

**EVALUATION OF VARIOUS MODULES
AGAINST MAJOR PESTS OF OKRA**

THESIS

**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of**

**DOCTOR OF PHILOSOPHY
IN
AGRICULTURE
(AGRICULTURAL ENTOMOLOGY)**

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Enrolment Number – Q/158

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DECLARATION OF STUDENT

I hereby declare that the experimental work and result of the thesis entitled “**EVALUATION OF VARIOUS MODULES AGAINST MAJOR PESTS OF OKRA**” or part thereof has not been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis or publication of any university or scientific organization. The source of material used and all assistance received during the course of investigation have been duly acknowledged.

Place: Akola

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Date: / /2019

Enrolment No. Q/158

CERTIFICATE

This is to certify that, the thesis entitled “**EVALUATION OF VARIOUS MODULES AGAINST MAJOR PESTS OF OKRA**” submitted in partial fulfilment of the requirement for the degree of “**Doctor of Philosophy in Agricultural Entomology**” of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Vandana Devanand Mohod** under my guidance and supervision.

The subject of thesis has been approved by the student’s Advisory Committee.

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(D) ABBREVIATIONS

%	-	per cent
/	-	per
@	-	at the rate
>	-	greater than
a.i.	-	Active Ingredient
ACC	-	Above the crop canopy
Ace	-	Acephate
AICC	-	Along the crop canopy
Av.	-	Average
Azadi.	-	Azadirachtin
BCC	-	Below crop canopy
BS	-	Both side direction
CD	-	Critical Difference
Ch	-	Chrysopa
cm	-	Centimeter
Cum.	-	Cumulative
CV	-	Coefficient of Variation
Cyper	-	Cypermethrin
SA	-	Soil application
ST	-	Seed treatment
DAS	-	Days After Sowing
DAS	-	Days After Spraying
DAT	-	Days After Treatment
DBS	-	Day Before Spraying
Dico	-	Dicofol
DCB	-	Dusky Cotton Bug
Dim	-	Dimethoate
Dr.PDKV	-	Dr. Panjabrao Deshmukh Krishi Vidyapeeth
EC	-	Emulsifiable Concentrate
et al.	-	et alia (And others)
etc	-	Etcetera

ETL	-	Economic Threshold Level
F	-	Flowable
fb	-	followed by
FB	-	Fruit borer
Fig.	-	Figure
Fenpo	-	Fenpopathrin
Fenv.	-	Fenvalerate
g	-	Gram
GHWF	-	Greenhouse Whitefly
ha	-	Hectare
i.e.	-	id est. (that is)
Inf.	-	Infestation
ICBR	-	Incremental Cost Benefit Ratio
kg	-	Kilogram
L	-	Leaf
Lit	-	Litre
Lamb	-	Lambda-cyhalothrin
LH	-	Leaf Hopper
LLB	-	Lady Bird Beetle
m	-	Meter
mg	-	Milligram
ml	-	millilitre
MT	-	Metric tones
MW	-	Meteorological Week
NB	-	Number basis
NE	-	North-East Direction
NMR	-	Net Monetary Return
No.	-	Number
NS	-	Non- Significant
NC	-	Neem Cake
P	-	Plant(s)
Pred.	-	Predator
q	-	Quintal
Quin.	-	Quinalphos

RBD	-	Randomized Block Design
RF	-	Rainfall
RH	-	Relative humidity
Rs.	-	Rupees
SE(m)±	-	Standard error of mean
SFB	-	Shoot and fruit borer
Sig.	-	Significant
SL	-	Soluble Liquid
SP	-	Soluble Powder
Spi.	-	Spider
Spi.	-	Spiromesifen
Sr.No.	-	Serial Number
SW	-	South-West Direction
Temp.	-	Temperature
TH	-	Thrips
Tr.	-	Treatment
Tria	-	Triazophos
Viz.,	-	Videlicet (Namely)
WB	-	Weight basis
WF	-	Whitefly
WG	-	Wettable Granules
WS	-	Water Soluble
WS	-	Wind speed
WSP	-	Water Soluble Powder
YST	-	Yellow Sticky Trap
YMV	-	Yellow Vein Mosaic
YVMV	-	Yellow Vein Mosaic Virus

(F)

THESIS ABSTRACT

- a) Title of the thesis : **EVALUATION OF VARIOUS MODULES
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ABSTRACT

Okra, *Abelmoschus esculentus* (L.) Moench is one of the important vegetables and the tender fruits are the rich sources of vitamins (A, B and C), iron, calcium, and magnesium and also certain other minerals and tender fruits of okra are used as vegetables. To tackle the sucking pest, shoot and fruit borer complex and YMV disease of okra crop, a number of chemical insecticides are liberally sprayed on okra crop, which led to several problems

like toxic residue, elimination of natural enemies, development of resistance leading to risk of rejection of consignments on account of residues during export. Present investigations on **“Evaluation of various modules against major pests of okra”** were undertaken during Summer 2014-15 and *Kharif* 2015-16 on the field of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS.).

An experiment was laid in randomized block design consisting of eight modules viz., M1 (fully organic), M2, M3 and M4 (Chemical module with sequential use of insecticides), M5, M6 and M7 (IPM based module having ST, Soil application, YST and sequential use of chemical insecticides) and untreated module M8 to find out effective modules against major pests and its effect on natural enemies and also to study the abundance of major pests and predators during both the seasons and incidence of YMV in various modules and their economics.

The results revealed that Module M6 and M4 were found most effective in reducing the population of leafhopper, whitefly, mites, shoot and fruit borer and incidence of yellow vein mosaic and in obtaining higher yield of okra fruits. However module M7 was significantly superior for arresting the population of aphids. The population of thrips was significantly reduced in module M6 and M5.

All modules were found equal in maintaining predator population on summer and *kharif* season on okra indicating safety to natural enemies. Peak incidence of sucking pests (aphid, leafhopper, whitefly, thrips and mites) fruit borer and predators (LBB, Chrysoperla and Spider) was observed on okra from 9th April to 20th May (15-20th MW) and 2nd Sept to 7th Oct. (35- 40th MW) during summer 2014-15 and *kharif* season 2015-16, respectively.

The module M6 followed by M4 and M5 were found significantly most effective in recording minimum incidence of YMV transmitted by whitefly at 60 to 95 DAS. The module M2 was found to be the least effective and at par with M7 and M3 in recording the minimum incidence of YMV.

The module M4 followed by M2 and M6 were proved most economical by registering higher ICBR and NMR. However highest first rank NMR and third higher rank of ICBR recorded in module M6 which is twice more NMR than in module M2. Hence out of all module tested in present investigation module M6 was found IPM based most effective and economical against all major pests and YMV disease of okra.

Maximum incidence of YMV (i.e. 10.90% and 22.22%) was observed during 14th to 20th May (20th MW) and 1st to 22th Oct (40-43rd MW) preceding the incidence of whitefly (i.e. 5.71-6.86 and 6.54 to 6.88 whitefly/leaf) during 18-19th MW and 37-38th MW in summer and *kharif* season.

Yellow Sticky Trap at 15 cm height above the crop canopy was found most suitable for trapping maximum number of adults sucking pests (aphid, leafhopper, thrips and whitefly) during both summer and *kharif* seasons.

Amongst the different chemicals tested in laboratory against leafhopper *A.biguttulla biguttula.*, the treatment with thiamethoxam 25 WG @ 0.2g/L proved most effective in recording highest (1649.94) persistence toxicity followed by cypermethrin 25 EC @ 0.4ml (933.26), dimethoate 30EC @ 2ml/L (833.28) and lambda cyhalothrin 5 EC @1ml/L (633.28) PT values, respectively.

Overall among various modules module M6 (ST, SA, YST, Cyper, Tria, Feno, Ace+Spir) was found significantly most effective and economical followed by module M5 (SA, YST, Thia, Fenpo, Lamb, Tria+Dico) and M4 (Tria, Fenv, Qin+Spir, Fenpo, Lamb) in minimizing the all sucking pests, shoot and fruit borer infestation, yellow vein mosaic diseases and in obtaining the highest ICBR (1:6.98) and net monitoring return (Rs. 1,10,562/ha).

CHAPTER I

INTRODUCTION

1.1 Background Information

Vegetables constitute an important item of our food supplying vitamins, carbohydrates and minerals needed for a balanced diet and of high value specially in under developed and developing countries like India, where malnutrition abounds (Khan et al., 2001). Okra (*Abelmoschus. esculentus* L. Monech) or *Bhindi* is an important vegetable crop due to its nutritional value. It is good source of vitamin A, B, C and is also rich in protein, minerals and iodine (Baloch et al., 1990). It has good nutritional value, particularly the high content of vitamin C (30 mg/100 g), calcium (90 mg/100 g), iron (1.5 mg/100 g) and other minerals like magnesium and potassium, fats and carbohydrates (Aykroud, 1963). Among the commercially cultivated vegetable crops in India, okra [*Abelmoschus esculentus* (L.) Moench] ranked sixth in terms of area and production with country contributing about 73.25 per cent to the world's total production (Anon., 2013). The crop is popular worldwide for its nutritionally rich tender fruits, which are consumed as raw or cooked. Besides, its use as food, the pods and seeds are used for the manufacture of paper and biodiesel (Anwar, 2010). Additionally, commercial seed production in okra crop is a remunerative business with increasing demand for quality seed among the vegetable growers with the expansion in the area under cultivation of this export oriented crop. The hybrid seed industry in this crop alone is worth of 150 crores with an annual growth rate of 30 per cent (Mani, 2013). The major okra growing states includes, Andhra Pradesh, West Bengal, Uttar Pradesh, Bihar, Assam, Orissa, Maharashtra and Karnataka (Anon., 2012).

Okra (*Abelmoschus.esculentus* L. Monech), an economically important vegetable crop grown in tropical and subtropical parts of the world. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopian, Crypus and the Southern United States. In Maharashtra, it is largely grown in Pune, Nagpur, Nashik, Jalgaon, Ahmednagar, Amravati, Aurangabad, Parbhani, Satara and Osmanabad districts. Okra requires a

long, warm and humid climate and can be successfully grown in hot humid areas. It is sensitive to frost and extremely low temperature. It is an important vegetable crop grown throughout the country during both summer and rainy seasons. Besides various reasons of low production, heavy damage inflicted by insect pests is a key limiting factor.

Okra plants are attacked by a number of insect pests at different growth stages. Okra is ravaged by many insect pests right from germination to harvest (Jagtab et al., 2007). These pests are major constraints in getting higher yields (Kumar et al., 2002). As many as 48 insect pest species which includes sap suckers, leaf suckers, leaf eaters, fruit borers, leaf rollers, flower feeders and leaf miners attack and damage okra crop (Ewate 1983). The crop suffers from as many as 72 species of insect pests, which are responsible for low yield in crop (Srinivas Rao and Rajendra, 2003).

The continuous growth is congenial for the infestation of insect pests and it is one of the major limiting factors in the profitable cultivation of the crop (Ashok Kumar et al., 2009). Many insect pests incidence were recorded from sowing upto harvest on bhendi plants in India and listed the most destructive insect pests as leafhopper, *Amrasca biguttula biguttula* (Ishida), aphid, *Aphis gossypii* (Glover), whiteflies, *Bemisia tabaci* (Gennadius), fruit borer, *Helicoverpa armigera* (Hubn.), spotted bollworm, *Earias vittella* (Fabricius) and *Earias insulana* (Boisd.) (Dikshit et al., 2001 Mandal, et al., 2006 and Mane, et al., 2010). Among these aphids, jassids and whitefly are considered as important sucking insect pests of okra. Krishnaiah (1980) reported about 40–56 per cent losses in yield of okra due to leafhoppers. Aphids and leafhoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield. Failure to control them in the initial stages was reported to cause yield loss to the tune of 54.04 per cent (Chaudhary and Dadeech, 1989). Among them, whitefly *Bemisia tabaci* Genn. (Hemiptera:Aleyrodidae) is most destructive causing significant damage in the crop during both the *kharif* and *rabi* seasons (Majumber et al. 1996; Oliveira et al., 2001). They desap the plant and transmit virus causing leaf curl disease (Kumawat et al., 2000). Known to be the vector of vein clearing disease (Gupta et al., 2009).

A number of pests interfere in its production system and yellow vein mosaic virus in particular has assumed global concern for both vegetable farmers and the scientists. Spread of YVM virus by white fly was suggested by Varma (1952) who further reported that vectors on starvation were more efficient in acquiring and transmitting the virus. Of the whitefly-transmitted virus species, 90% belong to the *Begomovirus* genus, 6% to the *Crinivirus* genus and the remaining 4% are in the *Closterovirus*, *Ipomovirus* or *Carlavirus* genera. Nineteen plant viruses are known to infect okra and amongst these, okra mosaic virus is the most serious concern (Brunt et al., 1990, Swanson and Harrison, 1993). About 63% yield loss due to OMV was reported from India (Krishnareddy et al., 2003). The virus induces mosaic, vein chlorosis and banding and plant stunting (Krishnareddy et al., 2003, Brown, 1994, Brunt et al., 1990). The disease is characterized by a homogenous interwoven network of yellow vein enclosing islands of green tissues within its leaf. In extreme cases, infected leaves become yellowish or creamy. If plants get infected within 20 days of germination, then their growth is retarded; few leaves and fruits are formed and loss may be about 94% (Leite et al., 2005). The extent of damage declines with delay in infection of the plants. Plants infected 50 and 65 days after germination suffered losses of 84 and 49%, respectively (Sastry and Singh, 1974). During the process of multiplication, virus competes with the plant for nutrition. Viral infection and spread can be controlled or checked by preventing or checking the vector. There is a positive correlation between vector population and disease incidence (Bhagabati and Goswami, 1992; Nath et al., 1992). Yellow vein mosaic disease is caused by a complex consisting of the monopartite begomovirus (Okra yellow vein mosaic virus (OYVMV) Family: Geminiviridae) and a small satellite DNA β component (Jose and Usha, 2003). Temperature and rainfall influence the whitefly population dynamics (Horowitz et al., 1984; Horowitz, 1986).

Spider mites (*Tetranychus* spp.) are potential pests of a variety of crops, of which two spotted spider mite, *Tetranychus urticae* Koch, [synonym red spider mite *Tetranychus cinnabarinus* (Boisd.)] is one of the serious pests and is widely distributed through out the tropical and sub-tropical areas of the world on more than 300 plant species, including fruits and

vegetables (Gupta, 1985). Yellowish white spots appear on infested leaves as a result of mite feeding and in severe cases, leaves dry and fall off and webbing is seen in heavily infested leaves (Dhooria, 2003), reducing crop yield by 25-50 per cent (Singh and Singh, 2005). In Punjab, almost all varieties of okra are susceptible to mite attack and the attack is more severe during May-June and during October (Kapur-Ghai and Bhullar, 2003).

The shoot and fruit borer, *Earias vittella* (Fabricius) is found through out the year with overlapping generations causing considerable damage to the crop. Caterpillars bore the terminal portion of growing shoots, and move down by making tunnels inside. As a result, the shoot dries downwards or upwards. On availability of fruits, the larvae enter the fruit by making holes, rendering them unfit for human consumption Pareek and Bhargava, (2003) recorded 5.33 to 75.75 per cent losses in okra fruits due to the infestation of *E. Vittella*, Brar et al., (1994) reported 50 per cent reduction in fruit yield. It is most serious pest as it takes upper hand by causing direct damage to tender fruits. The larvae feed on and damage growing vegetative parts developing seed in the cotton bolls, shoots of the main axes, succulent internodes, tops of side branches, young leaves and flower buds. *E.vitella* is a major insect pest, which causes 8.4 to 73.2 per cent infestation on fruit of okra depending on the season (Kumar and Urs, 1988).

The yield losses in okra to the extent of 69 per cent due to fruit borer have been observed (Rawat and Sahu, 1973). According to Radke and Undirwade (1981), this pest causes 88 to 100 per cent fruit damage. Fruit borers, *Earias vittella* Fabricius and *Earias insulana* Boisduval in the later stages of crop growth causes extensive damage to fruits resulting in 69% yield loss (Atwal and Singh, 1990). *Helicoverpa armigera* (Hübner), which was considered as one of the minor pests, has recently emerged as a major limiting factor in okra production. Its infestation affects the quality and quantity of fruit production, which ultimately reduce the market price. Both *E. vittella* and *H. armigera* causes up to 50% loss in okra in different parts of the country (Mani et al., 2005). It alone is reported to cause 57.1 per cent fruit infestation and 54.0 per cent net yield loss in okra (Chaudhary and Dadheech, 1989).

According to Misra et al., (2002) this pest can cause 36-90% loss in fruit yield of okra.

The seasonal occurrence of insect pests on a particular crop ecosystem is governed by a set of suitable weather conditions. In the past, a number of workers have attributed outbreaks of okra insect pests to favorable weather factors (Mohanasundaram and Sharma, 2011b; Singh et al., 2013. Nath et al., 2011. Selvaraj et al., 2010. Zala et al., 1999). Further, the perceivable effects climate change on the local weather parameters such as increased temperature, increased frequency and severity of extreme weather events and altered precipitation patterns will have definite impact on the insect pest development, survival, distribution and out breaks. So, the periodical assessment of the role of weather parameters in the perpetuation of the pest population is necessary. The knowledge of pest population dynamics in relation to biotic and abiotic factors is a pre-requisite for developing weather based pest forecasting system. Studies on seasonal abundance and population fluctuations will help in formulating effective management strategies against the pest in okra ecosystem.

Such insects are capable of survival only within certain environmental limits and hence one can predict their occurrence and peak activities through better understanding of preferred weather factors which in turn aids in pest management. Indiscriminate use of pesticides leads to undesirable load of pesticide residues in marketable vegetables (Kumari et al., 2005) and cause severe ecological consequences like destruction of natural enemy fauna, effect on non-target organisms, and directly affect in the form of residues.

1.2 Importance and need of the study

The demand of vegetables like Okra increases day by day. Being short duration and high yielding, growers get more profit per unit area. However, various problems are faced by cultivators at the time when incidence of sucking pests observed in initial stages on Okra crop. Boosting of its production is of prime importance and considerable.

To tackle this sucking pest menace, a number of chemical insecticides are liberally sprayed on this vegetable crop, which led to several problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. Due to the presence of pesticidal residues in the final commodity, there is a risk of rejection of whole consignments during export.

Indiscriminate use of pesticides leads to undesirable load of pesticide residues in marketable vegetables (Kumari et al., 2005) and cause severe ecological consequences like destruction of natural enemy fauna, effect on non-target organisms, and directly affect in the form of residues.

Yellow colour sticky trap are used for monitoring / controlling the pests like aphids, thrips, white fly, cabbage root maggot, carrot rust fly, cabbage white butterfly, cucumber beetle, fungus gnat and onion fly. Bright yellow is highly attractive to aphids, whitefly, leaf miners, leafhopper and thripsetc. Sticky material plays an important role in controlling/ monitoring adult stage of sucking pest and early detection of seedling pests in the field Which is not possible even with newer any group of insecticides.

Sticky traps being mechanical means of control are an important part of an integrated pest management programme. Traps consisting of square pieces of cardboard, hard plastic coated or foam sheet with sticky substances placed throughout the growing area among the plants to attract them. Yellow or blue colored sticky traps are commercially available.

Investigations were carried out in order to find out suitable, effective, ecofriendly and economical plant protection measures against major sucking pests of Okra with the following objectives.

1.3 Objectives

1. To find out effective module against major pests and its effect on natural enemies of okra.
2. Comparative study on abundance of major pests of okra in summer and *kharif* season.
3. To study the incidence of Yellow Vein Mosaic of okra in various modules.

4. To study the economics of various modules.

1.4 Scope and limitation

Plant protection is an important aspect in the agricultural sectors and it cannot be ignored. When the natural resources of a nation are shrinking, the prevention of crop losses owing to the pests is essential, to raise the agricultural production and ensure the food security. A lot of conventional and modern techniques have been tested to avoid losses, caused by sucking pests in the world.

A long-term control of this pest may be possible, through a well-planned pest-management-program, Integrated Pest Management (IPM) is a widely adopted alternative of a plant protection model, which besides being sustainable, reduces the production cost and makes available to the consumers a good quality vegetable at accessible prices. Hence, studies were conducted on Okra to evaluate the various modules against major pests management programme.

1.5 Hypothesis

There is no perfect and satisfactory plant protection schedule for protection of major sucking pest of okra, out of which whitefly acts as a vector of virus disease and shoot and fruit borer pest causes severe yield losses in okra. A crop being taken in both summer and Kharif season for obtaining best quality, hygienic and export quality fruit with yield of okra crop and recently farmers interest is also towards organic productions and to incorporate sequential use of conventional and newer insecticides in the trial care is being taken in the present investigation to include organic based, IPM based and chemical based module for three type of vegetable growers. Therefore it needs to develop module consisting of chemical, biological and IPM module, *vis a vis* integration of chemical, biological and gap modules consisting of possible alternatives to improve the effectiveness of IPM module.

In order to minimize the use of chemical pesticides, residues level in final commodity and availability of relatively safer vegetable fruits for human consumptions, present investigation was carried out to find out cost effective, suitable and relatively ecofriendly modules against major pest of

okra. The evaluation of these modules will provides varied option for pest management for bio-intensive farming, scope of use as seed treatment, soil application, sticky traps subsequently reducing the pest and disease incidence.

Now a day's organic farming is becoming popular amongst producers and consumers. Keeping this in view, the present study was planned to evaluate the various modules against major pests of Okra and it's effect on natural enemies, as well as seasonal abundance of pests in summer and kharif season, yellow vein mosaic disease incidence, different chemical combination, phytotoxicity and economics of various modules against pests of Okra.

Outcome of the project will prove not only economical and effective module for farmer who are implementing ecofriendly integrated pest management programme for major pests management on okra including ymv disease but also provide information for organic growers and for producing export quality fruit and sequential spraying of pesticides will reduce monotonous use of the single pesticides and insect pest resistance to insecticides. In future refiness of module need to be developed by increasing dose of seed treatment soil application of neem cake and yellow sticky trap and alternate use of azadiractin 1% @ 5ml per liter of dose.

CHAPTER II

REVIEW OF LITERATURE

The literature pertaining to relative bio-efficacy of insecticides against okra pests, population dynamics, on the incidence of major insect pests and sequential management module of major insect pests on the okra crop is reviewed as under. The available literature related to present studies have been reviewed and presented here under different headings and sub-headings.

2.1 Assessment losses due to major pests on Okra

Chaudhary and Dadeech (1989) reported that aphids and leafhoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield. Failure to control them in the initial stages was reported to cause an yield loss to the tune of 54.04 per cent.

Kadam (1993) reported that shoot and fruit borer alone causes 66.28, 46.45 and 69.04 per cent loss in fruit yield in crops sown in summer, *kharif* and *rabi* seasons, respectively with an average loss of 60.69 per cent in absence of plant protection umbrella.

Singh (1994) reported that the two spotted mite (TSSM), *Tetranychus urticae* Koch attacks wide range of agricultural and horticultural crops including several vegetable crops in India.

Singh (1995) reported that the losses reported in vegetable production vary from 2 to 35% in eastern part of the India due to mites.

Sarkar et al. (1996) reported that the sucking pest complex consisting of aphids, leaf hopper and whitefly are major pest and cause 17.46 per cent yield loss in okra.

Ghosh et al. (1996) reported that two spotted spider mite (TSSM), *T. urticae* Koch is a highly polyphagous pest of numerous vegetable crops. Incidence of mite pest, *T. urticae*, especially during summer season causes severe damage and yield loss up to 17.5 per cent.

Shivlingaswammy et al. (2002) reported that the losses in okra crop due to shoot and fruit borer (*Earias vitella*) was 22.79-54.04 per cent from Jassids/Leafhoppers (*Amrasca biguttula biguttula*) 54-66 per cent white flies (*Bemesia tabaci*) 54.04 per cent and from Fruit borer (*Helicoverpa armigera*) 22 per cent.

Pareek and Bhargava (2003) recorded 5.33 to 75.75 per cent losses in okra fruits due to the infestation of *E. Vittella*.

Satpathy et al. (2004) reported the yield loss due to leafhopper desapping in okra amounts to 54 to 66 per cent.

2.2 Effect of modules against major insect pests of okra crop

Mandal et al. (2006a) conducted a study during two consecutive summer seasons (2000 and 2001) in Bihar, India to evaluate neem based integrated management approaches for controlling insect pests (*A. biguttula biguttula* and *E. vittella*) on okra cv. Pusa sawani. The treatments included soil application on neem cake at 200 kg/ha with foliar application of neem seed kernel extract (NSKE 5%), neem oil 3%, Amrutguard 0.5%, neem leaf decoction at 0.5 kg, chlorpyrifos 20 EC at 0.5 kg, endosulfan 35 EC at 0.5 kg and recommended insecticides, monocrotophos 36 SL at 0.4 kg. The integrated treatments were effective against the pests and were superior to the recommended insecticide. Neem cake at 200 kg/ha + Endosulfan 35 EC at 0.5 kg and chlorpyrifos 20 EC at 0.5 kg were most effective than the other integrated treatments in increasing the yield and controlling the pests. The maximum cost benefit ratio (1:5.16) was obtained with neem cake + endosulfan, followed by neem cake + chlorpyrifos 20 EC (1:4.37) monocrotophos 36 SL (1:4.24) and neem cake + Amrutguard (1:3.55), while the minimum (1:2.01) was obtained from neem cake + neem oil.

Praveen et al. (2007) conducted field trial at Dharwad, Karnataka, India, to evaluate the effect of seed treatment and foliar spraying of insecticides and neem products on the growth and yield of okra cv. Arka Anamika. Treatments consisted of seed treatment of imidacloprid (Gaucho 600 FS) at 12 ml/kg seed, thiamethoxam (Cruiser 70 WS) at 10 g/kg seed, neem oil at 80 mg/kg seed, neem cake at 500 kg/ha (soil application) and

carbofuran at 15 kg/ha (soil application) as well as foliar sprays of imidacloprid (Confider 200 SL) at 0.25 ml/litre, thiamethoxam (Actara 25 WG) at 0.40 g/litre, fenvalerate (Fenval) at 0.5 ml/litre and neem seed kernel extract at 5%. Recommended cultural practices were adopted. Data were recorded for plant height, number of leaves per plant, days to flower initiation, number of fruits per plant, percentage of fruit damage as well as fruit length, dry fruit weight, percentage of seed damage, 100-seed weight and seed yield. Seed treatment with imidacloprid at 12 ml/kg seed recorded the highest seed yield of 642 kg/ha. Foliar spraying with fenvalerate produced the highest seed yield of 799 kg/ha, followed by neem seed kernel extract (720 kg/ha).

Preetha and Nadarajan (2007) carried out field experiments to test the efficacy of different IPM modules against major sucking pests of okra. The results revealed that bio-intensive module (M2) and the insecticide Module (M3) were equally effective against major sucking pests like thrips (*Thrips tabaci*), leaf hopper (*A. biguttula biguttula*) and aphids (*Aphis gossypii*) and the insecticide module (M3) showed the lower incidence of red spider mite (*T. cinnabarinus*).

Choudhary et al. (2008) reported that the lowest fruit damage (13.08%) due to *Earias spp.* and maximum fruit yield (80.72 q/ha) with maximum net return (Rs. 40070/ha) were recorded in module-1 comprising imidacloprid 100 ml/ha, acephate 1000 g/ha and indoxacarb 500 ml/ha, which was comparable with module-2 (three sprays of acephate 1000 g/ha) with regards to fruit damage and yield.

Rao et al. (2008) observed lower incidence of shoot damage (1.05%) and fruit damage (16.40 %) and more fruit yield (43.50 q/ha) in module comprising of sorghum as a border crop + seed treatment with imidacloprid @ 5g/kg of seed + spray of NSKE 5% alternated with the neem oil 5% compared to untreated control, which registered 13.40 and 52.40 per cent incidence of shoot and fruit borer damage, respectively with fruit yield of 30.50 q/ha.

Papal and Bharpoda (2009) noticed that lowest fruit damage due to fruit borer, *E. vittella* was obtained with chlorpyrifos (18.86%), cypermethrin + quinalphos (19.97%). Chlorpyrifos (0.04 %) recorded the

lowest (2.05%) percentage of damaged seeds, but was on par with all the insecticidal treatments tested, except alpha-cypermethrin and fipronil 5 SC @ 0.005%. The number of borer holes per fruit was lowest for chlorpyrifos (1.17), cypermethrin + quinalphos (1.19), chlorpyrifos + alpha-cypermethrin (1.20) and endosulfan (1.22).

Birah et al. (2010a) reported that the fruit damage by *E. vittella* was significantly less in all the modules as compared to control at each picking as well as in pooled analysis. Integrated module (M3) which included seed treatment with thiamethoxam @ 3g /kg seed + foliar spray of neem (Neembaan) @ 3 ml/lit at 40 days after sowing + foliar spray of endosulfan (1 ml/lit) + Neem @ 3 ml/lit. at 50 days after sowing + foliar spray of spinosad @ 3.0 ml/lit at 60 days after sowing recorded less incidence of shoot and fruit borer (4.8%) and more fruit yield (81.33 q/ha) as compared to untreated control (13.6% incidence and fruit yield 52.22 q/ha). the increase in yield over control in this module was 55.7 %.

Rajashekhar et al. (2010) evaluated different packages of integrated pest management for sucking pests of okra at Faridabad and reported that package comprising of seed treatment with imidacloprid @ 3 g/kg seed + yellow sticky trap @ 25/ha + border crop with sorghum of 3 rows + need based chemical protection consisting of sprays of fipronil @ 2 ml/lit and neem oil @ 5 ml/lit effectively reduced the aphid, jassid and whitefly population in okra.

Birah et al. (2012b) were conducted field trials during 2008-09 and 2009-10 with okra (*Abelmoschus esculentus*-variety Arka Anamika) to evaluate the pest management modules against sucking pest complex, jassid (*Amrasca devastans* Dist.) and whitefly (*Bemisia tabaci* Genn) and okra shoot and fruit borer, *E. vittella* (Fab.). The fruit damage by shoot and fruit borer was significantly lower in all the modules as compared to control at each picking as well as in pooled analysis. Integrated module included seed treatment with imidacloprid @ 5 g/kg seed a day before sowing + sowing of maize at the borders as barrier crop + weekly clipping of infested shoots and fruits + erection of pheromone trap @ 100 traps/ha for mass trapping + foliar spray of neem seed kernel extract @ 30 ml/litre, spinosad 45 SC @ 0.5ml/litre and

karanj oil @ 30 ml/litre at 45, 60 and 75 days after sowing, respectively. The pooled data revealed that integrated module and bio-intensive module recorded significantly lower jassid population (3.32 jassids/leaf, 4.27 jassids/leaf) than farmer's practices (5.31 jassids/leaf) and untreated control (10.12 jassids/leaf). Less incidence of shoot borer (4.23%) and fruit borer (5.64%) and more fruit yield (8.66 tonnes/ha) was recorded in integrated module as compared to untreated control, 13.42%, 16.85% and fruit yield of 5.25 tonnes/ha respectively. The results revealed that different types of management practices have significantly reduced jassid, whitefly population and shoot and fruit borer damage than untreated control in okra. By incorporating these management practices, application of synthetic insecticides can be reduced to a minimum possible level.

