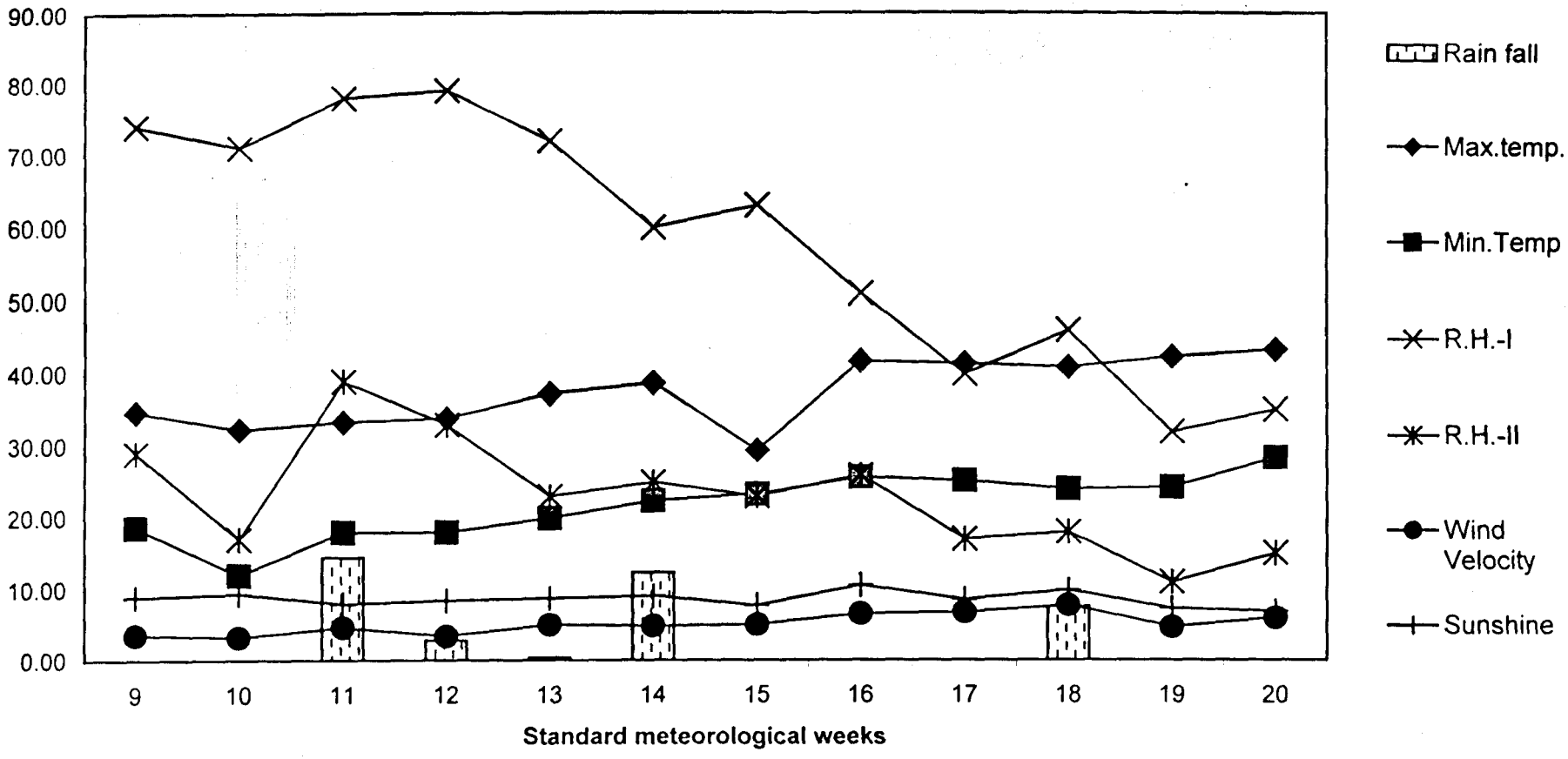

Fig. No. 3.2 Weekly meteorological data during the Rabi season crop growth period (26 February to 20 May 2003)

Table 3.3 Details and source of varieties :

S.No	Varieties	Source
1.	VRO – 05	IIVR, Varanasi
2.	Raigarh - 2	Raigarh (C.G.)
3.	Raigarh - 3	Raigarh(C.G.)
4.	JDP-4	Jagdalpur (C.G.)
5.	VRO – 4	IIVR, Varanasi
6.	JDP – 3	Jagdalpur (C.G.)
7.	Parbhani Kranti	MAU, Parbhani (M.S.)
8.	Kasturi	RARS, Bilaspur (C.G.)
9.	Bilaspur 45	Bilaspur (C.G.)
10.	Bilaspur 55	Bilaspur (C.G.)
11.	X2	Local market
12.	Arka Anamika	II HR, Banglore
13.	O.D.	Dharwad
14.	Kaweri selection	Local market
15.	O.H. – 77	Local market
16.	Daftari	IGAU, Raipur
17.	Arka abhaya	IIHR, Banglore
18.	Harsha	Local market
19.	JNDO – 5	Gujarat
20.	VRO – 3	IIVR, Varanasi
21.	JDP-4	Jagdalpur (C.G.)
22.	Raigarh - 5	Raigarh (C.G.)
23.	VRO – 6	IlVR, Varanasi
24.	Raigarh - 1	Raigarh (C.G.)

3.1.2.3 Fertilizer application :

Fertilizer was applied @ 100:50:50 kg/ha of N:P:K: in the form of urea, super phosphate and muriate of potash, respectively. Half of N and full of P_2O_5 and K_2O were applied as top dressing at 50 and 60 days after sowing i.e. ¼th each time.

3.1.2.4 Gap filling and thinning :

In order to get uniform plant population gap filling and thinning operation were done after emergence of seedlings.

3.1.2.5 Irrigation :

The first irrigation was given just after sowing the seed with the help of hazara (Rose cane) and subsequent irrigation were given by plot to plot system and the interval between two irrigation was adjusted accordingly to the requirement of the crop.

3.1.2.6 Weed management :

Two hoeings were done at 30 and 50 days after sowing, immediately after this hand weeding was done.

3.1.2.7 Observations recorded :

Observations were recorded on the insect pest incidence at weekly interval right from germination, till the maturity of the crop. For this purpose five randomly selected plant were observed for the insect pests.

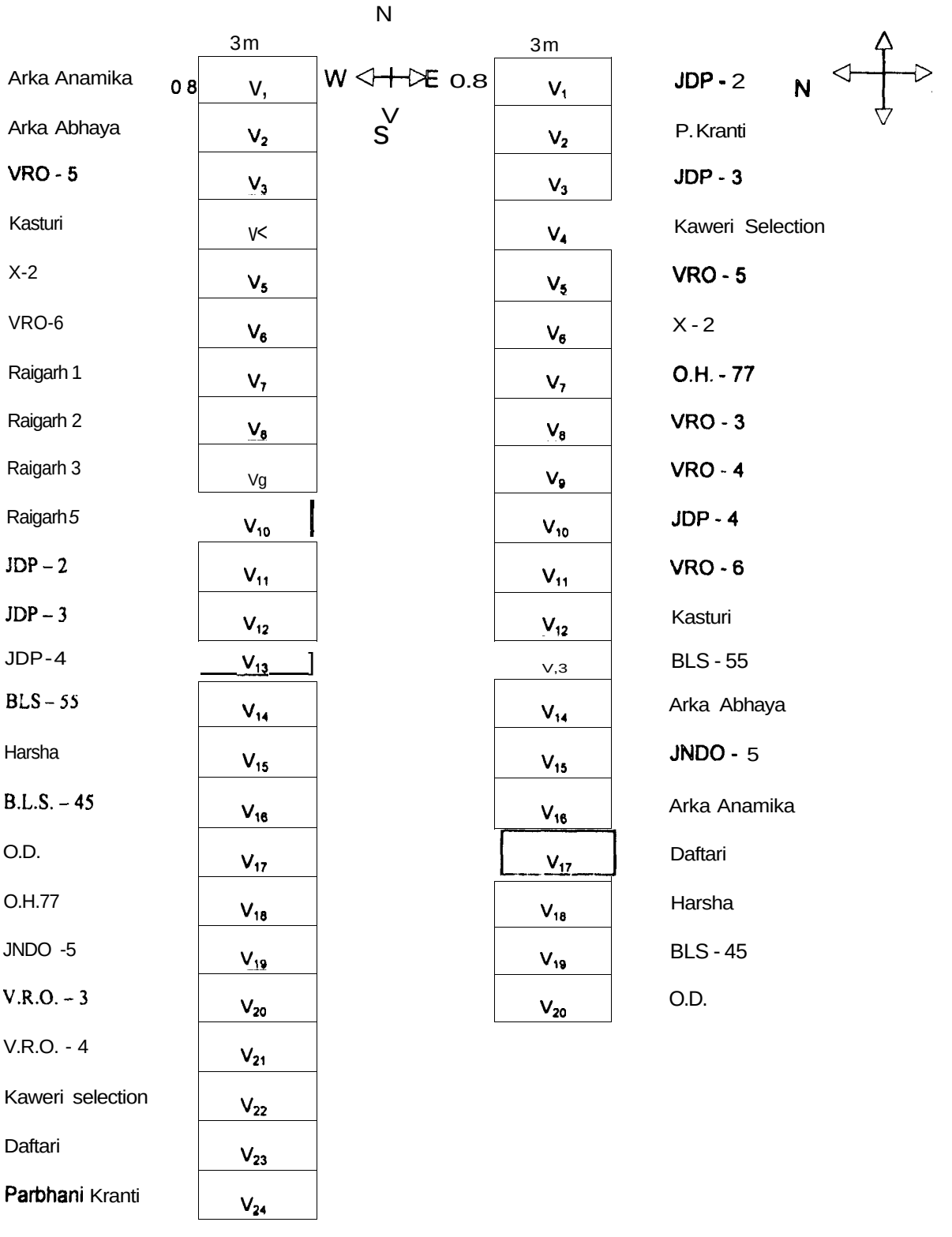

Fig. 3.3 Layout plan of the experimantal plots of okra during Kharif 2002 and Rabi 2003.

The observations on aphid, jassid, white fly and leaf miner, were recorded on 3 leaves per plant , i.e. one upper, one middle and one lower leaf. While for that of Red cotton bug semi looper, lady bird beetle, spider. Rove beetle, green stink bug and Red hairy cater pillar whole plant was observed. The number of infected shoots were the criterion for recording the shoot and fruit borer incidence in the early crop growth stage, whereas, in later crop growth stage infested buds/ fruits were taken into account. *H.armigera* was also observed on fruit of okra. In this case it was observed that half of the portion of larvae found inside and rest of the portion hanged out side the fruit during feeding.

3.1.2.7 Per centage fruit damage :

The per centage fruit damage was worked out with help of below mentioned formula :

$$\text{Per centage fruit damage} = \frac{\text{No. of damage fruit}}{\text{Total no of fruits (Healthy + damage)}} \times 100$$

3.1.2.8 Statistical analysis :

The data obtained were correlated with different weather parameters.

3.2 Biology of *Earias vittella* (Fab.)

To study the biology of *Earias vittella* (Fab.) mass culture of the insect was maintained in the laboratory.

The larvae were collected from infected fruits of okra from Horticulture field of College of Agriculture, Raipur. The larvae were reared in big petridishes (15 cm diameter) on okra fruits. Fresh food was provided daily and during experimental period proper hygienic condition were maintained. Full grown larvae were allowed to pupate.

Soon after eclosion, adult moths were transferred in glass chimneys containing black paper strips to facilitate proper egg laying. Upper end of each chimney was covered with muslin cloth held tightly with the help of a rubber band. Twenty per cent sugar solution was provided in cotton swabs for feeding. Eggs obtained from these moths were placed in glass petridishes by cutting the paper strips along with the eggs. After hatching, the larvae were reared individually for one more generations on okra fruits. The eggs obtained from the later generation were utilized for the detailed study.

The experiment was started with newly hatched first instar larvae (0-12 hours old) obtained from the nucleus culture. The newly hatched larvae from eggs were released in petridishes (10x10 cm) containing fresh fruits of okra crops. Fresh fruits of plants were given to larvae at 24 hours interval and uneaten leaves and faeces were cleaned from petridishes.

3.2.2 **Egg:**

Observations were recorded on the number of eggs by counting the eggs with the help of hand lens. The incubation period was also recorded.

3.2.3 Larvae :

The newly hatched larvae were transferred in petridishes (10 x 10 cm) containing fresh leaves of the host plants i.e. okra. Moist blotting paper was provided to maintain proper humidity and also to avoid drying of leaves.

Following observations were recorded on larvae.

(1) Larval period in days.

(2) Length of full grown larvae.

3.2.4 Pupae :

Full grown larvae were allowed to pupate on the okra leaves. The pupal stage is characterized by the formation of cocoon. This stage terminates as soon as the insect emerges from the cocoon. This duration was observed and recorded as the pupal period in this investigation.

The length of pupae were measured with the help of a measuring scale.

3.2.5 Adult :

After eclosion, size of the moth, length of the body and the longevity of adult were recorded.

3.3 Population dynamics/ seasonal incidence of insect pests of okra :

For population dynamics, okra was sown on 24th September, 2002 in kharif and on 8th January 2003 in Rabi. When crop reached the vegetative stage, observations on population of insect pests and natural enemies were recorded on five randomly selected plants at weekly intervals. For sucking pests, observations were recorded on three leaves from each plant i.e. upper, middle and lower, for recording the shoot and fruit borer incidence in early growth stage of the plant. Infested shoots were the criterian in the early stage and in later stage the infested fruits were taken into account. Based on these observations, the per cent fruit infestation was computed and the data so obtained was correlated with the weather parameters.

Results

CHAPTER - IV

RESULTS

4.1 Studies on pest succession in okra :

A field experiment was under taken to study the pest succession in okra. During the investigation weekly observations were recorded on the pest succession of different insect pests and the associated natural enemies, initiating from germination till the harvest of the crop and are presented in Table 4.1 and 4.3. list of insect pests and their natural enemies observed during the crop growth period along with their period of activity , crop stage attacked and their population range per plant are presented Table 4.2 and 4.5 for Kharif 2002 and for Rabi 2003 in Table 4.4 and 4.6, respectively.

The result in respect of the pest succession and mean population build up of observed insect pests along with the prevailing meteorological condition have also been presented in graphical form in fig. 4.1 and fig. 4.2 , for Kharif, 2002 and Rabi , 2003, respectively.

4.1.1 Insect pests of okra :

In the Kharif season (2002) during the crop growth period eight insect species were found causing damage to okra in relation to crop phenology from vegetative stage till maturity either singly or in an overlapping manner (Table 4.2). Maximum active period with high population of shoot and fruit borer was recorded during the entire month of November. The shoot and fruit borer

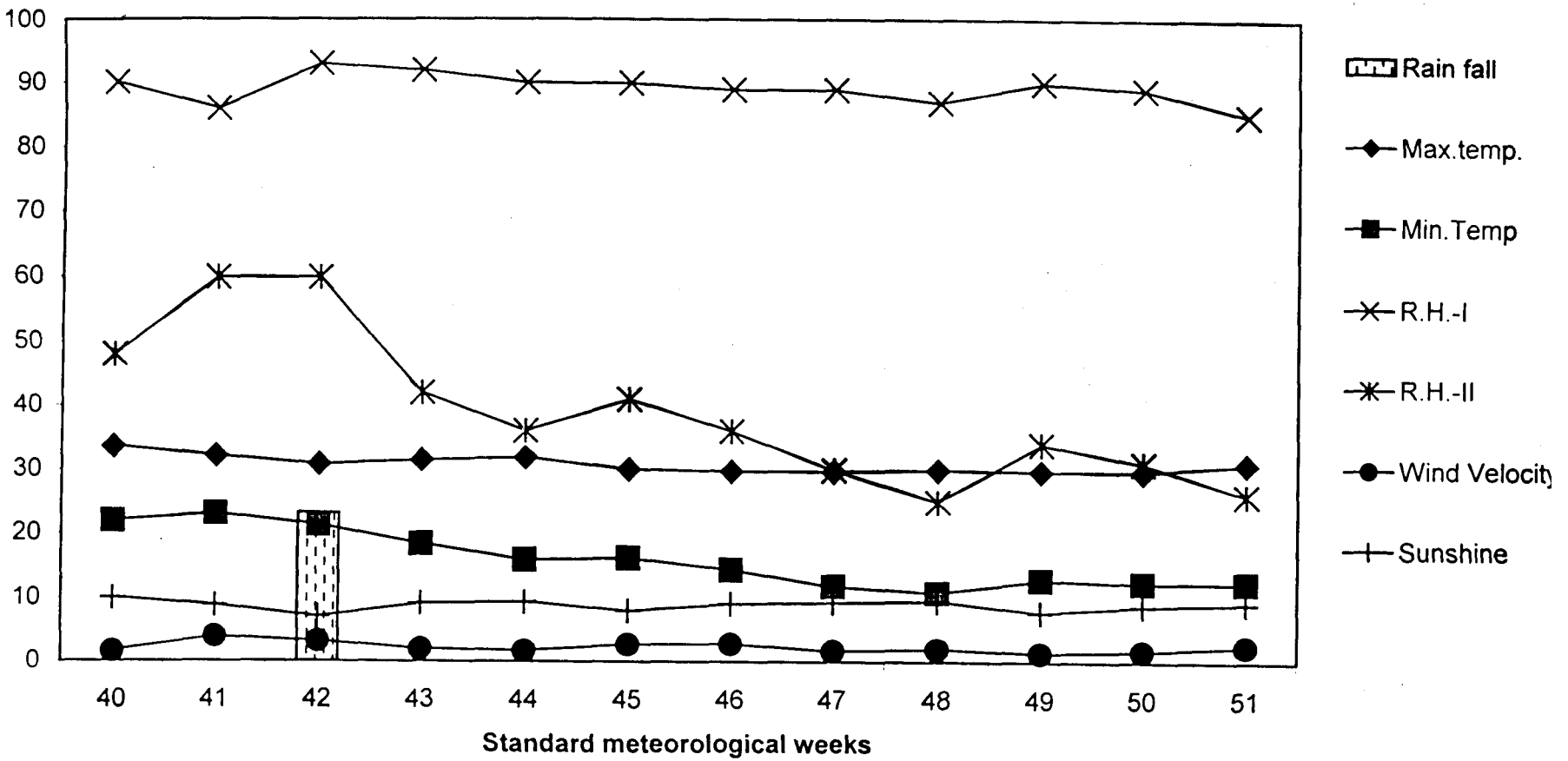

Fig. 3.1 Weekly meteorological data during the crop growth during Kharif 2002 period (1st October to 23rd December)

Table 4.1 : Pest succession on okra crop during Kharif season (2002)

Insect pest/ natural enemies	Date of observation (mean population/ Plant)												
	07/10/02	14/10	21/10	28/10	4/11	11/11	18/11	25/11	2/12	9/12	16/12	23/12	Over al mean
Jassid	2.60	3.65	3.95	3.76	4	2.78	2.4	3.18	4.29	5.45	4.02	4.8	3.74
White fly	0.00	2.23	2.7	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2·15
Shoot & fruit borer	0.00	0.02	0.17	0.33	0.7	1.08	0.8	0.38	0.68	0.68	0.75	0.00	0.55
Aphid	0.00	0.00	0.00	0.08	8.55	19.58	1.53	0.45	0.00	0.00	0.00	0.00	6.03
Semilooper	0.00	0.00	0.00	0.02	0.02	0.008	0.02	0.00	0.03	0.00	0.00	0.00	0.01
Red cotton bug	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.07	0.04	0.16	0.29	0.11
Red hairy caterpillar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.008	0.06	0.05	0.19	0.06
Heliothis armigera	0.03	0.07	0.06	0.08	0.05	0.008	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Lady bird beetle	0.00	0.008	0.04	0.01	0.02	0.04	0.07	0.06	3.22	6.39	5.55	3.6	1.72
Spider	0.00	0.00	0.008	0.03	0.03	0.00	0.00	0.008	0.008	0.05	0.01	0.00	0.02
Green stink bug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.008	0.00	0.00	0.01	0.00	0.0091
Damsel fly	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

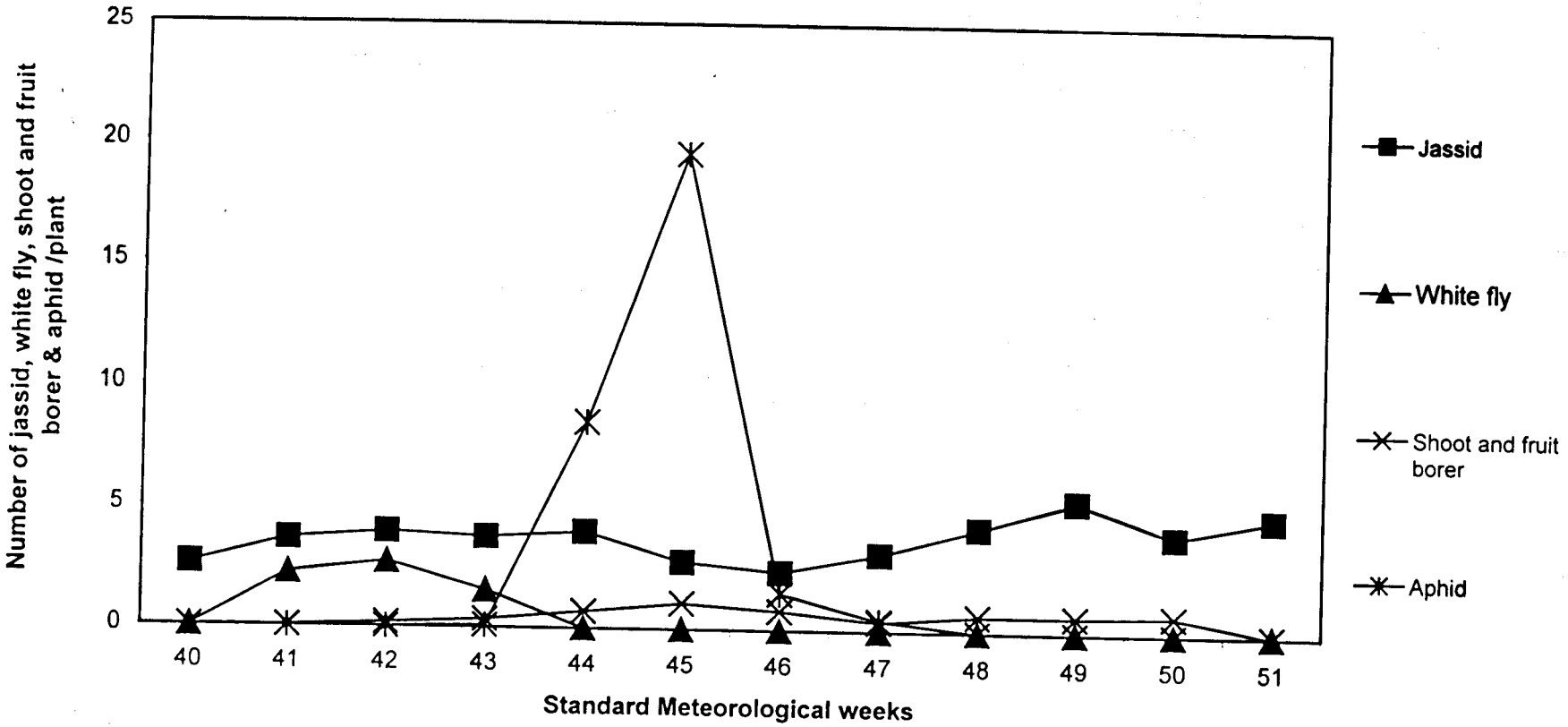

Fig.4.1 Weekly jassid, white fly, leaf miner & shoot and fruit borer population corresponding to weather condition during the crop growth period Kharif season 2002

incidence was found maximum 1.08 larvae/plant during the second week of November and there after steadily decreased.

The population of jassid, *Amrasca biguttula biguttula* initited in the vegetative stage during first week of October with 2.60 jassid/plant and its feeding continued on the lower surface of leaves. There was an increase in population in subsequent weeks and the peak jassid population was recorded in second week of December with a population of 5.45 jassid/plant and minimum population was recorded in third week of November. The average population varied from 2.4 to 5.45 jassid/plant during the okra cropping season.

The incidence of white fly, *Bemisia tabaci* initiated in the vegetative stage during second week of October with 2.23 white flies/plant. The maximum population was found in third week of October with a population 2.7 white flies/plant. After fourth week of October the white fly population decreased.

The incidence of aphid, *Aphis gossypii* initiated during fourth week of October with 0.08 aphid/plant. There was an increase in population in the subsequent weeks to a peak aphid population of 19.58 aphid/ plants during second week of November. There was a trend of decline in the population in the forthcoming weeks.

The larval population of semilooper was neglible. Its incidence initiated in the last week of October with 0.02 larva/plant and continued up to first week of December. The maximum population is found in first week of December with a 0.03 larvae/plant.

Table 4.2 : Activity period of insect on okra crop during Kharif 2002

Name of insect	Scientific Name	Mean Population	Period of maximum insect population	Period of activity	Crop stage attacked
Jassid	*Amrasca biguttula biguttula*	2.4 – 5.45	II[nd] week of December	I[st] week of October to last week of December	All stage
White fly	*Bemisia tabaci*	1.54 – 2.7	III[rd] week of October	IInd week of October to third week of December	Vegetative stage
Shoot and fruit borer	*Earias vittella*	0.02 – 1.08	II[nd] week of November	IInd week of October to IIIrd week of December	All stage
Aphid	*Aphis gossypii*	0.08 – 19.58	II[nd] week of November	IVth week of October to IVth Week of November	Vegetative stage
Semilooper	*Anomis flava*	0.008 – 0.03	I[st] week of December	IVth week of October to first week of December	All stage
Red cotton bug	*Dysdercus koenigii*	0.04 – 0.19	IV[th] week of December	IIIrd week of November to last week of December	All stage
Red hairycaterpillar	*Amsacta moorei*	0.008 – 0.19	IV[th] week of December	IVth week of November to last week of December	Later stage
Gram pod borer	*Heliothis armigera*	0.008 – 0.08	IV[th] week of October	I[st] week of October to II[nd] week of November	Vegetative stage
Gereen Stink bug	*Nezara viridula*	0.008 – 0.01	IIIrd week of December	IVth week of November to IIIrd week of December	Vegetative stage

fig. -Experimental Field

fig. -Shoot & fruit borer infested Plant of okra

The population of Red cotton bug, *Dysdercus koenigii* incidence initiated in the third week of November with 0.05 Red cotton bugs/plant and continued upto third week of December. The maximum population found as 0.29 Red cotton bugs/plant in last week of December.

Last larval population of Red hairy caterpillar, *Amsacta moorei* initiated in the last week of November (0.04 larva/plant) and condition upto third week of December. The maximum population found in the last week of December with (0.19 larva/plant).

Green stink bug, *Nezara viridula* was another predatory bug recorded in the fourth week of November to third week of December. The average population ranged from 0.008 to 0.01 adult/plant but its population was quite low.

The incidence of *Heliothis armigera* started in the vegetative stage. The maximum population was found in last week of October with (0.08 larva/plant). Further, these was a trend of decline in the population in the forth coming weeks. After that there was no incidence of this insect in the crop, where as okra shoot fruit borer, *Earias vitlella* (Fab.) was observed as a major insect pest of okra. The initial infestation (0.02 larva/plant) was observed during the second week of October. The build up of the population gradually increased and the peak was observed in the second week of November with mean population of 1.08 larvae/plant. The population of shoot and fruit borer was maximum during the entire month of November, later on there was decline in the population in the population in subsequent week.

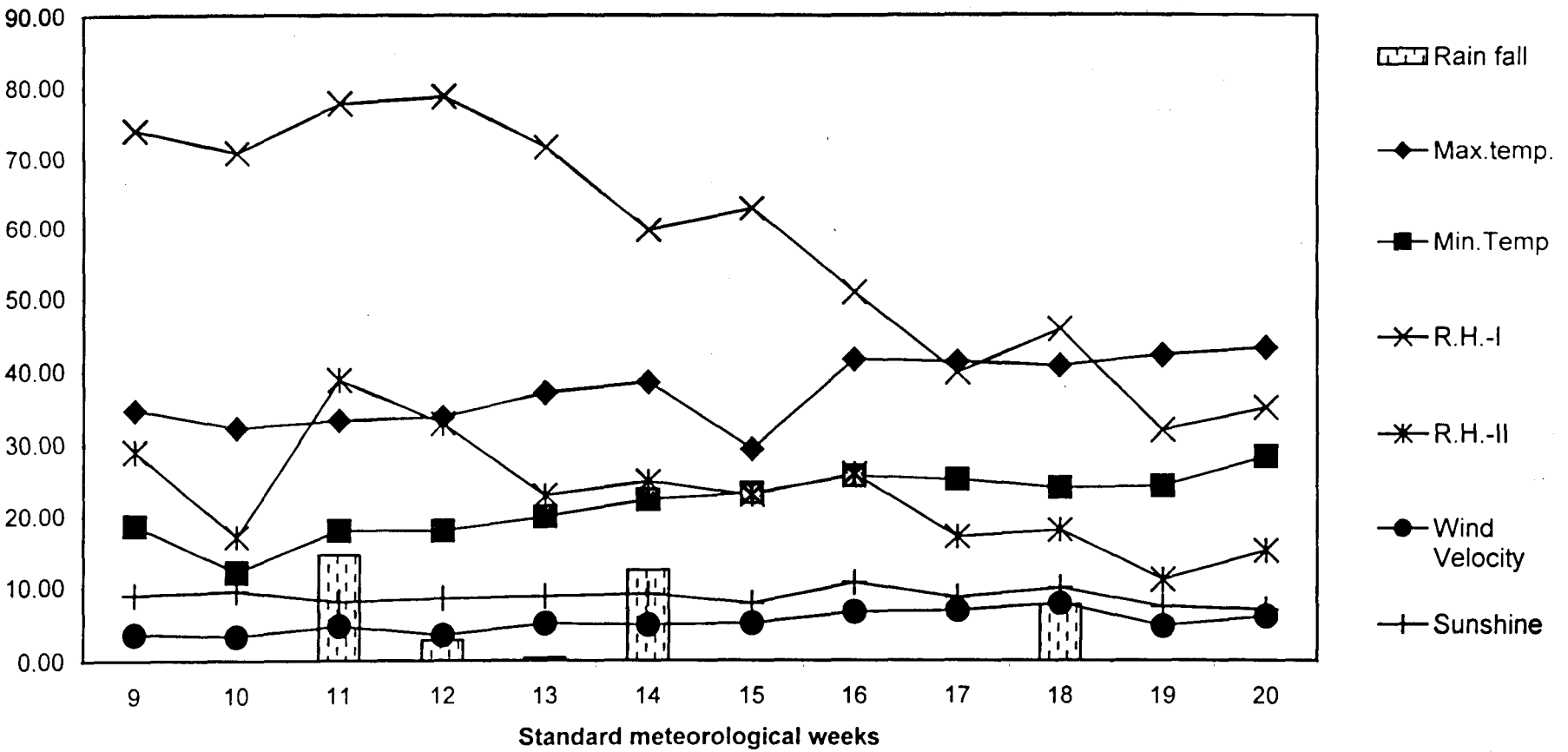

Fig. No. 3.2 Weekly meteorological data during the Rabi season crop growth period (26 February to 20 May 2003)

Table 4.3 : Pest succession on okra crop during Rabi 2003

Insect pest/ natural enemies	Date of observation (mean population. Plant)												
	01/03/03	8/3	15/3	22/3	29/3	5/4	12/4	19/4	26/4	3/5	10/5	17/5	Over al mean
Jassid	0.62	1.14	1.6	1.49	2.86	3.42	3.64	3.40	2.86	4.46	3.21	0.0	2.60
White fly	0.32	0.36	0.67	0.55	0.94	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.56
Leaf miner	0.00	0.20	0.68	0.41	0.00	0.0	0.00	0.0	0.00	0.00	0.00	0.00	0.43
Shoot & fruit borer	0.00	0.00	0.00	0.008	0.05	0.03	0.78	0.72	0.53	0.65	1.08	1.10	0.54
Semi looper	0.01	0.06	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.008	0.00	0.00	0.02
Lady bird beetle	0.00	0.00	0.008	0.04	0.09	0.02	0.00	0.00	0.00	0.008	0.05	0.01	0.03
Spider	0.00	0.00	0.00	0.008	0.05	0.01	0.02	0.03	0.008	0.04	0.41	0.10	0.07
Rove beetle	0.00	0.00	0.00	0.00	0.01	0.10	0.25	0.01	0.00	0.008	0.008	0.00	0.06