Chorage et al. (2012) reported the yield data on marketable fruits recorded in various modules that highest yield of 36.56 q/ha was recorded in module M9 (cypermethrin 10 EC 0.005 per cent followed by NSKE 5 per cent followed by custard apple leaf extract 10 ml aqueous solution L-1) followed by module M5 (deltamethrin 0.09 per cent, followed by Neemazal 4ml L-1 followed by soapnut 10ml aqueous solution L-1) (36.29 q/ha), followed by module M8 (Profenofos 50 EC 0.05 %, followed by NSKE 5 % then garlic and chilli extracts 10 ml aqueous solution-1) (36.11 q/ha) followed by M4 (endosulfan 35 EC (0.06%)) followed by *B. thuringiensis* var. *kurstaki* @ 1.5 g/L-1 followed by custard apple leaf extract 10 ml aqueous solution L-1 (35.72 q/ha) and M3 (endosulfan 35 EC (0.06%)) followed by *B. thuringiensis* var. *kurstaki* @ 1.5 g L-1 followed by serni leaf extract 10 ml aqueous solution L-1 (35.06 q/ha) which were at par with module M9.

Singh et al. (2012) observed that the IPM module consisting of hand picking and destruction of infested leaves, shoots and fruits, seed treatment with imidacloprid, application of indoxacarb, thiomethoxam, hexythiazox, deep summer ploughing and use of neem cake @ 250 kg/ha before sowing was the most effective against shoot and fruit borer, *E. vittella*, yellow vein mosaic virus, *Bemisia tabaci* (Genn.) and red spider mite, *Tetranychus cinnabarinus* (Boisd.) and recorded highest net returns.

Singh et al. (2013) revealed that module (M1) proved be the most effective treatment against shoot and fruit borer, *E. vittella*, yellow vein mosaic virus, *Bemisia tabaci* (Genn.) and red spider mite, *Tetranychus cinnabarinus* (Boisd.) in which lowest incidence was recorded as compared to other IPM modules during 2010 and 2011. The module M1 comprised of hand picking and destruction of infested leaves, shoots and fruits, seed treatment with imidacloprid, application of indoxacarb, thiomethoxam, hexythiazox, deep summer ploughing and use of neem cake @ 250 kg/ha before sowing was the most effective. The IPM module (M2) was the next effective treatment against the major pests of okra evaluated at six locations during both the years. The maximum fruit yield was observed in module (M1) i.e. 254.00 and 232.00q/ha, respectively during 2010 and 2011 which was significantly superior over all other treatments. The studies conducted on impact of various IPM modules showed that net return was also higher in module (M1) which was Rs. 182340 and Rs. 165060/ha, respectively during 2010 and 2011. Based on two years studies, it is concluded that judicious use of neonicotinoids pesticides (indoxacarb, thiomethoxam, imidacloprid and hexythiazox) used in module(M1) along with seed treatment kept the pests population below the economic threshold level.

Verma et al. (2014) recorded minimum average of *A. biguttula* population in okra seed crop treated with IPM module 1 containing treatment of okra seeds with thiamethoxam 70 WS @ 3 g/kg seed followed by foliar sprays of imidacloprid 200 SL @ 0.3 ml/l at 40 days after sowing (DAS), foliar spray of spinosad 45 SC @ 0.3 ml/l at 50 DAS, foliar spray of emamectin benzoate 25 WG @ 0.4 g/l at 70 DAS and foliar spray of spinosad 45 SC @ 0.3 ml/l at 80 DAS.

2.3 Effect of botanicals on sucking pest

Neem has antifeedant, antiovipositional, growth disrupting and fecundity reducing properties for different insects and is suitable for inclusion in integrated pest management programmes (Schumutterer, 1995). Among the various plant products studied during the last 25 years, extracts and compounds from neem tree (*Azadirachta indica* A. Juss) have attracted a special contemplation of entomologists all over the world. Neem is known to

contain assorted array of biologically active principles, of which azadirachtin is one of the best known ingredients (Singh, 1996). Neem and neem products have been reported to check population of more than 200 species of insects belonging to different orders like coleoptera, diptera, lepidoptera, heteroptera, homoptera, orthoptera and thysanoptera (Ramarethinam, 1998).

More than 68 neem (*A. indica*) based formulations are now commercially available in India (Srinivasamurthy, 1998) which have been largely tested and used against number of insect-pest species on various crops as compared to other botanical pesticides. Furthermore, the chances of developing resistance in insects to neem preparations are very less. Such preparations are also comparatively more economical, biodegradable, and safe to human beings and beneficial insects.

Coudriel et al. (1985) reported that neem seed kernel extract acted as a strong repellent against *B. tabaci* in cotton. So, our studies are in complete agreement with the workers using plant products containing virus inhibitory chemicals against the disease. Thus, the anti-feedant and repellent properties of different plant products and presence of anti-viral proteins offer a novel, economic and eco-friendly tool for the management of YVMV of okra.

Natarajan et al. (2000) studied the efficacy of some botanicals like NSKE, garlic kerosene extract and *Vitex* extract against the leafhopper, *A. biguttula biguttula* on okra and found that garlic kerosene extract recorded the lowest number of leafhoppers.

Rosaiah (2001a) studied the efficacy of plant products viz, NSKE 5%, neem oil 2%, pongamia leaf extract, calotropis sp. and *Jatropha* sp. leaf extract against okra leafhopper (*A. biguttula biguttula*). Results revealed that all the plant extracts were found significantly superior over untreated plot in reducing leafhopper population, in which neem oil was significantly superior over NSKE 5% and pongamia leaf extract.

Kumar and Singh (2001) conducted experiment at Faizabad (Uttar Pradesh), the efficacy of some botanicals was evaluated against *A. biguttula biguttula* infesting okra crop. It was observed that both achool

(0.07%) and neem seed kernel extract (NSKE 3%) were effective in checking jassid population and out of these (NSKE 3%) witnessed the most economical cost: benefit ratio (1:10.7).

Rosaiah (2001b) conducted field experiments at Guntur (Hyderabad) to evaluate the performance of various botanicals against the pest complex of okra for 3 consecutive years (1995-97) and showed that NSKE (5 and 10 %) and neemazal (0.5%) were less effective in reducing jassid population.

Hanumantappa (2003) studied the efficacy of botanicals against sunflower leafhopper, *A. biguttula biguttula* and found that among different botanicals used, NSKE 5% was the superior treatment over neem oil, pongamia oil and commercial neem formulation.

Panickar et al. (2003) reported from Anand (Gujarat) that 3 sprays of achool (0.15% EC) starting from 45 days old crop of okra registered substantially lower aphid population.

Mudathir and Basedow (2004) observed that neem preparations viz. neem kernel water extract (NKWE) containing 2.5-5.0 per cent *azadirachtin* a.i. ha-1 and neemazal containing 6-12 per cent *azadirachtin* a.i. ha-1 appreciably abridged the attack of *A. gossypii* and *B. tabaci* on okra in Sudan.

Dhanalakshmi (2006) reported that NSKE + garlic chilli – kerosene (GCK) extract + cow urine (CU) was the most effective treatment with 77.80 per cent reduction in the population of okra leafhopper, *A. biguttula biguttula* and found to be equally effective as that of oxydemeton methyl (2.16 leafhoppers/2 leaves) with 81.50 per cent reduction, followed by Garlic Chili Kerosene + Cow Urine + Cow Dung (4.3 leafhoppers/2 leaves) and GCK (4.49 leafhoppers/2 leaves).

Gundannavar (2006) reported that application of neem cake @125 kg/ha + vermicompost @ 625/g ha at transplanting and 50 days later (with 50 per cent nitrogen) and nimbecidine and NSKE spray interventions later was found to be the most effective against chilli pests.

Jat and Jeyakumar (2006) evaluated the efficacy of botanicals on sucking pest of cotton jassids (*A. biguttula biguttula*), among neem products neem oil at 1, 2 and 3 per cent (20.4-42.5%) was comparatively more effective against leafhopper than NSKE and both neem product tested to reduce more than 50% white fly population.

Khattak et al. (2006) reported that 3% neem seed water extract significantly reduced the population of jassids on cotton upto 168 hours after spray, but lost their efficacy up to 336 hours after spray.

Gundannavar et al. (2007) studied that the effect of four IPM modules on chilli pests. Amongst that NSKE 5% appeared to quite promising strategy to control aphids, thrips and mite pest of chilli.

Adilakshmi et al. (2008) observed that amongst the botanical insecticides tested, NSKE (5%) recording minimum population of aphid (7.57 aphids/leaf), leafhopper (1.72 hoppers/ leaf) and whitefly (1.33 whiteflies/leaf), NSKE (5%) proved to be more effective against sucking insects infesting okra and was at par with recommended conventional insecticide (endosulfan).

Anitha and Nandihalli (2008) observed that the neem oil 2% was found effective in controlling okra jassids (*A. biguttula biguttula*) population, while NSKE 5% was found effective against aphid (*Aphis gossypii*) population.

Nazrussalam et al. (2008) showed that the significant reduction ($P < 0.05$) on the population of jassid. Multineem (alone) was more effective against jassid and spotted bollworm infestation than NSKE. A combination of multineem with imidacloprid @ 1.0 L+150.0 ml/ ha proved to be more effective than other treatment combinations as well as causing a reduction of jassid population of 89.1, 82.6 and 79.5% on 3, 7 and 10 days after spraying during 2005.

Echereobia et al. (2010) showed that 10% aqueous extract of *Piper guineense* and *Azadirachta indica* had the highest percentage repellence values (100%) while control (Distilled water) had the least value (0%).

Subbireddy et al. (2018) conducted a field experiment to study the bio efficacy of seven plant extracts viz., neem oil 0.3%, neem seed kernel

extract 5%, azadirachtin 0.15 EC 0.0006%, *Aloe vera* extract 1%, *Citrulluscoco* leaf extract 1%, garlic bulb extract 3% and neem leaf extract 10% against fruit borers during summer and *kharif*, 2016 at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). Among seven different plant extracts tested, neem oil 0.3% and azadirachtin 0.15 EC 0.0006% observed with lowest number of larvae and per cent fruit damage followed by NSKE 5% and garlic bulb extract 3% during both the seasons, while remaining plant extracts *i.e.* *Aloe vera* extract 1% and *Citrulluscoco* leaf extract 1% found poor to manage fruit borers. The highest marketable okra fruits were recorded from the plots treated with azadirachtin 0.15 EC 0.0006% (55.60 and 116.41 q/ha) and neem oil 0.3% (52.58 and 118.25 q/ha) followed by NSKE 5% (50.80 and 111.89 q/ha) during summer and *kharif* season, respectively.

2.4 Effect of Botanicals on fruit borer

Ambekar et al. (2000a) reported from Pune (Maharashtra) that achook (0.5%) was the best in reducing okra fruit borer infestation among the various neem products *viz.* NSKE, achook, nimbecidine, rakshak, bioneem, nimbitor, neemgold and neemmark tested against this pest.

Three neem preparations *viz.* NSKE (5%), nimbitor (0.5%) and achook (0.5%) when used alone were less efficient than synthetic pesticides against okra fruit borer and recorded 27.25, 28.38 and 29.58 per cent fruit borer infestations, respectively, at Pune (Maharashtra) (Ambekar et al., 2000b).

Anaso and Lale (2002) reported from Maiduguri (Nigeria) that okras sprayed with aqueous neem kernel extract harboured appreciably less population of *H. armigera*.

Five sprays of NSKE (1.5%) gave good reduction of *E. vittella* on okra at Faizabad (Uttar Pradesh) and recorded higher fruit yield of 56.33 qha-1 compared to 29.17 qha-1 in untreated check (Singh et al., 2005 c).

Dhanalakshmi and Mallapur (2008) reported botanical insecticides (neem @ 3 ml per lit) and insecticides had not only reduced the incidence of shoot and fruit borer in okra but also improved the quality of marketable fruits.

Vishwanath and Singh (2008) evaluated that the insecticidal treatments were significantly effective in suppressing the incidence of fruit borer and effective in increasing the healthy fruits yield. They were followed by imidacloprid ST + Achook spray (18.35).

2.5 Effect of insecticides on sucking pest

Patil et al. (1993) were tested seven insecticides against pests of cotton in Karnataka, India in 1986-89. Triazophos 40 EC at 0.6 kg a.i. per ha as the best treatment which reduced the whitefly population in cotton. It was also effective against cotton aphid (*Aphis gossypii*) and leaf hopper.

Borah (1995) reported that foliar application of cypermethrin (0.01%, 0.015%), deltamethrin (0.0028%, 0.0042%) and dimethoate (0.03, 0.04) were effective in reducing whitefly population.

Singh et al. (1998) tested the efficiency of two insecticide viz., monocrotophos 36 SL (0.02%) and cypermethrin 25% EC (0.02%) under field condition in three consecutive years (1992 and 1994) against YVMV in okra. The disease incidence was decreased upto 0.44 per cent in 1994 as compared to 1.77 in 1992. The whitefly population was greatly reduced by spraying monocrotophos 36 SL (0.02%) or by cypermethrin 25% EC (0.02%) respectively.

Chinniah and Ali (2000) studied the efficacy of some insecticides/acaricides against spider mite, *T. cinnabarinus* and revealed that ethion (0.1 %) and fenpropathrin (0.01 %) were highly effective followed by carbosulfan (0.05 %) and bifenthrin (0.015 %).

Ma et al. (2000) were conducted field trials on upland cotton (*Gossypium hirsutum* L.) during its reproductive phase which was used to assess the toxicity of several biorational pesticides and chemicals to *Helicoverpa armigera* (Hubner) and *H. punctigera* Wallengren, as well as major predators at Dalby, Queensland, Australia. Moderate rate-dependent control

was obtained in plots treated with neem (*Azadirachta indica* A. Juss) seed extract *Δ azadirachtin* (Aza) at rates of 30, 60 and 90 g/ha. Plots treated with Talstar EC (bifenthrin) applications achieved the best results, followed by treatment with alternation of chemicals (methomyl, bifenthrin, thiodicarb and endosulfan) and biorational insecticides (neem oil, azadirachtin and *Bacillus thuringiensis kurstaki* var. Berliner). Predators, including lady beetles, lacewings, spiders and predatory bugs, were insensitive to Aza, tooseendanin (Tsdn) and BT applications. In contrast, chemicals were very destructive of predators. All treatments provided some protection from infestation of *H. armigera* and *H. punctigera*. The effect of Aza on *Helicoverpa* spp. was reflected in a relatively higher yield of seed cotton harvested from Aza-treated plots compared with the control, but chemical control achieved significantly higher yields than any other treatment.

Kalra et al. (2001) evaluated the toxicity of various insecticides (viz., malathion, oxydemeton-methyl, phosphamidon, dimethoate, thiamethoxam, endosulfan, and monocrotophos) against leafhopper on okra and found that thiamethoxam (0.000447 %) was the most toxic i.e. 2454 times more toxic than malathion. Further, imidacloprid gave more than 80 % mortality of the pest at 4 times lower the normal concentration (0.000225%), while fenvalerate could not bring even 20 % mortality at 30 times the normal concentration (0.15%) indicating development of resistance in leafhopper to the commonly recommended insecticides.

Kumar et al. (2001) studied efficacy of imidacloprid and thiamethoxan on okra against leafhopper and whitefly. Field experiments conducted in Bangalore (India) during the kharif and summer seasons of 1999 and 2000 had shown that various doses of imidacloprid and thiamethoxam had no phytotoxic effect on okra but effective against insects

Subhadra et al. (2002) evaluated the efficacy of some new insecticides against okra pests and reported that acetamiprid (20 g a.i./ha), thiamethoxam and imidacloprid (both at 25 g a.i./ha) were most effective in controlling jassids followed by abamectin (20 g a.i./ha). Neonicotinoids gave 77.2 to 86.0 % reduction of jassid population for 21 days after its application.

Kaur (2002) determined the efficacy of various seed-treatments and foliar-sprayin controlling *A. biguttula biguttula* and *Earias sp.* infesting okra cv. Arka anamika. Seed treatment with 5 g/kg imidacloprid/ha + foliar spray with 500 g a.i.monocrotophos/ha + 30 g a.i. cypermethrin/ha, resulted in a lowest mean population of cotton jassid, in 1999 (1.78) and 2000 (1.45). Mean fruit yield was the highest and leafinjury, due to jassid infestation, was the lowest with this treatment.

Mishra and Dash (2002) evaluated the efficacy of some new insecticides viz., acetamiprid, thiamethoxam, imidacloprid, NACLFMOA and abamectin against *A. biguttula biguttula* infesting okra and concluded that nitroguanidines such as acetamiprid (20 g a.i./ha) and thiamethoxam and imidacloprid (25 g a.i./ha) were the most effective in controlling the pest followed by the fermentation metabolites, NACLFMOA and abamectin both at 20 g a.i./ha. Nitroguanidines gave 77.2 to 86.0 % reduction of jassid population at 21 days after application followed by the fermentation metabolites which gave 66.8 to 70.9 % reduction in pest population. Imidacloprid and thiamethoxam, both used at 25 g a.i./ha proved significantly superior in controlling aphids and jassids on okra. Dimethoate at 300 g a.i./ha and cypermethrin at 100 g a.i./ha followed the above two treatments.

Misra and Senapati (2003) noticed that thiamethoxam at rates ranging from 25 to 50 g a.i./ha and imidacloprid at 25.0 g a.i./ha gave significant excellent control of jassid (83.3 to 100.00%) and increased the marketable fruit yield (32.40 to 35.44 %) of okra compared to conventional insecticides.

Rao (2003) conducted the field trials at Choppadandi, Andhra Pradesh during summer 2001 and *kharif* 2001 to evaluate the bioefficacy of certain pesticides for effective control of important pests of okra and reported that fenpropathrin 30 EC @ 100 ml/acre was found consistent in reducing the population of whitefly when sprayed at 15 days interval and was at par with triazophos 40 EC @ 150 ml/acre.

Rangraman et al. (2004) conducted two field experiment to test the efficacy of neem oil as a seed dresser @ 20ml/kg with systematic

chemical insecticides imidacloprid @ 7ml/kg performed better result by recording 11,280 and 11,580 kg/ha marketable fruit yield of Okra.

Nakat and Chede (2004) observed that dicofol (0.05%) was more effective in reducing the population of *T. Neocaledonicus*.

Dey et al. (2005) tested the efficacy of imidacloprid (70 WS and 200 SL) against sucking pest complex (*A. gossypii*, *Thrips tabaci*, *A. biguttula biguttula* and *Bemisia tabaci*) of okra and found that imidacloprid 70 WS (5 to 10 g/kg seed) provided effective control of early sucking pests. Imidacloprid 200 SL (100 to 125 ml/ha) was also equally effective against the sucking pests. Similarly, Sunitha et al. (2005) also reported that two sprays of imidacloprid at 0.006 % could be sprayed at 15 days interval to minimize the sucking pests (*A. gossypii* and *A. biguttula biguttula*) population on okra.

Jana and Somchoudhury (2005) relative efficacy of a synthetic pyrethroid, fenpropathrin 30 EC [IUPAC] name (RS) - a - cyano - 3 phenoxybenzyl 2,2,3,3 - tetramethylcyclopropane =carboxylate] along with two acaricides i.e. dicofol (18.5 EC), ethion (50 EC) and one broad spectrum acaro-insecticide profenophos (50 EC) was evaluated at 0.5, 0.75, 1.0, 2.5, 2.0 and 1.0 mVi of water dosages respectively on a tea clone "TV2t at Motidhar tea estate, terai, Darjeeling, West Bengal. Fenpropathrin 30 E.C. exhibited excellent control of tea red spider mite @ 0.75 and 1.0 mViitre of water than conventional acaricides at recommended doses.

Lal and Sinha (2005) carried out investigation to evaluate four (5, 9, 18, 36 g/kg) doses of imidacloprid seed treatments against the insect pests of okra. Studies revealed that seeds treated with imidacloprid afforded an effective protection of okra crop against the management of leafhoppers and their populations remained below the economic threshold level throughout the experiment. But, the treatments having imidacloprid seed treatment at 5 g/kg seed along with two foliar sprays of beta-cyfluthrin or altering of lambda-cyhalothrin and endosulfan were most effective treatments while seed treatment at 36 g/kg was second effective treatment ($p < 0.01$) against shoot and fruit borer. However, yield of all the treatments, except highest dose (36 g/kg) of imidacloprid seed treatment gave excellent results.

Misra (2005) stated that acetamiprid (20 g/ha) and imidacloprid (25 g/ha) proved significantly the best treatments in controlling the whitefly population on okra up to 3 weeks after application, with a population reduction of 81.02 and 82.71%, respectively, over the control. Among the insecticides evaluated dimethoate was intermediate in action, with 58.98% population reduction over the control. Dicofol, ethion, cypermethrin and azadirachtin did not give satisfactory control of the whitefly.

Safdar-Ali et al. (2005) reported that the spray of imidacloprid significantly reduced the *B. tabaci* population on okra.

Bhalala et al. (2006) evaluated the bio-efficacy of thiamethoxam 25 WG, endosulfan and monocrotophos against sucking pest complex of okra at Anand (Gujarat) and reported that the okra crop sprayed with thiamethoxam 25 WG at two higher doses (50 and 37.5 g a.i./ha) showed effective control of aphid, jassid, whitefly and mite. However, thiamethoxam (50 g a.i./ha) yielded a higher quantity of marketable fruits.

Jana et al. (2006) tested the efficacy of fenpropathrin 30 EC. (Meothrin), applied at four different concentrations (0.025, 0.050, 0.075 and 0.10%), along with imidacloprid 200 S.L. (Confidor) at 0.025% and dimethoate 30 EC., against the chilli aphid (*Aphis gossypii*) during rabi 2002-03 in Kakdwip, West Bengal, India. Fenpropathrin 30 EC 0.1% was the most effective dose in reducing aphid population to 90% and gave maximum higher green chilli yield (95.16 q/ha), followed by fenpropathrin 0.75% and imidacloprid 0.025%. Dimethoate 30 EC 0.2% and fenpropathrin at 0.025% proved less effective.

Rana et al. (2006) conducted experiments during kharif 2003 and 2004, in Karnal, Haryana, India and showed that imidacloprid at 2 ml as well as thiamethoxam and carbosulfan each at 2 g/kg seed were quite effective in controlling jassid. Imidacloprid at 2 ml, thiamethoxam at 2 g and carbosulfan at 4 g/kg seed were effective in controlling the whitefly (*Bemisia tabaci*). Okra seed yield was higher in thiamethoxam, imidacloprid and carbosulfan treatments. Management of sucking pests of okra with the use of insecticides as seed treatment provided an opportunity to minimize the quantity of the insecticide.

Suganthi et al. (2006) reported that premt @ 100 g a.i./ha was found equally effective as dicofol @ 180 g a.i./ha, dimethoate @ 300 g a.i./ha and endosulfan @ 350 g a.i./ha in controlling the okra mite population.

Solangi and Lohar (2007) determined the efficacy of different insecticides (imidacloprid, sundaphos, diafenthiuron and mospilan) against insect pests on okra and revealed that all the insecticides were significantly effective, but imidacloprid proved to be more effective compared to sundaphos, diafenthiuron and mospilan.

Sinha and Sharma (2007) seed treatment with imidacloprid (3.0 or 5.4 g a.i./kg seed) or foliar spray of thiacloprid @ 20 g a.i./ha or thiamethoxam @ 25 g a.i./ha at 50 days after sowing were found effective in managing *A. biguttula biguttula* population on okra.

Biswas and Chatterjee (2008) compared the efficacy of two new insecticides (thiamethoxam and acetamiprid) with that of conventional insecticides (monocrotophos, acephate, methyl demeton, dimethoate and phosphamidon) for the control of whitefly, *B. tabaci* on brinjal and jassid, *A. biguttula biguttula* on okra and revealed that thiamethoxam (35 g a.i./ha) and acetamiprid (30 g a.i./ha) were the highly effective chemicals against both the pests and caused the average reduction of 80.29 and 74.37 % in *B. tabaci* population on brinjal and 93.31 and 87.05 % in *A. biguttula biguttula* population on okra, respectively.

Mahalingappa et al (2008) studied bio-efficacy of certain insecticides against chilli thrips and mite at Students Farm, College of Agriculture, Rajendranagar, Hyderabad. The results indicated that fipronil 0.01 and triazophos 0.08 per cent were most effective against thrips in chillies, which were followed by profenofos 0.10, ethion 0.10 and cypermethrin 0.0012 per cent. Chlorpyriphos 0.0012 per cent was least effective against thrips. Profenofos 0.10 per cent was most effective against mite. The next best treatments were triazophos 0.08 and ethion 0.1 per cent. Cypermethrin 0.0012 was least effective against mite.

Nderitu et al. (2008) evaluated the efficacy of synthetic insecticides against aphid infesting okra at Kibwezi, Eastern Kenya and reported that lambda cyhalothrin 17.5 g a.i./ha was found highly effective in controlling aphids when sprayed at 15 days interval followed by imidacloprid 43.7 g a.i./ha.

Anitha and Nandihalli (2009) evaluated the efficacy of various insecticides against leafhopper and aphid on okra and found that at 25 days after sowing (DAS), imidacloprid 200 SL recorded the lowest aphid population followed by thiamethoxam 25 WG. At 35 DAS, there was an increase in aphid population for all foliar sprays and both imidacloprid and thiamethoxam seed treatments recorded the lowest aphid population. At 45 and 55 DAS foliar spray of imidacloprid resulted in the lowest aphid population followed by thiamethoxam and acetamiprid. Imidacloprid 200 SL registered the highest fruit yield (47.71 q/ha) followed by imidacloprid 70WS (44.43 q/ha) and thiamethoxam 70 WS (44.10 q/ha).

Biswas and Bhunia (2009) reported that a significant reduction in whitefly population and MYMV incidence with high yields compared to unsprayed control. Use of imidacloprid 70 % WS @ 5g/kg as seed treatment and one spray of fipronil 5 % SC at 1ml/l or thiomethoxam 25 % WG @ 0.5 g/l at 15 DAS gave good protection against whitefly by reducing YMV disease incidence with higher seed yield (512 kg/ha).

Shirale and Bidgire (2009) reported that two sprays of triazophos 40EC (800 ml/ha) at 30 and 50 DAS recorded less number of whiteflies at three (0.03), seven (0.03) and ten (0.00) days after spraying with maximum yield of 12.39 q/ha in soybean for the control of yellow mosaic virus.

Yasmin et. al. (2009) conducted field studies to evaluate the effect of Imidacloprid (Admire 200SL) and Thiamethoxam (Actara 25WG) on Jassid and Whitefly population and their impact on virus infestation in okra . Results revealed that the lowest mean number of Jassid (1.33) and Whitefly (1.86) population was recorded in Admire 200SL treated plots followed by Actara 25WG. The percent Jassid and Whitefly population reduction over control was exceeded 50% in both the chemicals. The number of okra yellow

vein clearing mosaic virus (OYVCMV) infected plants and leaves were significantly lowest in admire 200 SL treated plots at different stages of plant

Bagade and Ambekar (2010) conducted a field experiment in summer to evaluate neem formulations in alternation with synthetic insecticides against sucking pests of okra. The result revealed that, imidacloprid (0.004%) was the most superior treatment followed by cypermethrin (0.01%), the treatment with neem formulations viz., Achook (0.5%), ZA-199 (0.5%), NSKE (5%) alternated with imidacloprid (0.004%) and cypermethrin (0.01%) was found promising in checking the population of aphids and jassids infesting okra.

Boopathi et al. (2010) reported that dimethoate 30% EC @ 0.03% effectively reduced the aphid population in okra when sprayed on schedule base at an interval of 15 days at Kolasib, Mizorum.

Nath and Sinha (2010) made schedule based spray of thiamethoxam 25 g a.i./ha or acetamiprid 20 g a.i./ha followed by insecticide mixture sprays of triazophos 35% + deltamethrin 1% (Spark), chlorpyrifos 50% + cypermethrin 5% (Boro) and profenophos 40% + cypermethrin 4% (Polytrin C) twice at 15 days interval and reported that both neonicotinoids (thiamethoxam and acetamiprid) were effective against leaf hopper and whitefly infesting okra at IARI, New Delhi.

Pathan et al. (2010) conducted field experiment to evaluate some insecticides against sucking pests of okra at Parbhani. Findings showed that need based (ETL) spray of thiamethoxam 25 WG @ 0.0125% gave effective protection to okra crop against aphids and jassids; and population could be kept below the economic threshold level up to 14 days after spray.

Sathpath and Kumar (2010) reported that application of imidacloprid (3 g/kg seed) as seed treatment along with two sprays of betacyfluthrin @ 18.5 g a.i./ha at 40 and 55 days after sowing or three spray of imidacloprid @ 40 g a.i./ha at 25, 40 and 55 days after sowing effectively reduced the jassid population in okra at Varanasi.

Shivanna et al. (2011a) were determined the efficacy of new insecticides against sucking insect pests viz., leafhopper, aphid, whitefly and

thrips in cotton were determined. Seven insecticides viz., Dimethoate 30 EC @ 300 g a.i./ha, Triazophos 40 EC @ 600 ml a. i./ha, Fenpropathrin 30EC @120 ml a. i./ha, Imidacloprid 17.8 SL @44.5 ml a.i./ha, Spinosad 45 SC@45 ml a.i./ha, Eco neem 3%@120 ml a.i./ha and standard check Acetamiprid 20 SP@ 60 g a.i./ha were sprayed based on ETL in order to ascertain the mortality of the pests of transgenic cotton. All the treatments are superior to untreated check. Among the treatments one day after spraying Fenpropathrin showed superior efficacy in bringing down all the sucking pest population followed by Dimethoate, Imidacloprid and standard check Acetamiprid. Dimethoate and Imidacloprid were most effective against aphid and Dimethoate alone was most effective on leafhopper, whitefly and thrips at three days after spraying which were found to be superior over other treatments followed by Imidacloprid, Acetamiprid, Triazophos, Fenpropathrin, Eco neem and Spinosad. The similar trend was also observed even at seven days after spray.

Kalyan et al. (2012) conducted field studies to evaluate the bio-efficacy of some new molecules against jassids, *Amrasca biguttula biguttula* (Ishida) and whiteflies, *Bemisia tabaci* (Genn.) of cotton . Six molecules i.e. acephate 75 SP @ 500 a.i./ha, triazophos 40 EC @ 600 a.i./ha, fipronil 5 SC @ 40 a.i./ha, imidacloprid 70 WG @ 50 a.i./ha, spinosad 45 SC @ 75 a.i./ha and dimethoate 30 EC @ 300 a.i./ha were evaluated. Spinosad, imidacloprid, acephate and fipronil effectively control the population of jassids and whiteflies and gave significantly higher seed cotton yield over to untreated check and standard check. The highest avoidable losses (52.65%) were recorded in spinosad followed by Imidacloprid (42.38%), acephate (31.47%), fipronil (28.23%) and dimethoate (28.12%).

Mallapur et al. (2012) conducted the field experiment for evaluation of certain insecticides against insect pests of okra at Dharwad and reported that mixture of indoxacarb 14.5 SC + acetamiprid 7.7 SC @ 300 and 400 ml/ha when applied twice at 15 days interval found more effective against sucking pests of okra then indoxacarb 14.5 SC @ 500 ml/ha, cypermethrin 5 EC + chlorpyrifos 50 EC @ 100 ml/ha, oxydemeton methyl 25 EC @ 650 ml/ha and acetamiprid 20 SP @ 200 g/ha.

Iqbal et al. (2013) evaluated one combination of seed treatment with imidacloprid (Confidor 70 WS) and spray with detergent and for insecticide sprays: imidacloprid (Confidor 20% SL), acetamiprid (Acelan 20% SL), thiomethoxam (Actara 25 WG) and acephate (Commando 75 SP), against sucking insect pests on mungbean, *Vigna radiata* (L.) at Arid Zone Research Institute (AZRI), Bhakkar during 2012. All the treatments showed a significant difference with one another, regarding their effectiveness. The application of insecticide sprays immediately enhanced the mortality of the pests, whereas, the effect of seed-treatment and detergent did not show distinctive effect on the pests' population. Imidacloprid and thiomethoxam resulted in a maximum mortality of the jassid, followed by acetamiprid. While in case of whitefly, imidacloprid was the most effective and resulted in a minimum population followed by acetamiprid. Acephate resulted in the maximum control of thrips and was found the most effective insecticide, followed by acetamiprid.

Kaur and Singh (2013) evaluated different insecticidal and botanical formulations for the management of sucking pests on capsicum under net house conditions at Vegetable Research Farm, Punjab Agricultural University, Ludhiana during the year 2011. Sprays of different treatments viz. Asataf 75 SP (Acephate) @ 0.05 % and 0.10%, Decis 2.8 EC (deltamethrin) @ 0.025 % and 0.05 %, Confidor 17.8 SL (imidacloprid) @ 0.025 % and 0.05%, Neem Soap (Azadirachta indica) @ 1.0%, Pongamia Soap @ 1.0% were given for the control of aphid on 7.3.2011 and 18.3.2011. The sprays for the control of thrips and yellow mite were given on 13.5.2011, 3.6.2011 and 13.6.2011. The pooled data indicated that significantly low aphid counts/3 top clusters /plant (0.76-1.05) in treatments Neem Soap (Azadirachta indica) @ 1.0%, Pongamia Soap @ 1.0%, Confidor 17.8 SL (Imidacloprid) @ 0.025% and 0.05%, Asataf (Acephate) 75 SP @ 0.05 and 0.10% as against Decis 2.8 EC @ 0.025 and 0.05% (1.80-2.47) and control (1.77). Significantly low chilli thrips counts /top canopy/plant (0.03-0.06) were recorded in treatments confidor 17.8 SL (Imidacloprid) @ 0.05% and Asataf (Acephate) 75 SP @ 0.10% followed by Decis 2.8 EC @ 0.05% (0.12) and neem soap @ 1.0% (0.12) and other treatments (0.16-0.22) and control (0.28). Significantly lowest

mean thrips rating (0.37-0.72) was observed in treatments Decis 2.8 EC @ 0.05%, Asataf 75 SP @ 0.10% and confidor 17.8 SL @ 0.05% followed by neem soap @ 1.0% (0.90) as against other treatments (1.10-1.45) and control (1.37). Out of these treatments, significantly lower mean yellow mite rating (2.42-2.45) was recorded in Decis 2.8 EC @ 0.05 %, confidor 17.8 SL @ 0.05% and neem soap @ 1.0% followed by pongamia soap @ 1.0% (2.85) in comparison to other treatments (3.02-3.27) and control (3.15). No treatment could give complete protection against yellow mite on capsicum in net house. Total yield per plant was achieved highest (0.215- 0.239 kg/plant) in Asataf 75 SP @ 0.10% and confidor 17.8 SL @ 0.05 % followed by neem soap @ 1.0% (0.203kg/plant) and other treatments (0.106-0.168 kg/plant) and control (0.091 kg/plant).

Patil et al. (2014) studied the efficacy of some new insecticides against sucking insect pests viz., leafhopper, aphid and whitefly in okra. Three sprays of different insecticides viz., thiamethoxam 25 WG, lambda cyhalothrin 5 EC and triazophos 40 EC, at three different concentrations of were made at 15 days interval. This study revealed that, amongst the treatments tested, the cumulative effect of foliar spray of Thiamethoxam 25 G @ 0.006% was the most effective against aphids, followed by Lambda cyhalothrin 5 EC @ 0.004%. where, thiamethoxam 25 WG @ 0.006% was effective against leafhoppers population followed by thiamethoxam 25 WG @ 0.008%. Also, in case of whitefly the effective treatment recorded was thiamethoxam 25 WG @ 0.006%. The recommended doses of insecticides were more effective than other doses.

Shimoge and Vemuri (2014) evaluated the efficacy of six insecticides viz., bifenthrin 10 EC @ 80 g a.i./ha, fipronil 5 SC @ 500 g a.i./ha, flubendiamide 480 SC @ 60 g a.i./ha, quinalphos 25 EC @ 350 g a.i./ha, profenofos 50 EC @ 400 g a.i. /ha and beta-cyfluthrin 25 SC @ 18.75 g a.i./ha against shoot and fruit borer (*Earias vittella* Fabricius) and white fly *Bemisia tabaci* (Gennadius) on okra of which flubendiamide @ 60 g a.i./ha, profenofos @ 400 g a.i./ha and betacyfluthrin @ 18 g a.i./ha, applied twice as foliar sprays were found to be most effective in controlling the okra pests.

Vijayalakshmi et al. (2015) conducted field and poly house experiments to evaluate the new insecticides for the management of mite, *Polyphagotarsonemus latus* Banks on capsicum. Among the seven insecticides, mean of two seasons under field conditions reveal that, post count population was lower with spiromesifen (0.62 mites leaf⁻¹) followed by diafenthiuron (4.08 mites leaf⁻¹), triazophos (5.73 mites leaf⁻¹) and thiamethoxam (9.43 mites leaf⁻¹) which were superior over rest of the treatments and untreated check (17.60 mites leaf⁻¹). Under poly house condition, population was less with spiromesifen (0.06 mites leaf⁻¹) followed by diafenthiuron (2.21 mites leaf⁻¹), triazophos (3.68 mites leaf⁻¹) and thiamethoxam (5.30 mites leaf⁻¹) which were superior over untreated check (11.33). Comparison of efficacy of insecticides, there was significant difference in percent reduction of population over untreated check after each spray. The percent reduction and mortality in mite population were high in poly house (spiromesifen, flubendiamide and spinosad) compared to open field.

Ellora and Ray (2016) a field efficacy of seven pesticides viz. dimethoate 30 EC, dichlorvos 76 EC, chlorpyrifos 20 EC, phosphamidon 40 SL and quinalphos 20 EC, were conducted in Irongmara field. Two concentrations viz., as per label recommended and half of the label recommendation for each pesticides were used. Among the tested pesticides, quinalphos (0.012 g a.i) afforded mostly cent per cent mortality of immature and adult mites. This proved to be the most effective pesticides for controlling *Tetranychus cinabarinus* on brinjal among the seven pesticides. Quinalphos (0.012 g a.i) also proved to be more effective compared to other pesticides. And least mortality was recorded by chlorpyrifos (0.004 g a.i) in adult stage whereas in case of immature stage least effective was shown by chlorpyrifos (0.002 g a.i). Study revealed that the treatment of these pesticides showed significant effect ($p < 0.05$) against both adults and immature stages resulted significant effect at all the dates after treatment.

Jadhav et al. (2016) revealed that all the treatments proved their superiority over untreated control showing imidacloprid 70WG as the most effective treatment followed by thiamethoxam 25 WG, fipronil 5SC and

diafenthiuron 50WP. The second spray results showed that thiamethoxam 25WG, imidacloprid 70WG and fipronil 5SC proved to be the best treatments with maximum reduction of population and were found at par with each other

Meena et al. (2016) conducted the field experiment at Vegetable Research Farm, Banaras Hindu University, Varanasi to evaluate the efficacy of different insecticides against Leafhoppers, *Amrasca biguttula biguttula* (Ishida) in okra. The overall mean efficacy of the four observations recorded at one, five, ten and fifteen days after two sprayings indicated that imidacloprid (71.47 %) recorded highest reduction of leafhopper population and remained significantly superior over all the other treatments and was followed by thiacloprid and acetamiprid which recorded, 60.55 and 59.66 per cent (respectively) reduction over control. They are at par with each other. These treatments were closely followed by thiamethoxam and cartap hydrochloride being at par and showed >50 per cent reduction over control by recording, 51.94 and 51.83 per cent reduction, respectively. The next best treatment in the decreasing order of their efficacy was spinosad with 10.56 per cent reduction of population. Novaluron was the least effective with only 9.30 per cent reduction over control. However, all treatments showed significant reduction in leafhopper population over control.

Rita and sharan (2016) studied on evaluate various synthetic insecticides against thrips in Bt cotton revealed that maximum reduction (56.00%) in thrips population was recorded with the treatment of Acephate 75 % SP, followed by Imidacloprid 17.8% SL (49.66%). Both the treatments were at par and significantly superior over the other treatments. The phytotoxic effect on crop could not be observed during the experimental period.

Begum et al. (2017) tested newer insecticides for their efficacy as seed dressers against sucking pests of okra viz., leafhoppers, aphids, whiteflies and thrips, infesting okra revealed that clothianidin 600 FS @ 9ml/kg seed was significantly superior in reducing population of sucking pests and was at par with imidacloprid 70 WS @ 10g/kg seed. This was followed by clothianidin 600 FS @ 7ml/kg seed and thiamethoxam 70 WS. Clothianidin 600 FS @ 9ml/kg seed recorded 90.79, 92.83, 88.1, 85.7 per cent reduction over untreated control against leafhoppers, aphids, whiteflies and thrips

respectively and also recorded maximum marketable yield of okra fruits (58.9 q/ha) with 98.96 per cent increase over untreated control.

Patil et al. (2018) conducted experiment was at farmers field, Village Kesali, Ta. Gandevi, Dist. Navsari during 2015. There are two spray of fipronil 5 SC (25 mL a.i./ha), lambda-cyhalothrin 5 EC (25 mL a.i./ha), ethion 40 EC + cypermethrin 5 EC (499.5 mL a.i./ha), fenpropathrin 30 EC (150 mL a.i./ha) and fenazaquin 10 EC (50 mL a.i./ha) in chilli at 15 days interval resulted that, the treatment of fipronil 0.005 per cent (25 mL a.i./ha) and fenpropathrin 0.03 per cent (150 mL a.i./ha) found significantly superior in controlling the chilli thrips with significantly higher fruit yield (421.95 q/ha), which was at par with fenpropathrin (403.26 q/ ha). A treatment of ethion + cypermethrin 0.1 per cent (499.5 mL a.i./ha) proved as the second best treatment, though it was equally effective to fenpropathrin 0.03 per cent (150 mL a.i./ha) and lambda-cyhalothrin 0.005 per cent (25 mL a.i./ha). Fenazaquin 0.005 per cent (50 mL a.i./ha) remained least effective among all during present investigation.

2.6 Effect of insecticides on fruit borer

Ray and Chatterjee (2000) evaluated the efficacy of imidacloprid, acetamiprid, acephate and profenofos against *E. vittella* on okra and revealed that the reduction in infestation to the extent of 15.36, 12.42, 14.25, and 15.70% was noticed after 3 weeks of spray with the respective insecticide. Acephate gave the best cost benefit ratio of 1:5.58 followed by imidacloprid (1:4.63).

Among the different chemicals viz. endosulfan, cypermethrin, NSKE, achool, nimbitor, combination of neem products and synthetic pesticides tested against *Earias* spp. on okra at Pune (Maharashtra), cypermethrin (0.01%) was the most effective, recording the lowest fruit infestation (6.57 %), and was significantly superior over other treatments. This was followed by endosulfan (0.06%) which recorded 12.52 per cent fruit infestation compared to 44.16 per cent infestation in untreated check (Ambekar et al., 2000c).

Misra et al. (2002a) reported that significantly better control of the fruit borer was obtained with the application of cypermethrin, profenofos and profenofos + cypermethrin. The decrease in per cent fruit borer infestation with these three treatments ranged from 70.5 to 76.8 over control. Significantly highest (51.75 to 55.37 q/ha) healthy fruit yield was recorded with these treatments over other treatments and control (45.23 q/ha). The per cent increase in fruit yield was highest (22.4%) with profenophos + cypermethrin over control which was at par with profenofos (16.0%) and cypermethrin (14.4%).

Patil et al. (2002) reported that four sprays of cypermethrin 25 EC (0.0075%) at an interval of 10 days starting from flowering were found effective in reducing infestation of okra fruits by *E. vittella* at Rahuri in Maharashtra.

Prasad and Prasad (2004) reported that okra intercropped with either *Phaseolus vulgaris*, *Coriandrum sativum* and *Tagetes erecta* supplemented with four foliar sprays with either deltamethrin (10 g a.i./ha) or lambda-cyhalothrin (15 g a.i./ha) or cypermethrin (50 g a.i./ha) provided protection against *E. vittella* leading to economically viable cropping system.

Bagade et al. (2005) conducted two experiments in Maharashtra, India in 2001 to determine the effects of using neem alternately with synthetic insecticides against fruit borer (*Earias vittella*) of okra (cv. Arka Anamika). Treatments comprised: 0.01% cypermethrin alone, 0.004% imidacloprid alone, 0.5% Achook alternated with cypermethrin, 0.5% ZA-199 alternated with cypermethrin, 5% neem seed kernel extract (NSKE) alternated with cypermethrin, Achook alternated with imidacloprid, ZA-199 alternated with imidacloprid, and NSKE alternated with imidacloprid. Treatments were given either in 4 sprays at 15-days intervals or in 3 sprays at 21-days intervals. Neem formulations alternated with insecticides showed lower fruit infestation. Among the insecticides altered with neem formulations, cypermethrin was superior, recording 8.05 and 4.95% fruit infestation by number and weight basis, respectively. Individual cypermethrin treatment was also superior to individual imidacloprid treatment. Achook, ZA-199 and NSKE, when alternated with cypermethrin recorded 9.92, 11.57 and 10.86% fruit

infestation on number, and 5.52, 5.87 and 5.88% fruit infestation on weight basis, respectively.

Kadam et al. (2006) evaluated the efficacy of some insecticides against *E. vittella* on okra and concluded that for the first application, polytrin-C 44 EC (1000 ml/ha) resulted in the lowest fruit and shoot borer population, followed by monocrotophos 36 SL (1000 ml/ha). For the second application, the lowest pest population was obtained with polytrin-C 44 EC at 7 and 14 DAS, and with monocrotophos and polytrin-C at 1 DAS. For the third application, polytrin-C gave the lowest incidence of the pest. Polytrin-C was also superior in terms of yield of healthy fruits (135.91 q/ha) and cost benefit ratio (1:16.7).

Singh et al. (2006) evaluated the efficacy of synthetic pyrethroids against shoot and fruit borer (*E. vittella*) infesting okra and revealed that fenvalerate at 150 g a.i./ha and cypermethrin at 100 g a.i./ha recorded the lowest percentage of shoot and fruit damage. These treatments also recorded the highest fruit yields (99.83 and 98.00 q/ha). However, fenvalerate at 75 g a.i./ha recorded the highest benefit:cost ratio (8.10).

In field experiments conducted at New Delhi, okra seed treatment with imidacloprid (3 or 5.4 g a.i. kg⁻¹ seed) was found effective in managing *A. biguttula biguttula* population (Sinha and Sharma, 2007).

Tripathy et al. (2007) revealed that application of neem cake to okra was found beneficial in reducing the fruit borer incidence and yellow vein mosaic virus (YVMV).

Lal et al. (2008) studied efficacy of beta-cyfluthrin, lambda-cyhalothrin and imidacloprid against *E. vittella* in okra revealed that all the insecticides resulted in less shoot and fruit damage in comparison to the untreated control. Lambdacyhalothrin at 30 g a.i./ha was superior to the other treatments and on par with endosulfan at 500 g a.i./ha. Highest net return (Rs. 7018/ha) was obtained with lambda-cyhalothrin and the treatment at 15 g a.i./ha recorded the highest cost-benefit ratio (1:4.73). Nath and Singh, (2008). Revealed that foliar application of lambda-cyhalothrin at flowering and fruit initiation was the most effective against *E. vittella*.

Tomar (2008) showed that the seed treatment with imidacloprid 70 WS 10 g/kg of seed, was effective in suppressing the jassid-population below ETL up to 60 days, after sowing while imidacloprid 70 WS 7.5 g/kg of seed, was effective up to 50 days, after sowing. Cotton with imidacloprid @ 5 g/kg of seed, was more effective than other treatments, in keeping the population of leaf hopper, below the economic threshold level up to 40 days, after sowing. The use of insecticide, as seed treatment, provides an opportunity to minimize the pest population.

Papal and Bharpoda (2009) lowest fruit damage due to fruit borer, *E. vittella* was obtained with chlorpyrifos (18.86%), cypermethrin + quinalphos (19.97%). Chlorpyrifos (0.04 %) recorded the lowest (2.05%) percentage of damaged seeds, but was on par with all the insecticidal treatments tested, except alpha-cypermethrin and fipronil 5 SC @ 0.005%. The number of borer holes per fruit was lowest for chlorpyrifos (1.17), cypermethrin + quinalphos (1.19), chlorpyrifos + alpha-cypermethrin (1.20) and endosulfan (1.22).

Rahman et al. (2009) evaluated different insecticides against fruit and shoot borer and revealed that Fenfen 20EC @ 0.5 ml/lit. of water gave the best performance resulting the lowest per cent of shoot infestation (3.95%) and fruit infestation at early, mid and late reproductive stages (1.09 %, 1.61 % and 4.11 %, respectively) by number and provided the highest yield (12.97 t/ha). Decis 2.5 EC @ 1 ml/lit also gave statistically similar results for different parameters tested. However, Fenfen 20EC appeared to be superior in controlling fruit and shoot borer of okra over control and other insecticides tested.

Ghosh and Khan (2010) applied imidacloprid (2g/100g) as seed treatment along with neem cake @ 200 kg/ha proved to be best in reducing population of whitefly, jassid and shoot and fruit borer on okra.

Nath and Sinha (2011) conducted a field trial on okra cv. Arka Anamika with six treatments and a control. Two foliar sprays were conducted one was of neonicotinoids viz., thiamethoxam @ 25 g a.i. /ha in first four treatments while it was of acetamiprid @ 20 g a.i. /ha in other two treatments. In second spray, two dosages of each insecticide viz., triazophos (350 & 700

g a.i. /ha), deltamethrin (10 & 20 g a.i. /ha) and their registered mixtures, triazophos + deltamethrin (360 & 720 g a.i. /ha) were assessed against various insect pests of okra. Results revealed that neonicotinoids were very effective against leafhopper, *Amrasca biguttula biguttula* and whitefly, *Bemisia tabaci* in all treatments during first spray. All treatments were effective against leafhoppers and whiteflies during II spray except treatments with low dose of triazophos (350 g a.i. /ha) and deltamethrin (10 g a.i. /ha), which were not effective against whiteflies. As far as infestation due to shoot and fruit borer, *Earias vittella* was concerned, the damage in various treatments ranged from 2.4-14.2% compared to 27.3% in untreated check.

Seed treatment with imidacloprid 70 WS @ 5 g/kg seed followed by three spray of imidacloprid 20 SL @ 200 ml/ha and NSKE @ 5% at 15 days interval was found more effective in reducing jassid infesting okra at Faisalabad, Pakistan (Iqbal et al. 2012).

Mallapur et al. (2012) conducted the field experiment for evaluation of certain insecticides against insect pests of okra at Dharwad and reported that mixture of indoxacarb 14.5 SC + acetamiprid 7.7 SC @ 300 and 400 ml/ha when applied twice at 15 days interval found more effective against sucking pests of okra than indoxacarb 14.5 SC @ 500 ml/ha, cypermethrin 5 EC + chlorpyrifos 50 EC @ 100 ml/ha, oxydemeton methyl 25 EC @ 650 ml/ha and acetamiprid 20 SP @ 200 g/ha.

Aditi Badiyala and Raj (2013) carried out two year trials were at farmer's fields in village Kachhiari (Kangra) in Himachal Pradesh to study the seasonal incidence, varietal susceptibility and management of *E. vittella* (Fabricius) infesting okra crop through insecticides, biopesticides and a bioagent. Studies revealed that the okra shoot infestation varied between 1.78 to 2.24% during first year and 0.82 to 1.56% during second year, while the fruit infestation varied between 1.83 to 35.85% and 1.23 to 29.64% during the respective years. Peak fruit infestation (%) as well as peak larval population per fruit was observed in third to fourth week of August during the two seasons. Among the 10 okra varieties/hybrids screened for relative susceptibility to *E. vittella*, Tulsi and Varsha Uphar registered lower mean per cent fruit borer infestation as well as higher yield as compared to

the rest. Among the different treatments, cypermethrin (0.01%), endosulfan (0.07%) and *Bacillus thuringiensis* var. *kurstaki* (1.96×10^7 IU ha⁻¹) + endosulfan (0.035%) sprays were found efficacious against the pest.

Naik and Kumar (2014) evaluated that among insecticides, tested cypermethrin 25 EC @ 0.05%, chlorpyrifos 20 EC @ 0.05% and spinosad 45 SC @ 0.005% were found to be most effective, the shoot damage percentage was 5.3, 6.2 and 6.8%, respectively. Minimum % of fruit damage was observed with cypermethrin 25 EC @ 0.05%, chlorpyrifos 20 EC @ 0.05% and spinosad 45 SC @ 0.005% was 8.2, 11.5 and 12.7%, respectively. Occurrence of shoot and fruit borer commenced from 33rd standard week (August third week) with an average population of infestation 2.4% and gradually reached its peak level of infestation 45.7% at 41st standard week (October second week) there after declined trend was observed as temperature decreased. The highest yield was registered with cypermethrin 25 EC @ 0.05% about 88.42 q/ha which was followed by chlorpyrifos (0.05%) 85.02 q/ha and spinosad 78.52 q/ha, respectively.

Jadhav et al. (2016) revealed that all the treatments proved their superiority over untreated control showing imidacloprid 70 WG as the most effective treatment followed by thiamethoxam 25 WG, fipronil 5 SC and diafenthiuron 50 WP. The second spray results showed that thiamethoxam 25 WG, imidacloprid 70 WG and fipronil 5 SC proved to be the best treatments with maximum reduction of population and were found at par with each other.

2.7 Effect of botanicals and insecticides on sucking pests

Bhargava and Bhatnagar (2001) revealed that 2 formulations of imidacloprid 600 FS at the rate of 9 ml / kg and 70 WP at the rate of 10 g/ kg okra seed treatment performed well against jassids and whiteflies at Jaipur (Rajasthan) recording higher yields with no phyto-toxic symptoms on crop.

Chinniah (2001) evaluated the bio-efficacy of carbosulfan 25 EC, bifenthrin 10% WP and Neemita (a neem-based product) against spider mite, *Tetranychus cinnabarinus* and aphid, *A. gossypii* and revealed that ethion at 0.1% (EC and EW formulations) and fenpropathrin 10EC 0.01% were highly effective against mites which was followed by carbosulfan (0.05%) and

bifenthrin (0.015%) which registered more than 60 % mortality on seventh days after treatment. Neemitaif at 2 and 4 ml/litre registered only about 40 % mite mortality. Dimethoate (0.06 %) was the most effective against aphid followed by bifenthrin (0.015 %) and carbosulfan (0.05 %) as both the treatments recorded more than 80 % mortality on seventh day after spray. However, Neemitaif registered 60 % aphid mortality. Ethion and danitol were the most effective acaricides against *T. cinnabarinus*, while carbosulfan and bifenthrin were the most effective against *A. gossypii*.

Indumathi et al. (2001) studied the uptake and dissipation of imidacloprid, in okra by treating the seed with imidacloprid (Gaucho) at 9 g a.i. /kg seed. They reported that the residues of imidacloprid persisted in the plant for more than 30 days, after germination. However, residues could not be detected in the fruit harvested at 50, 55 and 60 days after germination.

Kumar and Singh (2001) reported from Bangalore (Karnataka) that seed treatment with imidacloprid (Gaucho 600 FS) at 12 ml / kg was efficient in reducing leafhopper infestation with no phyto-toxic effect on okra plants; however, the lower concentrations were not effective.

Lal et al. (2001) reported that seed treatment of okra with imidacloprid (5g/kg) managed population of *A. biguttula biguttula* successfully at Hisar in Haryana.

Satpute et al. (2001) reported that imidacloprid applied @ 7.5 and 10 g/kg, were most effective against the jassids with its toxicity lasting upto 56 DAG (Days after germination), while a dose of 5 g/kg lasted up to 42 DAG of cotton crop.

Kaur (2002) determined the efficacy of various seed-treatments and foliar-sprayin controlling *A. biguttula biguttula* and *Earias sp.* infesting okra cv. Arka anamika. Seed treatment with 5 g/kg imidacloprid + foliar spray with 500 g a.i.monocrotopho + 30 g a.i. cypermethrin, resulted in a lowest mean population of cotton jassid, in 1999 (1.78) and 2000 (1.45). Mean fruit yield was the highest and leaf injury due to jassid infestation was the lowest with this treatment.

Misra (2002b) evaluated some newer insecticides like (thiamethoxam 25 WG, imidacloprid 200 SL and profenofos + cypermethrin 44 EC along with conventional insecticides like dimethoate 30 EC, cypermethrin 10 EC, profenofos 50 EC and a plant product, azadirachtin 1500 ppm) against *A. gossypii* and *A. biguttula biguttula* infesting okra and revealed that imidacloprid and thiamethoxam each at 25 g a.i./ha proved significantly superior in controlling aphids and jassids which was followed by dimethoate (300 g a.i./ha) and cypermethrin (100 g a.i./ha).

Mani et al. (2003) the efficacy of acaricides viz., dicofol 18.5 EC and 5 % WP, ethion 50 EC, sulfur 80 % WP and abamectin 1.9 EC and botanical insecticides were evaluated by and reported that the tested acaricides and botanical insecticides were effective in reducing *T. urticae* population in okra.

Santharam et al. (2004) reported that the seed-treatment of sunflower, with imidacloprid 70 WS @ 7 g/kg, protected the crop upto 6 weeks, against the leaf hopper, while a foliar-spray of imidacloprid 200 SL @ 100 ml/ha, given 3 week after sowing, reduced the leaf hopper population, significantly and the effect persisted for 3 weeks. Imidacloprid 600 FS, as seed-treatment (5 ml/kg) protected the crop upto 6 weeks against the leaf hopper. Significant increase in the grain yield was observed imidacloprid treated plots.

Satpathy et al. (2004) reported that seed treatment of okra with imidacloprid @ 3 g/kg and subsequent application of monocrotophos @ 500 g a.i./ha, at 55 and 70 days after sowing, offered a maximum protection against leaf hopper, *A. biguttula biguttula* (0.53 nymphs/plant) through out the crop-growth stage. While, the foliar application of imidacloprid (200 SL) @ 18.5 g a.i./ha and monocrotophos (36 EC) @ 500 g a.i./ha, also protected the crop from leaf hopper (0.86 and 1.96 nymphs/plant, respectively).

Singh and Nagaraj (2004) tested three doses of imidacloprid, viz., Gaucho 600 FS@ 6, 9 and 12 ml/kg of seed and Gaucho 70 WS @ 5, 7.5 and 10 g/kg seed along with Confidor 200 SL @ 100 and 200 ml/ha and monocrotophos 0.04%, as a foliar spray for their efficacy in controlling

A. biguttula biguttula, infesting sunflower. Gaucho 70 WS or 600 FS @ 5 g or 6 ml/kg of seed, respectively, was effective in controlling leaf hoppers.

Chaudhary et al. (2005) also showed that imidacloprid (Confidor 350 SC) at 75 ml/ha was the most effective treatment in reducing the jassid incidence and recorded the maximum fruit yield of 87.4 q/ha.

Dey et al. (2005) conducted field experiments during the 1998 and 1999 summer season to valuate the efficacy of imidacloprid formulations (70WS, water dispersible powder for slurry treatment; 20SL, soluble liquid) against the sucking pest complex (*Aphis gossypii*, *Thrips tabaci*, *Amrasca biguttula biguttula* and *Bemisia tabaci*) of okra (cv. Vijaya) and their natural enemies. Imidacloprid 70 WS was used for seed treatment at the time of sowing and imidacloprid 200 SL was applied as foliar spray at 20 and 40 days after sowing. Imidacloprid 70 WS at 5-10 g/kg seed provided effective control of early sucking pest complex of okra. Imidacloprid 200 SL at 100-125 ml/ha was also equally effective against the sucking pest complex of okra. Comparative data on the mean number of *Aphis gossypii*, *Thrips tabaci*, *Amrasca biguttula biguttula* and *Bemisia tabaci* per leaf; mean germination percentage; mean plant height; mean number of predatory coccinellid grubs per plant; mean percentage of *Aphis gossypii* parasitized by *Aphidius spp.* and yield were also tabulated.

Nauen et al. (2005) conducted studies in baseline susceptibility spiromesifen did not have a marked effect against *T. urticae* adult females, but was highly toxic against eggs of the mite.

Razaq et al. (2005) compared the efficacy of neonicotinoid and conventional insecticides, on cotton and reported that diafenthiuron, acetamiprid, imidacloprid and thiamethoxam proved to be the most effective in reducing the jassid-population, below ETL (1-1.5/leaf) up to seven days, after application. Imidacloprid and diafenthiuron gave statistically, similar and higher mortality than all other insecticide applications.

Singh and Singh (2005) evaluated the efficacy of some commercially available pesticides, i.e. azadirachtin, dicofol, ethion, endosulfan, fenvalerate, monocrotophos and wettable sulfur at their

recommended doses against *T. urticae* on okra crop and reported that maximum (81.35%) mite mortality was obtained with dicofol followed by monocrotophos (79.72 %), endosulfan (79.37 %) and ethion (78.00 %).

Bhalala et al. (2006) evaluated the bio-efficacy of thiamethoxam 25 WG endosulfan and monocrotophos against sucking pest complex of okra at Anand (Gujarat) and reported that the okra crop sprayed with thiamethoxam 25 WG at two higher doses (50 and 37.5 g a.i./ha) showed effective control of aphid, jassid, whitefly and mite. However, thiamethoxam (50 g a.i./ha) yielded a higher quantity of marketable fruits.

Rana et al. (2006) revealed that imidacloprid @ 2 ml thiamethoxam and carbofuran @ 2 g/kg seed, were effective in controlling the jassid on okra.

Mandal et al. (2007) reported all the combination treatments were comparatively superior over sole treatments. The combination treatment comprising of the soil application of neem cake at 200 kg/ha along with three foliar spray of neem oil @ 0.5 L/ ha and endosulfan (35 EC) @ 250 g a.i. / ha recorded minimum population of jassid (7.4/30 leaves) and lowest percentage of shoot and fruit borer damage and minimum borer population. The aforesaid treatment yielded maximum marketable okra fruits (127.48 q/ha) and maximum percentage increase in yield (53.40) over control and also proved profitable with the maximum cost benefit ratio (1:8.17). Neem oil at 0.5 L/ ha recorded maximum infestation of pests and produced lowest yield but showed comparatively higher incremental cost benefit ratio (1:3.38) than *Bt* + Endosulfan (1:2.58), *Bt* + Acephate (1:2.13) and Neem cake (1:1.60).

Rahman et al. (2009) reported the lowest mean number of jassid (1.33/leaf) and whitefly (1.86/leaf) population on okra in plots treated with imidacloprid 200 SL followed by thiamethoxan 25 WG. Per cent reduction in jassid and whitefly population over control was exceeded 50 % in both the chemicals. at 450 g a.i./ha recorded highest reduction of 87.95, 96.08 and 89.38, 93.79 per cent in mite population on bhendi in first and second round of sprayings, respectively. They also found that the fenpyroximate, fenazaquin and buprofezin were next order in controlling of mite. As per the report of Sreenivas et al. (2008) the ecomite, a plant-based acaricide at 2.0 ml/lit. was

optimum for the control of mite, *T. cinnabarinus* on okra and protected against spider mite for up to 10 days after application.

Wale and Chandele (2010) reported that spiromesifen was superior to acephate and dicofol in reducing the whitefly and mite in tomato. The spiromesifen was very effective in managing the whitefly in okra.