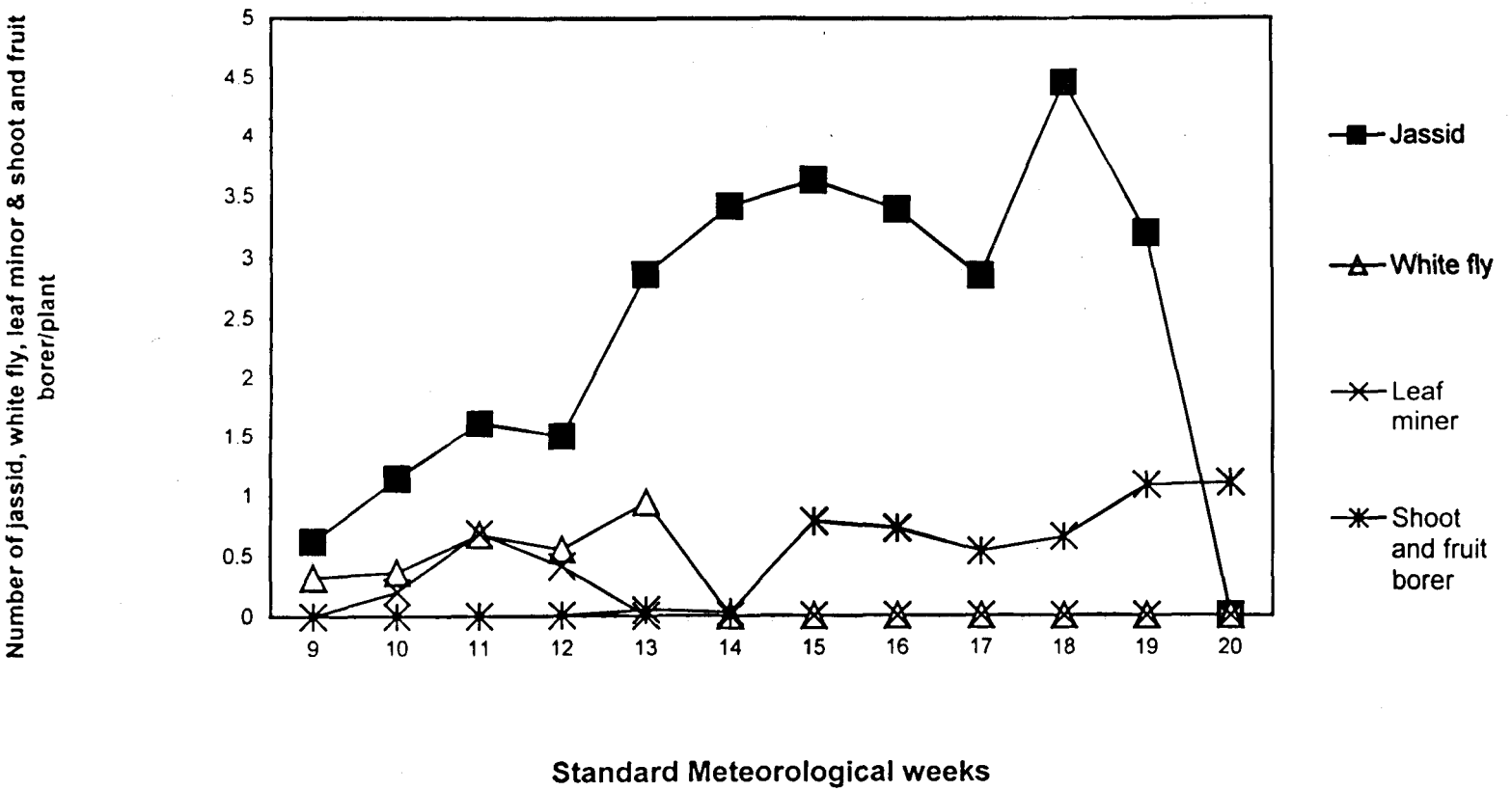

Fig.4.2 Weekly jassid, white fly, leaf miner & shoot and fruit borer population corresponding to weather condition during the crop growth period Rabi season 2003

During the Rabi season (2003) in the crop growth period five insect species were found causing damage to okra in relation to crop phenology from vegetative to pre-harvest either singly or in over lapping manner (Table 4.4). Maximum active period with high population of shoot and fruit borer was recorded during the third week of May. The shoot and fruit borer incidence was found maximum (1.10 larvae/plant) during the third week of May.

The population of jassid, *Amrasca biguttula biguttula* initiated in the vegetative stage during first week of March with 0.62 jassid/plant. There was an increase in the subsequent week and the peak jassid population was recorded in first week of May with 4.46 jassid/plant and minimum population was recorded in the first week of March. The average jassid population varied from 0.62 - 107.2 jassid/plant during the okra cropping season.

The incidence of white fly, *Bemisia tabaci* initiated in the vegetative stage during first week of March with 0.32 white flies/plant. There was an increase in population in the subsequent weeks with a peak population of 0.94 white flies/plant after that there was no incidence of this insect in the crop.

The population of leaf miner initiated in the second week of March to fourth week of March. The minimum population of 0.20 leaf miner/plant was recorded in second week of March and maximum population was found to be 0.68 leaf miner/plant in third week of March.

The larval population of semilooper initiated in the first week of March and the maximum population is found in second week of March. Its incidence was negligible through out the season. Its slight presence on the crop

Table 4.4 : Activity period of insect on okra crop during Rabi 2003

Name of insect	Scientific Name	Mean Population	Period of maximum insect population	Period of activity	Crop stage attacked
Jassid	*Amrasca biguttula biguttula*	0.62 – 4.46	I[st] week of May	I[st] week of March to II[nd] week of May	All stage
White fly	*Bemisia tabaci*	0.32 – 0.94	II[nd] week of March	I[st] wekk of March to last week of March	Vegetative stage
Leaf miner	*Acrocercops bifasciatavilsm*	0.20 – 0.68	III[rd] week of March	II[nd] week of March to last week of March	Vegetative stage
Shoot and fruit borer	*Earias vittella*	0.008 – 1.10	III[rd] week of May	IVth Week of March to III[rd] week of May	All stage
Semilooper	*Anomis flava*	0.008 – 0.06	III[rd] Week of March	I[st] week of March to I[st] week of May	All stage

Table 4.5 : Natural enemies recorded feeding on insect pest of okra during crop growth period during Kharif 2002

Name of insect	Scientific Name	Mean Population	Period of maximum insect population	Period of activity
Lady bird beetle	*Coccinella sp.*	0.008 – 6.39	II[nd] week of December	II[nd] week of October to last week of December
Spider	Unidentified	0.008 – 0.05	II[nd] week of December	IIIrd week of October to IIIrd week of December
Damsel fly	*Coenagrion sp.*	0.02	IIIrd week of October	IIIrd week of October

fig.- Earias vittella(fab.) Feeding on okra fruit

fig.-Infected fruit feed by Larva

was recorded with a very low population during first week of May 0.008 larva/plant.

Okra shoot and fruit borer, *Earias vittella* (Fab.) was observed as major insect pest of okra. The initial infestation (0.008 larva/plant) was observed during last week of March. The built up of the population gradually increased in the month May with a mean population of 1.10 larva/plant. The population of shoot and fruit borer was maximum during third week of May.

4.1.2 Natural enemies :

4.1.2.1 Kharif season 2002 **:**

During the course of investigation various natural enemies of okra insect pest were also recorded. Among them spider was observed preying upon the minute insect like aphids and jassids. Its activity was noted during the third week of October to third week of December with an average population of 0.008 to 0.05 spider/plant.

Two of lady bird beetles, *Menochilus sexmaculata* and *concinella septumpunctala* were recorded as major bioagents. Their activity was noticed from the second week of October to last week of December feeding on the nymphal stage of aphids and jassids. The average predator population ranged from 0.008 to 6.39 adult and grub/plant.

Damsel fly, *Coenagrion* spp. was another predator recorded in the third week of October. Average population ranged from 0.02 adult/plant which was very low.

Table 4.6 : Natural enemies recorded feeding on insect pest of okra during crop growth period during Rabi 2003

Name of insect	Scientific Name	Mean Population	Period of maximum insect population	Period of activity
Lady bird beetle	*Coccinella sp.*	0.008 – 0.09	IVth week of March	IIIrd wek of March to IIIrd week of May
Spider	Unidentified	0.008 – 0.41	IInd week of May	IVth wek of March to IIIrd week of May
Rove beetle	*Paederus sp.*	0.008 – 0.25	IInd week of April	IVth wek of March to IInd week of May

4.1.2.2 Rabi season 2003 :

During the course of investigation various natural enemies of okra insect pest were recorded in Rabi 2003. Among them spider was observed preying upon the minute insect like aphids and jassids. Its activity was noticed during third week of March to third week of May with an average population of 0.008 to 0.41 spider /plant.

Two species of lady bird beetle, *Menochilus sexmaculata* and *Coccinella septumpunctala* were recorded as major bioagents. Their activity was noticed from the third week of March to third week of May feeding on the nymphal stages of aphids and jassids. The average population ranged from 0.008 to 0.09 adult/plant.

The other natural enemy was predatory rove beetle, *Paederus* sp. which was preying upon the early larval stage of soft bodied insect during last week of March to second week of May. The average predator population was 0.008 to 0.25 adult/plant.

4.2 Biology of ***Earias vittella*** (Fab.) :

The biology of okra shoot & fruit borer *Earias vitlclla* (Fab.) was studied under laboratory condition by using okra as a food plant. Two generations, one after another were continuously studied for this purpose. The laboratory temperature during this period ranged between 12.40°C to 30.90° C. The result are being presented in this chapter.

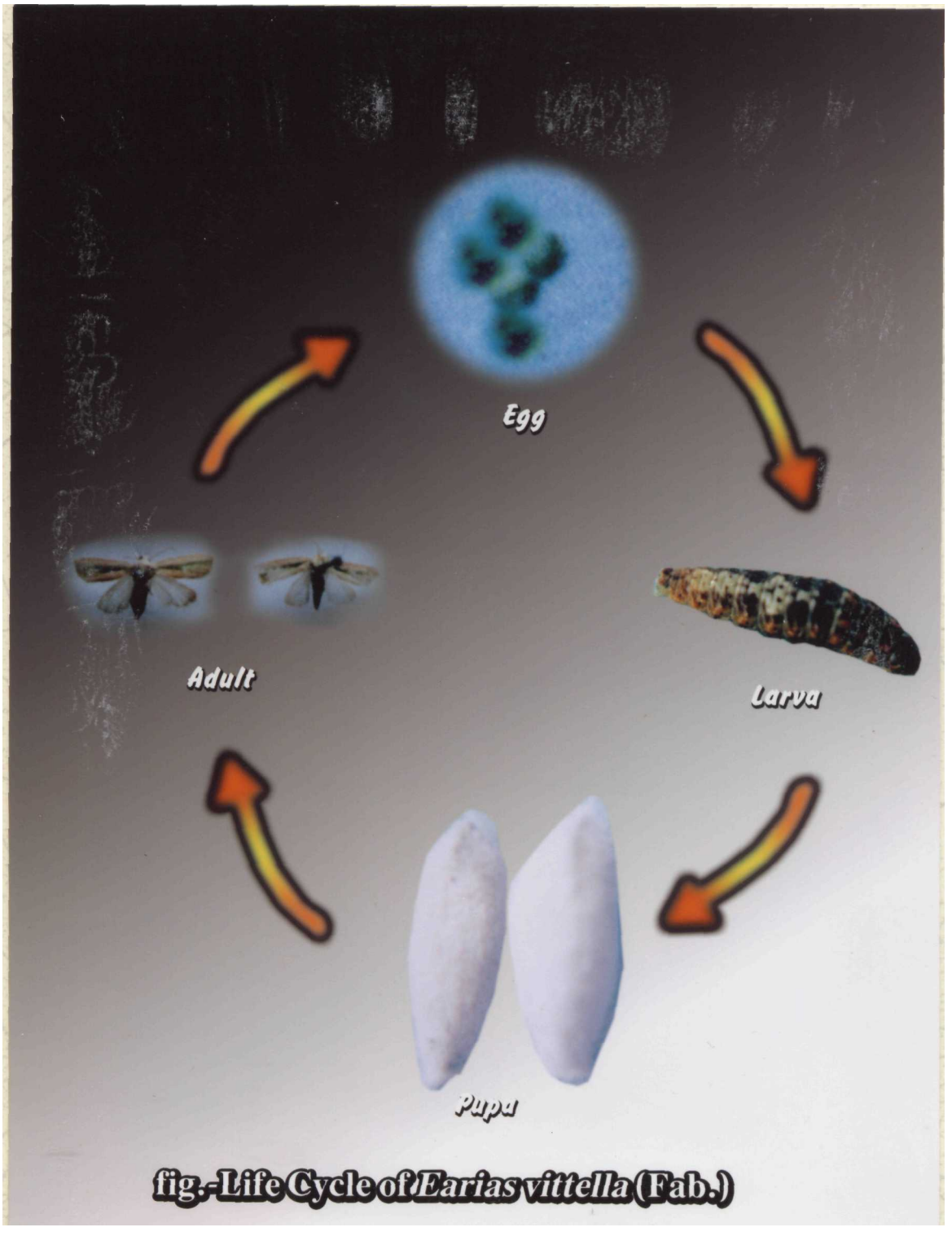

fig.-Life Cycle of *Earias vittella* (Fab.)

4.2.1 Incubation period :

The eggs laid by *Earias vittella* female on okra leaves were observed to record the incubation period in days. Overall five eggs per generation were observed for this purpose. In first and second generation the mean incubation period were recorded as 3.6 and 3.2 days respectively. The overall mean incubation period was found to be 3.4 days. (Table 4.7).

4.2.2 Larvae :

Observations were recorded on length of full grown larvae and total larval period (Table 4.8). The mean length of full grown larvae were recorded as 23.6 and 22.8 mm in first and second generation, respectively. The overall mean length of full grown larvae was 23.2 mm. The mean larval duration were also recorded in days. In first and second generation the larval period were recorded as 14.2 and 15.0 days respectively. The overall mean larval period was 14.6 days, based on the two generation.

4.2.3 Pupae :

The length of pupae and pupal period of *Earias vittella* were studied and result are presented in Table 4.9. The mean length of pupa in two generations were recorded as 12.3 and 12.28 mm in first and second generation, respectively. The mean length of pupa was 12.29 mm. The pupal period in first and second generation were 10.6 and 9.8 days respectively. The mean pupal period was recorded as 10.2 days.

4.2.4 Adult :

The body length and longevity of *E. vittella* (Fab.) was studied and are presented in Table 4.10. The length of male recorded in first and second generations were 9.97 and 9.95 mm respectively. The overall mean length of male was 9.96 mm based on the two generations. Longevity of the adult males were 3.66 and 4.0 days during first and second generation respectively. The overall mean longevity of the male adult was recorded as 3.83 days. However, in case of female the body length of adult in two generation were recorded as 11.83 and 11.66 mm in first and second generations respectively. The mean length of female adult was 11.74 mm. The longevity of female moth were 6.33 and 6.66 days in first and second generations respectively. The overall mean longevity for female moth was 6.49 days.

To sum up the biology of *Earias vittella* (Fab.) it can be said that eggs were laid on leaves, shoots and buds of okra. The colour of eggs was bluish which gradually changed to brown before hatching. The average incubation period was recorded as 3.4 days. After hatching the larvae started feeding on leaves. The colour of the newly hatched caterpillar is brownish white. The average length of full grown larvae was recorded as 23.3 mm. The larval period on an average, completed in 14.6 days. The colour of the pupa was purplish brown and it was covered by silken thread. The average length and pupal period were recorded as 12.29 mm and 10.2 days respectively. The average length of the body and longevity of male were 9.96 mm and 3.83 days respectively. The female were bigger in size than the male with higher longevity. The total life cycle on an average was completed in 32.03 days in case of males and 34.694 days in case of female.

Table 4.7 : Incubation period of eggs of *Earias vittella* (Fab.)

Observation	Generation		Overall Mean
	I	II	
Mean incubation period (in days)	3.6	3.2	3.4

Table 4.8 : Larval length and longevity of *Earias vittella* (Fab.)

Observation	Generation		Overall Mean
	I	II	
Length of full grown larvae (mm)	23.6	22.8	23.2
Total larval period (in days)	14.2	15	14.6

Table 4.9 : Pupal length and pupal period *of Earias vittella* (Fab.)

Observation	Generation		Overall Mean
	I	II	
Length of pupa (mm)	12.3	12.28	12.29
Total pupal period (in days)	10.6	9.8	10.2

Table 4.10: Body length and longevity of adult male & female of *Earias*

Observation	Generation		Overall Mean
	I	II	
A. Male			
Length of body (mm)	9.97	9.95	9.96
Longevity (In days)	3.66	4.00	3.83
B. Female			
Length of body (mm)	11.83	11.66	11.74
Longevity (In days)	6.33	6.66	6.49

Table 4.11 : Life cycle of *Earias vittella*

	Different stages	Generation		Mean average period (In days)
		I	II	
1.	Egg	3.6	3.2	3.4
2.	Larva	14.2	15.00	14.6
3.	Pupa	10.6	9.8	10.2
4.	Adult Female	6.33	4.00	6.49
	Male	3.66	4.00	3.83
	Total life cycle of Female	34.73	34.66	34.694
	Male	32.06	32.00	32.03

4.3 Population dynamics/seasonal incidence of insect pest of okra :

4.3.1.1 During kharif season 2002, studies on population dynamics of insect pest of were okra conducted on two varieties viz. "Parbhani Kranti" and "B.L.S.-55" which are among the most popular varieties in Chhattisgarh region. The findings are presented under the following sub heads.