Marcic et al. (2011) noticed that spiromesifen toxic to eggs and immature stages of spider, while it acts more slowly against adult females, causing reduction in fertility and fecundity

Sato et al. (2011) observed among the different developmental stages studied that the egg stage of *T. urticae* was found to be the most sensitive to spiromesifen. In the present study also spiromesifen recorded a higher reduction in egg count over untreated control compared to standard check, dicofol. Spiromesifen, a tetrone acid derivative acts as inhibitor of acetyl-CoA-carboxylase, a key enzyme in fatty acid biosynthesis.

Venkataramanappa et al. (2012) conducted the field experiment to evaluate the efficacy of neem product on whitefly of Okra. The lowest mean whitefly population (1.18/plant) was also recorded in seed treatment imidacloprid 70 WS + spray imidacloprid 17.8% and its yield (57.40q/ha) followed by thiomethoxam (38.20q/ha), nimbecidin (32.12q/ha), neem oil (34.18q/ha) and NSKE(31.16q/ha).

Chaure (2013) studied that the foliar application of NSE 7% was found most effective for the control of cotton aphids followed by NSE 5% and acetamiprid 20 SP @ 0.003% and it was at par with remaining treatments. Azadirachtin 1500 ppm was next effective in reducing aphid population. Neem oil 3%, acetamiprid 20 SP @ 0.003% and NSE 7% were consistent and most effective against jassids. However, neem oil 2%, azadirachtin 3000 ppm, NSE 5%, azadirachtin 1500 ppm, were equal and next effective in reducing jassid population. acetamiprid 20 SP @ 0.003% and neem oil 3%, were equally effective against thrips. Neem oil 3% and acetamiprid 20 SP @ 0.003% were equal and most effective from 3 to 14 DAT against whitefly.

Khan and Lyall (2013) reported that cypermethrin 25% EC @ 0.0625, chlorpyrifos 20% EC @ 0.04 % concentration and profenophos

50% EC @ 0.04 concentrations were found to be most effective. The treatment with botanicals viz. Garlic 30 gm /lit. of water neem oil 4 ml/lit. and chilli extract 10 gm /lit. water were also effective resulting 7.8 and 9.0% fruit damage, respectively compared with control plot 21.4% Garlic 30 gm /lit. of water was found best botanical treatment against *E. vittella*.

Saryazdi et al. (2013) observed ovicidal activity as well as reduction in the survival rate, fecundity and egg hatching rate when spiromesifen was used. This peculiar growth regulatory effect of spiromesifen might be the reason for very low adult mortality as observed in the present study.

Bajad et al. (2014) conducted field experiment during the year 2011-12 to evaluate the efficacy of organophosphate and some other insecticides against shoot and fruit borer, *E. vittella* (Fab.) on okra (*Abelmoschus esculentus* L.). The experiment was laid out in randomized block design with ten treatments which was replicated thrice. The different treatments were; T1 cypermethrin 25 EC (0.05%), T2 acephate 75 SP (0.05%), T3 malathion 50 EC (0.05%), T4 chlorpyrifos 20 EC (0.04%), T5 imidacloprid 17.08 SL (0.03%), T6 dichlorvos 76 EC (0.03%), T7 spinosad 45 EC (0.015%), T8 quinolphos 25 EC (0.05%) and T9 indoxacarb 14.05 SC (0.007%). The result revealed that cypermethrin 25 EC@ 0.05 per cent was found to be most effective in managing the fruit borer infestation on okra followed by indoxacarb 14.05 SC @ 0.007 per cent and T7 spinosad 45 EC @ 0.015 per cent. The highest marketable fruit yield of okra (75.33q/ha) and incremental cost benefit ratio (1:16.49) was obtained from the treatment of cypermethrin 25 EC @ 0.05 per cent. The most economically viable treatment followed by acephate 75 SP @ 0.05 per cent (74.05 q/ha) and spinosad 45 SC @ 0.015 percent (72.66q/ha).

Ghelani et al. (2014) were evaluated ten insecticides against major sucking pests infesting the *Bt* cotton. Among them, five were of bio-pesticides (Neem oil 1.0 %, NSKE (Neem seed kernel extract) 5.0 %, Azadirachtin 0.0009 %, *Verticillium lecanii* (Zimmermann) @ 2.5 kg/ha and *Beauveria bassiana* (Balsamo.) @ 2.5 kg/ha) and five were chemical pesticides (Acetamiprid 0.004 %, Thiamethoxam 0.01 %, Imidacloprid 0.0089

%, Dinotefuran 0.008 % and Flonicamid 0.02 %) at KVK farm, JAU, Targhadia (Rajkot) during *Kharif*, 2012-13. The result on the field efficacy of newer insecticides against major sucking pests of Bt cotton (G Cot Hy 6 BG II) showed that the chemical pesticides caused higher mortality, while bio-pesticides caused moderate to lower mortality of sucking pests. Among the insecticidal treatments, flonicamid 0.02 per cent was found more effective against all major sucking pests, acetamiprid 0.004 per cent against aphid and whitefly, dinotefuran 0.008 per cent and imidacloprid 0.0089 per cent against jassid and thiamethoxam 0.01 per cent were found effective against thrips on Bt cotton. Among the bio-pesticides, neem oil 1.0 per cent, *V. lecanii* @ 2.5 kg/ha and azadirachtin 0.0009 per cent were found moderate effective against major sucking pests of *Bt* cotton. In case of toxicity of insecticides on predators (Coccinellids and Chrysoperla) of sucking pests, all the bio-pesticides were found safer to predators, while chemical pesticides were found moderate to higher toxic to predators on *Bt* cotton.

Ahmad et al. (2015) were conducted the field experiment on farmers field okra in Randomized Block Design with 8 treatments replicated thrice. The bio-efficacy of different novel insecticides against white fly revealed that among the treatments, seed treatment of imidacloprid 5 g/kg seed + neem Azal @ 5000 ppm spray + indoxacarb 75 g a.i/ha spray + *Bacillus thuringiensis* (Biolep) @1 kg/ha spray was significantly most effective treatment and reduced whitefly count by 63.01 - 52.13 and 52.45 - 42.34% at one and seven days after first and second spraying, respectively. However, imidacloprid 5 g/kg seed + neem Azal @ 5000 ppm + indoxacarb 75 g a.i/ha + *Bt* @ 1 kg/ ha combination was not so much effective treatment after 3rd spray as that was after 1st and 2nd spray of the insecticides and biopesticides

2.8 Effect of botanicals and insecticides on fruit borer

Soil application of neem cake (@ 200kg ha⁻¹) combined with sprays of endosulfan 35 EC (@ 0.5 kg ha⁻¹) or chlorpyrifos 20 EC (@ 0.5 kg ha⁻¹) were quite effective in reducing the incidence of jassid and shoot and fruit borer on okra at Samastipur, Bihar (Mandal et al., 2006b).

Dhanalakshmi and Mallapur (2008) reported botanical insecticides (neem @ 3 ml per lit) and insecticides had not only reduced the incidence of shoot and fruit borer in okra but also improved the quality of marketable fruits.

Vishwanath and Singh (2008) evaluated that the Insecticidal treatments were significantly effective in suppressing the incidence of fruit borer and effective in increasing the healthy fruits yield. They were followed by imidacloprid ST + Achook spray (18.35).

Hegde and Nandihalli (2009) evaluated the bio efficiency of some indigenous products against okra fruit borers, *Earias vittella* Fabricius and *Helicoverpa armigera* Hubner. Different indigenous product like NSKE (5%), GCKE, Sweet flag extract (5%), Garlic extract (5%), Cow-dung (10%) and cow-urine (10%) were tried individually and in combination with endosulfan (0.07%) and untreated control. Repeated sprays of GCKE recorded least no of eggs (1.40 eggs/plant) followed by NSKE (5%) alternated with cow-dung 10% (1.71 eggs/plant). repeated sprays of cow dung and cow urine used individually were not effective against the borers and recorded higher fruit damage of 55.70 and 52.10 percent, respectively. GCKE was significantly superior in reducing fruit borer damage to the tune of 64.83% with higher fruit yield of 35.87 q/ha. The highest incremental B:C Ratio was noticed in endosulfan treatment (15.00), followed by treatment involving NSKE alter with cow-urine 10% (13.00), repeated sprays of GCKE (10) and NSKE alternated with cow-dung of 10% (7.90).

Hasan (2010) determined the efficiency of eight insecticides viz. dimethoate, profenofos, lambda-dacyhalothrin, monocrotophos, indoxacarb, endosulphan, chlorpyriphos and multineem against the spotted bollworm, *Earias vittella* on Okra cultivars viz. *Arka anamica*, *Parbhani Kranti*, *Selection-9*, *Seedtech-71*, *NBR-1*, *Hari Rani*, *Deepti green gold*, *Ajeet-121*, *Ajeet-311 (Hybrid)* during summer season of 2005 and 2006. The highest suppression of fruit borer infestation was with lambda-cyhalothrin 14.60% and 27.07%. while the lowest with multineem was 26.91 and 32.64% compared to untreated control with 40.41 and 36.09% infestation during 2005 and 2006. The highest seed yield was observed with application of dimethoate (234.9g), lambda-

dacyhalothrin (244.9) and the lowest was with multineem (226.1g) and endosulfan (241.3g/10plants) during 2005 and 2006. All the insecticides proved significantly effective in controlling *Earias vittella* infestation and the yield among treatment differed significantly in all cultivars of Okra during both the years

Subbireddy et al. (2018) conducted a field experiment to study the bio efficacy of seven plant extracts viz., neem oil 0.3%, neem seed kernel extract 5%, azadirachtin 0.15 EC 0.0006%, *Aloe vera* extract 1%, *Citrulluscylindrica* leaf extract 1%, garlic bulb extract 3% and neem leaf extract 10% against fruit borers during summer and *kharif*, 2016 at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). Among seven different plant extracts tested, neem oil 0.3% and azadirachtin 0.15 EC 0.0006% observed with lowest number of larvae and per cent fruit damage followed by NSKE 5% and garlic bulb extract 3% during both the seasons, while remaining plant extracts i.e. *Aloe vera* extract 1% and *Citrulluscylindrica* leaf extract 1% found poor to manage fruit borers. The highest marketable okra fruits were recorded from the plots treated with azadirachtin 0.15 EC 0.0006% (55.60 and 116.41 q/ha) and neem oil 0.3% (52.58 and 118.25 q/ha) followed by NSKE 5% (50.80 and 111.89 q/ha) during summer and *kharif* season, respectively.

2.9 Effect of botanicals and insecticides on natural enemies

Chakraborti (2000) reported that neem based treatments like spraying of neem oil and NSKE were found safer to natural enemies and were on par with untreated check in chilli ecosystem.

Schuster and Stansly (2000) tested Azatin EC on two species of green lace wings, they found that the Neem product was not toxic to eggs, larvae and adults, topically or residually.

Chakraborti (2001) found that the pre-sowing soil application of neem cake at 300 kg/ha was found quite safe to predatory coccinellids in mustard.

Mann and Dhaliwal (2001) reported that neem products viz., Rakshak gold and NeemAzal at 200 ppm registered maximum number of

coccinellids (6.06 and 5.66/15 plants, respectively) and chrysopids (3.73 and 4.33/15 plants, respectively). While the same products at 800 ppm suppressed the population of coccinellid and chrysopid predators.

Smitha (2002) reported that neem cake @ 2q/ha was safer to predatory coccinellid beetle and mites *Polyphago tarsonemus latus* (Banks) in chilli ecosystem which was found next best to untreated check

Ming et al. (2003) indicated that the predator levels in *Bt* cotton fields are significantly higher than those in conventional cotton fields where insecticide has been used for control of the cotton bollworm *H. armigera*. However, the population density of parasitic wasps which parasitizes *H. armigera* larvae decreases dramatically due to lower density and poor quality of *H. armigera* in Bt cotton field.

Butter and Dhaliwal (2006) reported that the laboratory experiments were conducted to determine the safety level of Econeem to predator, *C. carnea* (Stephens) and parasitoid, *Trichogramma chilonis* Ishii. Econeem was found to be safer to predator at 20.45 ppm as it did not cause mortality of larvae of *C. carnea* when fed with treated eggs of host *Helicoverpa armigera* (Hubner). Econeem at 130.05 ppm was safe to predator as contaminated honey solution when fed to adults did not cause mortality of predator. At 303.33 and 724.54 ppm of Econeem, mortality levels of predatory adults were 17.33 and 38.67 per cent, respectively.

El-wakeil et al. (2006) were conducted laboratory and green house experiment to evaluate the side effect of Neem products on some natural enemies of *Helicoverpa armigera* Hub. (*Trichogramma spp.* and *Chrysoperla sp.*) The laboratory experiments dealt with the side effects of Neem products, NeemAzal-T/S, NeemAzal Blank, NeemAzal PC 05 and NeemAzal PC 05 Blank, on *Trichogramma spp.* and *C. carnea* (Stephen). Neem concentrations 2, 1, 0.5 and 0.25% were arranged in a completely randomized block design and each treatment was replicated at least six times. Parasitism and emergence rates of *T. pretiosum* (Riley) and *T. minutum* (Riley), and predation rates of *C. carnea* and its longevity were investigated. The greenhouse experiments dealt with the side effects of Neem products on parasitism rates of *T. pretiosum* and *T. minutum* on three different cotton

cultivars. There were no serious side effects on parasitism and emergence rates of *Trichogramma* spp. and on efficiency of Chrysoperla.

Soumya (2006) reported that organic soil amendments viz. vermicompost, neemcake and botanicals sprays like NSKE and neem Azal were found quite safe to the natural enemy fauna in chilli ecosystem.

Anjuman Suhail et al. (2007) were conducted laboratory experiment and larvae of the seven spotted ladybird beetle, *Coccinella septempunctata* L. were treated with 0.3, 0.0096 and 0.0036% azadirachtin (Nimbokill 60 EC), spinosad (Tracer 480 SC) and abamectin (Sure 1.8 EC) respectively. Overall, azadirachtin was found relatively safe for *C. septempunctata* larvae compared with spinosad and abamectin.

Shinde et al. (2007^a) observed that the treatment spinosad 45 SC @ 75 g a.i./ ha (2.99 per plant) was found least toxic registering maximum population followed by neem seed powder (50 kg/ha) and NSKE 5% that recorded the Ladybird beetle population i.e. 2.84 and 2.64 per plant, respectively which were comparatively safer to the Ladybird beetles.

Shinde et al (2007^b) observed that on seventh day after spraying the maximum population of chrysopa (0.55 per plant) was recorded in the treatment of spinosad 45 SC @ 75g a.i./ha followed by untreated control (0.46 per plant) and NSKE 5%. The neem seed powder @ 50 kg/ha and delfin WG @ 1kg/ha were found to be safer to chrysopa.

Tanwar et al. (2007) reported that neem products were found to be harmless to natural enemies, pollinators and other non target organisms in cotton.

Parsai and Shashtry (2009) recorded the seasonal incidence of key pests and their natural enemies on cotton variety JK-4 during 2005-06 and 2006-07 at Main Cotton Research, Khandava and observed the population of predators (coccinellids and chrysopa) from 30th -50th SMW. It means that predators were present all the time when there was incidence of sucking pests.

Prabhaker et al. (2011) evaluated their impact on six species of beneficial arthropods, including four parasitoid species in the laboratory by

using a systemic uptake bioassay. Exposure to systemically treated leaves of both neonicotinoids had negative effects on adult survival in all four parasitoids, with higher potency against *A. melinus* as indicated by a low LC50. Mortality was also high for *G. ashmeadi*, *E. eremicus*, and *E. formosa* after exposure to both compounds but only after 48 h posttreatment. The two predators *G. punctipes* and *O. insidiosus* were variably susceptible to imidacloprid and thiamethoxam after 96-h exposure. However, toxicity to these predators may be related to their feeding on foliage and not just contact with surface residues. Our laboratory results contradict suggestions of little impact of these systemic neonicotinoids on parasitoids or predators but studies will be needed to better quantify the levels of such impacts under natural conditions.

Sahito et al. (2011) were carried out field study to determine the efficacy of different insecticides against cotton mealy bug and predators. The activities of natural enemies (Predators and parasitoids) were found maximum in control plot followed by neem oil, imidacloprid and profenophos indicating that neem oil (repellent) was the least toxic against natural enemies followed by imidacloprid (WP).

Shabozoi et al. (2011) conducted field studies to determine the comparative effect of neem and tobacco based synthetic insecticides and use of natural enemies on insect pests of okra (*Abelmoschus esculentus*). Maximum mean population of insect pests was recorded in control, while it was minimum on okra fields treated with synthetic insecticides as compared to botanical treated fields. Population of natural enemies viz. lady bird beetles, *Chrysoperla* spp. spiders and predatory bugs was minimum in synthetic insecticides treated fields compared to botanical treated fields. There was negative a correlation between insect pests and natural enemies population. It was concluded that biopesticides are safe to natural enemies and integration of biopesticides with natural enemies have a good impact on crop yield parameters. The cost benefit ratio was maximum in case of biosal followed by natural enemies as compared to the application of synthetic insecticides.

Borkar and Sarode (2013) were carried out an experiment to evaluate twenty different treatments comprising NSE 5% (Neem Seed

Extract), neem oil 1%, azadirachtin 1500 ppm @ 2 ml/lit, CASE 5% (Custard Apple Seed Extract) against predators. Amongst natural enemies of sucking pests, syrphid larvae, larvae and adults of lady bird beetle and Chrysopa eggs played important role in sucking pest management programme. NSE 5% and azadirachtin 1500 ppm were found safer to natural enemies. The population of natural enemies gradually increasing in each observations was observed.

Although thiamethoxam is approximately safe for the ladybird beetle, more care should be taken when it is used in IPM programmes (Rahmani et al., 2013).

Ahmed et al. (2014) opined that neonicotinoids can be suitable candidates for inclusion in Integrated Pest Management of sucking insect pests in major cotton growing areas because they were comparatively less toxic to predators as compared to non-selective insecticides.

Amirzade et al. (2014) showed that thiamethoxam with an LC50 value of 56.35 mg a.i./L was more toxic to fifth instar nymphs of *Ag. pistaciae* in comparison to acetamiprid (60.75 mg a.i./L) and imidacloprid (138.21 mg a.i./L). Imidacloprid with an LC50 value of 218.89 mg a.i./L compared to acetamiprid (222.65 mg a.i./L) and thiamethoxam (232.37 mg a.i./L) had more lethal effects on fourth instar larvae of *Ad. bipunctata*. However, on the fourth instar larvae of *C. undecimpunctata aegyptica*, acetamiprid with an LC50 value of 263.44 mg a.i./L was more toxic than thiamethoxam (296.62 mg a.i./L) and imidacloprid (447.82 mg a.i./L). The laboratory findings showed that the three tested insecticides were more toxic to the common pistachio psylla than to its natural predators. Thiamethoxam was the most toxic against *Ag. pistaciae*. However, its toxicity to the predators was lower than imidacloprid and acetamiprid. This result suggests that thiamethoxam is the best insecticide for control of *Ag. pistaciae* in combination with predatory lady beetles.

Sabry et al. (2014) tested insecticides residual effect against some natural enemies such as green lacewing, *Chrysoperla carnea*, seven-spotted ladybug, *Coccinella septempunctata* and trichogramma wasps, *Trichogramma evanescens*. The results showed that all tested insecticides were less toxic to the second instar larvae of *C. carnea* larvae. The percent of

mortality with the highest concentrations ranged from 40 to 43.3%. Thiamethoxam and chlorantraniliprole were most toxic to the second instar larvae of *C. septicapunctata*. Spinetoram was the most toxic against the larvae of *T. evanescens*. The results recommended that chlorantraniliprole was the most suitable insecticides for control of pink bollworm larvae and less toxic to *C. carnea* and *T. evanescens* larvae. So, it can be used when the population density of *C. carnea* and *T. evanescens* larvae in peak safely. Spinetoram can be used against the pink bollworm larvae during the *C. septicapunctata* population in peak safely.

2.10 Population dynamics of sucking pests

2.10.1 Aphid, *Aphis. gossypii* Glover.

Prasad and Logiswaran (1997) observed that the peak activity of *A. biguttula biguttula*, *A. gossypii* occurred during winter (September-October) and summer (March-April).

Devasthali and Saran (1997) reported from Indore (Madhya Pradesh) that the sucking pests viz. *A. biguttula biguttula*, *A. gossypii* and *B. tabaci* were the first to appear on okra crop i.e. in 1st week of July.

Sarvendra et al. (2005) reported that temperature and relative humidity had a role in seasonal fluctuation of aphids and their natural enemies on brinjal.

Anitha et al. (2007) reported the incidence of aphid from first week of December with 19.1 aphid/ 3 leaves which was an increasing trend in population and reached up to 24.9 aphid/ 3 leaves during the first week of January. Afterward it gradually declined. This was supposed to be because of the fluctuation of temperature, the population of aphid increase or decrease.

Patel et al. (2012) revealed that aphid population was reached to its peak level (18.50 aphid/leaf) during 13th week after sowing i.e. first week of October, whereas peak period of jassids and whitefly was third week of September and last week of August.

Konar et al. (2013) were conducted experiment during two consecutive kharif season of 2010 and 2011 at Adisaptagram Block Seed Farm, Hooghly, West Bengal, India to study the population dynamics of aphid,

Aphis gossypii (Glover) and efficacy of some insecticides against it on okra. The incidence of aphid was initiated during second week of July in both the years. Population of aphid was increased gradually to reach its peak during first week of September (39.28 aphids/3 leaves) when minimum and maximum temperature was 26.10°C and 33.50°C; minimum and maximum R.H. was 72.57% and 97.57%, respectively with 1.6 mm rainfall and persisted throughout the crop period with low incidence. Imidacloprid @ 30g a.i./ha was found most effective in reducing population of aphids and maximum net return was obtained from emamectin benzoate @ 18g a.i./ha-1, the cost benefit ratio was recorded from imidacloprid treated plots i.e. 1:12.16.

Singh et al. (2013) observed that aphid population showed negative correlation with minimum and mean temperature, rainfall and maximum and minimum relative humidity whereas, positive correlation with maximum temperature and Ahidophagous predators like Coccinellids appeared more or less with aphid population. The coccinellids showed negative correlation with maximum, minimum and mean temperature, rainfall and maximum and minimum relative humidity. Whitefly and leafhopper population showed negative correlation with maximum, minimum and mean temperature and maximum and minimum relative humidity whereas positive correlation with rainfall.

Nisha Shukla (2014) reported that the periodic incidence of different sucking pests on okra during the crop season was significant at different period of crop growth. The period mean revealed that the aphid population was reached to its peak level (27.17 aphids / 3 leaves) during 14th weeks after sowing (first week of July). The aphids were considered as sucking insect pests. The population of aphids was more abundant on the crop during June and July 2011. Results revealed that maximum activity was recorded during July and the correlation studies were made between the incidence of major sucking insect pests and select weather parameters. Aphids showed positive correlation with rainfall ($r = 0.261$) and negative correlation with both maximum and minimum temperature. Aphids showed positive correlation with relative humidity.

Tufail Ahmad et al. (2015) noticed that the dusky cotton bug population was 0.6 to 11 per plant during February to March. The natural enemies lady bird beetle and syrphid fly were recorded but their population were non significant with ($r=0.800$) and ($r=0.316$) with maximum and minimum temperature.

2.10.2 Leafhopper, *Amrasca biguttula biguttula* (Ishida)

Gogoi and Dutta (2000) noticed at Jorhat (Assam) that jassid population was maximum in the last week of May in 1998 (37.53 nymphs/leaf) and middle of April in 1999 (30.00 nymphs/leaf) and low rainfall period coupled with bright sunshine hours favoured the development of this pest.

Inee and Dutta (2000) investigated the seasonal abundance of cotton jassid, *Amrasca biguttula biguttula*, on okra in Jorhat, Assam, India during 1998-99. Results revealed that meteorological parameters played an important role in the population build up of cotton jassid. The jassid population was maximum in the last week of May in 1998 (37.53 nymphs per leaf) and middle of April in 1999 (30.00 nymphs per leaf). High temperature (30-36 degrees), evening relative humidity (below 80%) and low rainfall period coupled with bright sunshine hours favoured the development of cotton jassid population.

Kumawat et al. (2000) reported from Jobner (Rajasthan) that the infestation of leafhoppers on okra crop started on the 4th week of July and reached peaks in Second week of September. They further reported that maximum temperature was negatively correlated with leafhopper population.

Ghosh and Senapati (2003) found that life cycle duration of jassid was lowest (25.11 days) in June-July and highest (36.36 days) in October-November. The highest jassid population (4.63/leaf) was in April-May and lowest (0.50/leaf) in mid-July.

Singh et al. (2005) revealed that the jassid *A. biguttula biguttula* incidence was recorded from the 3rd week (33SMW) of August till the last week of December (52 SMW). The jassid population gradually increased from the last week of October (44SMW) until the 3rd week (47 SMW) of November (82.20-100.0% incidence, and 1.11-1.84 jassid/leaf). The highest jassid

density was recorded in the 1st week of November (45 SMW), coincided with average temperature (22.57⁰ C).

Arif et al. (2006) showed the period of abundance of jassid in 1st, 2nd and 3rd peak during the 3rd, 2nd and 2nd week of July, August and September, respectively.

Anitha and Nandihalli (2008) observed the incidence of leafhopper on kharif sown okra crop from the first week of August under agro-climatic conditions of Karnataka with its peak activity observed between last week October and first week of November.

Selvaraj et al. (2010) noticed the peak incidence of leafhopper between 33rd and 36th SW (mid August and mid September) on kharif okra crop at Tamil Nadu. Further, they observed no significant relationship between weather parameters and leafhopper population. Whereas, Shera et al. (2010) from Punjab recorded a significant positive correlation between leaf hopper population and minimum temperature as well as rainfall on cotton crop.

Boopathi et al. (2011) reported that the infestation of *A. biguttula biguttula* on okra crop at Mizoram commenced from last week of May and remained till the final harvest i.e. first week of August. The peak level of incidence was noticed during first week of July i.e. 12th week after sowing followed by 9th week after sowing and 11th week after sowing.

Mohanasundaram and Sharma (2011a) carried out a two year study to know the role of abiotic and biotic factors on abundance of major insect pests on okra at New Delhi. They concluded that the activity of leafhoppers started from 21 days after sowing and continued throughout the crop season with its maximum population observed between on last week of August and first week of September. The fluctuation of leafhopper population showed significant negative correlation with mean relative humidity ($r = - 0.673$). However, sunshine hours showed a significant positive correlation ($r = + 0.685$) with the leafhopper population.

Nath et al. (2011) noticed the infestation of *A. biguttula biguttula* on kharif okra crop under agro-climatic conditions western. In Uttar Pradesh from 29th SW and reached its peak level on last week of August (35th SW) to

1st week of September (36th SW). They further reported that leafhopper population had non-significant positive correlation with temperature, sun shine hours and a non significant negative correlation with relative humidity.

Shivanna et al. (2011b) investigated population dynamics and the impact of abiotic factors on population dynamics of sucking insect pests of transgenic cotton viz., leafhopper (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci* Gennadius) and thrips (*Thrips tabaci* Linnman), under unprotected condition. The peak population of leafhopper, aphid, whitefly and thrips were 19.20, 45.07, 29.50 and 26.81 per three leaves during May second fortnight for leafhopper and aphid, April second fortnight for whitefly thrips, respectively. Simple correlation analysis revealed that maximum temperature showed significant positive effect on all the sucking pests. The minimum temperature showed negative effect on aphid population and non significant effect on leafhopper, whitefly and thrips population. The relative humidity had non significant effect, whereas precipitation had negative effect on all the sucking pests.

Kumari et al. (2012) reported that the leafhopper population was positively correlated with maximum temperature and minimum temperature but it showed a negative correlation with relative humidity and rainfall.

Kumawat and Jat (2012) reported that the infestation of jassid and whitefly was maximum in the second and third week of September, respectively and mite was in the third week of October. The infestation of jassid and whitefly showed significant negative correlation with maximum temperature and non-significant with minimum temperature, relative humidity and rainfall. Whereas, infestation of mite showed significant positive correlation with maximum temperature, significant negative with minimum temperature and relative humidity and non-significant with rainfall. The infestation of *Earias spp.* on fruits of okra crop was maximum in the last week of October which showed significant positive correlation with maximum temperature and significant negative with minimum temperature, relative humidity and rainfall.

Singh et al. (2013) while studying the population dynamics of sucking insect pests and their natural enemies on okra crop at Madhya Pradesh observed that the initiation of leafhopper activity from fourth week of

August (35th SW) on 15 days old crop and reached its peak between first fortnight of October and third week of November. Further, they revealed that leafhopper population was negatively associated with maximum and minimum temperature as well as morning and evening relative humidity, whereas leafhopper population had significant positive correlation with rainfall.

Ghosal et al. (2014) Leaf hopper infestation was recorded during first and second week of July but its population build-up starts from third week of July (2.51 leaf hoppers/3 leaves), the first peak population was recorded during second week of August (12.78 leaf hoppers/3 leaves) and it reached its highest peak during first week of September and recorded maximum leaf hoppers population (16.45 leaf hoppers/3 leaves) .

Meena et al. (2015) revealed that the incidence of jassid started two weeks after germination in okra (third week of March), population increased rapidly and reached to its peak in the first week of April. The infestation of whitefly started in the third week of March and remained throughout the growth period. The infestation of shoot borer started in the fourth week of March and remained up to second week of May, being maximum in the first week of April. The infestation of shoot borer declined after fruit setting and completely disappeared thereafter. The infestation of fruit borer was recorded in the third week of April (seven weeks after germination) and remained upto last week of June with a maximum in the first week of May. Jassid, whitefly and fruit borer population was not significant with maximum & minimum temperature, relative humidity and rainfall, while maximum and minimum temperatures had negative significant effect on the shoot borer infestation.

Dhandge et al. (2018) revealed that peak population of jassid (16.1 jassid/3leaves) and whitefly (15.7 whitefly/3 leaves) was observed at 17th and 16th standard meteorological week of summer 2016, respectively. Whereas, in summer 2017 the peak population of aphid (17.8 aphid/3 leaves) was observed at 16th standard meteorological week. There was positive correlation between pest population with maximum temperature, minimum temperature, morning relative humidity and bright sunshine. Only evening relative humidity was negatively correlated.

2.10.3 Whitefly, *Bemisia tabaci* (Gennadius)

Therhan (1944) reported that high temperature and low rainfall were found to favour the rapid multiplication of whitefly pest.

Borad et al. (1993) observed the population and the incidence of yellow vein mosaic virus (YVMV) in okra field of *Bemisia tabaci* of Maharashtra, India. It was low in both years i.e. August-October during 1988 and 1989. The population reached to maximum during the first week of October while symptoms of yellow vein mosaic virus (YVMV) infestation appeared with *B. tabaci* were observed at 16 and 20 days after seed sowing.

Kumawat et al. (2000) reported from Jobner (Rajasthan) that the infestation of jassids and whiteflies started in 4th week of July and reached peaks in 2nd and 4th weeks of September, respectively, and maximum temperature was significantly and positively correlated with whitefly density.

Watson et al. (2003) reported that low rainfall caused significant outbreaks of whitefly population and dense population developed only where both humidity and temperatures were high. Temperature above 30°C increased the rate of egg laying but above 40°C reduced the length of life cycle of *B. tabaci* to less than two weeks in okra crop.

Safdar et al. (2005) noticed that minimum temperature and relative humidity had significant correlation with whitefly population on okra; the whitefly population decreased with increase in relative humidity and increased with increase in minimum temperature at Faisalabad (Pakistan).

Anitha and Nandihalli (2008) noticed the appearance of the whitefly in kharif sown okra at Karnataka started from first week of August and reached its peak during fourth week of October with a mean density of 6.43 whiteflies/ 3 leaves.

Das et al. (2011) from Gujarat reported highly significant positive correlation between whitefly population and minimum and mean temperature, evening and mean relative humidity, vapour pressure, wind speed and rainfall.

Singh et al. (2013) observed the activity of whiteflies on the okra crop from third week after sowing i.e. first fortnight of September with the gradual increase in the activity in the succeeding weeks with maximum

population reached on fourth week of September. Whitefly population showed significant negative correlation with maximum, minimum and mean temperature and morning as well as evening relative humidity, whereas, it had a significant positive correlation with rainfall.

2.10.4 Two spotted spider mite, *Tetranychus uticae* Koch

Puttaswamy and Channa Basavanna (1980) reported that population of mite attained peak during May-June. The first sight of infestation by red spider mite is usually chlorotic, stippled appearance on the leaves. As the mites feed on the underside of the leaves, they remove leaf cell contents, including the chlorophyll. Without the chlorophyll, those empty cells appear whitish or bronze.

Prasad and Singh (2003) also reported the mite population underneath of leaf during rainy season and it started building during May-July. Increase was associated with less rainfall, low R.H., and high temperature. In both investigations, a significant positive correlation was obtained between temperature, non-significant negative correlation between R.H. and positive correlation between rainfall with population of mites. The multiple correlation coefficient showed that significant relation with mite population and abiotic factors. Among all abiotic factors, temperature appeared to have overall influence in regulating the pest population dynamics. Similar type of results were reported by Bairwa and Singh (2013) on sugarcane.

Gulati (2004) reported that on summer okra crop the mite population appeared in the month of April, showed an increasing trend in May and then attained a peak in the month of June. In kharif crop, mite population was maximum in the month of October, after that there was a gradual decline. Abiotic factors also influenced *T. cinnabarinus* population in different okra varieties. 32^o C and 22.5^o C temperature and 86.5 and 64.5 per cent relative humidity, respectively for summer and kharif crops were considered as optimum as mite population was maximum during these periods. *T. cinnabarinus* completed its life cycle in 19-29 days but at 22.8^oC, period was shortened to 10-13 days.

Geroh and Gulati (2007) observed two peaks in the activity of *T. urticae* during first fortnight of June and first fortnight of August. Among the abiotic factors, spider mite population showed significant positive correlation with maximum and minimum temperature and significant negative correlation with relative humidity.

Anitha and Nandihali (2008) reported that incidence of mite on summer crop commenced from 16th standard week (2.12 mites/3leaves) and peak infestation was on 2nd week of May (14.61 mites/3leaves) and on kharif crop peaked during 4th week of October (29.25 mites/3leaves).

Ghosh (2012) reported that red spider mite, *Tetranychus urticae* Koch causes heavy damage. The pest was active throughout the growing period with a peak population (6.18 mites/leaf) during 23rd SMW (last week of May) in the pre-kharif crop. Highest population (7.56mites /leaf) was found on the 42nd SMW (first week of October) in the post kharif crop

Ghosh (2013) recorded the activity of *T. urticae* throughout the crop season at West Bengal with a peak population during 23rd SW (last week of May) in summer crop and 42nd SW (first week of October) in the kharif okra crop. Weekly population counts on mites showed non-significant positive correlation with temperature, maximum relative humidity, total rainfall and significant positive correlation with minimum and average relative humidity.

Kanika et al. (2013) also reported higher temperature favoured the multiplication of *T. urticae* population on okra with the decrease in temperature in subsequent months, a gradual decrease in mites population was recorded. To measure the effect of abiotic factors on the population of *T. ludeni*, it is evident that positive significant relation existed between temperature and mites population.

Tripathi et al. (2013) recorded the maximum population of *Tetranychus urticae* in the month of June 1st fortnight (352.50) on okra and *T. ludeni* (308.60) on brinjal when average atmospheric temperature was 35.53,relative humidity 33.0% and rainfall nil while minimum population of *T. urticae* (7.20) on okra and *T. Ludeni* (4.20) on brinjal was recorded in 1st fortnight of March when average atmospheric temperature was 21.7, relative

humidity 61.7% and rainfall 6.40 mm. A positive correlation was found between temperature and mite population and negative with humidity and rainfall.

Zeshan et al. (2015) studied on relationship of whitefly (*B. tabaci*) population and environmental conditions five tomato cultivars. Environmental conditions had a significant contribution in development of whitefly population during two years of study. Temperature and relative humidity contributed towards the whitefly population buildup. The whitefly population increased with increased in temperature while decreased with the decrease in relative humidity. The contribution of maximum temperature was explained by linear regression which showed 83 to 91% variability in whitefly development. The minimum temperature explained 75 to 85% whitefly population variability. Relative humidity exerted 78 to 85 percent contribution in the whitefly population development. The linear regression could not explain the contribution of rainfall and wind speed.

2.11 Population dynamics of fruit borer

Fruit borers, *Earias spp.* and *Helicoverpa armigera*

Ahmad et al. (2000) revealed the larval population peak (185.7) of *E. vittella* in fruits of okra cv. Parbhani Kranti during summer remained confined during 1st fortnight of July at 29.9+ or -2.9 degrees C, 84.0+ or -5.1% relative humidity (RH) and 61.4 mm precipitation while the population was minimum (109.3) during 2nd fortnight of May when the temperature (31.6+or-7.7 degrees C) was comparatively higher, RH (54+or-2.1) lower or no rainfall. The larval population in fruits of Parbhani Kranti was correlated with the minimum temperature ($r=0.578$) and negative correlation with the maximum temperature ($r=-0.747$) as well as positive correlation with both the RH at 7 h ($r=0.774$) and 14 h ($r=0.800$), respectively. Rainfall too had significant impact on the larval population as the coefficient of correlation ($r=0.410$) was significant. Multiple regression analysis revealed that with one unit increase in maximum and minimum temperature there were 7.9% decrease and 10.2% increase in larval population, respectively. Similarly with one unit increase in rainfall, there were 0.8 % decreases in larval population.

In a field experiment at Mohanpur (West Bengal) damage by *E. vittella* on okra shoots and fruits occurred on 3 and 6-weeks old crop, respectively, with two peaks of the pest, one at the vegetative stage (2nd fortnight of August) and other at reproductive stage (2nd week of September) (Naresh et al., 2003).

Bairwa et al. (2005) conducted field study with okra cv. Pusa Sawani with different dates (7, 14, 21 and 28 July) during *kharif* 2000, in Jobner, Rajasthan, India. Natural incidence of jassids (*A. biguttula biguttula*), whiteflies (*B. tabaci*) and shoot and fruit borer (*E. insulana* and *E. vitella*) was evaluated on okra cv. Pusa Sawani was sown on different dates (7, 14, 21 and 28 July) during *Kharif* 2000. Infestation and fruit damage by all pests increased with delay in sowing. The highest fruit yield of 32.02 q/ha was obtained under the earliest sowing.

Mandal et al. (2006b) conducted a field experiment during summer 2000 and 2001 to evaluate the impact of weather parameters on the incidence and activity of *E. vittella* in okra (*Abelmoschus esculentus*)cv. Pusa Sawani. The analysis revealed that the pest activity started to build up from four-week-old crop and remained intensified critically below a maximum temperature of 35 degrees C and above a minimum temperature of 22 degrees C. A significant negative correlation with maximum temperature and positive relationships with minimum temperature, relative humidity, vapour pressure and rainfall were observed. Regression models explained 93-95% variability due to weather parameters for okra borer infestation.

At Samastipur (Bihar), the activity of *E. vittella* on summer okra crop was observed from 35 days age of the crop. The infestation on shoots ranged from 0.3 to 3.46 per cent in 2000 and 1.45 to 4.86 per cent in 2001. Maximum temperature had negative effect while minimum temperature, relative humidity (morning and evening) and rainfall had positive effect on larval population and fruit damage (Mandal et al., 2006 c).

Jagtap et al. (2007) conducted a field experiment in Maharashtra, India, during *kharif* 2005. Revealed the population of *E. vittella*, *Helicoverpa armigera*, *Condica illecta*, *Trichoplusia ni* and *Spodoptera litura* ranged from 1.0 to 8.8, 1.2 to 5.4, 0.6 to 0.8, 0.4 to 2.2 and 1.2 to 2.8 larvae

per quadrat, respectively, on okra grown in. The minimum temperature and evening relative humidity showed highest positive and negative effects on *E. vittella* on okra respectively. The increase in maximum temperature associated with the increase in rainfall and number of rainy days increased the larval population of *H. armigera* on okra. The decrease in maximum temperature along with the increase in minimum temperature increased the larval population of *C. illecta*. The before noon relative humidity and maximum temperature showed highest direct positive effect on incidence of *S. litura* on okra.

Jagtap et al. (2008) observed the population of *E. vittella*, *Helicoverpa armigera*, *Agrotis ypsilon* [*A. ipsilon*], *Condica illecta* and *Pectinophora gossypiella* varied from 0.6 to 8.6, 0 to 3.2, 1.4 to 15.0, 7.0 to 15.8 and 0.8 to 4.0 larvae per quadrat, on okra during summer 2005. Maximum temperature and after noon relative humidity showed the highest direct positive and negative effects on larval population of *E. vittella* on okra. Before noon relative humidity and number of rainy days had highest direct positive and negative influences on larval population of *H. armigera*. The increase in 1 degrees C maximum and minimum temperature, 1 per cent before noon relative humidity and 1 mm rainfall decreased 2.08, 0.58, 0.32 and 0.09 per cent larval population of *A. ypsilon*, respectively. The variation in larval population of *C. illecta* was due to maximum temperature and rainfall. The minimum temperature and before noon relative humidity showed highest direct positive and negative effects on incidence of *P. gossypiella*.

Nath and Singh (2008) reported the maximum damage 43.5% and 42.3% in 41st SW. Damaged caused by *E. vittella* to control the insect pest by use of suitable insecticides. The population of *E. vittella* was positively correlated with the maximum temperature and sunshine hrs and negatively correlated to humidity, and rainfall.

Aziz et al. (2009) observed that the maximum and average temperature had a significant positive effect, while the relative humidity and rainfall had a negative significant correlation with the shoot infestation.

Yadav et al. (2009) observed the field density of *A. biguttula* *biguttula* and *E. vittella* along with their associated abiotic and biotic factors in

okra field at Kanpur. The incidence of jassid *A. biguttula biguttula* began from July and fruit and shoot borer, *E. vittella* from August and continued till October. Among the parasitoids, *Anagrus flaveolus* associated with jassid and *Trichogramma chilonis* with *E. vittella* were the most important natural enemies. The percentage of parasitism of *A. flaveolus* ranged from 3 to 9 and of *T. chilonis* from 10 to 12 per cent. The data revealed a high positive relationship between the pest and parasitoids indicating an important role in suppressing pest population to some extent predator, *Crysoperla carnea* was recorded preying on nymph and adult of *A. biguttula biguttula*. The abiotic factors were closely related with pest population.

Bhavani et al. (2010) reported positive correlation of *E. Vittella* with maximum and minimum temperature.

Meena et al. (2010b) reported the incidence of shoot (*E. insulana*) and fruit borer (*E. vitella*) on okra (cv. Parbhani Kranti) was studied in Jobner, Rajasthan, India, during the *kharif* of 2002 and 2003. Minimum temperature and relative humidity had a significant negative correlation with shoot borer infestation. Fruit borer infestation commenced on the first week of September in 2002 and 2003. The level of infestation gradually increased as the crop matured, reaching a peak of 31.6% in terms of number and 29.7 on a weight basis in 2002 (34.0 and 31.0%, respectively, in 2003). The maximum and minimum temperatures were negatively correlated with fruit borer infestation.

Aziz et al. (2011) investigated the role of weather factors on the fluctuations of fruit and shoot infestation by *Earias spp.* on three comparatively more susceptible (Parbani Karanti, Pusa sawani, Ikra-1), three moderately susceptible (PMS-beauty, Ikra anamika, Lakshami-24) and three comparatively least susceptible (Diksa, Sabz ari, Super Star) genotypes of okra. Maximum, minimum and average temperatures showed a positive effect; whereas, the relative humidity and rainfall exerted a negative effect on the fruit infestation, separately as well as on cumulative basis. The shoot infestation of okra was found to be positively correlated with maximum and average temperatures and negatively correlated with the relative humidity and rainfall on the basis of an average for both the years of studies. Multiple

Linear Regression Models revealed that the maximum temperature was the most important factor, which had maximum impact on fruit and shoot infestation, i.e. 60.50 and 53.20% for an average of both the study years, respectively. The impact of all the factors on an average of both the study years when computed together was found to be 67 and 55.50%, for fruit and shoot infestation, respectively.

Chundawat and Ameta (2011) conducted a field experiment at Rajasthan College of Agriculture farm, Udaipur, during *kharif* 2010 to investigate the incidence of sucking insect pests of okra. The incidence of aphid, *Aphis gossypii* (Glover) was initiated in the second week of August, while, jassid, *A. biguttula biguttula* (Ishida) and whitefly, *B. tabaci* (Gennadius) commenced in fourth week of July. Aphid, jassid and whitefly touched the peak during fourth week of August (86.5 aphids/ten plants), first week of October (15.4 Jassids/ten plants) and first week of September (6.9 whiteflies/ten plants), respectively. The aphid and whitefly exhibited a positive correlation with temperature, relative humidity and negative correlation with total rainfall; however, the correlation was non-significant. The correlation between jassid population and temperature, relative humidity and rainfall was significantly negative.

Mohanasundaram and Sharma (2011b) observed major insect pests of okra viz., leafhopper, (*A. biguttula biguttula*); whitefly, (*B. tabaci*); red spider mite, (*T. cinnabarinum*) and fruit borer, (*E. vittella*) damaged heavily during the *kharif* seasons. Leafhopper and whitefly occurred from last week of July. The infestation of okra fruit borer was observed during middle of August, whereas the red spider mite appeared during 1st week of September. Peak incidence of leafhopper (217.00 nymphs/15 leaves), whitefly (28.90/15 leaves), red spider mite (231.10 mites/cm²) and fruit borer (56.6%) during last week of August, 1st week of August, 3rd week of September and 3rd week of September, respectively. The incidence of leafhopper and fruit borer showed significant negative correlation with relative humidity ($r = -0.673$ and -0.906) and significant positive correlation with sunshine hours. Positive correlation was observed between the minimum ($r = +0.994$) and mean temperature ($r = +0.889$) with density count of whitefly, whereas fruit borer damage was

significant negatively correlated with evening relative humidity ($r = -0.862$). Among biotic factors viz., coccinellids ($r = +0.874$) and spider ($r = +0.907$) there was significant positive correlation with leafhopper population, whereas the fruit infestation had significant negatively correlation with coccinellids ($r = -0.911$) and spiders ($r = +0.923$).

Prasad et al. (2011) reported that biotic and abiotic factors limit the productivity of okra including insect pests like jassid, whitefly and shoot and fruit borer, *Earias vittella*. The high population of 10.76 Jassids/leaf was observed on 3rd week of August (34th SW) during the first year and 8.96 Jassids/leaf during the second year on 4th week of August (35th SW). The maximum level of whitefly population 10.52 flies/leaf was recorded on 2nd week of August (33rd SW) during first year. During second year the maximum population of 11.66 flies per leaf was recorded in 3rd week of August (34th SW). Jassid and white fly population with temperature (maximum, minimum and average), rainfall, sun shine hours and RH showed non-significant positive correlation during both the years. The maximum damage 43.52% and 42.31% in 41st SW during both the years was caused by *Earias vittella*. The temperature with per cent fruit damage showed significant negative relationship during 2005 and 2006 and RH showed non significant positive relationship with this pest.

Dabhi et.al (2013) conducted a field experiment at Anand Agricultural University, Anand, Gujarat to study the impact of weather variables on population dynamics of aphid, *Aphis gossypii* and shoot & fruit borer, *Earias vittella* in summer and *kharif* okra for two consecutive years (2005-06 and 2006-07). Peak activity of aphid population was found during 12th & 14th and 13th & 15th Meteorological Standard Week (MSW) whereas, the peak infestation to fruits due to *E. vittella* observed in the 13th & 15th and 29th & 32nd MSW during *summer* and *kharif* season, respectively. Bright sunshine hours, temperature (maximum and minimum), vapour pressure (morning and evening) and wind speed had significant positive effect on population of aphid during summer season, while Bright sunshine hours, maximum temperature and temperature range showed significant negative impact with aphid population during *kharif* season. Maximum and minimum temperature had

significantly negative effect, while morning and evening relative humidity significant positive effect on fruit damage due to *E. vittella* during *kharif* season. However, per cent fruit damage showed significant positive impact with BSS, temperature (maximum and minimum) and vapour pressure deficit (morning and evening) during summer season.

Konar et al. (2013) conducted an experiment during two consecutive *kharif* season of 2010 and 2011 at Adisaptagram Block Seed Farm, Hooghly, West Bengal, India to study the population dynamics of aphid, *Aphis gossypii* (Glover) and efficacy of some insecticides against it on okra. The incidence of aphid was initiated during second week of July in both the years. Population of aphid was increased gradually to reach its peak during first week of September (39.28 aphids/3 leaves) when minimum and maximum temperature was 26.10°C and 33.50°C; minimum and maximum R.H. was 72.57% and 97.57%, respectively with 1.6 mm rainfall and persisted throughout the crop period with low incidence.

Singh et al. (2015) revealed that shoot and fruit borer incidence on fruits started from fourth week of August on 5-week-old plants and continued until fourth week of October on 14-week-old plants. The highest population of *E. vitella* was observed in the third week of September. Bright sunshines hours, maximum and minimum temperature showed non significant positive effect, whereas relative humidity and rainfall showed a negative non significant and significant influence on *E. vitella*, respectively.

Khating et al. (2016) revealed that leafhoppers incidence reached its peak activity during the second week of September (23 leafhoppers/3 leaves/plant) whereas the peak incidence of aphids was noticed in the first week of September (43.3 aphids/3leaves/plant). The peak incidence of the whiteflies was recorded during the second week of September (21 whiteflies/3 leaves/plant), whereas peak activity of predator lady bird beetle was reported during second week of September (26 lady bird beetle/plant), when the population of sucking pests was at its peak. The incidence of aphids ($r = 0.170$), whiteflies ($r = 0.287$) and leafhoppers ($r = -0.060$) do not show any significant correlation with maximum temperature. The minimum temperature showed positive non-significant correlation with

leafhoppers ($r = 0.131$) and positive significant correlation with aphids ($r = 0.644^*$). The morning relative humidity showed positive non significant correlation with occurrence of the leafhoppers ($r = 0.454$), aphids ($r = 0.458$), whitefly ($r = 0.313$). Similarly, the evening humidity showed negative non-significant correlation with the pests such as leafhoppers ($r = -0.100$), aphids ($r = -0.223$) and whiteflies ($r = -0.339$) during *Kharif* 2015 season. The rainfall had non-significant effect at 5 per cent and 1 per cent level with whitefly, aphid and leafhopper.

Agurla et al. (2017) study the fluctuations in the population of fruit borer *Helicoverpa armigera* in okra against prevailing weather conditions at student farm, college of Agriculture, Hyderabad, PJTSAU during *Kharif*-2015. The results recorded that the incidence of *H. armigera* was commenced in the 35th standard week, peak incidence were recorded in terms of per cent fruit damage on number and weight basis 33.67 and 56.34 per cent, respectively at temperature 31.9°C, RH 73.5%, Rainfall 0.3 mm and sunshine 7.2 hr day⁻¹. Maximum larval population was noticed in 41st standard week (13.8 larvae per plant) at maximum temperature 33.4°C, Rh 62.9% and sunshine 7.9 hrday⁻¹. Maximum temperature and sunshine hours were positively correlated with larval population and fruit damage. Minimum temperature, relative humidity and rain fall were negatively correlated with larval population and fruit damage. Maximum temperature was most influencing weather parameter on population dynamics of *H. armigera*.

Kumar et al. (2017) conducted study at Vegetable Research Farm, BHU, Varanasi during *Kharif* season 2014-15 and 2015-16. Incidence of jassids was started during 35th SW (15 days after sowing), while initial aphids and whitefly infestation was observed during 36th SW. However, peak population of Jassids had been observed during 40th SW while aphids and whiteflies peak population was observed at 41st SW. In the field sucking insect population persisted up to 46th S.W. (3rd week of November). The aphid population was positively influenced by morning R.H ($r = 0.768$ and 0.614 during both the years), evening R.H. ($r = 0.587$ during 2015-16) and average R.H. ($r = 0.587$ during 2015-16) while negatively ($r = -0.720$ during 2015-16), influenced by rainfall but not significantly influenced by other weather

parameters. The Jassid incidence was also positively influenced by morning R.H. ($r = 0.861$ during 2014- 15) and average R.H. ($r = 0.587$ during 2015-16), while the whitefly incidence found to have significant positive relationship with morning R.H. ($r = 0.782$ & 0.608) during both the years and with average R.H. ($r = 0.699$) during 2015-16.

Rajput and Tayde (2017) conducted a field experiment during *Kharif*-2016 at Central Agriculture, SHUATS, Allahabad. on abundance of shoot & fruit borer. The occurrence of shoot and fruit borer, (*E. vittella*) in 34th standard week (August third week) with an average population of 2.71% infestation and then the population gradually increased and reached to its peak level by 39th standard week (October first week) with an average population of 39.44% infestation. There after declined trend was observed as temperature decreased. It was found that a population of shoot and fruit borer increased with increasing maximum temperature and positively correlated with maximum temperature.

Siddartha et al. (2017a) Okra was attacked by sucking pests like leafhoppers, *A. biguttula biguttula* (Ishida), Aphids, *Aphis gossypii* (Glover), whitefly, *B. tabaci* (Gennadius) in the early crop growth stages. Whereas, two spotted spider mite, *T. urticae* Koch dominated in the mid and later crop growth stages resulting in substantial losses in the yield. Although knowledge of seasonal activity of different insect pests determines the predisposing climatic factors affecting their population dynamics. Maximum temperature and average temperature had significant positive effect on leaf hoppers, aphids and whiteflies but negative on mites. Morning and evening relative humidity did not influence much on the population of sucking pests, whereas rainfall had significant effect on the sucking pest population.

Siddartha et al. (2017b) studied the fluctuation in the population of fruit and shoot borers of okra and their relation with prevailing weather conditions at Bagalkot during *rabi* 2014, summer and *kharif* 2015. Eggs and larvae of *Earias* spp. were noticed on five weeks old crop during all the cropping seasons while *H. armigera* was observed a week later. Larval population of *Earias* spp. (1.34 ± 0.18 larvae/plant) and *H. armigera* (0.27 ± 0.04 larvae/plant) was highest in *kharif* 2015, while highest mean percent

fruit damage (22.83 ± 0.64 %) and mean percent shoot damage (4.61 ± 0.11 %) by *Earias* spp. was noticed in *rabi* 2014. Temperature and rainfall did not influence much on the population of borers in all the cropping seasons.

Archunan et al. (2018) revealed that the per cent shoot damage and fruit damage by *E. vittella* on bhendi reached peak on 13th and 15th MSW in *rabi* season, whereas 43rd and 42nd MSW in *kharif* season. The per cent shoot damage and fruit damage by *E. vittella* were exerted significantly positively correlated with minimum (0.552 and 0.698) and maximum temperature (0.629 and 0.748), whereas rainfall positively correlated with per cent shoot and fruit damage but it was non significant (0.111 and 0.297), however relative humidity (-0.178 and -0.210) and sunshine hours were exerted negatively correlated with per cent shoot damage and fruit damage by *E. vittella* during *rabi* 2017. The *kharif* season 2017 indicated that per cent shoot damage and fruit damage of bhendi was positively non significant association with RH and rain fall, while negatively non significant correlation with minimum temperature (-0.43 and -0.309) and sunshine hours (-0.265 and -0.283) was recorded.

Dhandge et al. (2018b) Investigated on seasonal incidence of okra shoot and fruit borer and its relation with weather parameters in summer okra. The data on seasonal abundance of *E. vittella* on okra showed that, in first season (2016), the pest activity of this noctuid commenced from 11th standard week (0.9 larva/ plant) and continued up to 24th standard week (0.93 larva/ plant) and in next season at 11th standard week (0.7 larva/ plant) to 24th standard (0.10 larva/ plant). Shoot damage was observed from 11th standard week whereas fruit damage was started during 5th week after sowing during both the years of study. While in correlation study maximum and minimum temperature showed significant positive correlation and bright sunshine showed negative correlation with okra shoot and fruit borer population.

Pathan et al. (2018) revealed that Leafhopper population showed highly significant positive association with Bright Sunshine Hour (BSS) ($r = 0.72^{**}$) and maximum temperature (MaxT) (0.70^{**}) during *kharif*, 2014. The highest activity of mite was recorded during 3rd week of October and 2nd week of September during *kharif* 2014 and *kharif* 2015, respectively.

Fruit damage caused by *Helicoverpa armigera* (Hubner) Hardwick showed highly significant negative association with WS ($r = -0.73^{**}$), MinT (-0.78^{**}) and RH2 (-0.83^{**}) whereas, BSS (0.77^{**}) and MaxT (0.74^{**}) revealed highly significant positive association during *kharif*, 2014. During *kharif*, 2015; MinT (-0.70^{*}) exerted significant negative association. *E. vittella* (Fabricius) study revealed that BSS ($r = 0.88^{**}$) and MaxT (0.86^{**}) exhibited highly significant positive impact whereas, WS (-0.75^{**}) and RH2 (-0.90^{**}) had highly significant negative association during *kharif*, 2014. There was highly significant positive association (0.99^{**}) in simultaneous occurrence between *Scymnus* sp. and mite, whereas it was highly significant between spiders and aphid during *kharif*, 2014. As in case of *kharif*, 2015; coccinellids significant positively associated with aphid (0.88^{**}).

Potai and Chandrakar (2018) conducted a experiment to observe the “Studies on the seasonal incidence of major insect pests and their natural enemies on okra” during *kharif* season of 2016 at, Chhattisgarh. Major activity period of jassid (*A. biguttula biguttula*) was observed from August 2016 to October 2016 with one distinct peak during 39th SMW (Standard Week) (10.36 jassid/ per plant) and *Aphis gossypii* was observed from August 2016 to October 2016 with one distinct peak 40th SMW (39.24 Aphid/ per plant), respectively. While *B. tabaci* was appeared second week of August to last week of October 2016 with one distinct peak 38th SMW (4.89 whitefly/ per plant), Thrips (*Thrips tabaci*) was observed from August 2016 to October 2016 with one distinct peak during 38th SMW (4.23 thrips/ per plant). Shoot and Fruit borer, *E. vittella* observed from second week of August 2016 up to crop maturity 44th SMW with one distinct peak 40th SMW (3.54 % fruit infestation).

2.12 Population dynamics of natural enemies

Rao et al. (1989) carried out studies on cotton whitefly and its natural enemies between 1985 and 1987 in Andhra Pradesh. They showed that the pest was predated by Coccinellids, *verania vincta*, *Menochilus sexmaculata*, *Chrysoperla carnea* and the phytoseiid *Amblyseius* sp. Remained low until October. Both pest (*B. tabaci*) and natural enemy

populations were decreased by rainfall. They also reported a significant correlation of temperature with the population of predators.

The population fluctuation of predators, *Coccinella sp.* and *Scymnus sp.* was occurred during late June and during July of both seasons (Abou-Elhagag, 1998). The maximum population of lady bird beetle (*Coccinella spp.*) was recorded during 3rd week of August and in the 2nd week of December during 2003 and during 1st week of September and December during 2004 (Purohit et al., 2006).

Anitha (2007) observed that the Coccinellid population on summer okra crop noticed during second week 15 of April 2006. Maximum population was observed during third week of July 06 (0.99 Coccinellids/plant), while the population of Coccinellids on *Kharif* crop appeared from 3rd week after sowing, i.e., second week of August 06 and reached its peak incidence during second week of October 06 (3.96 Coccinellids/plant). On *rabi* crop population appeared during first week of December 06 and reached peak during last week of December (2.13 Coccinellids/plant). From January 07 onwards population started declining and reached a lowest population of 0.93 Coccinellids/3 leaves at last week of March 07. Highest Coccinellid population was noticed during October month. *Chrysoperla* population on *summer* crop appeared during third week of April 06 and the peak incidence was noticed during fifth week of April 06 (0.56 grubs/plant). On *kharif* crop, population appeared during first week of December (0.61 *Chrysoperla* grubs/plant) and peak incidence was noticed during second week of March 07 (0.99 grubs/plant). There was a great fluctuation in *Chrysoperla* population throughout the year with highest population was noticed in the months of October 2006 and November 2006 and from January 2007 to March 2007.

Meena and Kanwat (2010) studied the seasonal fluctuation of coccinellid beetle population on okra at Rajasthan and they observed that population build up of coccinellids on the crop starting from the first week of August (1.8 and 1.7 beetles/ plant) and reached the maximum (6.2 and 6.4 beetles/plant) in the first week of October in both the years. Minimum temperature and relative humidity showed a negative correlation with coccinellid population. While, maximum temperature had non-significant

positive relationship and rainfall had non significant negative correlation with coccinellids population.

Singh et al. (2013) reported the Coccinellids appeared more or less after the fifth week of the occurrence of aphid that is, fourth week of September (39th standard week) with 0.33 Coccinellid/leaf. The population gradually increased and peaked with 2.51 Coccinellids/leaf at the second week of October (41st standard week) which was found coincided with peak density of the aphid. The population then decreased but continued till third week of November (47th standard week).

The abundance of spiders and coccinellids was at its peak between 33rd and 34thSW (second and third week of August) during 2011-2013. Spider and coccinellids population had significant positive correlation with morning relative humidity and rainfall during 2011 and 2012 (Kumaranag, 2015).

Vanlaldiki et al. (2017) revealed that the leafhoppers first appeared in 2nd week of February (0.20^{-13} leaves) and reached a peak in the 3rd week of July (83.60 and 95.40^{-13} leaves in 2011 and 2012, respectively). Thereafter, the incidence reduced till the end of the cropping season. Aphids were observed in the first week but then showed a rise and fall with a peak during 1st week of July and 3rd week of June in 2011 and 2012, respectively. Incidence of whiteflies commenced from last week of January (0.07^{-13} leaves) and 1st week of February (0.13^{-13} leaves) during 2011 and 2012, respectively, which reached a peak population in the 1st week of June (3.97 and 3.03^{-13} leaves, respectively) and thereafter declined gradually till the end of the crop. Mites were first observed only from the 2nd week of March and reached their peak in the 2nd and 1st week of June in 2011 and 2012, respectively. The coccinellid predator first appeared in the 3rd and 4th week and reached a peak in the 3rd week of July and 3rd week of June (1.77 and 2.13^{-1} plant) in 2011 and 2012, respectively. *Chrysoperla* was first observed from the last week and 3rd week of March and maintained a low population throughout. Correlation of seasonal incidence with maximum and minimum temperature, and morning and evening relative humidity revealed a positive relationship in case of leafhoppers, whiteflies, mites, coccinellids and chrysoperla. Only the

aphids had negative and non significant relationship with most weather parameters.