4.3.1.1 Seasonal activity of okra Jassid.

The data on intensity and population fluctuation of major insect pests in two varieties of okra viz. "Parbhani Kranti" and "B.L.S. - 55" along with prevailing weather conditions during kharif 2002 are presented in Table 4.12. and fig. 4.3 and 4.4.

Periodical observations on the incidence of major insect pests of okra in variety "Parbhani Kranti" revealed that the jasid appeared in the first week of October (40^{th} SMW) with a population of 2.4 jassid / plant, the weather parameters i.e. maximum and minimum temperature during the week was 33.60°C and 21.90°C, with R.H. I and II as 90% and 48%, respectively. The population in its peak reached to 6 jassid / plant during the second week of December (49^{th} SMW) where the maximum temperature during the week was 29.80°C and the minimum temperature was 12.90°C with Relative humidity. I 90% and II 34%. Further there was decline in population and 4.6 jasid/plant was observed during the third week of December (51^{st} SMW).

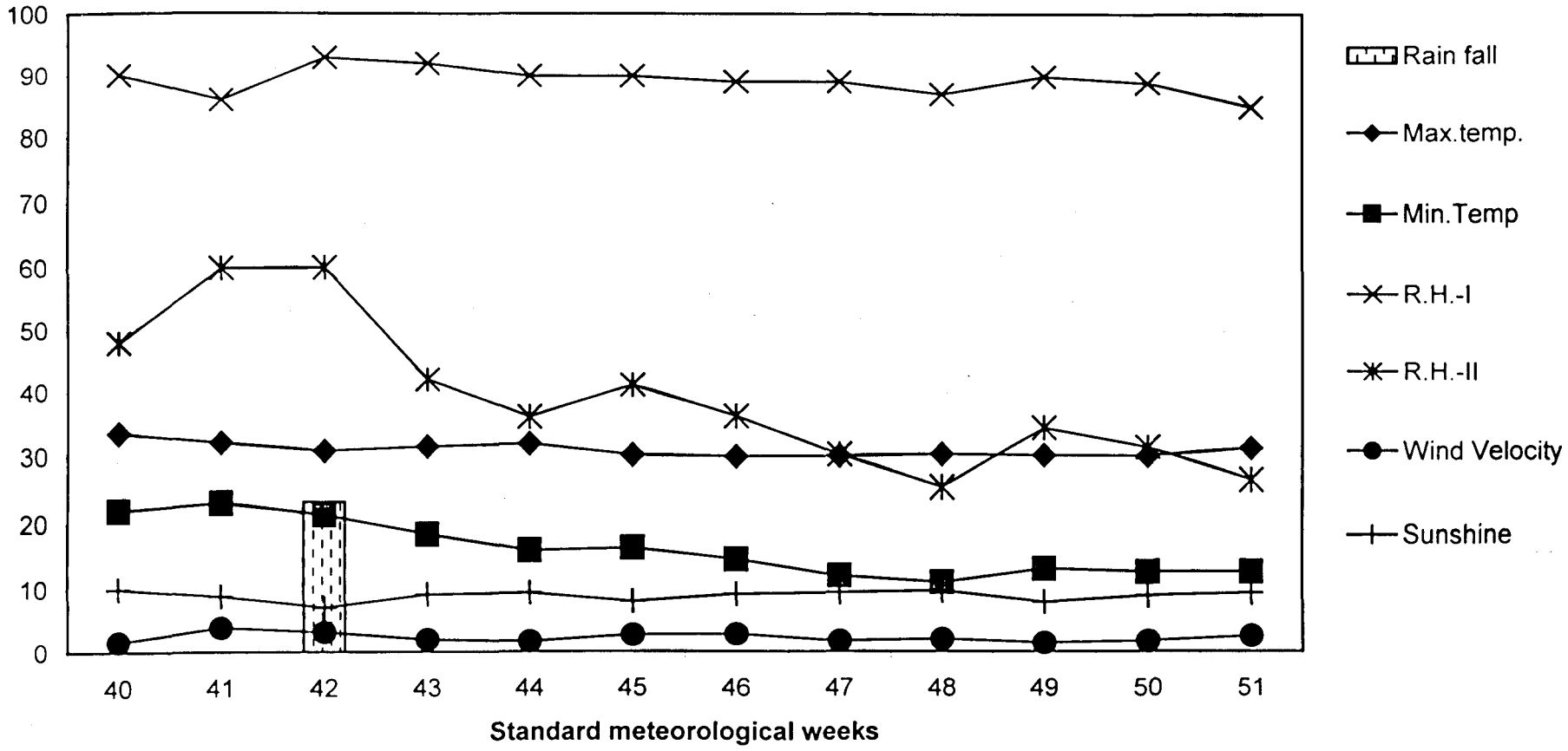

Fig. 3.1 Weekly meteorological data during the crop growth during Kharif 2002 period (1st October to 23rd December)

Table 4.12 : Population dynamics of insect pest of okra variety "Parbhani Kranti" and B.L.S.-55" during Kharif season (2002)

Insect pest/ natural enemies	Date of observation (mean population/ Plant)												
	07/10/02	14/10	21/10	28/10	4/11	11/11	18/11	25/11	2/12	9/12	16/12	23/12	Over al mean
Parbhani Kranti													
Jassid	2.4	3.6	3.4	3.2	4.6	2.8	2.8	3.4	5.6	6	4.8	4.6	3.99
White fly	0.00	1.8	3.2	2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40
Shoot & fruit borer	0.00	0.00	0.2	0.6	0.8	1.2	1.0	0.4	1	0.2	0.8	0.00	0.68
Aphid	0.00	0.00	0.00	0.00	16	21.4	3	0.00	0.00	0.00	0.00	0.00	13.46
B.L.S. –55													
Jassid	3.6	3.8	4.4	4.4	3.6	2.6	2.8	3.2	4	5.2	4.4	4.6	3.88
White fly	0.00	2.8	3.2	1.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.46
Shoot & fruit borer	0.00	0.00	0.2	0.6	0.6	1.4	0.8	0.4	0.8	0.2	0.6	0.00	0.60
Aphid	0.00	0.00	0.00	0.00	11.5	13	2.8	0.00	0.00	0.00	0.00	0.00	9.10

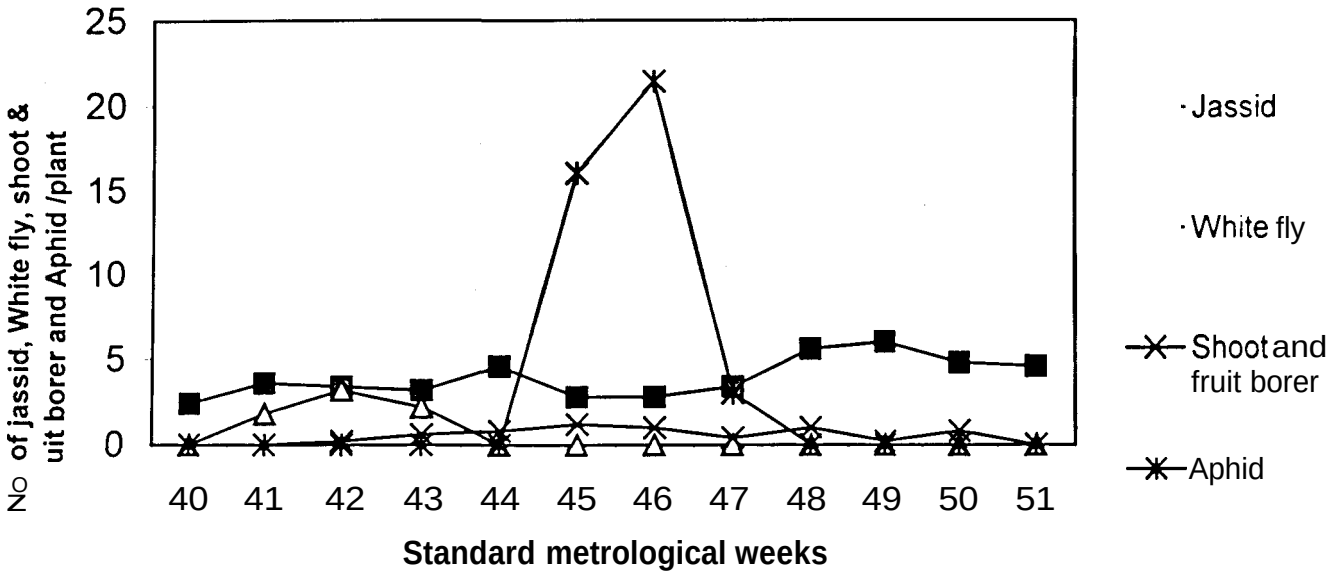

Fig. 4.3 Weekly insect pest population of okra in varities "Parbhani Kranti" corresponding to weather parameters, during crop growth period Kharif 2002

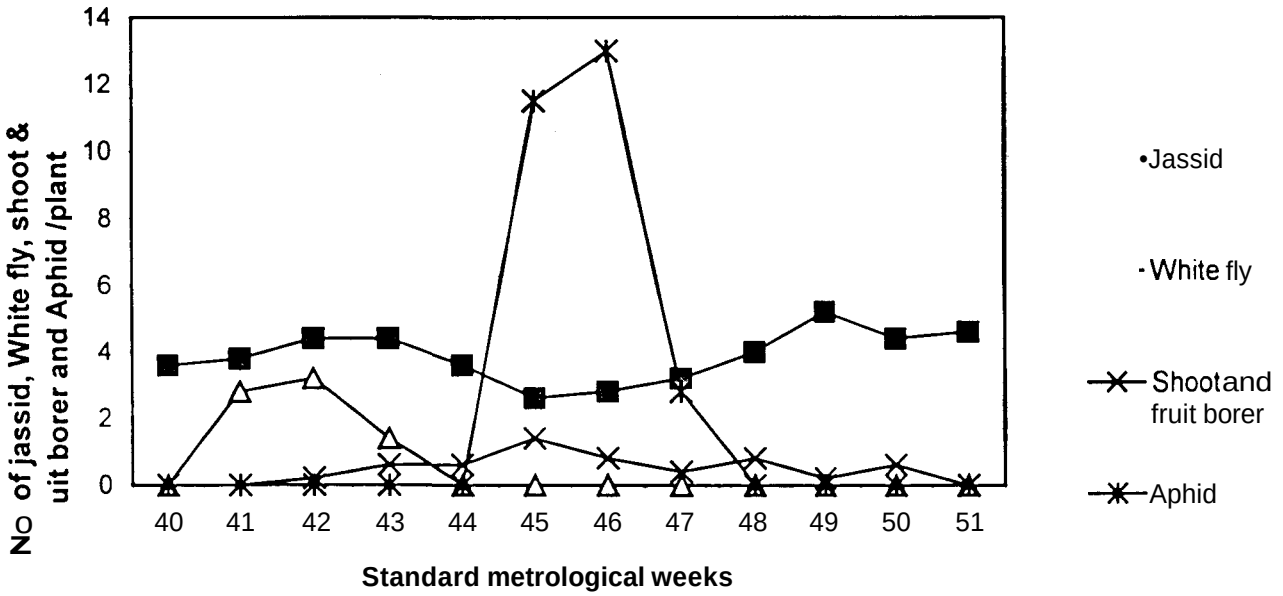

Fig. 4.4 Weekly insect pest population of okra in variety "BLS 55" corresponding to weather parameters, during crop growth period Kharif 2002

In case of varieties "B.L.S. - 55" the average population ranged from 2.6 to 5.2 jassid/plant during the season. Jassid appeared during the first week of October (40th SMW) with (3.6 jassid/plant). The maximum temperature during the week was 33.60°C and the minimum was 21.90°C with relative humidity 1 and II were 90% and 48% respectively. Population ofjassid reached to its peak of 5.2 jassid/ plant during the second week of December (49th SMW). When the maximum temperature during the week was 29.80°C and the minimum temperature was 12.90°C with relative humidity I 90% and II 34%. The over all seasonal mean ofjassid population were 3.99 and 3.88 jassid/ plant in varieties "Parbhani Kranti" and "B.L.S.-55" respectively.

4.3.1.2 Seasonal activity of okra white fly (*Bemisiatabaci)*

The next to appear on variety "Parbhani Kranti" was white fly during the second week of October (41st SMW) and the population was 1.8 white flies/plant. When the maximum temperature during the week was 32.20°C and the minimum temperature was 23.10°C with R.H. I 86% and II 60%. The maximum population was recorded as 3.2 white flies/plant during third week of October (42nd SMW). When the maximum temperature during the week was 30.90°C and the minimum temperature was 21.30 °C with R.H. I 93% and II 60%. In the fourth week of October (43rd SMW) the population was recorded as as 2.2 white flies/plant. On the consecutive weeks there was no population of white flies during the entire season.

In case of variety B.L.S. - 55 while flies appeared during the second week of October (41st SMW) with a population was 2.8 white flies/plant,

when the maximum temperature during the week was 32.20°C and the minimum temperature was 23.10°C with R.H. 1 86% and II 60%. The maximum population 3.2 white flies/plant was recorded during the third week of October (42nd SMW) when the maximum temperature was 30.90 oC and the minimum temperature was 21.30 with R.H. I 93% and II 60% due to week rainfall (23.20mm) during the last week of October (43rd SMW) the population was recorded as 1.4 white flies/plant. In the later weeks no population of white flies was found on the crop. The overall seasonal mean of white fly population were 2.40 and 2.46 white flies/plant in varieties "Parbhani Kranti" and "B.L.S.-55", respectively.

4.3.1.3 Seasonal activity of okra shoot & fruit borer (*E.vittela)*

In case of variety "Parbhani Kranti" the incidence of shoot and fruit borer, (*E.vittella*) was first recorded during the third week of October (42ndSMW) and the population was very low 0.2 larvae/plant. When the maximum temperature during the week was 30.90°C and the minimum temperature was 21.30°C with R.H. I 93% and II 60%. The population reached to its peak of 1.2 larvae/plant during the second week of November (45th SMW), when the maximum temperature during the week was 30.10°C and the minimum temperature 16.20 °C with R.H. I 90% and II 41%. During the later weeks there was progressive decline in the population.

In case of "BLS - 55" the incidence of shoot and fruit borer was first recorded in third week of October (42nd SMW), when the pest population was 0.2 larvae/plant. When the maximum temperature during the week was 30.90 °C and minimum temperature was 21.30 °C with RH - I 93% and II 60%. During

week rainfall (23.20 mm) the population reached to its peak of 1.4 larvae/plant during the second week of November (45th SMW), when the maximum temperature during the week was 30.10 °C and minimum temperature 16.20°C with RH I 90% and II 41%. During the onward weeks the population was progressively declining. The overall seasonal mean of shoot and fruit borer population were 0.68 and 0.60 larvae/plant, in varieties "Parbhani Kranti" and "B.L.S. - *55*". respectively.

4.3.1.4 **Seasonal** activity **of** okra Aphid *(Aphis **gossypii**)*

In case "Parbhani Kranti", the next pest to appear on crop was aphid *(Aphis gossypii).* It appeared on the crop during the first week of November (44th SMW), when the pest population was 16 aphid/plant , when the maximum temperature during the week was 31.90°C and the minimum temperature was 15.90°C with R.H.I 90% and II 36%, and reached its peak of 21.4 aphid/plant. during the second week of November (45th SMW) when the maximum temperature during week was 30.10 °C and minimum tempeature was 16.20°C with RH I 90% and II 41%. In the third week of November (46th SMW) low population with 3 aphid/plant was recorded and in further weeks there no aphid population.

In case of "BLS - *55*" the first aphid population was recorded during the first week of November (44th SMW) with 11.5 aphid/plant, when the maximum temperature during the week was 31.90 °C and minimum temperature was 15.90 °C with RH I 90 % and II 36%, and reached its peak of 13 aphid/plant in the second week of November (45th SMW), when the maximum temperature during the week was 30.10°C and minimum temperature was 16.20°C with RH I

90% and II 41%. During the third week of November (46^{th} SMW), low population was 2.8 aphid /plant was recorded. In further observations the aphid population was not noticed. The overall seasonal mean of aphid population were 13.46 and 9.10 aphid/plant, in varieties "Parbhani Kranti" and "BLS - 55", respectively.

It is therefore, concluded that among the insect pest recorded on okra, only jassid was found active during the entire cropping season, with varying populations , however. the maximum activity was recorded during the middle and later crop growth stages, when the minimum temperature was lower, during the cropping season. In case of white fly (*Bemisia tabaci*) the activity was recorded during the early crop growth stages only i.e. in the month of October only, when the minimum temperature was higher ranged from 18.40°C to 21.90°C. On both the varieties. The incidence of shoot and fruit borer *(Earias vittella)* started little but later i.e. from third of October and continued till the maturity of the crop, when the minimum temperature was lower, during the cropping season.

Aphid *(Aphis gossypii)*, was recorded on okra during the month of November only, i.e. during the vegetative crop growth stage, when the maximum temperature was moderately, raged from 14.40°C to 16.20°C, in both the varieties.