Bhatt and Karnatak (2018) studied the population dynamics of sucking pests and their predators on okra agro ecosystem during the *kharif*, 2016. The major sucking pests recorded in the experimental field were whitefly (*B. tabaci* Gennadius), leaf hopper (*A. bigutulla bigutulla* Ishida) and aphids (*Aphis gossypii* Glover). Ladybird beetle (*Coccinella* spp.), green lacewing (*Chrysoperla carnea*), *Eocanthecona* spp., spiders, syrphid fly and ants were some of the predators observed in the bhindi ecosystem. Among them *Coccinella* spp. and spiders were most commonly occurring predators in the field. The peak densities of insect pests and their predators were attained peak in September-October. *A. bigutulla bigutulla* and *Bemisia tabaci* attained the peak (11.13 leafhopper/3 leaves and 12.11 whitefly/3 leaves) in the 40th standard meteorological week (SMW) while *Aphis gossypii* attained its highest density (23.08 aphids/3 leaves) in 39th SMW. The predator population attained its peak (3.16 spiders/ plant and 3.01 coccinellids/ plant) in the 39th SMW (13.53%).

2.13 Incidence of Yellow Vein Mosaic on Okra

Verma (1952) who further reported that vectors on starvation were more efficient in acquiring and transmitting the virus. Of the whitefly-transmitted virus species, 90% belong to the *Begomovirus* genus, 6% to the *Crinivirus* genus and the remaining 4% are in the *Closterovirus*, *Ipomovirus* or *Carlavirus* genera. Nineteen plant viruses are known to infect okra and amongst these, okra mosaic virus is the most serious concern.

Mandal (1989) reported that minimum of 10 min IAP was sufficient to transmit Croton yellow vein mosaic virus. Similar time period was also reported for Pumpkin yellow vein mosaic virus (Babitha, 1996).

Mathew and Muniyappa (1991) found that the AAP of 10 min by *B.tabaci* was sufficient for transmission of Indian cassava mosaic virus.

Jarande and Dethe (1994) reported that seed treatment of chilli with imidacloprid 70 WS at 15 g/kg seeds followed by seedling root dip in 0.03

% imidacloprid gave excellent control of sucking pests in chilli and also recorded highest yield of 63.47 q/ha as compared to 37.12 q/ha in control.

Ali et al. (2000) observed that as plants age increased the rate of yield loss decreased due to pathogen. They recorded loss of 84 and 49 per cent when disease observed on plants at the age of 50 and 65 days old, respectively.

Pun and Doraiswamy (2000) reported that morning relative humidity had a highly significant negative relationship with the disease.

Dandale *et al.* (2001) tested imidacloprid (Gaucho 70 WS) as seed treatment chemical for the control of sucking pests in cotton. They reported that lower dose of 5 g/kg seed recorded mean of 1.20 whiteflies per three leaves per plant. Higher yield of cotton was obtained in imidacloprid seed treated plot (10 g/kg) compared to control.

Kumar et al. (2001) studied efficacy of imidacloprid and thiamethoxam on okra against leafhopper and whitefly. The experiment showed that various doses of imidacloprid and thiamethoxam had no phytotoxic effect on okra but effective against insects.

Hudu et al. (2002) reported the superiority of mulched plants over unmulched plants. Very few of the plastic mulched okra plots were infected with okra mosaic virus while the incidence was high in the unmulched plot.

Sarabani et al. (2002) reported effective management of yellow vein mosaic disease of okra through the use of tolerant cultivars, cost effective scheduling of efficient insecticide.

Summers and Stapleton (2002) reported that the reflective, metalized plastic mulch, formed by adhering a thin coat of aluminium ions to a sheet of polyethylene, has been shown to help control other types of aphid-borne viruses as well as whiteflies. They were noticed control of viruses and whiteflies due to the fact that reflective plastic mulch reflects ultraviolet (UV) wavelengths, unlike black or clear plastic mulches. Flying aphids and whiteflies were repelled by these UV wavelengths. The outcome was to delay and reduce the incidence of aphid borne viruses.

Krishnareddy et al. (2003) reported that about 63% yield loss due to OMV from India. The virus induces mosaic, vein chlorosis and banding and plant stunting.

Asha Shivapuri et al. (2004) tested imidacloprid 70 WS (at 5g/kg seed) as seed dressing in okra for the control of Yellow Vein Mosaic (YVMV) disease transmitted by insect vector whitefly (*Bemisia tabaci*). The imidacloprid treatments at 5ml/kg seed proved most effective in reducing the incidence of YVMV, whitefly population and increased fruit yield when tried as seed dressed along with one spray of monocrotophos and three sprays of endosulfan.

Usha Rani et al. (2004) reported that *B. tabaci* required 24 h. AAP to transmit soybean yellow mosaic disease to blackgram, cowpea, mungbean and soybean, where it produced typical yellow and golden mosaic symptoms.

Al-Ajaln (2005) used yellow sticky traps to monitor two piercing-sucking insects; whiteflies and thrips on okra during May and June, 2001. These sticky traps were placed at three heights (50, 100 and 150 cm) in greenhouses of three districts namely Al-Hasa, Qatif and Riyadh. The data showed that the mean number of whitefly adults captured per yellow sticky trap that placed at the three heights in May was higher in Qatif followed by Al-Hasa and Riyadh districts. The mean number of whiteflies/trap captured on sticky traps was also more than thrips in the respective districts. The whiteflies population was abundant in the three districts when compared with that of thrips. The variation of whiteflies and/or thrips population densities at different heights of sticky traps in different districts might be due to the natural flying ability affecting their migration due to climatic conditions.

Ali et al. (2005) Four okra cultivars (Pahuja, Safal, Subz Pari and Surkh Bhindi) were cultivated in a field trial to determine the response of these to okra yellow vein mosaic virus (OYVMV) and to evaluate the efficacy of pesticide/bio-pesticide (Neem extract, Effective Microbes (EM) and Imidacloprid) against insect vector *Bemisia tabaci* Genn. Surkh Bhindi was found highly resistant, Subz Pari and Safal were moderately resistant and Pahuja was tolerant against OYVMV. Among the pesticide/biopesticide

applied, the imidacloprid significantly reduced the whitefly population. Neem extract and biocontrol (EM) were also found to be effective against *B. tabaci* compared to distilled water and untreated control.

The disease is characterized by a homogenous interwoven network of yellow vein enclosing islands of green tissues within its leaf. In extreme cases, infected leaves become yellowish or creamy. If plants get infected within 20 days of germination, then their growth is retarded; few leaves and fruits are formed and loss may be about 94% (Leite *et al.*, 2005).

Nagaraja (2005) reported that seed treatment with imidacloprid (5g/kg seed) + 4 sprays of imidacloprid (0.05%) at 15 days interval gave reduced BYVMV disease incidence by 80.9 per cent with increased yield by 64.96 per cent as compared to control. Five sprays of imidacloprid 200 SL (0.05%) or thiamethoxam 25 WG (0.03%) alone at 15 days interval was found equally good in reducing disease incidence and increased yield.

Pun *et al.* (2005a) reported that the yellow vein mosaic virus (YVM) in okra could effectively managed by growing maize as border crop, the disease incidence was 30.0% compared to 50.06% in control with yield of 46.90 and 2.73 t ha, respectively.

Gowdar *et al.* (2007) reported that the sprays of acetamiprid, imidacloprid, triazophos and monocrotophos resulted in significant reduction of the YVMV incidence and whitefly population in okra compared to the control. The sprays with these insecticides recorded higher cost benefit ratio in fruit yield compared to control. Two sprays of acetamiprid 20 SP at 40 g a.i./ha was effective in reducing the incidence of YVMV, whitefly population and increased the yield.

Reddy *et al.* (2007) showed that two sprays of acetamiprid at 40 g a.i./ha gave the maximum reduction in whitefly count, least incidence of YVMV disease and consequently increased fruit yield of okra.

Prabu *et al.* (2008) revealed that minimum temperature had significant correlation With OYVMV coefficient of infection while minimum and maximum temperature had a significant correlation with whitefly population. OYVMV incidence increased with the rise in minimum temperature and

whitefly population decreased with increase in relative humidity. Rainfall had no significant correlation with disease development and whitefly population. Relative humidity had a significant negative correlation with whitefly population in case of OYVMV susceptible *A. esculentus* cultivars. Inter specific hybrid *A. caillei* x Arka Anamika was found resistant to OYVMV under field epiphytotic conditions. This was further confirmed by artificial inoculation through grafting in polyhouse. None of the cultivated *A. esculentus* cultivars screened were found resistant to OYVMV.

Fajinmi and Fajinmi (2010) studied the degree of okra mosaic virus at different growth stages of okra plants. It was observed that the plants protected from vector up to 28 days after emergence were less infected by virus (17.1 to 22.1 %) as compared to control (30.8 to 38.2 %). As a result there was a significant increase in okra fruit yields (7.5 t/ha) as compared to control (3.6 t/ha).

Shroff et al. (2010) reported the association of OYVM disease with whitefly population. Results revealed that whitefly population was positively correlated at 25 and 50 DAS. The crop stage during this period could be the most vulnerable for attack by whitefly vector to cause OYVM disease.

Sunita and Nirmal (2010) conducted the experiment on the incidence of yellow vein mosaic disease, whitefly population and yield of okra. They observed that the occurrence of whitefly populations found to vary with cultivar and month of sowing. Crop sown in month of January, February, September, October, November and December had considerably less whiteflies (0.74 to 0.81 whitefly/leaf) than rest of the months. When considered as individual month, the crop sown in January (0.74 whitefly/leaf) and October (0.72 whitefly/leaf) recorded lowest whitefly population. The cultivars responded differently for the occurrence of whiteflies. The Local cultivar had more whitefly population (0.99 to 2.38 whitefly/leaf) followed by Parbhani Kranti (0.60 to 0.87 whitefly/leaf) and Cultivar AROH-10 (0.47 to 0.79 whitefly/leaf) when sown in the months from January to December.

Das et al. (2011) conducted a field experiment to assess the impact of weather on pest-disease of okra, in summer season 2009 at

Agronomy Farm of B. A. College of Agriculture, Anand Agricultural University, Anand. The results revealed that different weather parameters were found to have different effect on various pests and diseases. The correlation study revealed that the Tmax had significant influence on jassid population while relative humidity had significant influence on aphid population. The whitefly, percent fruit damage and YVMV disease were significantly influenced by most of the parameters. However, bright sunshine hours (BSS) and pan evaporation (EP) did not have significant influence on any of the pests and disease of okra. Linear simple regression models, multiple regression models and curvilinear regression models developed with various weather parameters. Among all models, the curvilinear regression model using GDD was found well fitted in order to explaining the maximum extent of variability (83** to 98**%) in the population and intensity of most of the pests and disease except whitefly which was well explained by linear regression developed with VPmean (R² 0.88**).

Dastoooger et al. (2011) conducted study to determine the minimum number of the viruliferous vector required for successful transmission of the jute leaf mosaic virus. It has been observed that even a single whitefly was capable of transmitting the disease although 15 whiteflies could transmit the jute leaf mosaic virus to extent of 100 per cent and showed that the maximum 15 viruliferous whiteflies required for effective transmission of jute leaf mosaic virus. There found the positive correlation between number of whitefly and transmission of causal agent.

Karri and Acharya (2012) studied the effect of stage of infection and incidence of yellow vein mosaic in different varieties of okra. It was observed that when plants were infected within twenty days after germination, the losses recorded were up to 90 per cent. The varieties which showed more incidence of YVMV at thirty and sixty days after sowing was found to have greater loss in yield rather than those varieties which having the same intensity of the disease at later stage of the growth.

Vyas et al. (2012) conducted experiment on the management of whitefly and yellow vein mosaic virus in okra during summer 2012, revealed that significant reduction in whitefly population and yellow vein mosaic virus

incidence and higher marketable yield of okra were recorded in all the treatments compared to untreated control. The seed treatment with imidacloprid 600 FS @ 6 g/kg seed and roughing of infested plants at respective interval gave significantly higher protection against white fly, thereby reducing yellow vein mosaic virus incidence and provided highest marketable yield of okra. It was followed by spray of imidacloprid 17.8 SL at 200 ml/ha.

Jambhulkar et al. (2013) evaluated synthetic chemicals and bio-products were against white fly (*B. tabaci*), the insect vector of Bhindi yellow vein mosaic disease. Among the chemicals, seed treatment and two sprays with imidacloprid was found most effective in reducing disease incidence by 70.9% in 2010 and 67.9% in 2011 experiments. This treatment also reduced whitefly population by 92.9% over control. Among the bioproducts, spray of azadirachtin at 15 days interval was the most effective in reducing disease incidence by 53 to 58% and whitefly population by 79.2%. Association of whitefly population with disease incidence indicated that 25 to 50 days after sowing was the most vulnerable stage to be attacked by virus infested whitefly vector to cause disease.

Sanwal et al. (2013) reported a single whitefly can transmit the yellow vein mosaic virus effectively however, the minimum number of whiteflies required to induce 100 per cent infection was 10 per plant.

Sindhumole and Manju (2013) studied association of okra yellow vein mosaic incidence with vector population. They indicated that whitefly population at 30 DAS (Days after sowing) had positive correlation with disease incidence at 50 DAS to final harvest. This demonstrated the fact that feeding by the vectors during the initial stage of crop growth, especially at 30 DAS, leads to the incidence and development of YVM disease throughout the crop phase. Moreover, whitefly count during 50 DAS also influenced the disease expression during the final phase of the crop.

Chakraborti et al. (2014) The approach using components like yellow sticky trap, repellent crop (coriander), plant sanitation, periodic removal of YVMV infected plants and plant fractions (leaf extract of rose apple and neem oil) worked well by effectively arresting the disease development and

vector population build up. Besides one application each of emamectin benzoate and spinosad was sufficient to produce a conclusive effect on the vector and YVMV disease development and resulted in good yields. Only 2.5 - 2.9% YVMV infected plants and 0.8 - 1.1 white fly/leaf were recorded on 30 days after sowing. Thereafter, both the vector and the virus were wiped away from the plants under these treatments.

Mutetwa and Mtaita (2014) reported that insect pest started appearing 15 DAS except for silvery-grey coloured mulch which started recording the incidence of whitefly 18 DAS. All treatments recorded a peak in the incidence of the pest 27 DAS. The incidence was then started to gradually decrease until 51 DAS for the control and other coloured mulches except silvery-grey which remained relatively constant.

Patil et al. (2014) revealed that, amongst the treatments tested, the cumulative foliar spray of thiamethoxam 25 WG @ 0.006% was found the most effective against YVMV transmitting aphids, followed by Lambda cyhalothrin 5 EC @ 0.004%. While, thiamethoxam 25 WG @ 0.006% was effective against leafhoppers population followed by thiamethoxam 25 WG @ 0.008%. Also in case of whitefly the effective treatment recorded was thiamethoxam 25 WG @ 0.006%.

Solankey et al. (2014) reported that one of the major limiting factors of okra is the incidence of okra yellow vein mosaic virus (OYVMV), its vector being whitefly. Infection of 100% plants in a field is very common and yield losses range from 50 to 94% depending on the stage of crop growth at which infection occurs. A total of 91 okra genotypes were evaluated in summer and rainy season of 2012 to 2013, out of which only 6 genotypes (IIHR123, IC90381, CI140982, IC141065, IIHR1 and Kavya) were found to have highly resistant disease reaction during both the season. The highest fruit yield in rainy and summer season was observed in the genotypes IC32855 (308 g/ plant) and IC99646 (212.3 g/plant), respectively. These genotypes could be used for further hybrid breeding programme due to their high yield and lower disease incidence for OYVMV. They concluded that there was significant effect of season on yield and yield attributing traits as well as incidence of OYVMV in okra. Rainy season favours incidence of OYVMV.

Pagire et al. (2017) conducted experiment under field condition to test the effect of insecticides against whiteflies checking the incidence of yellow vein mosaic virus (YVMV) on okra at Indian Agriculture Research Institute, Regional Station, College of Agriculture, Pune. The present study conducted in randomized block design with eight treatments. The seven insecticides were evaluated against whiteflies checking the yellow vein mosaic virus (YVMV) incidence. The observations on whiteflies mortality and incidence of YVMV incidence recorded at 3, 7 and 14 days after each spray. The results revealed that thiamethoxam 0.005 per cent was the most effective treatment and followed by acetamiprid (0.005%) and imidacloprid (0.01%) against whiteflies checking yellow vein mosaic virus (YVMV) incidence. Further, the results of correlation studies showed positive association of whitefly mortality with YVMV incidence.

Kumari et al. (2018) Okra (*Abelmoschus esculentus* L. Moench) has wide popularity in terms of cultivation and acceptability all over the world. In spite of its high nutritive value, well acceptability among end users and wide range of available genetic variability, the country is still lagging behind the leading productive countries like Ghana and Egypt in the world. One of the main okra production constraints is high incidence of most destructive yellow vein mosaic virus (YVMV) disease which infects crop at all phenological stages and can cause yield loss ranges between 50 and 94% depending on the stage of crop growth at which infection occurs. This disease is caused by a complex consisting of the monopartite begomovirus BYVMV encapsulated within a typical geminated particle and a small satellite DNA β component. However, several wild species of okra showed high degree of YVMV disease resistance. The reaction of YVMV on 20 okra genotypes including 4 checks Kashi Kranti, Kashi Satdhari, Kashi Lalima and Arka Anamika was determined using whole-plant scoring at 30, 45 and 60 days intervals. These genotypes were screened and evaluated in open field conditions in rainy season of 2015-16. Out of 20 genotypes five were showed resistant reaction to YVMV, whereas eight were moderately resistant to this disease. Remaining genotypes during whole period of experiment showed susceptible and moderately susceptible reaction. Response of these genotypes towards

YVMV disease shows variability on the basis of their comparison to each other. Among the five resistant genotypes, highest resistant reaction was observed in Kashi Kranti (18.35%) followed by Kashi Satdhari (19.39%), Kashi Lalima (20.34%), Kashi Mohini (20.81%) and Punjab-8 (21.45%), respectively at 45 days after sowing. The genotypes 307-10-1 (25.45%), Pusa Makhmali (32.35%), VROB-159 (33.45%), VROB-178 (38.27%), Arka Anamika (41.93%), IBS-02 (42.36%), Pusa Sawani (43.75%) and BO-13 (44.35%) showed moderately resistant to YVMV in their increasing order of disease infection. The incidence of YVMV is higher during the months of April and May because of high temperature coupled with high rainfall. Screening of genotypes provides an idea in identification of stable source of resistance for YVMV in okra which can be utilized for development of disease resistant cultivars.

Manju et al. (2018) conducted a field experiment to evaluate the efficacy of certain vegetable oils and novel chemicals as sequential spray against whitefly, *B. tabaci* Gennadius and whitefly transmitted okra yellow vein mosaic virus (OYVMV) during summer seasons of 2015 and 2016 at National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Rajendranagar, Hyderabad. Results revealed that among the treatments, spinosad 45 SC was found to be the best treatment against whiteflies followed by acetamiprid 20 SP and sequential spray of neem oil @ 2% and buprofezin 25 SC. The lowest OYVMV incidence was reported in thiamethoxam 70 WS (16.56%) followed by imidacloprid 70 WS (16.90 %) and spinosad 45 SC (19.43%). Maximum marketable fruit yield of 122 q/ha was recorded in thiamethoxam 70 WS followed by Imidacloprid 70 WS (115 q/ha).

Usha Sree et al. (2018) revealed that incidence of YVMV was initiated in March and reached maximum in May. The correlation studies revealed that maximum and minimum temperature showed highly significant correlation ($p < 0.01$) with YVMV incidence on different okra varieties. Relative humidity (maximum) was significantly negative correlated with disease incidence. Evaporation has shown significant correlation with disease incidence only on V2 (Parbhani OK-1). Wind velocity showed significant positive correlation ($p < 0.05$) with varieties (V1, V3, V4, V5) while varieties V2

and V6 were positively correlated. Hence, the variety Parbhani Kranti can be grown in summer season as it showed less YVMV incidence and recorded higher productivity over other varieties.

2.14 Effect of Yellow sticky traps on sucking pest incidence of okra

A number of mechanical devices are used for a specific purpose of destruction, reducing or preventing insect populations or their attack on plant. Several colors of sticky traps are used, to sample and control pests in the greenhouses and field crops. Yellow colour of sticky-traps are used the mostly to attract insects. Yellow sticky trap, can be used for monitoring and controlling flying insect and seems to give a reliable indication of the general population trend of test insects. These traps are hung immediately above the plants. Locally available, empty, yellow tin coated with grease/ vasline/ castor oil, on the outer surface, may also be used. Iron board also painted in yellow colour can be used. Yellow sticky traps, can be used to observe whether the insect population is rising or falling. This can help to keep a vigilant eye on any problem before it arises. Yellow sticky-plastic traps had a significant favorable effect on the yield of pepper crop (Budnik et al., 1996). The sticky traps captured a large number of spider mite species, in pear orchards, when compared to beating and direct observation methods.

Venkatesh (2000) used yellow sticky traps for monitoring *B. tabaci* in relation to tomato leaf curl virus disease and reported that more number of *B. tabaci* trapped on yellow sticky cylindrical traps in bottom strips (19.75-193.2 adults per trap) than middle strip (2-45 adults per trap) during the crop growth period.

Liao and Liao (2002) showed that the blue (or yellow) traps placed in front of a yellow (or blue) background, could capture 11.5 thrips, it captured, significantly more thrips than traps with other background colors.

Rodrigues et al. (2002) evaluated that the efficiency of yellow and blue sticky traps in the attractiveness of adults of *Anastrepha* spp. and *Ceratitis capitata*, a survey was carried out in an organic crop of passion fruit (*Passiflora alata*). During the experiment, 1261 adult fruit flies were captured.

The yellow sticky trap was more attractive than the blue one, capturing 71.61% of the adults.

Saljoqi and Emden (2003) reported that the yellow sticky plastic-sheet traps were found to be a good management technique for suppressing the aphid populations. The number of aphids, stuck on the yellow-traps, was strongly correlated with the number of aphids on the crop plants, on each time interval.

Simmon and Alvin (2003) reported that the impact of colour sticky trap (blue, yellow and white) on the sweet potato whitefly. More whiteflies and beetles were captured on yellow sticky trap than on traps of other colors.

Atakan and Canhilal (2004) assessed that yellow sticky traps at 60, 80, 100 and 120 cm above ground level in various developmental stages of cotton for their relative efficiency in capturing the following pests as leafhoppers, *Asymetresca decedens* Paoli and *Empoasca decipens* Paoli, cotton whitefly, *B. tabaci* Genn., and western flower thrips *Frankliniella occidentalis* (Pergande). The leafhopper catch was significantly higher at 60 cm than 80, 100 and 120 cm when plant heights were less than 80 cm. The number of leafhoppers on traps at 80 cm was similar to 60 and 100 cm but significantly higher than at 120 cm when plant heights were more than 80 cm. The numbers of western flower thrips were similar at 60, 80 and 100 cm but significantly lower at 120 cm when plant heights varied from 100 to 120 cm. Numbers of whiteflies were highest at 60 cm and lowest at 120 cm trap heights at all plant heights.

Raja and Arivudainambi (2004) reported that the highest number of *A. biguttula biguttula*, per sticky trap (89.82) was recorded in the yellow with red border traps while the lowest (18.07) was recorded in red-trap in Okra crop.

Aziz and Al-Ajaln (2005) reported that the mean number of whiteflies captured /trap on yellow sticky-traps was more than the thrips.

Kaufman et al. (2005) evaluated large sticky traps for the stable fly and house fly and suggested that the fly-management practices greatly

influenced the trap captures. These traps reduced flies in their calf greenhouses to acceptable levels.

Rak-Cizej and Milevoj (2005) studied the three different colour sticky traps, yellow, white and blue. The largest number of hop flea beetles got trapped by yellow sticky traps. Fewer hop flea beetles got trapped by white and blue sticky traps in hop garden and so was in different parts of hop garden and at different times of monitoring.

Vekaria and Patel (2005) reported that the catches of alate aphid was maximum (3973.65/trap) and (2362.50/trap) during the third and second week of February during 1993-94 and 1994-95, respectively. The capterate population of *L. erysimi* on the crop showed significantly positive correlation with the alate catches on yellow sticky traps. The temperature, relative humidity and sunshine hours did not exert significant influence on the catches of alate *L. erysimi* however, wind velocity showed significant positive correlation with alate catches.

Gencsoylu (2007) recorded that the yellow sticky cards were placed in horizontal and vertical position at two heights with two positions. The height of yellow sticky traps affected the populations. The largest population was captured at 25 cm above the plants for *Frankliniella* spp. In contrast, *B. tabaci* and *Empoasca* spp. were at 30 cm above the ground level. Vertical position in each dimension captured more *Empoasca* spp and *Frankliniella* spp. than horizontal. However, there were not significant differences on *B. tabaci*. Direction also affected the pests. The largest population of *Empoasca* spp. was captured in north to south direction of dimension 2 whereas more *Frankliniella* spp. population captured in east to west direction. However, more *B. tabaci* captured in north to south direction in the dimension 1.

Green and Venter (2007) studied that the attractiveness of various sizes of sticky traps reported that an increased trap-size increased the catches of *Glossina brevipalpis* females and both sexes of *Glossina austeni*, significantly.

Karut and Kazak (2007) evaluated yellow sticky traps in cotton crop for two years. Mean ($\pm$ SE) numbers of *B. tabaci* captured on traps were 697.8 ± 55.6 in no-choice and 533.3 ± 47.4 in choice studies in each year.

Held and Boyd (2008) compared captures of adult *G. uzeli* on blue, yellow, white and green sticky traps. Yellow traps were effective for capturing adult *Thripastichus gentilei* (del Guercio), a larval parasitoid of *G. uzeli*.

Chakraborty (2011) studied that the incidence and abundance of tomato leaf miner, *Liriomyza trifolii* by using yellow sticky trap of 4 mm thick plywood board having 30 cm $\times$ 45 cm area. This was attached with a wooden frame. Results showed that, the maximum trap collection with 3.57 ± 0.48 individuals was noted at about 9th Stand Meteorological Week. At 12 and 13 Stand Meteorological Week the number of individuals were 3.15 ± 0.71 and 3.08 ± 0.75 respectively.

Moreau and Isman (2011) concluded that yellow sticky traps were most effective in trapping adult whiteflies. However, yellow sticky traps did significantly reduce oviposition on peppers. Adult whiteflies were most effectively trapped on yellow sticky traps followed by eggplant trap crops.

Premalatha and Rajangam (2011) studied the number of whitefly adults attracted towards yellow sticky trap and was compared with conventional method *i.e.*, tying of yellow charts coated with castor oil. The experimental results revealed that irrespective of the varieties, yellow chart coated with castor oil caught whiteflies more than the yellow sticky trap. Marginal benefit cost ratio (MBCR) was also higher in the treatment of yellow charts coated with castor oil whereas MBCR of yellow sticky traps was only 0.88.

Idris et al. (2012) studied that the trap designs (cylindrical, horizontal and vertical), colours (yellow, blue, green, red, white and black) and time (sampling dates) gave significantly ($P < 0.05$) different effectiveness of trapping the alate WF, as well as indication of its population abundance in the field. Both vertical and cylindrical traps were the most effective traps as significantly ($p < 0.05$) higher numbers of alate WF caught on these traps than

on traps of other designs. Meanwhile, yellow was the most attractive colour to alate WF, regardless of the trap design as it had the highest number of alates caught compared to the other colours. Comparatively, the vertical yellow trap was the most attractive and efficient trap to use in monitoring WF.

Iqbal et al. (2012) observed that A combination of treatments, viz., seed treatment, spray with imidacloprid and installation of yellow sticky traps, was found the most effective and resulted in a minimum population of jassid, per leaf, on okra and the combination of seed-treatment + spray of imidacloprid + installation of yellow sticky traps, showed a maximum yield of okra.

Krishnan (2012) prepared locally innovated yellow sticky traps at the farm level in cotton field where trying out different coloured sticky traps and he observed that the yellow colour attracted the maximum number of sucking pests like jassids (2640), white flies (1166) and thrips (352) etc. for yellow sticky traps @ 50 per ha.

Moreau and Isman (2012) studied in cage bioassays, whitefly adult settling, oviposition and gender were compared between six treatment combinations made up of two spray treatments (1) untreated main crop and (2) treated main crop (5% safer's soap) and three trap treatments (1) pepper (control), (2) trap crop (eggplant) and (3) trap crop (eggplant) + yellow sticky trap. Results demonstrate that the eggplant trap crops and eggplant combined with yellow cards reduced adult settling on main crops by 31.5 and 40.9% respectively. Treating main crops with 5% Safer's Soap only reduced the proportion of adults by 6% and no significant advantage was obtained by combining the traps with the sprays.

Nandini et al. (2012) studied under naturally ventilated polyhouse condition. Each bed consisting of 160 plants of *Capsicum annuum* hybrid Bomby was installed with yellow sticky traps at 3 traps/1000 m², prepared by wrapping the yellow coloured PVC sheet around a card board sheet measuring 10.5 x 7.5 in. Monitoring of sucking pests through these traps was performed at 15 days interval. A higher number of sucking pests, i.e. whitefly [*Bemisia tabaci*], thrips, red mite and leafhopper [*Cicadelloidea*], was trapped on side-1 compared to side-2 of the traps. A maximum of 8.3 ±

0.96 whiteflies and 1.4 ± 0.14 mites during the second fortnight of September, 1.53 ± 0.55 thrips during the first fortnight of September and 5.3 ± 0.57 leafhopper during the second fortnight of September was recorded on side-1. A lower catch was observed on side-2. Higher catches on side-1 of the yellow sticky traps was due to wind direction which aided dispersal of these soft bodied insects.

Bhonde (2013) studied that the Bright yellow color sticky trap at 15 cm height above crop canopy + Azadirachtin 10000 ppm @ 2ml/L found significantly effective treatment in trapping maximum population of adult aphid, leaf hopper and whitefly on NE, SW and both directions of the trap.

Thakare et al. (2013) reported from feeler trial that the yellow colour traps with castor oil at 15 cm height above crop canopy closely followed by blue colour traps with motor oil at 30 cm height above crop canopy, yellow colour traps with motor oil at 30 cm height above crop canopy, blue color trap with motor oil at 15 cm height above crop canopy and yellow colour traps with white grease at 15 cm height above crop canopy were found numerically most effective in trapping maximum population of aphids, leaf hopper and whitefly together on cotton crop.

Khaire (2014) revealed that treatments with Yellow sticky trap with castor oil along the crop canopy followed by azadirachtin 10,000 ppm @ 2 ml/L, Yellow sticky trap with castor oil at 15 cm height above crop canopy followed by azadirachtin 10,000 ppm @ 2 ml/L were found significantly most effective treatments in order of merit in minimizing the infestation of sucking pest viz., aphid, leaf hopper, whitefly and thrips at 7 and 14 days after spray and in trapping maximum population of aphids (53.14, 12.06, 65.28), leaf hopper (2.36, 0.82, 3.18) and whitefly (29.07, 12.90, 41.97) per trap per week on NE, SW and BS direction together.

2.15 Effect of treatments on yield and ICBR

Misra (1987) tested bio-efficacy of some indecticides against pest complex of okra in summer season and revealed that there were significant differences in the effectiveness of the compounds against the various pests, but fruit yield was highest (8033 kg/ha) with 0.005% fenvalerate

followed by 0.0015% deltamethrin, with the yield of 7350 kg/ha, as compared to 1992 kg/ha in untreated control.

Misra and Senapati (2003a), thiamethoxam at rates ranging from 25 to 50 g a.i./ha and imidacloprid at 25.0 g a.i./ha gave significant excellent control of jassid (83.3 to 100.00%) and increased the marketable fruit yield (32.40 to 35.44 %) of okra compared to conventional insecticides.

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

Pun et al. (2005) reported that the spraying with NSKE proved most effective in reducing the load of whitefly population on okra and also increased the yield. Economics of different treatments (Table 2) showed that highest (1: 41.55) Incremental Cost Benefit Ratio (ICBR) was found in NSKE followed by endosulfan (1: 28.49), Neem oil (1: 25.43) and Vanguard (1: 18.23). Both the formulations of Neemazal exhibited relatively poor (1: 7.16 to 8.19) economic return.

Singh et al. (2005) evaluated insecticides under field condition at Kumarganj, Faizabad, Uttar Pradesh for the management of the shoot and fruits borer, *Earias vittella* (Fabr.), on okra during *Kharif* season 2003. Fenvalerate (0.015%) was the most effective in reducing the pest incidence and realized the maximum yield of 76.95q/ha followed by neem seed Kernel extract (NSKE) (1.5%), acephate (300a.i./ha), NSKE (1%), karanj seed kernel extract (KSKE) (1.5%) and KSKE (1%) giving fruits yield of 58.27, 56.53, 47.32, 44.25, and 41.5q/ha, respectively. Malathion (0.1%) was the least

effective, gave the fruit yield of 39.83q/ha as against 29.17q/ha in untreated control. Based on the yield data and the cost of application of 5 sprays of each insecticide, the cost- benefit analysis revealed that the most favourable cost :benefit (C:B) ratio was 1:18.14 in fenvalerate, followed by 1:2.58 in malathion, 1:1.81 in acephate, while in botanicals the C:B ratio were either low or negative, not only due to less effective borer control but mainly because of high cost of treatment.

Two new systemic insecticides belonging to nitroguanidine group, imidacloprid and acetamiprid, were evaluated and compared with currently recommended methyl demeton for the control of the jassid, *A. biguttula biguttula*, on okra for two cropping seasons, 2002 and 2003 at Durgapura, Jaipur, Rajasthan, India. The pooled data for two years revealed that imidacloprid formulation, Confidor 350SC at 75 ml/ha, was the most effective treatment in reducing the jassid incidence to a seasonal mean of 10.65 per 5 plants, and recording the maximum fruit yield of 87.4 q/ha. In comparison, treatments with methyl demeton (1000 ml/ha) and acetamiprid formulation (Pride 20 SP; 50 ml/ha) recorded significantly lower fruit yield of 40.25 and 35.69 q/ha, respectively, but were better than the control (29.02 q/ha) (Swaroop et al., 2005).

Gandhi et al. (2006) reported that the seed treatment with imidacloprid was effective in reducing the level of Homopterous sucking pests of okra. They reported that imidacloprid performed better by recording about two-fold increase in the marketable fruit yield of 'okra' from the untreated check. A maximum of 11,280 and 11,580 kg, per ha, were recorded from imidacloprid treated plants, in two years respectively, in 2001 and 2002 experiments.

Biswas et al. (2009) revealed in two years trials that dimethoate and profenphos were significantly superior over untreated control (damage fruit 34.33% in number and 31.36% in weight). However, better yield was obtained from a mixed formulation of profenphos and cypermethrin (42.17 q/ha) followed by flubandiamide (40.20q/ha) and profenphos (38.06q/ha). Yield was positively related with the efficacy of insecticides. Only 13.98% damaged (in weight) fruits were recorded from neem treated plots with a

better yield of 39.60 q/ha. Neem can be recommended for IPM programme in okra.

Das and Ghosh (2009), reported that the treatments of dimethoate and profenophos were significantly superior against *E. vittella* over untreated control (damage fruit 34.33% in number and 31.36% in weight). However, better yield was obtained from a mixed formulation of profenophos and cypermethrin (42.17 q/ha) followed by flubendiamide (40.20 q/ha) and profenophos (38.06 q/ha).

Prasad et al. (2009) evaluated the bio-efficacy of five insecticides against jassid and fruit borer on okra and concluded that their effectiveness were found to be almost in the order of oxydemeton-methyl > chlorpyrifos > quinalphos > neem oil > fenvalerate in reducing the incidence of both the pests. The insecticides hold also almost the same rank in terms of enhancement of yield of healthy and marketable fruits and cost : benefit ratio. As such, the yield of marketable fruits of 90.2, 73.8, 69.5, 76.1 and 67.7 q/ha and CBR of 1:16.4, 1:12.8, 1:10.6, 1:9.6 and 1:7.6 were obtained due to reduction in the incidence of jassids to the tune of 88.9, 80.9, 72.4, 72.3 and 59.9% and that of fruit borer up to 88.6, 90.8, 86.9, 72.4 and 67.7 %, respectively over the unprotected crop by the foliar spray of the respective chemical insecticides at 500 g a.i./ha, and neem oil at 3.5%.

Pardeshi et al. (2010) tested different insecticides against *E.vittella* on okra. Profenophos+cypermethrin (0.044%), chlorpyrifos +cypermethrin (0.055%), cypermethrin (0.006%) and profenophos (0.05%) were found to be the most effective in reducing the fruit infestation i.e. 6.47 to 10.52%. Highest yield of healthy fruits was recorded in profenophos+cypermethrin (2366.6 kg/ha) followed by chlorpyrifos +cypermethrin (2155.35 kg/ha), cypermethrin (2127.06 kg/ha) and profenophos (2103.91 kg/ha). Cypermethrin gave the highest (1:20.3) NICBR followed by profenophos+cypermethrin (1:11.9), chlorpyrifos (1:10.4), chlorpyrifos+cypermethrin (1:10.2) and profenophos (1:8.7).

Girhe et al. (2011) investigated, on the basis of field parameters, and reported that, lowest infestation (Shoot and fruit Infestation) and highest yield over control observed in treatment with NSE 5% alternated with

cypermethrin 0.01% (T₇) (6.50% shoot 13.70% fruit infestation and 13.17% fruit damage with 84.12 q/ ha yield) followed by NSE 5% alternated with endosulfon 0.07% (T₈), NSE5% (T₁), Neem oil 1% (T₂), release of *T. chilonis* 1.25 lakh eggs/ha (T₅) and *B. thuringiensis* 100 ml/ha (T₄). The treatment KSE 5% (T₃) and clipping of shoots (T₆) were found to be least effective but superior over control (T₉) for managing the okra shoot and fruit borer infestation.

Pardeshi et al. (2011) determined the efficacy of eleven chemical treatments against *E. vittella* (Fabricius) infesting okra at Junagadh Agricultural University campus, Junagadh during *kharif* season of 2006. Among tested insecticides, profenophos + cypermethrin (0.044%), chlorpyriphos + cypermethrin (0.055%), cypermethrin 0.006% and profenophos 0.05%, were found to be the most effective in reducing the fruit infestation to 6.47 to 10.52 % against 43.5% in the control. The highest yield of healthy fruits was recorded in the treatment of profenophos + cypermethrin 0.044% (2366.3 kg/ha) followed by chlorpyriphos + cypermethrin 0.055% (2155.4 Kg/ha), cypermethrin 0.006% (2127.1 Kg/ha) and profenophos 0.05% (2103.9 Kg/ha). The highest cost benefit ratio (1: 20.3) was obtained in the treatment of cypermethrin 0.006%, followed by profenophos + cypermethrin (1:11.9), chlorpyriphos (1:10.4), chlorpyriphos + cypermethrin (1:10.2), profenophos (1:8.7), acephate (1:5.1) and methomyl (1:4.1).

Dabhi et al. (2012) evaluated various insecticides for the control of shoot and fruit borer, *E.vittella* in *kharif* season Okra crop. Among various treatments, indoxacarb @ 0.075% was found significantly superior over rest of treatments in controlling fruit damage. The next best effective treatment was profenofos +cypermethrin @ 0.044% which was on par with endosulphan @ 0.07 %, chloripyriphos @ 0.04% and provided protection against *E. vittella* during *kharif* season. Significant maximum yield of marketable Okra fruit was recorded from the plot sprayed with indoxacarb (7846kg/ha.). The insecticides profenophos + cypermethrin, endosulfan, indoxacarb and chloripyriphos registered the higher profit of Rs. 39210, 38692 and 37460/ha, respectively.

Parmar et al. (2013) studied relative bio-efficacy of deltamethrin (0.0028 %), alphasmethrin (0.01 %), deltamethrin + triazophos (0.036

%), ethion + cypermethrin (0.045 %), profenophos (0.1 %), imidacloprid (0.0053 %) and acetamiprid (0.02 %) were evaluated against pest complex of okra at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat) during summer and *kharif* 2009-10. Imidacloprid and acetamiprid proved the most effective against aphid, *A. gossypii* Glov., leafhopper, *A. biguttula biguttula* Ishida and whitefly, *B. tabaci* Gen. Also, Deltamethrin + triazophos was proved effective against *B. tabaci*. Ethion + cypermethrin, imidacloprid and acetamiprid proved significantly the most effective against red mite, *Tetranychus telarius* on okra, deltamethrin + triazophos and deltamethrin alone were found moderately effective. Among the insecticides evaluated, significantly low damage due to shoot and fruit borer, *E. vittella* Fab. was registered in the plots treated with profenophos and deltamethrin. The treatment of imidacloprid produced highest (105.22 q/ha) yield, followed by acetamiprid (100.16 q/ha) and deltamethrin + triazophos (89.78 q/ha). Ethion + cypermethrin, deltamethrin and profenophos performed equally effective and exhibited yield ranging from 75.61 to 85.93 q/ha. With respect to Incremental Cost Benefit Ratio (ICBR), highest (1: 22.08) return was registered in imidacloprid followed by deltamethrin (1: 14.22) and deltamethrin + triazophos (1: 12.70).

Singh et al. (2013) tested different insecticidal seed treatments viz., imidacloprid @ 3 g kg⁻¹, thiamethoxam @ 3g kg⁻¹, acetamiprid @ 2 g kg⁻¹, carbosulfan @ 30 g kg⁻¹, fipronil @ 2ml lit⁻¹kg⁻¹ for 1 hour, monocrotophos @ 3 ml lit⁻¹kg⁻¹ for 1 hour and untreated check were tested against sucking pests of okra. Among the treatments, imidacloprid @ 3 g kg⁻¹ was most effective. It provided maximum reduction in population of sucking pests, seed germination %, numbers of fruit plant⁻¹, plant height, fruit damage, fruit yield and cost benefit ratio which was significantly equal to thiamethoxam and acetamiprid.

Barakzai and Lyall (2014) reported that the treatment with combined cypermethrin 25 EC (0.0625%) + neem oil (1%) was found most effective, the fruit damage was 4.3%, with highest cost benefit ratio 1:3.31, and yield 98.07 q/ha. The treatment with chemical insecticide of chlorpyrifos was effective, the fruit damage was 5.7%. The treatments with botanical

insecticides viz. neem oil 1%, datura leaf extract 10%, garlic bulb extract 3% and green chilli extract 1% were also effective, resulting 6.6%, 8.6%, 9.0% and 10.5% fruit damage, compared with control plot 22.0%. Among the botanical insecticides, neem oil 1% gave highest CBR 1:2.59 and yield 80.43 q/ha. So neem oil 1% was found best botanical treatment against *E. vittella* as it is eco-friendly, no residual effect and not caused hazardous effect to environment, also it could be an important tool in IPM programme.

Kamble et al. (2014) conducted experiment to evaluate the efficacy of newer combination insecticides against shoot and fruit borer, *E. vittella* (Fabricius) on okra. Among tested insecticides, indoxacarb 14.5 SC + acetamiprid 7.7 SC @ 400 ml/ ha, profenophos 40 EC + cypermethrin 4 EC @1000 ml/ha and chlorpyrifos 50 EC + cypermethrin 5 EC @1000 ml/ha were found to be the most effective in reducing the fruit infestation on number basis as well as weight basis which was 15.65 to 14.80 and 16.25 to 15.24%, respectively as against 32.14 and 31.31% in the control. The significantly highest yield (124.44 q/ha) of healthy fruits was recorded in indoxacarb 14.5 SC + acetamiprid 7.7 SC followed by profenophos 40 EC + cypermethrin 4 EC (114.52 q/ha) and chlorpyrifos 50 EC + cypermethrin 5 EC (112.70 q/ha). The highest incremental benefit cost ratio (12.45) was registered by indoxacarb 14.5 SC + acetamiprid 7.7 SC followed by profenophos 40 EC + cypermethrin 4 EC (11.07) and chlorpyrifos 50 EC + cypermethrin 5 EC (9.66).

2.16 Effect of chemicals on phytotoxicity

Uptake and dissipation of imidacloprid in okra was studied by treating the seeds with Gaucho at 9 g a.i./kg seed and spraying okra crop at the fruiting stage with Confidor 200 SL at 0.3 and 0.6 ml/litre. Imidacloprid was taken up by the plant from its seed treatment and the residues persisted in plant for more than 30 days after germination. However, residues could not be detected in fruits harvested at 50, 55 and 60 days after germination. Imidacloprid residues dissipated exponentially with time following foliar application with a half-life of 2-4 days in two consecutive seasons. The residues, however, became non-detectable 10 days after treatment at lower

concentration and 15 days after treatment at higher concentration (Indumathi et al., 2001).

Kumar et al. (2001) studied efficacy of imidacloprid and thiamethoxam on okra against leafhopper and whitefly. Field experiments conducted in Bangalore (India) during the *kharif* and *summer* seasons of 1999 and 2000 had shown that various doses of imidacloprid and thiamethoxam had no phytotoxic effect on okra but effective against insects.

Prasad Kumar (2010) critical visual observations were made for phototoxic symptoms such as injury on leaf tips or surface, wilting etc. on ten randomly selected plants in plots and no phototoxic symptoms were observed in any of the treatments. It can be concluded that the application of triazophos 40 EC @ 1250 ml per ha was effective against leaf hopper, whiteflies and shoot and fruit borer of brinjal.

Suganthi et al. (2010) conducted experiment at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore to assess the compatibility of Confidence® (imidacloprid 17.8% SL) with other chemical pesticides on cotton, bhendi and chilli. The physical stability in terms of emulsion stability revealed that out of eight pesticides tested namely, azoxystrobin, wettable sulphur, carbendazim, spiromesifen, dicofol, neem oil, neem seed kernel extract and emamectin with imidacloprid 17.8% SL at 25 g a.i./ha, none of these products produced creaming matter or sediment, more than 2.0 ml at the top or bottom of the 100 ml cylinder. The results confirmed the physical stability of these pesticides with imidacloprid 17.8 % SL. The phytotoxic effects of these combination products on cotton, bhendi and chilli revealed that imidacloprid 17.8% SL at 25g a.i./ha with the above eight pesticides at recommended doses had not caused any phytotoxic symptoms such as injury to leaf tip and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty.

Govindan et al. (2013) conducted two field experiments, first season at Deenampalayam during (January 2009 - March 2009) and second season at Udayampalayam during April 2009 – June 2009). The new formulation of emamectin benzoate 5 SG at 11 g a.i. ha⁻¹ and combination treatments were highly effective and reduced the okra fruit borer, *H. armigera*

and fruit damage when compared to other agrochemicals. Emamectin benzoate 5 SG at 11 g a.i. ha⁻¹ was physically compatible with endosulfan, carbendazim and urea which did not produce any sedimentation. When emamectin benzoate 5 SG was sprayed as tank mix on okra plants, in combination with urea, carbendazim and endosulfan it did not exhibit any phytotoxic symptoms on okra plants and was effective in controlling *H. armigera* and their damage to fruits. Similarly, emamectin benzoate 5 SG at 11 g a.i. ha⁻¹ was physically and biologically compatible with endosulfan, carbendazim and urea and effective against fruit borer and reducing their damage on okra plants.

2.17 Effect on modules on growth parameters.

Preetha and Stanley (2012) investigated the effect of neonicotinoids viz. imidacloprid, thiamethoxam, acetamiprid and thiacloprid on plant height, chlorophyll, and soluble protein of cotton and okra. Thiamethoxam was found to exert an influence on the plant height of cotton and okra. There was no marked influences of neonicotinoids on the total chlorophyll content of cotton leaves, whereas acetamiprid recorded a gradual increase in the total chlorophyll content of okra leaves at 7, 14 and 21 days after treatment. All the neonicotinoid insecticides under study showed an increase in the soluble protein content of cotton and okra. An increase in soluble protein content is reported to increase the ability of plants to fix carbon dioxide (CO₂) effectively and thus increase photosynthesis.

Sharma and Lal (2002) reported that thiomethoxam was superior to others against both leafhoppers and whiteflies on brinjal.

Bhalala et al. (2006) concluded that okra crop sprayed with thiomethoxam 25 WG at two higher doses (50 and 37.5 g a.i./ha) showed effective control of jassid and aphids.

Kulkarni and Adsule (2006) revealed that thiamethoxam @ 25 g a.i./ha was found to be most effective dose in reducing jassid infestation and it was on par with higher dose of 50 g a.i./ha but superior over the lowest dose of 12.5 g a.i./ha.

CHAPTER III

MATERIAL AND METHODS

The sucking pests like aphids, leaf hopper, whiteflies, thrips, Mites and shoot and fruit borer constitute the major group of insect pests on okra which needs to be managed below the level of economic damage which can be achieved by using various modules.

Therefore, various modules with yellow sticky traps, seed treatment, soil application of neem cake and foliar application of various insecticides against abundance of major pests of Okra and its effect on natural enemies of okra in *summer* and *kharif* season as well as the incidence of Yellow vein mosaic disease. The fruit yield and cost economics were also studied.

3.1 Material

The material required for conducting field experiment for evaluation of various modules against major pests of okra during *summer* 2014-15 and *kharif* season of 2015-16 viz, okra seed (variety-Akola bahar), such as experimental land, various agricultural implements required for preparatory tillage, sowing and intercultural operations and various inputs such as fertilizers, neem cake for soil application, imidacloprid 48 FS for seed treatment, farm implements, land, labour, bullock pair, fertilizer, tape, measuring cylinder, polythene bags, bamboo pegs, weighing balance, foam sheet, Golden yellow colour paint brush, plastic string, bamboo sticks of 7 ft height, castor oil, azadirachtin 10000 ppm, knapsack sprayer, various insecticides as per treatment designed etc. were supplied by the Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

3.2 Experimental site

Field experiments were conducted during *Summer* 2014-15 and *Kharif* 2015-16 at the experimental farm of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The geographically Akola is situated at an elevation of 307.4 meter above the

mean sea level at 220 42' North latitude and 770 02' East longitude and has subtropical climate.

3.3 Soil type

The experiment was conducted on well drained, typical deep black cotton soil which was uniform in level. The depth of soil varied from 2 to 3 meters.

3.4 Climatic conditions

The mean annual rainfall of Akola is 700- 750 mm. The rainfall is received during four months i.e. June to Sept. Summer is hot and dry while winter is cool. The mean daily maximum temperature varies from 33.5⁰C in winter (December) to about 46.1⁰C in summer (April-May), whereas, mean minimum temperature varies from 12.5⁰C to 28.6⁰C during winter and summer, respectively. The mean relative humidity ranges from 30 to 90 per cent. In general Akola has hot dry summer and cool winter, however, July, August and September months are humid and moisture index is positive. Rest of the period of the year is dry. Akola is grouped in assured rainfall zone with *kharif* cropping pattern. The climate is subtropical. The meteorological data for the year summer 2014-15 and *kharif* 2015-16 is given in Annexure-I & II

3.5 Agronomic practices / Cultural operations

The necessary tillage operations (before and after sowing) were performed as per the standard package of practices for raising okra crop.

3.5.1 Preparatory tillage

During *summer* and *kharif* the soil was thoroughly ploughed by tractor mould board plough followed by two harrowing. The field was cleaned by collecting stubbles. The experiment was laid out as per given in plan of layout.

3.5.2 Layout of experiment

Field experiment was laid out in Randomized Block Design with eight treatments replicated thrice. Yellow sticky traps along crop canopy and 15 cm height above crop canopy, azadirachtin and different chemical insecticides and neem cake for soil application were evaluated in different

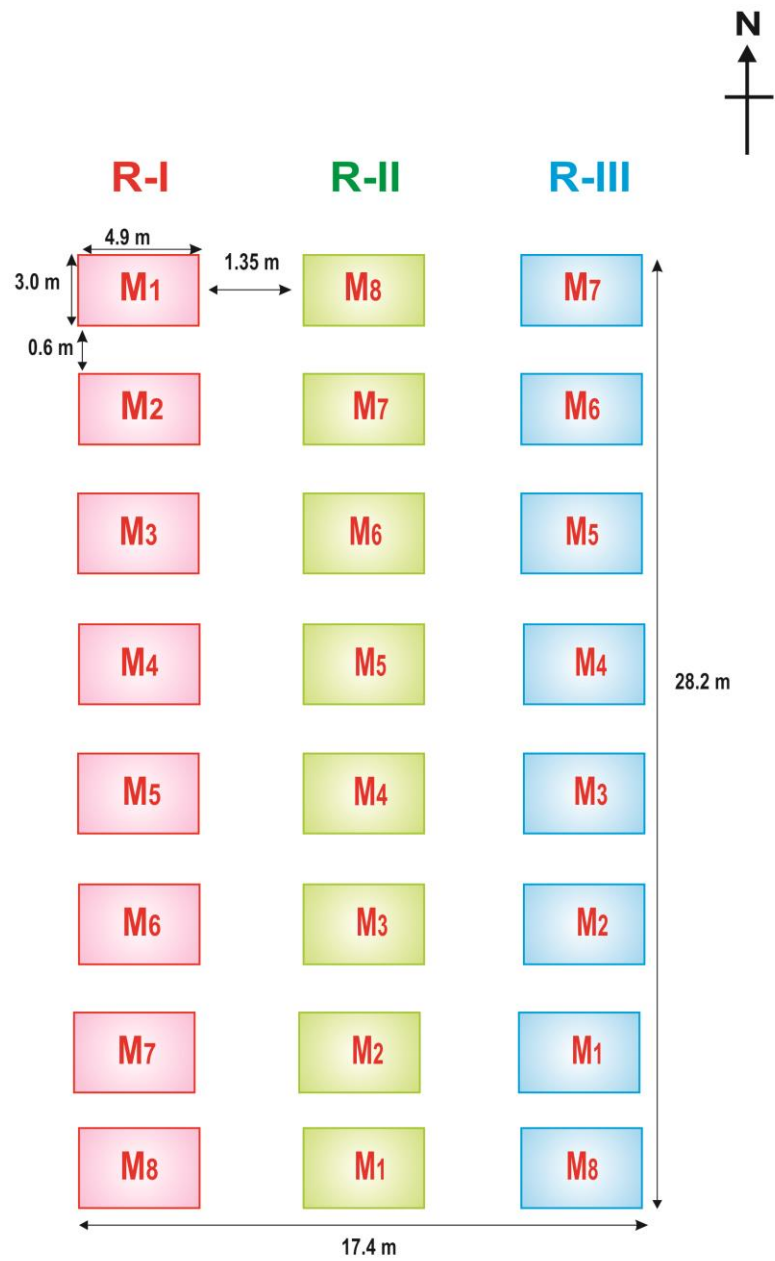


Fig. 1(a). Plan of layout (Summer 2014-15)

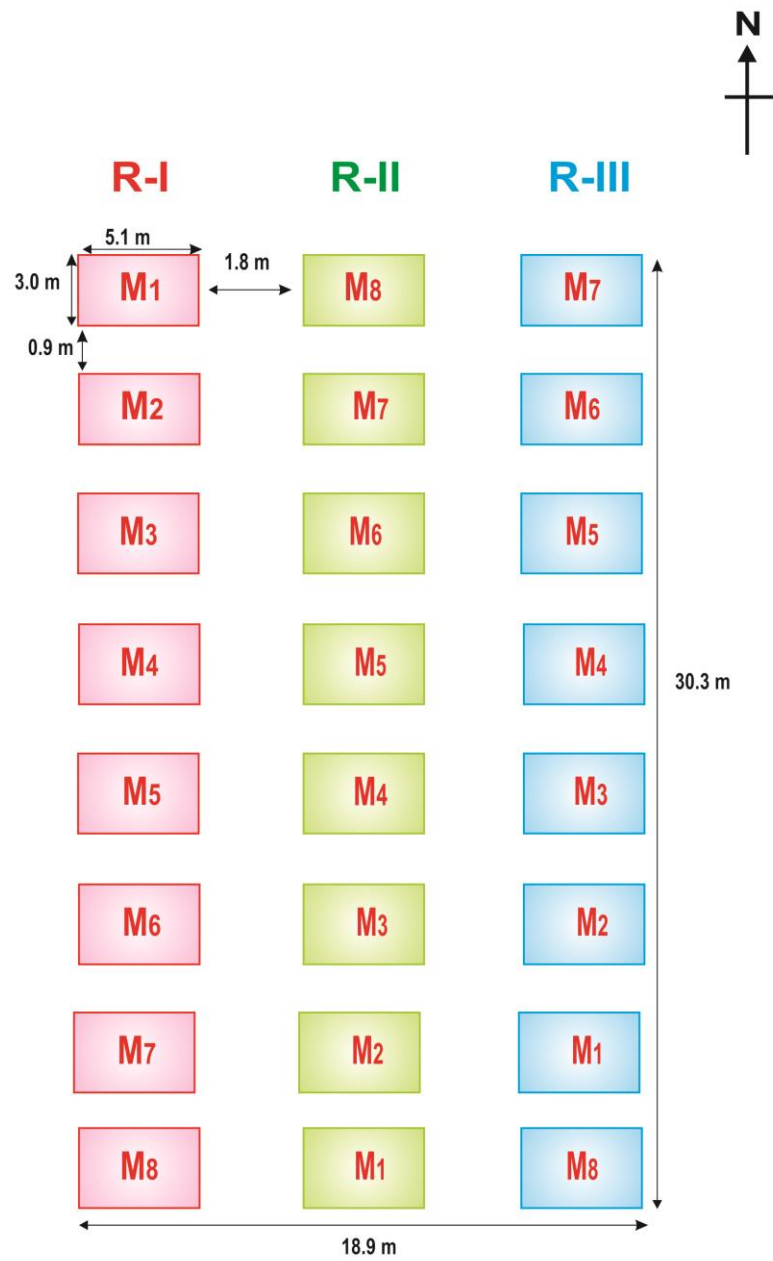


Fig. 1(b). Plan of layout (*Kharif* 2015-16)

module for management of pests of okra . Data on completely untreated plots and plots treated with chemical insecticides was also recorded for the sake of comparison. The crop was sown at a spacing of 45 cm x 30 cm and 60 cm x 45 cm with gross plot size of 4.95 m x 3 m and 5.1 m x 3.0 m. Distance between two replications was 1.35 m and 1.8 m and between two treatment plots was 0.6 m and 0.9 m. Total area of the experiment was 1546 m² in summer and 1620 m² in *kharif* .

3.5.3 Sowing

The sowing was done by dibbling at 45 cm x 30 cm on 04/02/2015 in Summer and in *Kharif* 60 cm x 45 cm with Akola bahar variety by placing 2 seeds per hill Trial during *kharif* 2015-16 was sown on 11/07/2015 because of delayed monsoon arrival.

3.5.4 Gap filling and thinning

Gap filling was done 7 days after emergence and thinning operation performed at 12 days after emergence of the crop. One healthy seedling was kept at each hill.

3.5.5 Application of fertilizers

The fertilizers were applied at the rate of 50:50:0 kg of N, P₂O₅ and K₂O per hectare, respectively. The half dose of Nitrogen and full dose of P₂O₅ and K₂O was applied at the time of sowing. Remaining half dose of nitrogen was applied after 30 days of sowing.

3.5.6 Intercultural operations

Hoeing and weeding were done from time to time to remove competition from weeds and to improve soil aeration along with conservation of soil moisture. In all, three weeding and hoeing were undertaken during the crop season.

3.6 Experimental details

The details of the experiments conducted and methods of observations adopted are given below.

3.6.1 Details of experiment conducted

1. Design : Randomized Block Design (RBD)
2. Replications : Three (3)
3. Treatments : Eight (08)
4. Season : Summer 2014-2015 and
Kharif 2015-16
5. Crop : Okra
6. Variety : Akola bahar
- 7 Plot size
 - Summer* : Gross 4.95 mx 3.0m (14.85) M²
: Net 4.05 mx 2.4m (9.72) M²
 - Kharif* : Gross 5.1 x 3.0m (15.1) M²
: Net 3.9 m x 2.1 m (8.19) M²
8. Spacing
 - Summer* : 45 x 30 Cm
 - Kharif* : 60 x 45 Cm
9. Spacing between replication:
 - Summer* : 1.35 m
 - Kharif* : 1.8 m
10. Spacing between treatments
 - Summer* : 0.6 m
 - Kharif* : 0.9 m
11. Fertilizer dose : 50:50:00 Kg NPK/ha
12. Date of sowing : 04.02.2015 (summer)
: 11.07.2015(*Kharif*)
13. Date of emergence : 10.02.2015 and 16.07.2015
14. Date of installation of trap : 19.02.2015 and 25.07.2015

3.6.2 Details of treatment:

b) Treatments details	
M₁	• Soil application of neem cake @250kg/ha at time of sowing • Installation of yellow sticky trap at 15 DAS (30x15cm size of foam sheet) at 2 opposite corner along crop canopy and 15 cm above crop canopy • Weekly clipping of infested shoots from the appearance of pests. • Foliar application of azadirachtin 1% w/w @5ml/L at 15 days interval from sowing to 75 days after sowing.
M₂	• Seed treatment with Imidacloprid 48 FS @ 9ml/kg seed • Dimethoate 30EC @ 2ml/L at 30 DAS followed by. • Quinalphos 25 EC @ 2ml/L at 45 DAS followed by • Fenpropathrin 30 EC @ 0.35ml/L at 60 DAS followed by. • Dicofol 18.5 EC @ 2.7ml/L+Quinalphos 25 EC @ 2ml/L at 75 DAS.
M₃	• Installation of yellow sticky trap at 15 DAS (30x15cm size of foam sheet) at 2 opposite corner along crop canopy and 15 cm above crop canopy • Acephate 75 SP @ 1.6g/L at 15 DAS followed by. • Quinalphos20 EC @ 2ml/L at 30 DAS followed by • Fenpropathrin 30 EC @ 0.35ml/L at 45 DAS followed by • Spiromesifen 22.9 SC @1ml/L + Lambda cyhalothrin 5 EC @1ml/L at 60 DAS followed by • Fenvalerate 20 EC @ 1ml/L at 75 DAS .
M₄	• Triazophos 40 EC @ 2ml/L at 15 DAS followed by • Fenvalerate 20EC @ 1ml/L at 30 DAS followed by • Quinalphos 25 EC @ 2ml/L+ Spiromesifen 22.9 SC @1ml/Lat 45 DAS followed by • Fenpropathrin 30 EC @ 0.35 ml/L at 60 DAS followed by • Lambda cyhalothrin 5 EC @1ml/L at 75 DAS .
M₅	• Soil application of neem cake @250kg/ha at time of sowing • Installation of yellow sticky trap at 15 DAS (30x15cm size of foam sheet) at 2 opposite corner along crop canopy and 15 cm above crop canopy • Thiamethoxam 25 WG @ 0.2g/L at 30 DAS followed by • Fenpropathrin 30 EC @ 0.35ml/L at 45 DAS followed by • Lambda cyhalothrin 5 EC @1ml/L at 60 DAS followed by • Triazophos 40 EC @ 2ml/L + Dicofol 18.5 EC @ 2.7ml/L at 75 DAS.
M₆	• Seed treatment with imidacloprid 48 FS @ 9ml/kg seed

	• Soil application neem cake @250kg/ha at time of sowing • Installation of yellow sticky trap at 15 DAS (30x15cm size of foam sheet) at 2 opposite corner along crop canopy and 15 cm above crop canopy • Cypermethrin 25 EC @ 0.4ml at 30 DAS followed by • Triazophos 40 EC @ 2ml/L at 45 DAS followed by • Fenpropathrin 30 EC @ 0.35ml/L at 60 DAS followed by • Acephate 75 SP @ 1.6g/L+ Spiromesifen 22.9 SC @1ml/Lat 75 DAS.
M₇	• Seed treatment with imidacloprid 48 FS @ 9ml/kg seed • Soil application neem cake @250kg/ha at time of sowing • Installation of yellow sticky trap at 15 DAS (30x15cm size of foam sheet) at 2 opposite corner along crop canopy and 15 cm above crop canopy • Cypermethrin 25 EC @ 0.4ml + Dimethoate 30EC @ 2ml/L at 30 DAS followed by • Fenpropathrin 30EC @ 0.35ml/L at 45 DAS followed by • Ethion 50 EC @ 2.5ml/L + Quinalphos 25 EC @ 2ml/L at 60 DAS followed by • Lambda cyhalothrin 5 EC @1ml/L at 75 DAS
M₈	• Untreated control

3.7 Method of application of treatments

3.7.1 Preparation of traps:-

Foam sheet of 15cm x30 cm was used as material for preparing traps. The golden yellow colour was applied on traps. Castor oil was used as the sticky material for trapping of the insect fauna. Wet cotton cloth swab was used for washing the trap at an interval of 7 days. A border of 2 cm width (white portion) was kept for the purpose of handling of the traps without disturbing sticky material.