Effect of temperature :

Influence of ambient temperature an insect pest of okra variety "Parbhani Kranti" and "B.L.S.-55", during kharif 2002, and simple correlation studies between the minimum temperature and insect pest population.revealed that in variety "Parbhani Kranti", the correlation between the minimum temperature and jassid population /plant was found to be negative and significant, the V value

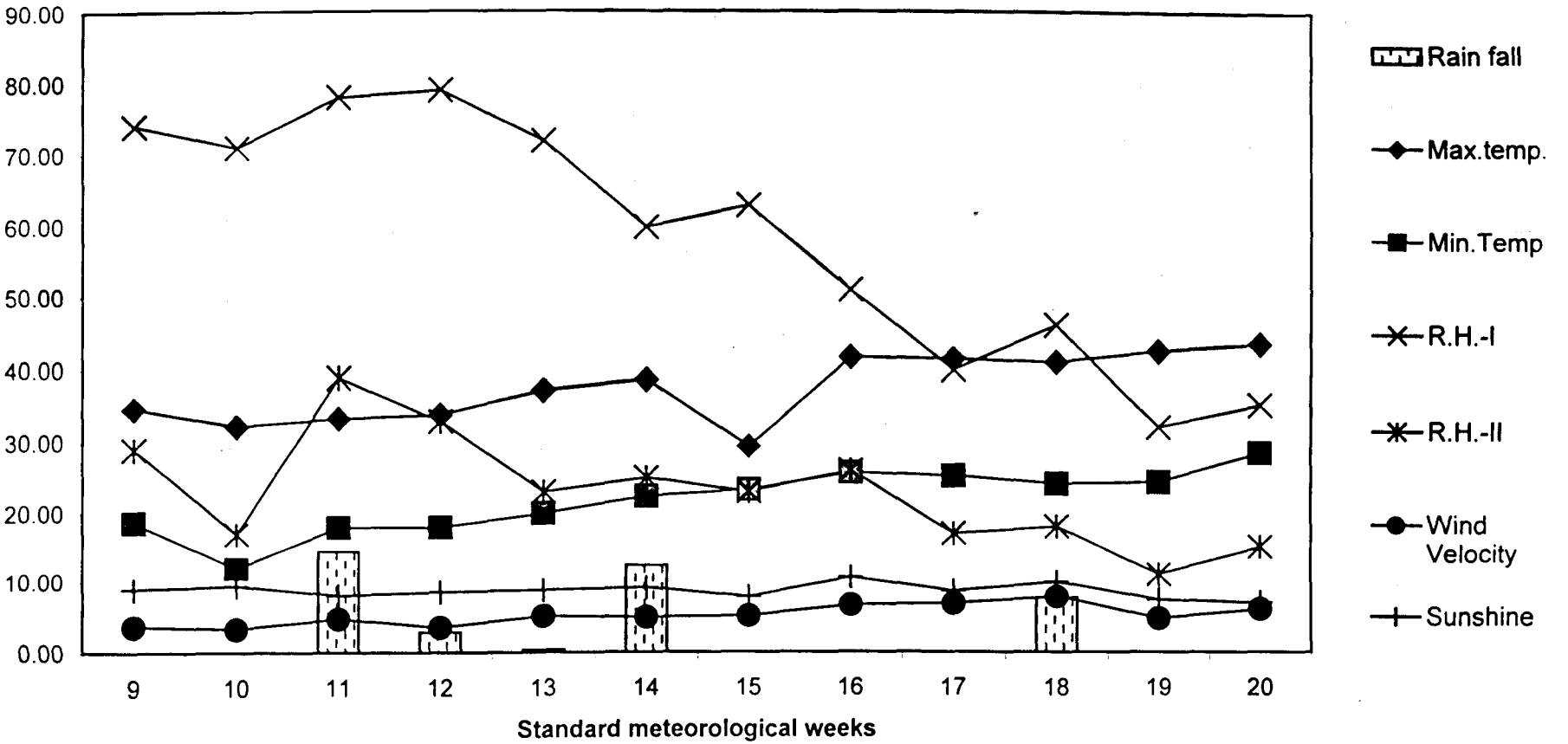

Fig. No. 3.2 Weekly meteorological data during the Rabi season crop growth period (26 February to 20 May 2003)

Table 4.13 : Population dynamics of insect pest of okra variety "Parbhani Kranti" and B.L.S.-55" during Rabi season (2003)

Insect pest/ natural enemies	Date of observation (mean population. Plant)												
	01/03/03	8/3	15/3	22/3	29/3	5/4	12/4	19/4	26/4	3/5	10/5	17/5	Over al mean
Parbhani Kranti													
Jassid	0.6	1.4	1.6	2.2	4	4.4	4.2	4.8	3.8	6.0	2.6	0.00	3.23
White fly	0.4	0.8	0.6	0.8	2.2	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.96
Leaf miner	0.00	0.6	1.4	0.4	0.00	0.0	0.00	0.0	0.00	0.00	0.00	0.00	0.80
Shoot & fruit borer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2	0.8	1	1.2	1.6	1.16
B.L.S.-55													
Jassid	0.8	0.6	2.2	2	2.4	4.2	4.8	3.8	2.2	5.0	4.6	0.00	3.10
White fly	0.00	0.00	1.6	0.8	0.8	0.00	0.00	0.00	0.00	0.00	0.05	0.00	1.06
Leaf miner	0.00	0.6	0.8	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Shoot & fruit borer	0.00	0.00	0.00	0.00	0.6	0.6	1	0.8	0.6	0.6	1.4	0.00	0.825

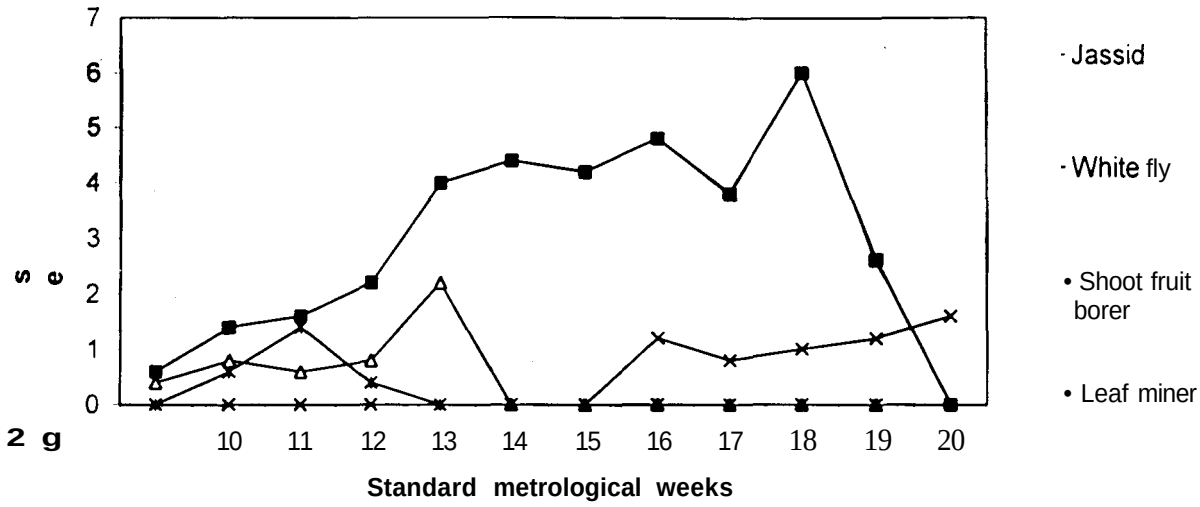

Fig. 4.5 Weekly insect pest population of okra in varieties **"Parbhani** Kranti" corresponding to weather parameters, during crop growth period Rabi 2003

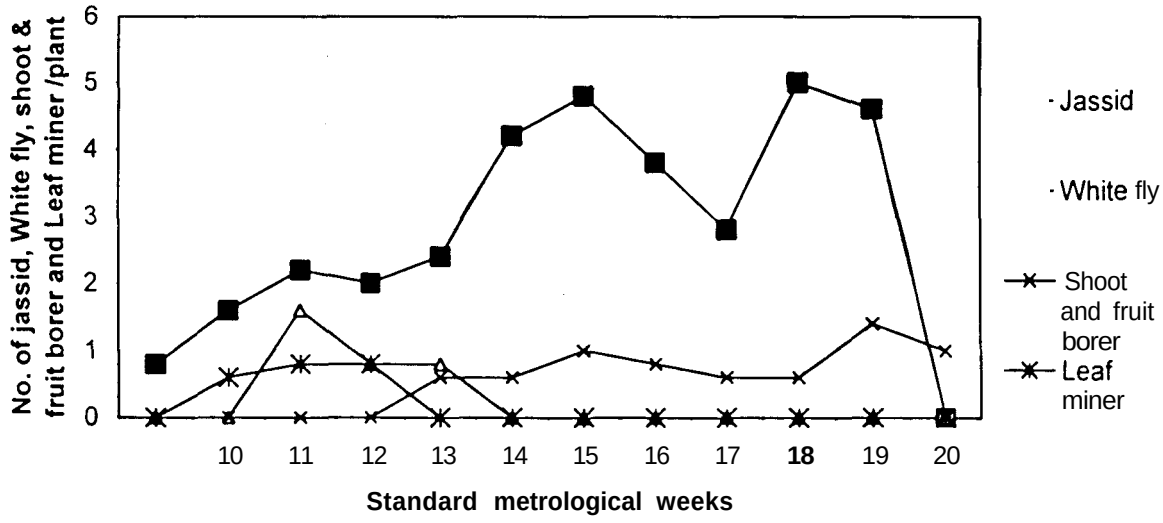

Fig. 4.6 Weekly insect pest population of okra in varieties "BLS 55" corresponding to weather parameters, during crop growth period Rabi 2003

being - 0.60083,and between the minimum temperature and white flies population /plant was found to be positive and significant, the 'r' value being 0.66518, and between the minimum temperature and shoot and fruit borer population / plant was found negative and non-significant, the 'r' value being –0.43861. and between the minimum temperature and aphid population /plant was found negative and non-significant, the 'r' value being -0.00324.

In case of variety "B.L.S.-55" the correlation between the minimum temperature and jassid population/plant was found negative and non-significant, the 'r' value being –0.8573, and between minimum temperature and white fly population/ plant was found positive and significant, the 'r' value being 0.7258, and between the minimum temperature and shoot and fruit borer population /plant was found negative and non significant, the 'r' value being –0.3506, and between minimum temperature and aphid population /plant was found negative and non-significant, the 'r' value being –0.01056.

4.3.2 During Rabi season 2003, studies on population dynamics of insect pest of okra were conducted on two varieties of okra viz. "Parbhani Kranti" and "B.L.S. - 55", which are among the most popular varieties grown in Chhattisgarh region. The finding are presented under the following sub heads.

4.3.2.1 Seasonal activity of okra jassid (***Amrascabiguttula biguttula***)

The data on intensity and population fluctuation in major insect pest in two varieties of okra viz. "Parbhani Kranti" and "B.L.S. - 55" , along prevailing weather condition during Rabi 2003 are presented Table 4.13. and Fig. 4.5 & 4.6.

Periodical observations on the incidence of major insect pests of okra in variety "Parbhani Kranti", revealed that the jassid appeared on the okra in the first week of March (9th S.MW.), with a population of 0.6 jassid/plant, when the maximum and minimum temperature during the week was 34.7°C and 21.90 °C with RH I and II as 90% and 48%, respectively. The population in its peak record to 6 jassid /plant during first week of May (18th SMW) when the maximum and minimum temperature during the week was 41.0°C and 24.0°C, respectively with RH I and II as 46 % and 18%, respectively. Further, there was decline in population and 2.6 jassid/plant was observed during the second week of May (19th SMW).

In case of "B.L.S. - *55"* , jassids appeared during the first week of March (9th SMW) with a population of 0.8 jassid/ .plant, when the maximum and minimum temperature was 34.7°C and 18.6°C with RH I and II as 74 % and 29% , respectively. The population of jassid reached to its peak of 5 jassid/plant, during the first week of May (18th SMW) during maximum and minimum temperature was 41.0°C and 24.0°C, respectively, with RH I and II as 46% and 18%, respectively, due to week rain fall (7.6 mm). Further, there was decline in population and 4.6 jassid/plant during the second week of May. The over all seasonal mean of population were 3.23 and 3.10 jassid/plant in varities "Parbhani Kranti" and "B.L.S. - 55" , respectively.

4.3.2.2 **Seasonal** activity of white fly **(*Bemisia tabaci*)**

The next pest to appear in variety "Parbhani Kranti" was white fly during the first week of March (9th SMW) with a population of 0.4 white flies

/plant, when maximum and minimum temperature was 34.7 and 18.6°C , with RH I and II as 74% and 29%, respectively. The maximum population was recorded as 2.2 white flics/plant during the last week of March (13 SMW), when the maximum and minimum temperature was 37.3°C and 20.0°C, with RH I and II as 72 % and 23%, respectively, on the consecutive weeks there was no population during the entire season.

In case of variety "B.L.S. - 55" white flies appeared the third week of March (11th SMW), with a population of 1.6 white flies /plant, and was the peak population during entire season when the maximum and minimum temperature was 33.4°C and 18.0°C , with RH I and II as 78% and 39%. Week rainfall (14.5 mm) during the last week of March (12th SMW), result in low population with 0.8 white flies/plant and in the further weeks there no white flies population. The overall seasonal mean of white flies population were 0.96 and 1.06 white flies/plant in varieties "Parbhani Kranti" and "B.L.S - 55", respectively.

4.3.2.3 Seasonal activity of okra shoot and fruit borer (*E.vittella)*

In case of variety "Parbani Kranti" the incidence of shoot and fruit borer *(E.vittella)* was first recorded during the thirs week of April (16th SMW) and the population was 1.2 larvae /plant, when the maximum and minimum temperature was 41.8°C and 25.7°C with RH I and II as 51% and 26%,respectively. The population reached to its peak of 1.6 larvae /plant during the third week of May (20" SMW), during which the maximum and minimum temperature was 43.3°C and 28.3°C with RH I and II as 35% and 15%, respectively.

In case of "B.L.S.-55 " the incidence of shoot and fruit borer was first recorded in last week of March (13th SMW) and the population was low 0.6 larvae/plant, where the maximum and minimum temperature was 37.3°C and 20.0°C with RH I and II as 72% and 23% , respectively. The population reached to its peak of 1.4 laevae/plant during the second week of May (19th SMW), when the maximum and minimum temperature was 42.4°C and 24.2°C , respectively , with RH I and II as 32% and I 1%, respectively. The overall seasonal mean of shoot and fruit borer population were 1.16 and 0.825 larvae /plant in varieties "Parbhani Kranti" and "B.L.S.-55", respectively.

4.3.2.4 Seasonal activity of okra leaf miner :

In case of "Parbhani Kranti" the leaf miner incidence was seen in the second week of March (10th SMW). The population was initially low i.e.0.6 maggot/plant, when the maximum and minimum temperature was 32.3°C and 12°C with RH I and II as 71% and 17%, respectively. The maximum population was recorded as 1.4 maggot/plant, during the third week of March (1 I th SMW) , when the maximum and minimum temperature was 33.4°C and 18.0°C with RH I and II as 78% and 39%, respectively. Due to rainfall (14.5 mm), on the consecutive weeks there was no population was of white flies during the entire season.

In case of "B.L.S.-55" leaf miner appeared during the second week of March (10th SMW), with a population of 0.6 maggot/plant, when the maximum and minimum temperature was 32.3°C and 12.0°C with RH I and II as 71% and 17%, respectively. The maximum population was recorded as 0.8 maggot/plant, during the third week of March (11th SMW), when the maximum and minimum

temperature was 33.4°C and 18.0°C with RH I and II as 78% and 39%, respectively. Due to rain fall (14.5 mm), in the consecutive weeks there was no population during the entire season. The over all seasonal mean of leaf miner population were 0.80 and 0.73 maggot/plant in varieties "Parbhani Kranti" and "B.L.S.-55" ,respectively.

It is there fore, concluded that among the insect pest recoded on okra only jassid was found active during the entire corpping season, with varying population, however, the maximum activity was recorded during the middle and later crop growth stages, when the minimum temperature was higher during the cropping season. In case of white flies (*Bemisia tabaci*) the activity recorded during the early crop growth stage i.e.in the month of March only, when the minimum temperature was lower. In case of "B.L.S.-55" the activity was recorded during the second week of Mach to last week of March only.

The incidence of shoot and fruit borer, *E.vittella* started from third week of April and continued till the maturity of the crop, when the minimum temperature was higher. In case of "B.LS. -55" incidence started from the last week of March and continued till the maturity of the crop.

Leaf miner (*Acrocercops bifscata Wlsm*) were recorded on okra during the month of March only i.e.during the vegetative crop growth stage, when the minimum temperature was lower in both the varieties.

Effect of temperature :

Influence of ambient temperature in insect pest of okra variety viz. "Parbhani Kranti" and "B.L.S.-55", during the Rabi season 2003 simple correlation studies between the minimum temperature and insect pest of okra.

Variety "Parbhani Kranti", the correlation between the minimum temperature and jassid population /plant was found to be positive and non significant, the 'r' value being 0.3128, and between minimum temperature and white flies population / plant was found to be negative and non-significant, the 'r' value being –0.5470, and between the minimum temperature and leaf miner population/plant was found to be negative and significant, the 'r' value being -0.5878, and between minimum temperture and shoot and fruit borer population/plant was found to be positive and significant.

In case of variety "B.L.S.-55", the correlation between the minimum temperature and jassid population / plant was found to be positive and non significant, the 'r' value being 0.2854, and between the minimum temperature and white fly population/plant was found to be negative and non significant, the 'r' value being -0.3919, and between minimum temperature and leaf miner population/plant was found to be negative and significant, the 'r' value being -0.70345, and between the minimum temperature and shoot and fruit borer population/plant was found to bc positive and significant, the 'r' value being 0.7882.

4.4 Evaluation of okra varieties against shoot and fruit borer, *Earias vitella*:

Experiments were conducted to evaluate okra varieties against shoot and fruit borer. *Earias vittella*, during kharif 2002 and rabi 2003 with 24 and 20 varieties, respectively. Observations on per cent fruit infestation, total yield and yield ofhealthy fruits, were recorded.

4.4.1 Per cent fruit infestation during kharif 2002.

The per cent fruit infestation, as affected by the shoot and fruit borer, *E. vittella* was computed on the basis of the total number of fruits and number of infected fruits and are presented in Table 4.14. The data on per cent fruit infestation revealed that during kharif 2002, the present infestation varied from 2.35 to 17.7 per cent. Minimum per cent fruit infestation were recorded from variety. O.H. 77(2.35%) followed by V.R.O.(2.84%), Raigarh -2 (5.35%) , V.R.O. - *6* (5.46%) and B.L.S.55 (5.64%), respectively. Higher per cent fruit infestation were recorded from variety J.D.P. -2, (17.07%) followed by "Kaweri selection(16.10%). O.D. (14.69%), Parbhani Kranti (13.75%) and VRO – 3 (13.79%), respectively.

4.4.2 Per cent fruit infestation during Rabi 2003

The per cent fruit infestation, as affected by the shoot and fruit borer. *E.vittella*, was computed on the basis of the total number of fruits ans number of infested fruits and are presented in Table 4.15.

The data on per cent fruit infestation reveal that during Rabi 2003. the infestation was higher as compared to Kharif 2002 varied from 16.66 to 49.65

per cent. Minimum per cent fruit infestation were recorded from variety "B.L.S. - 55" (16.66%) followed by B.L.S. - 45 (17%), Arka Abhaya, (19.80), J.D.P. - 4 (10.97%) and Daftari (21.60%) respectively. Higher per cent fruit infestation were recorded from variety, Kawari selection (49.65%), followed by J.D.P.-3 (44.94%), V.R.O. -3 (36.95%) C-2, (35.33%) and V.R.O.-4, (33.58%) respectively..

It is therefore concluded that among the varieties with least per cent infestation during the kharif season 2002, were O.H.77, V.R.O. - 5, Raigarh - 5, VRO - 6 and B.L.S. - 55. Higher per cent fruit infestation were recorded from vareties, J.D.P. -2, Kaweri selection, O.D.Parbhani Kranti, V.R.O. -3.

Table 4.14: Number of total healthy, damage fruit & per cent of infestation, fruit of okra in different varieties, during Kharif season (2002)

S.N.	Varieties	No. of fruit healthy	No. of fruits	Total no of fruits	% of damage
1.	Arka Anamika	206	20	226	8.84
2.	Arka Abhaya	232	21	253	8.30
3	VRO – 5	478	14	492	2.84
4.	Kasturi	-	-	-	-
5.	X-2	288	22	310	7.09
6.	VRO-6	346	20	366	5.46
7.	Raigarh 1	119	11	130	8.46
8.	Raigarh 2	57	4	61	6.55
9.	Raigarh 3	85	10	95	10.52
10.	Raigarh 5	106	6	112	5.35
11.	JDP – 2	34	7	41	17.07
12.	JPD –3	204	19	223	8.52
13.	JDP – 4	207	28	235	11.91
14.	BLS – 55	334	20	354	5.64
15.	Harsha	251	22	273	8.05
16.	B.L.S. – 45	257	19	276	6.88
17.	O.D.	180	31	211	14.69
18.	O.H.77	249	6	255	2.35
19.	JNDO –5	177	13	190	6.84
20.	V.R.O. - 3	300	44	344	12.79
21.	V.R.O. – 4	322	42	364	11.53
22	Kaweriselection	224	43	267	16.10
23.	Daftari	276	36	312	11.53
24.	Parbhani Kranti	207	33	240	13.75

Table 4.15 : Number of total healthy, damage fruit & per cent of infestation, fruit of okra in different varieties, during Rabi season (2003)

S.N.	Varieties	No. of fruit healthy	No. of fruits	Total no of fruits	% of damage
1.	JDP –2	49	20	69	28.98
2.	P.Kranti	45	20	65	30.76
3.	J.D.P.-3	49	40	89	44.94
4.	Kaweri selection	74	73	147	49.65
5.	VRO – 5	118	49	167	29.34
6.	X- 2	97	53	150	35.33
7.	O.H. -77	171	50	221	22.62
8.	VRO - 3	87	51	138	36.95
9.	VRO – 4	89	45	134	33.58
10.	JDP – 4	113	30	143	20.97
11.	VRO – 6	115	36	151	23.84
12.	Kasturi	-	-	-	-
13.	BLS – 55	135	27	162	16.66
14.	Arka Abhaya	81	20	101	19.88
15.	JNDO – 5	104	29	133	21.80
16.	Arka Anamika	61	20	81	24.69
17.	Dftari	98	27	125	21.60
18.	Harsha	59	26	85	30.58
19.	B.L.S. 45	83	17	100	17.00
20.	O.D.	65	27	92	29.34

During Rabi season 2003, least per cent infestation were recorded from B.L.S. - 45, Arka Abhaya. J.D.P. - 4. Daftari. Higher per cent fruit infestation were recorded from varieties like Kavvari selection, J.D.P. -2, V.R.O. - 3 , X-2 and V.R.O.-4.

4.4.3 Total yield of okra during Kharif 2002

The total yield of okra obtained in different varieties and presented in Table 4.16. The total yield of different varieties of okra ranged between 0.480 to 5.840 kg/plot (i.e. 20 to 243.33 q/ha). Maximum yield was recorded from variety V.R.O.-5, (5.84 kg/plot) followed by V.R.O. - 6, (4.540 kg/plot i.e. 189.16 q/ha VRO– 3 (4.385 kg/plot i.e. 182.70 q/ha) an VRO - 4 (3.905 kg/plot i.e. 162.70 q/ha). The lowest total yield, however, was recorded from J.D.P.- 2 and Raigarh - 2 , i.e. (0.480 kg/plot i.e. 20 q/ha) and (0.760 kg/plot i.e. 31.66 q/ha), respectively.

The yield of healthy fruit of okra ranged between 0.405 to 5.650kg/plot (i.e. 16.87 to 235.41 q/ha) maximum healthy yield was recorded from the variety VRO -5, (5.650kg/plot i.e. 159.37 q/ha) B.L.S.55, (3.7 kg/plot i.e. 154.16 q/ha) and VRO-4 (3.35 kg/plot i.e. 139.58 q/ha)

The lowest yield of healthy fruits however, was recorded from varieies J.D.P. - 2 and Raigarh - 2, i.e. (0.405 kg/plot i.e. 16.87 q/ha) and (0.670kg/plot i.e. 27.919 q/ha) respectively.

The per cent reduction in yield due to attack of shoot & fruit borer in different varieties of okra sanged between 2.82 to 1897 per cent. The least per cent reduction was recorded in O.H. -77, (2.82%), followed by V.R.O - 5 , (3.25%), Raigarh-5 (4.02%) , B.L.S. - 55, (5.37%) and Arka Abhaya (6.27%) .

Table 4.16 : Per cent reduction in yield due to infestation of *E.vittella* in different varieties, during Kharif season (2002).

S.N.	Varieties	Total yield		Healthyyield		% reduction in yield
		in (gm)	in q/ha	in (gm)	in Q/ha	
1.	ArkaAnamika	2200	91.66	2025	84.37	7.95
2.	Arka Abhaya	2470	102.91	2315	96.45	6.27
3.	VRO – 5	5840	243.33	5650	235.41	3.25
4.	Kasturi	-		-	-	-
5.	X-2	3440	143.33	3150	131.25	8.43
6.	VRO-6	4540	189.16	4230	176.25	6.82
7.	Raigarh 1	1695	70.62	1585	66.04	6.48
8.	Raigarh 2	760	31.66	670	27.91	11.84
9.	Raigarh 3	1240	51.66	1070	44.58	13.70
10.	Raigarh 5	1365	56.87	1310	54.98	4.02
11.	JDP – 2	480	20.00	405	16.87	15.62
12.	JPD –3	2225	92.70	2060	85.83	7.41
13.	JDP – 4	2555	106.45	2320	96.66	9.19
14.	BLS – 55	3910	162.91	3700	154.16	5.37
15.	Harsha	2640	110.00	2425	101.04	8.14
16.	B.L.S. – 45	2765	115.20	2575	107.29	6.87
17.	O.D.	2070	86.25	1725	71.87	16.66
18.	O.H.77	2830	117.91	2750	114.58	2.82
19.	JNDO -5	2030	84.58	1890	78.75	6.89
20.	V.R.O. – 3	4385	182.70	3825	159.37	12.77
21.	V.R.O. – 4	3905	162.70	3350	139.58	14.21
22	Kaweri selection	2820	117.50	2285	95.20	18.97
23.	Daftari	2995	124.79	2615	108.95	12.68
24.	Parbhani Kranti	2510	104.58	2175	90.62	13.34

The maximum per cent reduction in yield was recorded on varieties Kaweri selection (18.97%) followed by O.D.(16.66%), j.d.p.-2, (15.62%), VRO - 4. (14.21%) and Raigarh-3, (13.70%).

It is therefore concluded that among the varieties were showed during the kharif 2002, the maximum total yield, like VRO - 5 , VRO - 6, VRO - 3 . B.L.S. -55, VRO - 4 and this variety also showed the maximum yield of healthy fruits. The least per cent reduction was recorded in varieties O.H.-77, VRO-5. Raigarh - 5, B.L.S-55 Arka Abhaya.

4.4.4 Total yield of okra during Rabi 2003

The total yield of okra obtained in different varieties are presented in Table 4.17. The total yield of different varieties of okra ranged between 0.635 to 2.210 kg/plot (i.e.26.46 to 92.08 q/ha). Maximum yield was recorded from the varieties V.R.O.-5, (2.210 kg/plot i.e.92.08 q/ha) followed by O.H.-77, (1.625 kg/plot i.e. 67.70 q/ha), J.D.P.-4, (1.355 kg.plot i.e. 56.54 q/ha), B.L.S.-55, (1.315 kg/ha i.e.54.79 q/ha) and V.R.O.-6 , (1.250 kg/plot i.e.52.08 q/ha).

The lowest total yield, however, was recorded from varieties J.D.P.-2 (0.635 kg/plot i.e. 26.45 q/ha), Arka Abhaya (0.690 kg/plot i.e. 28.75 q/ha), Harsha, (0.865 kg/plot i.e. 36.04 q/ha), Parbhani Kranti (0.870 kg/plot i.e.36.04 q/ha) and O.D., (0.915 kg/plot i.e. 38.12 q/ha).

The yield healthy fruit of okra ranged between 0.290 to 1.580 kg/plot (i.e. 12.08 to 65.83 q/ha). Maximum healthy yield was recorded from the varieties V.R.O.-5, (1.580 kg/plot i.e.65.83 q/ha) followed by O.H.-77, (1.290

kg/plot i.e. 53.75 q/ha), J.D.P.-4, (1.075 kg/plot i.e.44.79 q/ha) , B.L.S.-55, (1.015 kg/plot, i.e.42.29 q/ha) and VRO - 6 , (0.910 kg/plot i.e. 37.91 q/ha)

The lowest healthy yield, however was recorded from varieties J.D.P.3 (0.290 kg/plot i.e 12.08 q/ha), Kaweri selection, (0.500 kg/plot i.e. 20.83 q/ha), Arka Abhaya (0.540 kg.plot i.e.22.50q/ha), Prabhani Kranti (0.605 kg/plot i.e. 25.20 q/ha) and Harsha, (0.605 kg/plot i.e. 25.20 q/ha).

The per cent reduction in yield due to different varieties of okra varied ranged between 18.03 to 59.51 per cent. The least per cent reduction was recorded in varieties B.L.S.-45, (18.03 %) followed by JNDO-5, (20%), O.H.-77, (20.61%), JDP-4, (20.66%) and Arka Abhaya, (21.73%).

The maximum per cent reduction in yield was recorded on varieties Kaweri selection (59.51%) followed by J.D.P.-3 (54.33%), X-2, (41.73%), VRO - 3 (37.19%) and Arka Anamika (31.05%).

It is therefore concluded that during the Rabi season 2003 among the varieties VRO-5, O.H.-77, J.D.P.-4, B.L.S.-55,V.R.O.-6 showed the maximum total yield and maximum yield of healthy fruits. The least per cent reduction of yield was recorded in varieties B.L.S.-55, JNDO-5, O.H.-77, .D.P.- 4 and Arka Abhaya.

Simple correlation studies between the yield of healthy fruit of okra and per cent reduction in yield, and regression equation in during kharif 2002 and rabi 2003.

Table 4.17 : Per cent reduction in yield due to infestation of *E.vittella* in different varieties, during Rabi season (2003)

S.N.	Varieties	Total yield		Healthy yield		% reduction in yield
		in (gm)	in q/ha	in (gm)	in Q/ha	
I.	JDP –2	1045	43.54	725	30.20	30.62
2.	P.Kranti	870	36.25	605	25.20	30.45
3.	J.D.P.-3	635	26.45	290	12.08	54.33
4.	Kaweri selection	1235	5.45	50	20.83	59.51
5.	VRO – 5	2210	92.08	1580	65.83	28.50
6.	X- 2	1150	47.91	670	27.91	41.73
7.	O.H. –77	1625	67.70	1290	53.75	20.61
8.	VRO – 3	1035	43.12	650	27.08	37.19
9.	VRO – 4	1040	43.33	725	30.20	30.28
10.	JDP – 4	1355	56.54	1075	44.79	20.66
11.	VRO – 6	1250	52.08	910	37.91	27.20
12.	Kasturi	-	-	-	-	-
13.	BLS – 55	1315	54.79	1015	42.29	22.81
14.	Arka Abhaya	690	28.75	540	22.50	21.73
15.	JNDO - 5	1050	43.75	840	35	20.00
16.	Arka Anamika	950	35.58	655	27.29	31.05
17.	Dftari	1075	44.79	845	35.20	21.39
18.	Harsha	865	36.04	605	25.20	30.05
19.	B.L.S. 45	915	38.12	750	31.25	18.03
20.	O.D.	915	38.12	650	27.08	28.96

During kharif 2002. The correlation between the yield of healthy fruit of okra and per cent reduction in yield was found to be negative and non-significant, the 'r' value being –0.1166. The regression equation y = 34.7379, x - 0.1272, where y is the yield of healthy fruit of okra and x is the per cent reduction in yield, this indicate that per cent reduction in yield decrease. (Fig.4.7)

During rabi 2003. the correlation between the yield of healthy fruit and per cent reduction in yield was found to be negative and non-significant, the 'r' value being –0.1399. The regression equation y = 111.4711 x- 1.5352, where y is the yield fruit and x is the per cent reduction in yield. This indicate that per cent reduction in yield decrease. (Fig 4.8)

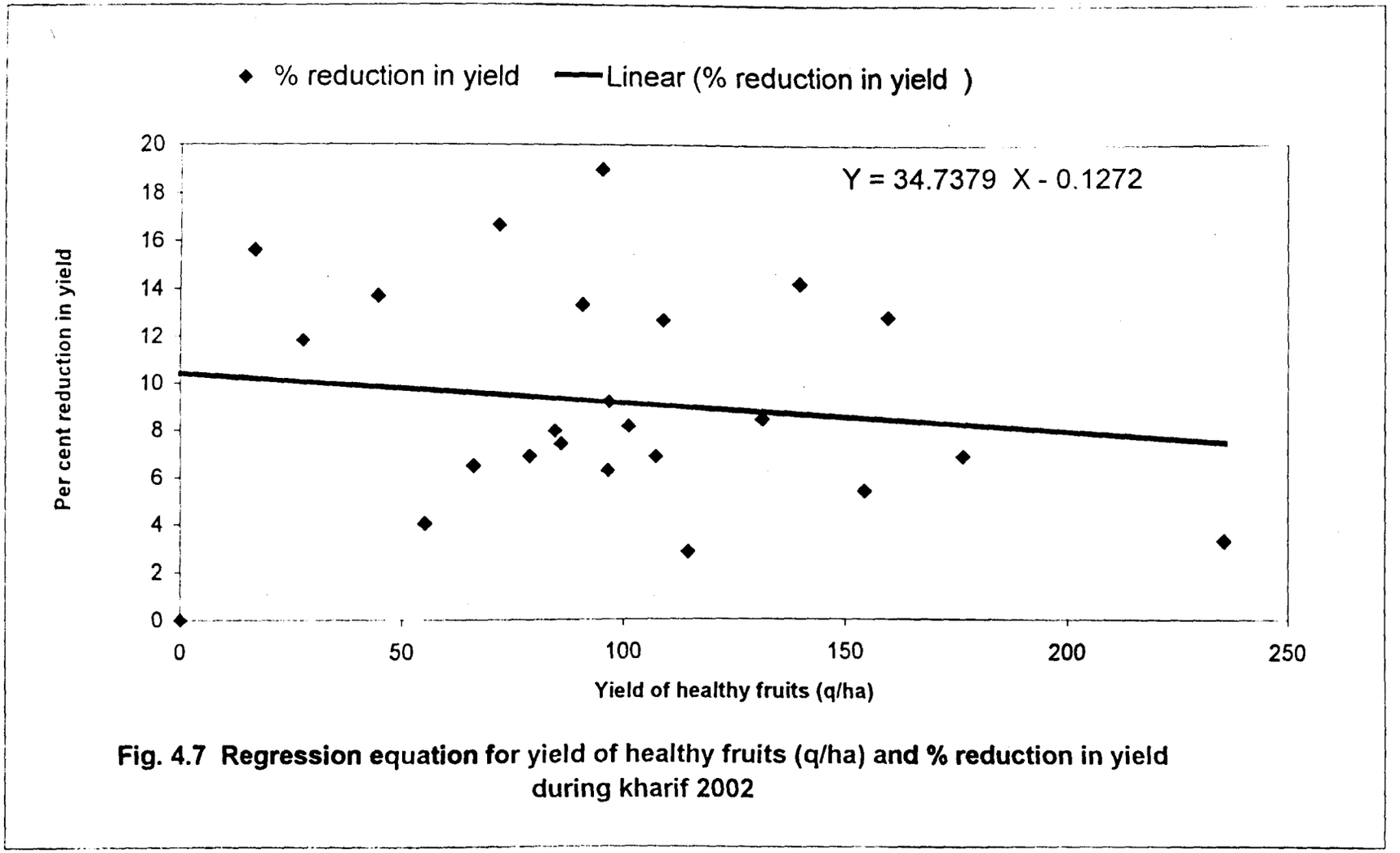

Fig. 4.7 Regression equation for yield of healthy fruits (q/ha) and % reduction in yield during kharif 2002

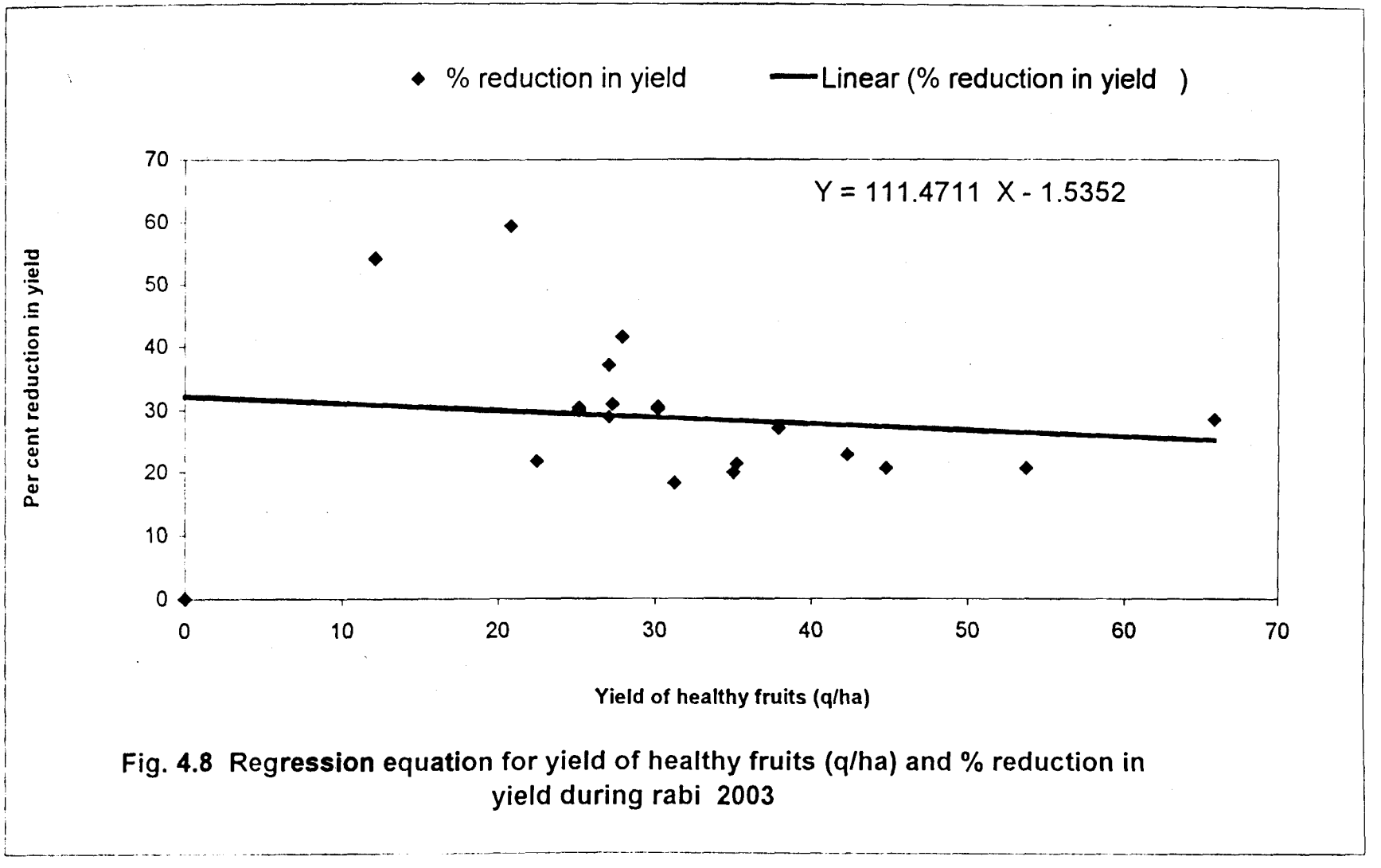

Fig. 4.8 Regression equation for yield of healthy fruits (q/ha) and % reduction in yield during rabi 2003

Discussion

CHAPTER-V

DISCUSSION

5.1 Studies on pest succession in okra crop :

In the present investigation nine insect species were found infesting okra in this region right from its germination to the maturity stage, namely jassid, *Amrasca biguttula biguttula*, white fly, *Bemisia tabaci* shoot and fruit borer, *Earias vittella*, aphid, *Aphis gossypii*, semilooer, *Anomis flava*, Red cotton bug *Dysdercus* koenigii Red hairy caterpillar *Amsacta moorei*, gram pod borer, *Heliothis armigera* and green stink bug, *Nezara viridula* during the kharif 2002. And rabi 2003. Five insect species were found damage the okra crop, namely jassid, white fly, leaf miner *(Acrocercrops bifasciata* Wlsm) shoot and fruit borer and semi looper, with varying degree of infestation during different crop stage.

Shoot and fruit borer was recorded through out the cropping season i.e. from second week of October to third week of December, with the maximum population in the IInd week of November, (1.08 larvae/plant), during kharif 2002, and rabi 2003. Shoot and fruit borer was recorded from IVth week of March to IIIrd week of May with maximum population IIIrd week of May (1.10 laevae/plant). In rest of the season the population was comparatively low.

These findings are in accordance with that of Dhamdhere *et.al*, (1984), Dhawan and Sidhu (1984), who also observed the incidence *of Earias* sp. on okra. They reported that the larval population was (1.4/plant) in late July. The population of *Earias* sp. increased slowly up to mid September and rapidly their after in present investigation, however, the peak population was observed during

November. This is because of the fact that the present investigation was carried out in the late kharif seasons. Kumar and Urs (1988) recorded the seasonal incidence of *Earias vittella* on okra. Singh and Bichoo (1989) observed the injuriousness of *E. vittella* and *E.insulana* on okra. Srinivasan (1993) reported shoot and fruit borer, *E.vittella* and *E.insulana* Boisd. as serious pests on okra.

The leaf miner appeared from early vegetative stage of the crop, findings of the present investigation in which the maximum population (0.68/plnant) was found in the IIIrd week of March are more or less in agreement to Bhagat (1996), who also observed this pest with peak population (15.75 adult/110 plants) in 9th SMW.

The next insect pest which appeared was aphid *(Aphis gossypii)*, it was observed from vegetative stage from i.e. IVth week of October to IVth the week of November. Its maximum population (19.58/ plant) was seen in IInd week of November during kharif in present investigation. Dhamdhere *et.al*, (1984) also recorded it as a minor pest on okra at Gwalior (Madhya Pradesh), whereas, Choudhary and Dadheech (1989) reported that the peak population (2.89/ plant) in summer crop.

The next insect pest jassid was recorded through out the cropping season right from its germination the maturity stage. According to Dhamdhere *et.al*, (1994), the activity ofjassid was observed throughout the kharif and summer season in okra crop. In the present investigation, the period of activity was observed during Ist week of October to last week of December with a peak population (5.45/ plant) during IInd week of December, during the kharif season

2002 and during the rabi season 2003, the period of activity was observed during Ist week of March to IInd week of May, with a peak population of (4.46jassid/ plant) during Ist week of May. Similarly, Kakar and Dogra (1988) have reported this pest as the most important pest of okra in Himachal Pradesh, while Chaudhary and Dadheech (1989) have reported on intensity of 4.78/leaf in Rajasthan during the summer.

The white fly, *Bemisia tabaci* was found from vagetative stage i.e. IInd week of October to last week of October, with a peak population (2.7/ plant) was observed during the third week of October, during kharif season 2002, and during rabi season 2003, white fly was found i.e.Ist week of March to last week of March with a peak population (0.94.plant) during the IInd week of March. Dhamdhere *et.al*, (1984) reported it as a minor pest on okra at Gwalior (Madhya Pradesh), Choudhary and Dhadheech (1989) observed its population as very low (0.78/leaf). Singh *et.al*, (1993) also reported it as a pest on okra.

The pest semilooper, *Anomis flava* was found in during IVth week of October to first week of December with a peak population (0.03/plant) during Ist week of December in kharif 2002. In rabi 2003, the activity of semilooper was during Ist week of March to Ist week of May, with a peak population (0.06/plant), during the IIIrd week of March. Dhamdhere *et.al*, (1984) observed the pest of okra and semilooper during the kharif (hot) season of 1980 and summer 1981 at Gwalior (M.P.). Bhagat (1996) observed the semilooper on okra crop during summer season of 1996 at Raipur.

The next pest was red cotton bug, *Dysdercus koenigii* which appeared in later stage of crop i.e. III[rd] week of November to last week of December with a peak population (0.19/plant) IV[th] week of December during kharif season 2002. Dhamdhere *et.al,* (1984) also reported *Dysdercus koenigii* as a minor pest on okra. Bhagat (1996) observed the Red cotton bug on okra crop during summer season 1996 at Raipur.

The pest *Heliothis armigera* attacked the crop at vegetative stage. In the present investigation activity *Heliothis armigera* was recorded during I[st] week of November. With a peak population (0.08/plant), in the IV[th] week of October during kharif 2002, Singh *et.al*, (1993) have been also reported *Heliothis armigera* (Hub). as a pest on okra crop.

Other insect pest i.e. Red hairy caterpillar, *Amsacta moorei*, green stink bug, *Nezara viridula* have been found infesting the crop at different stages but their population in general, were not high in the present investigation. The above insects have also been reported by Dhamdhere *et.al,* (1984) and other authors as infesting the okra crop.

Natural enemies like lady bird beetles, *Coccinella* sp. Damsel fly. *Coenagrion* sp. , Rove beetle, *Peaderus* sp. and spiders have also been recorded in the present investigation though in very small numbers in both the seasons.

In this way, in the present piece of study for the insect pest succession on the okra crop. 24 varieties during kharif 2002 and 20 varieties during rabi 2002 were observed. The crop was invaded by nine insects pests during kharif 2002 and by five during rabi in an overlapping manner, like wise Ewete (1983)

reported seventy two insects on okra in Nigeria, while Dhamdhere *et.al*, (1984) found twelve insect pests on okra during the kharif and summer season at Gwalior (Madhya Pradesh) and Bhagat (1986) also observed twelve insect pest on okra at IGAU, Raipur (Madhya Pradesh)

5.2 **Biology *of Earias vittella* (Fab.) on okra :**

Biology of *Earias vittella* (Fab.) was studied under laboratory condition using okra leaf as the host plant. The result of the biology of the *Earias vittella* (Fab.) are being discussed here.

The present investigation indicate that the average egg., larval and pupal period were 3.4, 14.6 and 10.2 days, respectively. The longevity of male and female moths were 3.83 days and 6.49 days, respectively. Total life cycle on an average was completed in 32.03 days in case of male and 34.69 days in case of female, respectively.

Dadgeon (1916) reported that the average duration of the egg and , larval period, were 3-4 , and 14 days, respectively, whereas pupal and adult period were of more than a month. The findings of the present investigation of egg and larval period is similar to that reported by Dadgeon (1916). The longevity of the pupae and adult in the present investigation is 10.2 days and 3.83 - 6.49 days, respectively, which are not in agreement, with that of Dadgeon who reported of much higher duration than recorded in the present investigation.

The total life cycle on an average was completed in 32.03 to 34.69 days in the present investigation. This is in agreement with the findings of Fletcher and Mishra (1920) who have reported that the life cycle from egg to adult in case

of *Earias vittella* (Fab.) to be completed which 21 to 32 days. This trend is more or less similar with that of the present investigation.

Butac (1939) reported that. the egg, larval and pupal stage were completed in 2 to 4 . 11 to 17 and 8 to 11 days, respectively, which are following the same trend as found in the present investigation.

Butac (1939) reported the adult longevity up to 4 weeks. whereas, the present investigation recorded 3.83 to 6.49 days only, which is much lower than the reported one.

Cherian and Kylasam (1947) reported that, the egg, larval and pupal stage lasted for 2.5 to 3 , 10 to 12 and 7 to 10 days respectively and longevity of adult was up to 15 days. In the present investigation the average egg, larval and pupal period varied from 3.4 to 14.6 and 10.2 days respectively, and the longevity of adult varied from 3.83 to 6.49 days which is not similar to that of Cherian and Kylasam (1947).

Pant (1960) reported that the egg. pupal and adult longevity were 3 to 4 , 4 to 15 and 8 to 10 days respectively, this trend is more or less similar with that of the present investigation.

Tasi and Yu (1962) reported that in *Earias vittella* (Fab.) the egg, larval, pupal period were 3 to 6 , 10 to 28 and 5 to 25 days respectively, which is similar with that of the present investigation.

Singh and Bichoo (1989) reported that egg, larval, pupal and adult period of *Earias vittella* (Fab.) were 3 to 4, 9- 17, 6 – 14 and 2 to 6 days

respectively, which are following the same trend as found the present investigation. The total life cycle varied from 19 to 29 days, the finding of the present investigation is also following more or less the same trend in the total life cycle of *Earias vittella*.

Kain (1998) supports the finding of the biology of*Earias vittella* in the present investigation. According to him the average duration to egg, larval and pupal period were 3.5, 14.0 and 9 days, respectively. He also reported that the female moth survived longer than the male moth.

5.3 Population dynamics/seasonal incidence of insect pest of okra :

(a) Jassid :

During kharif 2002, in variety :Parbhani Kranti" seasonal activity of okra jassid *A.bigutula biguttula* was observed throughout the cropping season. Jassid appeared in the first week of October (40^{th} SMW) with a population of 2.4 jassid/plant, and reached to its peak (6 jassid/plant) during the second week of December (49^{th} SMW).

In case of variety "B.L.S.-55", jassid appeared during the first week of October (40^{th} SMW), with 3.6 jassid/plant and population reached to its peak of 5.2 jassid/plant, during the second week of December (49^{th} SMW). During rabi 2003, however variety "Parbhani Kranti" jassid appeared in first weekof March (9^{th} SMW) with a population of 0.6 jassid/plant and the population was in its peak of 6 jassid/plant, during the first week of May (18^{th} SMW).

In case of varieties "B.L.S.-55", jassid appeared during the first week of March (9th SMW) with a population of 0.8 jassid/plant, reached to its peak of 5 jassid/plant, during the first week of May (18th SMW).

The finding of the present investigation are in accordance with that of Dhamdere *et.al*, (1984), who observed the activity of jassid throughout the kharif season on okra crop. Mahmood *et.al,* (1990) reported *A.devastans* appearing in June and remained active until end of crop season, this findings also supports the result of the present investigation.

The correlation between jassid populations with mimimum temperature was found to be negative and significant in variety "Parbhani Kranti", in case of "B.L.S.-55", however it was non-significant during kharif 2002. During rabi 2003variety "Prabhani Kranti" and "B.L.S.-55" the correlation was found to be positive and non-significant. The present findings are in agreement with those of Sriramula and Ravi (1997) who found jassid population negative correlated with temperature. The result also in accordance with those of Patel *et.al*, (1997) who reported significant relation between jassid population and maximum temperature and non-significant relationship with other weather parameters.

(B) Aphid **(*Aphis gossypii*):**

During kharif 2002 in variety "Parbhani Kranti" aphid *(Aphis gossypii)* appeared on okra during the first week of November (44th SMW) with a population of 16 aphid/plant and reached to its peak of 21.4 aphid/plant, during the second week of November (45th SMW). In case of "B.L.S.-55" aphid appeared during the first week of November (44th SMW) with 1 1.5 aphid /plant, and reached

to its peak of 113 aphid/plant in second week of November (45th SMW). Choudhary and Dadheech (1989), have also reported the occurrence of *A.gossypii* as economically important pest on okra in Rajasthan, having a population of 2.89 aphid/leaf. Correlation between aphid population/plant and minimum temperature was found negative and non-significant, during kharif 2002 in variety "Parbhani Kranti". These findings are in agreement with that of Patel *et.al,* (1997) who found non-significant relationship between population aphid and weather parameters.

(C) Shoot **and fruit borer (*E.vittella*)**

During kharif 2002, *E.vittella* in variety "Parbhani Kranti" appeared during the third week of October (42 nd SMW) however, the population was very low (0.2 larvae/plant) and population reached to its peak of (1.2 larvae/plant), during the second week of November. In case of "B.L.S.-55" pest appeared during the third week of October (42 nd SMW), with a population of (0.2 larvae/plant) and reached to its peak of (1.4 larvae/plant), during the second week of November (45th SMW).

During rabi 2003, variety "Parbhani Kranti" *E.vittella* appeared during first weekof April (16th SMW), and the population was 1.2 larvae/plant. the population reached to its peak of 1.6 laevae/plant, during the third week of May (20th SMW). In case of "B.L.S.-55", the pest appeared in the last week of March (13th SMW) with a population of 0.6 larvae/plant, where reached to its peak of 1.4 larvae/plant, during the second week of May. These finding are in accordance with that of Dahmdhere *et.al,* (1984) and Dhawan and Sidhu (1984), who reported the incidence of *E.*sp on okra in Punjab, India, during 1994-77, the larval population

(1.4.plant) was observed in late July. Srinivasan (1993) has also reported shoot and fruit borer. *E.vittella* and *E.insulana* Boisd. as serious pest on okra.

During kharif, 2002 the correlation between shoot and fruit borer with minimum temperature was found negative and non-significant in variety "Parbhani Kranti" and variety "B.L.S.-55", both.

During rabi 2003 in both the varieties "Parbhani Kranti" and "B.L.S.-55" the correlation between shoot and fruit borer with minimum temperature was found to be positive. Patel (1997), however reported non-significant relationship between population of *Earias vittella* with any weather parameters.

(D) White fly :

During kharif 2002, *Bemisia tabaci* in variety "Prabhani Kranti" seasonal activity of okra white fly Bemisia *tabaci* was observed in the vegetative stage only and appeared in the second week of October (41st SMW) with a population of 1.8 white flies/plant, and maximum population 3.2 white flies/plant during third week of October (42nd SMW). In case of variety "B.L.S.-55" pest appeared during the second week of October (41st SMW) with a population of 3.2 white flies/ plant, during the third week of October (42nd SMW).

During rabi 2003: however in variety "Parbhani Kranti" white fly appeared in first week of March (9th SMW) with a population of 0.4 white flies/plant and the population reached to its peak 2.2 white flies/plant during last week of March (13th SMW). In case of varieties "B.L.S.-55", white fly appeared during the third week of March (11th SMW) with a population of 1.6 white

flies/plant, and it is peak population during the entire season during the last week of March (13th SMW), low populaiton with 0.8 white flies/plant was recorded.

Dhamdhere *et.al*, (1984) reported it as a minor pest on okra at Gwalior (Madhya Pradesh). Choudhary and Dadheech (1989) observed its population as very low (0.78/leaf). Singh *et.al*, (1993) also reported it on a pest on okra. These finding also support the result of the present investigation. During kharif 2003 correlation between white files population with minimum temperture was found positive and significant in both varieties "Parbhani Kranti" and "B.L.S.-55". During rabi 2003, in varieties "Parbhani Kranti" and "B.L.S.-55" the correlation was found to be negative and non-significant. Dhawan *et.al,* (1998) reported that weather played a significant role in population build-up during 1995.

(E) Leaf Miner :

During rabi 2003 in variety "Parbhani Kranti" leaf miner appeared on okra during second week of March (10th SMW) with a population of 0.6 maggot/plant, the maximum population of 1.4 maggot/plant during the third week of March (11th SMW). In case of "B.L.S.-55" leaf miner appeared during second week of March (10t SMW) with a population of 0.6 maggot/plant. The maximum population of 0.8 maggot/plant during the third week of March (11th SMW). Leaf miner were recorded on okra during the month of March only i.e. during the vegetative crop growth stage. These findings are in agreeent with that of Bhagat (1996) who also observed this pest with peak population (15.75 adult /10plant) in 9th SMW

Kain (1998) also observed this pest with peak population 47.33/20plants in 12th SMW. Correlation between leaf miner population with

minimum temperature was found negative and significant in "Parbhani Kranti" in case of "B.L.S.-55", it was found positive and significant.

5.4 Evaluation of okra varieties against shoot and fruit borer, ***Earias vittella*** (Fab.)

During kharif 2002, 24 varieties of okra were recorded against shoot and fruit borer, *Earias vittella.* Among them, varieties, O.H.-77, VRO -5, Raigarh 5, VRO-6 and B.L.S.-55, were found least susceptible to the pest, similarily during rabi 2003 , B.L.S.-55, B.L.S.-45, Arka Abhaya, J.D.P.-4 and Daftari were comparatively less attacked by the pest. The data of both the seasons. indicate that O.H.77, VRO-5, Raigarh-5, VRO-6 and B.L.S.-55 varieties were comparatively resistant to shoot and fruit borer, *Earias vittella.*

As far as yield is concerned though it is a varietal character, however best on the basis of less infestation by the shoot and fruit borer and giving higher yield, the varieties like VRO-5, VRO-6, B.L.S.-55, O.H.-77, VRO-3 can be said on better varieties among the evaluated ones. These findings are in a agreement with that of Khambete and Desai (1996) who screened 26 okra cultivars for resistance to shoot and fruit borer (*E.vittela*)in naturally infested field. 20-30% infestation was recorded by shoot and fruit borer damage. Abhishek *et.al*, (1998) observed that on field trials conducted at two different locations in Madhya Pradesh during summer 1993 to test seven okra varieties/ hybrids for resistance to *Earias vittella* (Fab.), varieties Ankur 35 and "Parbhani Kranti" registered significantly higher shoot damage (7.5 and 8%) but produced higher healthy fruit yield of 72.81 and 62.06 q/ha.

Summary, Conclusion and Suggestions for Further Work

CHAPTER – VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

The present investigation entitled "Studies on insect pest of okra, *Abelmoschus esculentus* (L). Moench in Chhattisgarh with special reference to shoot and fruit borer, *Earias vittela* (Fab.)" was carried out at Department of Entomology. Indira Gandhi Agricultural University, Raipur during kharif and rabi season of 2002-2003.with the following objectives :

(1) To study the insect pest succession in okra.

(2) Biology of shoot and fruit borer, *Earias vittella* (Fab.) on okra.

(3) Population dynamics/seasonsal incidence of insect pests of okra.

(4) Evaluation of okra varieties against shoot and fruit borer, *Earias vittella* (Fab.)

To study the insect pest succession in okra crop, during kharif and rabi 2003-2003, observations were recorded on 5 randomnly selected plants for the presence of insect pest and natural enemies through out the cropping season in the field. Over all nine insect pests namely jassid, *A.bigutulla biguttula*, white fly, *Bemisia tabaci*, shoot and fruit borer, *Earias vittella,* aphid, *Aphis gossypii*, semilooper, *Anomis flava*, red cotton bug *Dysdercus koenigii*, red hairy caterpillar, *Amsacta moorei*, gram pod borer, *Heliothis armigera* and green stink bug, *Nczara viridula*, during kharif 2002, and rabi 2003, five insect species were found infesting the okra crop, namely jassid, white fly, leaf miner, shoot and fruit borer,

semilooper, with varying degree of infestation during different crop stage. Among them jassid and shoot and fruit borer were found as important insect through out the crop growing period in both the seasons. During kharif shoot and fruit borer was recorded from second week of October to third week of December. Maximum insect population (i.e. 1.08 larvae/plant) during second week of November. In case of jassid it was recorded from first week of October to last week of December, with a peak population (5.45/plant), during IInd week of December. During rabi 2003, shoot and fruit borer was recorded during fourth week of March to third week of May with a peak population 1.10 larvae/plant, during third week of May. Jassid was recorded during first week of March to second week of May, with a peak population of 4.46 jassid/plant, during the first week of May. The other insect pests were recorded at different crop stages but the their population were considerably low. Natural enemies like lady bird beetles *coccinella* sp. damselfly *coenagrion* sp., rove beetle *Peaderus* sp. and spiders have also been recorded in both the seasons, though their population was very low.

The biology of okra shoot and fruit borer *E.vittella* (Fab.) was studied under laboratory condition by using okra as a food plant. The culture shoot and fruit borer were collected from the research field and were reared the laboratory to study their life stages for consecutive two generations. The larval, pupal period and adult longevity were recorded. The dimensions of larva and pupa were also recorded. The average incubation period was recorded as 3.4 days whereas the larval and pupal period were completed in 14.6 and 10.2 days, respectively. The average length of full grown larva and pupa were recorded as 23.2 and 12.29 mm, respectively. The total life cycle of the shoot and fruit borer

(*E.vittella*) was completed in 32.03 and 34.69 days in case of male and female, respectively.

Population dynamics of insect pest of okra was studied on two varieties viz. "Parbhani Kranti" and "B.L.S.-55" , in both the season, which are among the most popular varieties in Chhattisgarh region.

During kharif 2002, in varieties "Parbhani Kranti" and "B.L.S.-55", seasonal activity of okra jassid *A.biguttula biguttula* was observed through the cropping season, which appeared in the first week of October (40^{th} SMW) and reached to its peak in the second week of December (49^{th} SMW). There was negative correlation between the jassid population and minimum temperature. Aphid *(Aphis gossypii)* appeared in first week of November (44^{th} SMW) and reached to its peak on second week of November (45^{th} SMW). The correlation between minimum temperature and aphid population was negative, shoot and fruit borer, *E.vittella* appeared in third week of October (42^{nd} SMW) and reached to its peak in second week of November (45^{t} SMW), correlation between minimum temperature and shoot and fruit borer population was negative. White fly *(Bemisia tabaci)* appeared second week of October (41^{st} SMW) and reached to its peak in third week of October (42^{nd} SMW). The correlation between minimum temperature and white fly population was positive.

During rabi 2003, in varieties "Parbhani Kranti" and "B.L.S.-55" jassid appeared first wek of March (9^{th} SMW) and reached to its peak in first week of May (18^{th} SMW), correlations between minimum temperture and jassid population was positive.

Shoot and fruit borer *E.vittella* appeared first week of April (16^{t} SMW) and reached to its peak third week of May. (20th SMW). Correlation between minimum temperature and shoot and fruit borer was positive, white fly (*Bemesia tabaci*) appeared during the first week of March (9th SMW) and reached to its peak in the last week of March (13th SMW). Correlation between minimum temperature and white flies was negative. Leaf miner appeared second week of March (10th SMW) and reached to its peak on third week of March (11th SMW). The correlation between minimum temperature and leaf miner was negative.

Experiment on evaluation of okra varieties against shoot and fruit borer, *E.vittella* (Fab.) were conducted during kharif 2002, with 24 varieties. Among them, O.H.-77, VRO-5, Raigarh - 5, VRO - 6 and B.L.S.-55, were found least suscetible to the pest, similarly during rabi 2003, 20 okra varieties were evaluated, among them B.L.S.-55 , B.L.S.-45, Arka abhaya, J.D.P.-4 and Daftari were compartively less attacked by the pest.

The data of both the seasons, indicate that O.H.-77, V.R.O.-5, Raigarh -5, VRO-6 and B.L.S.-55, varieties were comparatively resistant to shoot and fruit borer,*E.vittela*, however, based on the infestation by the shoot and fruit borer and yield the varieties like VRO-5, VRO-6, BLS-55, O.H.-77, VRO-3, can be said as better varieties among the evaluated ones.

Conclusions :

The pest succession studies indicated that nine insect pest attacked okra in the entire cropping season, during kharif 2002, and during rabi 2003 five inset pest were recorded. Among them jassid and shoot and fruit borer were active

through out the cropping season, whereas aphid, white fly and leaf miner were active during the vegetative crop growth stage only. The population of other insect pest viz. semilooper, red cotton bug, red hairy caterpillar and green pod borer were compratively very low during the cropping period.

The average incubation, larval and pupal period of *E.vittella* were found as 3.4, 14.6 and 10.2 days, respectively. The total life cycle was completed 32.03 and 34.69 days in case of male and female, respectively.

Studies on population dynamics of major insect pest of okra, two varieties viz. "Parbhani Kranti" and "B.L.S.-55" which are among the most popular varieties in Chhattisgarh region, reveal that there was a negative correlation between minimum temperature and jassid, aphid and shoot and frtuit borer populaiton where as, positive correlation was observed between minimum temperature and white flies. During kharif season, however, there was a positive correlation between minimum temperature and jassid and also with shoot and fruit borer. White flies and leaf miner were found to have negative correlation between minimum temperature during rabi 2003.

Suggestions for further work :

(1) Natural enemies associated with the major insect pest of okra should be studied in detail.

(2) More and more varieties of okra shall be evaluated against the insect pest of okra to find suitable varieties for this region.

(3) Pest management studies shall be conducted, against shoot and fruit borer, combining all the possible control measure in an unified programme.

Abstract

" Studies on insect pests of okra, *Abelmoschus esculentus* (L.) Moench in Chhattisgarh with special reference to shoot and fruit borer, *Earias vittella* (Fab.)"

by

Piyush Kant Netam

ABSTRACT

The investigation entitled "Studies Studies on insect pests of okra, *Abelmoschus esculentus* (L.) Moench in Chhattisgarh with special reference to shoot and fruit borer, *Earias vittella* (Fab.)" was conducted at the Horticultural field of College of Agriculture, IGAU, Raipur (C.G.), during the kharif and rabi seasons of 2002-2003. Nine insect pests namely, jassi *A. biguttula biguttula*, white fly. *Bemisia tabaci*, shoot and fruit borer, *Earias vittella*, aphid, *Aphis gossypii*, semilooper, *Anomis flava*, red cotton bug, *Dysdercus koenigii*, red hairy caterpillar, *Amsacta moorei*, gram pod borer, *Heliothis armigera*, and green stink bug, *Nezara viridula*, were recorded infesting okra during kharif 2002. During rabi 2003, five insect species namely, jassid, white fly, shoot and fruit borer, semilopper and leaf miner, *(Acrocercops bifasciata* Wlsm) were found infesting the orka crop. Among them jassid and shoot and fruit borer were recorded during the entire cropping seasons, where as white fly, aphid, and leaf miner were recorded during vegetative crop growth stage, with low degree of infestation.

The average incubation, larval and pupal period were recorded as 3.4, 14.6 and 10.2 days, respectively. The total life cycle of shoot and fruit borer *Earias vittella* was completed in 32.03 and 34.69 days, in case of male and female, respectively. Population dynamics of major insect pest of okra in two varieties viz. "Parbhani Kranti" and "B.L.S.-55", during kharif 2002 and rabi 2003. reveal that, jassid and shoot and fruit borer were found infesting the crop as the major pests and there was negative correlation between minimum temperature and insect population during kharif 2002. Where as during rabi 2003 this relation was positive. Evaluation of okra varieties against shoot and fruit borer, *Earias vittella* , reveal that varieties like VRO-5, VRO-6, B.L.S.-55, O.H.-77 and V.R.O.-3 were better among the tested varieties as they recorded less per cent fruit infestation and higher yield.

College of Agriculture

Raipur (C.G.)

Dr.R.N.Ganguli

Major advisor

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