3.7.2 Installation of sticky traps

Yellow sticky trap (size 15cm x 30cm) erected in okra crop @ one / plot along crop canopy and 15 cm height above the crop canopy as per treatment 15 days after emergence of the crop. Yellow colour sticky traps were placed diagonally (NE & SW direction wise) in the Okra crop along crop canopy and 15 cm above the height of crop and 20cm away from the centre



Summer field View 2014-15



Kharif Field View 2015-16

Plate 1 Field view of experiments

of plant so as to attract (capture) maximum number of insects in the plot and not stuck to the plant. The trap height were adjusted once in week and ensure the trap height with reference to average plant height as per treatment. Yellow sticky trap were installed in M1, M3, M5, M6 and M7 modules.

3.8 Preparation and application of spray solution.

3.8.1 Soil application of treatments:-

Neem cake @ 250 kg/ha was applied as soil application before sowing in module M1, M5, M6 and M7 as per treatment schedule during both the seasons. summer 2014-15 and *kharif* 2015-16.

3.8.2 Seed treatment application:-

Seed treatment with imidacloprid 48 FS @ 9 ml / kg seed was given during both the seasons in M2,M6 and M7.modules

3.8.3 Application of azadirachtin

Spraying of azadirachtin 10,000 ppm @ 5ml/lit was undertaken at 15 days interval. First application of azadirachtin commenced from 15 days after sowing of crop and continued up to 75 days after sowing. In all five sprays were undertaken for the management of major pests of okra in module M1.

3.8.4 Preparation of Insecticidal spray solution.

The spray solutions of insecticide desired concentrations were freshly prepared every time at the site of experimentation just before the start of spraying operations The quantity of spray material required was prepared for coverage of crop. It was gradually increase as the crop growth advances.

In order to prepare the spray liquid of desired concentration, the following formula was used.

$$V = \frac{C \times A}{\% \text{ a.i.}}$$

Where,

- V = Quantity of commercial insecticide required (ml)
- C = Concentration of spray solution (%)
- A = Quantity of water (ml)
- % a.i. = Active ingredient of commercial insecticide (%)

Table : 1a Details of insecticides

Sr. No.	Common name	Formulation	Trade name	Chemical name	Source of Supply
1	Azadirachtin	(10,000 ppm)	Econeem plus	Azadirachtin in crude form	Margo, Biocontrol,Pvt. Ltd., Bangalore
2	Imidacloprid	48 % FS	Gaucho 600 FS	1-[(6-chloro-3-pyridinyl)methyl]- <i>N</i> -nitro-2-imidazolidinimine	M/S. Bayer Crop science Ltd., Mumbai
3	Thiamethoxam	25 % WG	Actara	3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl- <i>N</i> -nitro-4 <i>H</i> -1,3,5-oxadiazin-4-imine	Syngenta , India Ltd. Mumbai.
4	Acephate	75% SP	Tata Asataf	O,S-Dimethyl acetylphosphoramidothioate .	Rallis India Ltd. Mumbai.
5	Quinalphos	25 EC	Vazra 25	O,O-diethyl O-2-quinoxaliny phosphorothioate	Cheminova India Pvt. Ltd. Gujrat
6	Triazophos	40% EC	Triazocel	O,O-diethyl O-(1-phenyl-1 <i>H</i> -1,2,4-triazol-3-yl) phosphorothioate	Excel Crop Care, Limited Gujrat
7	Fenpopathrin	30% EC	Meothrin	cyano (3-phenoxyphenyl) methyl 2,2,3,3-tetramethylcyclopropanecarboxylate	Sumitomo Chemicals India Pvt.Ltd., Mumbai

8	Cypermethrin	25% EC	Cymbush	(<i>RS</i>)- α -cyano-3-phenoxybenzyl (1 <i>RS</i> ,3 <i>RS</i> ;1 <i>RS</i> ,3 <i>SR</i>)-3-(2,2- dichlorovinyl)-2,2- dimethylcyclopropanecarboxylate	Rallis India Ltd. Mumbai
9	Lambda Cyhathrin	5% EC	Lakshya	(<i>R</i>)-cyano(3-phenoxyphenyl)methyl (1 <i>S</i> ,3 <i>S</i>)- <i>rel</i> -3-[(1 <i>Z</i>)-2-chloro-3,3,3- trifluoro-1-propen-1-yl]-2,2- dimethylcyclopropanecarboxylate	Advance Pesticides, Nasik
10	Dicofol	18.5 EC	Difol or kelthane	2,2,2-trichloro-1,1-bis (4- chlorophenyl) ethanol	Sulphur Mills Limited , Mumbai.
11	Spiromesifen	22.9% SC	Oberon	2-oxo-3-(2,4,6-trimethylphenyl)-1- oxaspiro[4.4]non-3-en-4-yl 3,3- dimethylbutanoate	Bayer crop science Jammu (J&K)
12	Fenvalerate	20 EC	Fenval	cyano(3-phenoxyphenyl)methyl 4- chloro- α -(1-ethylethyl)benzene acetate	Isagro (Asia) Agrochemicals Pvt. Ltd. Gujrat.
13	Ethion	50 EC	Mit-505	<i>S,S'</i> -methylene bis(<i>O,O</i> -diethyl phosphorodithioate)	Shwal Corporation Ltd. Worli, Mumbai.
14	Dimethoate	30% EC	Tafgar	<i>O,O</i> -dimethyl <i>S</i> - methylcarbamoylmethyl phosphorodithioate	Rallis Tata enterprises , Mumbai

3.8.2 Detail of spraying treatment:

Sr. No.	Foliar Spray	Summer 2014-15	Kharif 2015-16
		Date of foliar spray	Date of foliar spray
1	First	19/2/2015	26/07/2015
2	Second	6/3/2015	10/08/2015
3	Third	21/3/2015	24/08/2015
4	Fourth	4/4/2015	08/09/2015
5	Fifth	19/4/2015	23/09/2015

3.9 Method of recording observations for management of pests :

3.9.1 Observations of sucking pest and natural enemies

The experiment was conducted in RBD with eight modules replicated thrice. Pre treatment observation were taken 24 hrs before spray and post treatment observation were recorded at 3, 7 and 14 days after each spraying on randomly selected 5 plants per plot. For observation on sucking pest particularly, nymphal population of aphids, leafhopper, thrips and population of adult whitefly were recorded on 3 leaves (top, middle and bottom canopy of the plant) per plant. Observation on nymph and adult of red spider mite was recorded from 3 leaves (Top, Middle and Bottom) at 3, 7 and 14 DAS on five randomly selected plants per plot after each spraying. The natural enemies like ladybird beetles, chrysopa and spider were recorded on whole plant on 5 randomly selected plant per plot at 3, 7 and 14 days after each spraying.

3.9.2 Shoot and fruit Borer

Mechanical clipping of shoot damage by fruit borer from onset of incidence was done at weekly interval up to first picking of okra in module M1. Observation for shoot and fruit borer infestation in initial stages at 15 and 30 days after sowing and up to first picking was recorded on the basis of number of plants infested by shoot and fruit borer. For this purpose, total number of healthy plants and total number of damage plant infested by shoot and fruit borer were recorded in each plot. On this basis, per cent infestation of shoot and fruit borer was work out and subsequently

during each picking number of fruit damage by *E.vittella* and *H.armigera* and healthy fruits were counted on number basis and weight basis. Accordingly per cent fruit borer infestation was worked out.

3.9.3 Observation of sucking pests and yellow sticky traps

First count of sucking pest population such as aphids, leafhopper, thrips and whitefly were recorded 7 days after installation of colour sticky traps in field and subsequent counts were recorded at weekly interval up to 100 day old crop. Adult insect observed on sticky trap were wiped out for removal of sticky material with trapped insect with wet cotton swab every times. The sticky material was smeared again on the trap for trapping of new pests. Cumulative total of sucking pests trapped on NE, SW direction and both sides of trap together were worked out on the basis of average of all counts every time at an weekly interval.

3.9.4 Abundance of major pests on okra in Summer and *Kharif* season

In addition to above, separate plot was sown for recording observation on seasonal abundance of major pest, YMV and natural enemies of okra during Summer 2014-15 and *Kharif* season 2015-16. Observation on sucking pests viz. aphid, leafhopper, whitefly, thrips and mites were recorded on (top, middle and bottom canopy) three leaves per plant on randomly selected ten plants in separate plots. Observations on natural enemies (viz, LBB, chry and spider) were also recorded per plant from randomly selected ten plants. Similarly shoot and fruit borer infestation were recorded at 15 and 30 days after sowing. Fruit borer infestation was also recorded at weekly interval on the basis of fruit damage by *E.vittella* and *H.armigera* separately from ten randomly selected plants in plots. In addition to this, observation of YMV disease was also recorded at weekly interval from whole plant per plot and percentage incidence of YMV was worked out.

3.9.5 Observation of yellow vein mosaic disease

Incidence of Yellow Vein Mosaic disease was recorded at weekly interval from 25 days after sowing on the basis of number of plant infected and healthy plant per plot and percentage of YMV disease was

work out.

3.10 Yield and economics

3.10.1 Yield of fruit okra

Yield data of healthy okra fruits (marketable) were plucked at each picking. Yield data was obtained from all pickings from net plot was recorded. Total yield of okra (marketable) fruit obtained from all pickings from each net plot was converted in quintal per hectare.

3.10.2 Incremental cost benefit ratio

Incremental cost benefit ratio (ICBR) is a major parameter to be taken into consideration for comparing the different treatments to sort out the most economical one. ICBR is the ratio between net profit and expenditure on treatment application. Net monetary returns were based on increase in okra fruit yield over control (Rs/ha). The cost of plant protection included treatment cost and labour charges. The net monetary returns were calculated at the prevailing market rates for okra fruit declared by State Government during the period of experimentation in order to evaluate cost of different modules against major pests of okra.

3.11 Ancillary data

Spraying operation were undertaken at an interval of 15 days from 15 DAS to 75 DAS. Spraying were undertaken at 15, 30, 45, 60, 75, days after sowing (DAS) according to various modules. Observation on phytotoxic effect on okra plant and fruits were recorded at 1,3 and 5 days interval after each spraying.

As the incidence of Dusky Cotton Bug was suddenly observed on 86 days after sowing during summer 2014-15 on okra crop. Hence the ancillary data on no. of DCB observation was also recorded at 10cm/twig/plant on five randomly selected plants per plot at an interval of seven days until the appearance of this pests.

3.12 Persistence Toxicity of different insecticides against okra leafhopper (*Amrasca biguttula biguttula*)

3.12.1 Raising of Test Insect

Prior to conduct of experiment on residual toxicity of different insecticides on okra leafhopper (test insect) the initial culture was raised from the nymphs of leafhopper collected from the untreated field on okra plants and colonized on okra plants which were raised in the green house under caged conditions.

The nymphal instars for bioassay were collected from F1 generation of field population.

3.12.2 Raising of Test Plants

Okra plants were raised in 20 cm X 12 cm sized polythene bags (1 plant in 1 bag) up to the age of 30 days.

3.12.3 Treatments and Design

The bioassay of leafhopper with different insecticides used for this experiment followed CRD design. The insecticides and dosage used in the bioassay were mentioned below.

Table : 1b Dosages of different insecticides tested for residual toxicity against Cotton leafhopper

S.No	Insecticide	Dosage (ml or g/l)
1	Thiamethoxam 25 WG	0.2g/L
2	Quinalphos 25 EC	2ml/L
3	Lambda cyhalothrin 5 EC	1ml/L
4	Acephate 75 SP	1.6g/L
5	Dimethoate 30 EC	2ml/L
6	Triazophos 40 EC	2ml/L
7	Cypermethrin 25 EC	0.4ml
8	Fenvalerate 20 EC	0.1ml/L

3.12.4 Preparation of Spray Fluid

A measured quantity of insecticidal solution / powder was mixed with a little quantity of water and stirred well, after that remaining quantity of water was added to obtain the required concentration of spray fluid.

3.12.5 Application of Spray Fluid

Ganesh Pneumatic sprayer was used. Sprayer and accessories were thoroughly washed before changing the insecticides and also rinsed with the spray fluid of the chemical to avoid contamination

3.12.6 Bioassay of Leafhopper with Insecticides

The required dose of each insecticide was prepared and spraying was done on potted plants. The bottoms of the treated plants are covered with circular disc like blotting papers and the entire plants were secured in open top plastic bottles individually. Twenty nymphs of third instar leafhoppers were released with the help of aspirator on each treated plant. After the release of the insect, the top of the plastic bottle was tightly wrapped with muslin cloth to prevent escape of test insects and to facilitate proper aeration. The bioassay was carried out by releasing freshly collected leafhoppers from the initial culture on 30 days old plants at 1,3,7,10,14 and 21, days after treatments on the same potted plant of the respective insecticide.

3.12.7 Relative persistence values of insecticides

The procedure by Saini (1959) and elaborated further by Pradhan (1967) and Sarup *et al.*, (1970) were utilized. After compilation of the data on mortalities corrected percentage mortalities for each treatments were calculated as per Abbott formula (1925) and used for further computation of persistent toxicity values. The values of corrected percentage mortalities at various specified periods were added. This sum was then divided by number of observations to obtain an average percent mortality (T). The product (PT) of average per cent mortality (T) and the period (P) of toxicity in days was used as an index of persistent toxicity (PTi). The persistent toxicity of each insecticide was worked out as per the criteria suggested by Pradhan and

Venkatraman (1962) in which PT (Persistent Toxicity) was taken as an index i.e,

$$PT_i = P \times T$$

Where,

PT_i - Persistent Toxicity index

P -The period for which some toxicity observed (time in days up to which some mortality observed)

T - Average per cent mortality (mean corrected per cent mortality of the period P).

3.12.7 Observations Recorded

Observations were recorded on number of dead and live nymphs after 24 hours of release for all the duration of bioassay (i.e.1, 3, 5, 7, 10, 14 and 21 one days after treatment) which was replicated thrice for each insecticide. Data was subjected to probit analysis by using statistical package. LT50 values of test insecticide were calculated and assessed the residual toxicity of respective insecticide by using Abbott formula.

3.13 Statistical analysis

The data on population counts i.e. observations on aphids, leafhopper, thrips, whiteflies, mites and natural enemies i.e. lady bird beetle, *chrysoperla* and spider and per cent infestation of fruit borer etc. were subjected to square root or $X+0.5$ value transformation before statistical analysis (Gomez and Gomez (1984). Data recorded during Summer 2014-15 and *kharif* 2015-16 were pooled and analysed.

3.14 Meteorological data

Weekly meteorological data for Summer 2014-15 and *Kharif* season during 2015-16 on maximum and minimum temperature, relative humidity (morning and evening), rainfall, rainy days and sunshine hours, during the crop season was obtained from Agricultural Meteorological Observatory, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Appendices).

CHAPTER IV

RESULTS AND DISCUSSION

Okra or Lady's finger (*Abelmoschus esculentu* (L.) Monech) is one of the favourable vegetable crops of India. It is well known for its high nutritive value and medicinal use. It is good source of vitamin A, B, C and is also rich in protein, minerals and iodine okra (*A.esculentus* L. Monech), is an economically important vegetable crop grown in tropical and subtropical parts of the world.

It is grown commercially in India, okra plants are attacked by a number of insect pests at different growth stages. Okra is ravaged by many insect pests right from germination to harvest. These pests are major constraints in getting higher yields. The crop suffers from as many as 72 species of insect pests, which includes sap suckers, leaf suckers, leaf eaters, fruit borers, leaf rollers, flower feeders and leaf miners, which are responsible for low yield in crop.

Among them pests like aphids, leaf hopper and whiteflies causing considerable damage to the crop and result in heavy yield loss. Okra growers depend on chemical insecticides to combat sucking pests. At least on an average 3-4 sprays are required against sucking pests. Continuous and indiscriminate use of synthetic insecticides resulted in resistance development to these insecticides.

Among different constraints that limit the yield of Okra in India, insect pests are considered to be the most serious. Among the various insect pests like aphid, leafhopper, thrips whitefly and mites are the major sucking pests of okra and fruit borer which directly limiting the profitable cultivation. The severe infestation of sucking pests resulted in the yellowing of leaves which inhibit the growth and development of plant and ultimately the plant dried due to loss of cell sap. However, sucking insect pests causes damage throughout the crop period with considerable losses in yield. Similarly whitefly *Bemisia tabaci* causes yellow vein mosaic directly in okra which causes 63% yield losses (Krishna reddy et.al,2003) .

The fruit and shoot borers, *Earias* spp. cause more serious damage to the crop by boring into tender shoots, floral buds and developing fruits as a result tender shoots dry up and droops down, heavy shedding of flower buds occur at the early growth stages. The infestation on the developing fruits results in poorly developed and deformed pods with staining of seeds. These alone causes damage ranging from 52.33 to 70.75 per cent (Pareek and Bhargava, 2003). In general overall damage due to insect pest amounts to 48.97 per cent loss in pod yield (Kanwar and Ameta, 2007).

Although, many workers have recommended the several pesticides for management of these pests. They could not be effectively solved. Moreover due to the continuous use of same insecticide or same group of chemical pesticides, the problems like development of resistance in targeted species; harmful residues in the commodity to be consumed have arisen. Considering the above facts, present investigation was conducted to minimize the use of pesticides, residues level in final commodity, availability of relatively safer vegetable fruits for human consumptions and to find cost effective suitable, feasible and relatively ecofriendly modules against major pest of Okra.

Observations on 24 hrs before first spray as pre treatment observation were undertaken for sucking pests like aphid, leafhopper, thrips, whitefly and mites. Observations on population of aphids, leafhopper, thrips, whitefly, mites and predator *i.e.* lady bird beetle, chrysoperla, and spider were recorded at 3, 7 and 14 days after each treatment spray. Similarly per cent infestation of fruit borer were recorded at each picking.

The findings in the present investigations on different aspects of insect pests associated with okra are reported and discussed in this chapter with previous work done by other workers in this regard under following heads.

The treatments consisting of eight module in which, seed treatment, soil application YST, foliar spraying started from 15 days after sowing were undertaken as per schedule so as to protect crop from sucking pests and fruit borer. Overall 4 to 5 sprays were applied in each module as per schedule. The treatments consisting of sticky traps of castor oil along crop

canopy and at 15 cm above crop canopy in combination with spraying in 5 modules viz. M1, M3, M5, M6 and M7 were evaluated against sucking pests of okra. Observations on trapped sucking pests on sticky trap were recorded at weekly interval. The cost economics of each treatment was also worked out.

The experiment was conducted on the field of Department of Chilli and Vegetable Research Unit, Dr. PDKV, Akola, Maharashtra during the Summer and *kharif* season of 2014-15 and 2015-16

The data thus obtained were subjected to statistical analysis after appropriate transformation and are presented in Table 2 to 60. The observations and their findings are discussed herewith under different heads.

4.1.1 Effect of various modules on mean population of aphids

/leaf/plant on okra during summer 2014-15.

4.1.1.1 Pre-treatment observation (24 hrs before spray) on aphids/ leaf

The data presented in Table 2 showed that data on the incidence of aphid 24 hours before first spray during summer 2014-15 were found statistically non-significant.

However, incidence of aphids in various treatments was found in the range of 0.00 aphids/leaf in module M1 to 0.31 aphids/leaf in module M4.

4.1.1.2 Mean aphid population at 3 days after spray.

The data pertaining Table 2 and depicted in Fig 2 to effect of various modules on cumulative mean population of aphids on okra during summer 2014-15 at 3 days after spray was found to be statistically significant. The treatment module M7 was found significantly superior over, M4, M2 and M8 modules in recording minimum incidence of aphids (1.93/leaf) and was statistically at par with M5 (2.11/leaf), M6(2.21/leaf), M3 (2.52/leaf) and M1 module (2.76/leaf). Second best effective modules M5 was found statistically at par with M6, M3, M1 and M4 (2.87/leaf) and superior over rest of the treatments.

However, module M2 (3.70/leaf/aphids) was found in effective which was statistically at par with module M4 and module M1. Maximum

incidence of 8.29 aphids/leaf was recorded in module M8 *i.e.* (Unprotected control)

4.1.1.3 Mean aphid population at 7 days after spray.

The data given in Table 2 and predicated in Fig 2 as regard to effect of various modules on cumulative mean population of aphids on okra during summer 2014-15 at 7 days after spray was found to be statistically significant. The Module M7 was found statistically at par with M5 (2.81 aphids/leaf) and module M6 (3.32 aphids/leaf) in recording minimum incidence of aphids (2.42 aphids/leaf) and superior over all other remaining treatments. Second best effective module M5 was found statistically at par with M6 and M3 (3.84aphids/leaf) and superior over rest of the treatments except module M7.

Next effective module in order of merit M6 was found statistically at par with M3 (3.84 aphids/leaf), M1(4.03 aphids/leaf) and M4 (4.18 aphids/leaf) and superior over M2 and M8. Module M2 was found least effective in recording comparatively minimum incidence of (5.22 aphids/leaf) which in turn was found statistically at par with module M4 and M1.

Maximum incidence of aphids 8.83 aphids/leaf was recorded in module M8 (Untreated control).

4.1.1.4 Mean aphid population at 14 days after spray.

The data pertaining to Table 2 and depicted Fig 2 effect of various modules on cumulative mean population of aphids on okra during summer 2014-15 at 14 days after spray was found to be significant. The Module M7 was found significantly superior over module M2 and M8 in recording minimum incidence of aphids (4.67/leaf) and it was statistically at par with M5 (4.86 aphids/leaf), M6 (5.31 aphids/leaf) M1(5.90aphids/leaf) and M3 (5.83aphids/leaf) and M4 (6.17 aphids/leaf). Second best modules M1&M3 were found statistically at par with module M4 (6.17aphids/leaf) & M2 (7.17aphids/leaf). Maximum incidence of 9.23 aphid/leaf was recorded in module M8 which in turn was statistically at par with module M2 (7.17 aphids/leaf).

4.1.1.5 Cum.mean population of aphids.

The data presented in Table 2 and depicted in Fig 2 as regard to the effect of various modules on cumulative mean population of aphids based on five sprays was found to be statistically significant. The module M7 was found statistically at par with M5 (3.26 aphids/leaf) and M6 (3.61 aphids/leaf) in recording minimum incidence of 3.01 aphids/leaf and superior over all other remaining modules. The next best effective module M6 (3.61 aphids/leaf) was found statistically at par with M3 (4.06 aphids/leaf), M1 (4.20 aphids/leaf) and M4 (4.41 aphids/leaf) and superior over M2 and M8. The module M2 was found least effective in recording (5.36 aphids/leaf) and superior to M8. Maximum incidence of 8.78 aphids/leaf was recorded in module M8 (Unprotected control).

Table: 2 Effect of various modules on cumulative mean population of aphids on okra during summer 2014-15

Tr. No.	Treatment details	Cum. Mean aphids population / leaf				Cum. pooled mean
		Pre-treat. obs.	3 DAT	7 DAT	14 DAT	Based on five spray
M ₁	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	2.76 (1.64)	4.03 (2.00)	5.90 (2.41)	4.23 (2.06)
M ₂	ST,Dim, Quin, Fenpo,Dico+Quin.	0.01 (0.71)	3.70 (1.91)	5.22 (2.29)	7.17 (2.67)	5.36 (2.31)
M ₃	YST,Ace ,Quin, Fenpo, Spi+Lam,Fenv.	0.25 (0.86)	2.52 (1.59)	3.84 (1.96)	5.83 (2.41)	4.06 (2.02)
M ₄	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.31 (0.88)	2.87 (1.69)	4.18 (2.04)	6.17 (2.48)	4.41 (2.10)
M ₅	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.01 (0.71)	2.11 (1.45)	2.81 (1.67)	4.86 (2.20)	3.26 (1.80)
M ₆	ST,SA,YST,Cyper,Tria,Fenpo,Ace+ Spir	0.01 (0.71)	2.21 (1.48)	3.32 (1.82)	5.31 (2.29)	3.61 (1.90)
M ₇	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin, Lamb.	0.01 (0.71)	1.93 (1.38)	2.42 (1.55)	4.67 (2.16)	3.01 (1.73)
M ₈	Untreated control	0.28 (0.87)	8.29 (2.88)	8.83 (2.96)	9.23 (3.03)	8.78 (2.96)
	SE (m)±	0.07	0.09	0.10	0.12	0.06
	CD at 5%	NS	0.28	0.31	0.37	0.20
	CV%	16.02	9.21	8.63	8.59	5.38

N.B: Figures in parenthesis are square root transformation

4.1.2 Effect of various modules on mean population of aphids /leaf/ plant during *Kharif* 2015-16

4.1.2.1 Pre-treatment observation (24 hrs before spray) on aphids/ leaf

The data presented in Table 3 showed that data on the incidence of aphid 24 hours before first spray during *kharif* 2015-16 were found statistically non-significant.

However, incidence of aphids in various treatments was found in the range of 6.00 aphids/leaf in module M7 to 8.93 aphids/leaf in module M8.

4.1.2.2 Mean aphid population at 3 days after spray

The data presented in Table 3 and depicted in Figure 2 pertaining to effect of various module on cumulative mean population on okra during *kharif* 2015-16 at 3 days after spray was observed to be statistically significant. All the treated modules were found to be significantly superior over untreated module. The lowest population of aphids was recorded in treated module M7 (2.90/leaf) followed by M5 (4.03/leaf) and M3 (4.26/leaf) and these treatments were found to have statistically similar effect. Of these, the module M7 was found to be significantly superior over the remaining treated modules and module M5 and M3 although were next promising modules against aphids but they were found to be statistically at par with rest of the treated module viz. M6 (4.38 aphids/leaf), M4 (4.78aphids/leaf), M1 (5.01aphids/leaf) and M2 (5.22aphids/leaf) whereas the maximum aphid population was noticed in untreated control module M8 (12.40 aphids/ leaf).

4.1.2.3 Mean aphid population at 7 days after spray

The data presented in Table 3 and depicted in Fig 2 revealed that the effect of various modules on aphid population at 7 days after spray was found to be statistically significant. All the treated modules were found to be significantly superior over untreated module. The lowest aphid population was recorded in module M7 (3.91/leaf) and it was followed by M5 (4.74/leaf) and both the treatments were found to be statistically similar effective. The treated module M5 was observed to be further at par with M3 (5.40 aphids/leaf), M6, (5.48 aphids/leaf), M4,(6.22 aphids/leaf), M2 (6.29 aphids /leaf). The M1 had noticed aphid population to the tune of 6.40/leaf and it has

shown equal effect to those of M3, M6, M4 and M2. The module M8 had shown the maximum incidence of aphids(13.24/leaf).

4.1.2.4 Mean aphid population at 14 days after spray.

From the data presented in Table 3 and depicted in Fig 2 revealed that the results were found to be statistically significant. All the treated modules were found to be significantly superior over untreated module. The module M7 had accounted the lowest population of aphids (5.58/leaf). It was followed by M5 (6.46 aphids/leaf), M3 (6.66 aphids/leaf) and M6 (6.88 aphids/leaf) and these four module were found to be statistically at par with each other. The treated module M1, M2 and M4 exhibited aphid population to the tune of 7.63 7.64 and 7.70 aphids/leaf, respectively and they were found to be statistically at par M5, M3 and M6 However, the module M8 noticed the maximum incidence population of aphids (14.87/leaf).

Table: 3 Effect of various modules on cumulative mean population of aphids on okra during *kharif* 2015-16

Tr. No.	Treatment details	Cum. Mean aphids population / leaf				Cum. pooled mean
		Pre-treat. obs. Before 24 hrs	3 DAT	7 DAT	14 DAT	Based on five spray
M ₁	SA.YST,Azadirachtin 1%w/w	7.33 (2.70)	5.01 (2.23)	6.40 (2.52)	7.63 (2.76)	6.35 (2.52)
M ₂	ST, Dim.,Quin, Fenpo,Dico+Quin.	6.38 (2.51)	5.22 (2.28)	6.29 (2.51)	7.64 (2.76)	6.38 (2.52)
M ₃	YST,Ace, Quin Fenpo, Spi+Lam,Fenv.	8.52 (2.92)	4.26 (2.06)	5.40 (2.32)	6.66 (2.57)	5.44 (2.33)
M ₄	Tria, Fenv, Quin+Spir, Fenpo,Lamb	7.52 (2.73)	4.78 (2.18)	6.22 (2.49)	7.70 (2.77)	6.23 (2.49)
M ₅	SA,YST,Thia, Fenpo,Lamb, Tria+Dico	7.20 (2.64)	4.03 (2.00)	4.74 (2.18)	6.46 (2.53)	5.08 (2.25)
M ₆	ST,SA,YST,Cyper,Tria, Fenpo,Ace+Spir	7.10 (2.66)	4.38 (2.09)	5.48 (2.34)	6.88 (2.62)	5.58 (2.36)
M ₇	ST,SA,YST,Cyper+Dim., Fenpo,Ethion+Quin., Lamb.	6.00 (2.45)	2.90 (1.70)	3.91 (1.98)	5.58 (2.35)	4.13 (2.03)
M ₈	Untreated control	8.93 (2.99)	12.40 (3.51)	13.24 (3.62)	14.87 (3.85)	13.50 (3.66)
	SE (m)±	0.36	0.12	0.10	0.12	0.09
	CD at 5%	NS	0.37	0.33	0.39	0.27
	CV%	23.08	9.46	7.51	8.00	6.20

N.B: Figures in parenthesis are square root transformation

4.1.2.5 Cum. mean population of aphids.

The cumulative mean data presented in Table 3 and depicted in Fig 2 showed that the data on effect of various modules against aphid population were found statistically significant. All the treated modules were found to be significantly superior over untreated module. The lowest population of aphids was observed in module M7 (4.13/leaf) and it was statistically at par with module M5 (5.08/leaf).

The next best treatment module M5 was found to be further statistically at par with M3 (5.44aphids/leaf), M6 (5.58 aphids/leaf), M4 (6.28 aphids/leaf), M1 (6.35aphids/leaf), M2 (6.38 aphids/leaf). The highest population at aphids was observed in module M8 (13.50/leaf).

4.1.3 Pooled effect of various modules on mean population of aphids /leaf/ plant

4.1.3.1 Pre-treatment observation (24 hrs before spray) on aphids/ leaf

The data presented in Table 4 showed that pooled mean data on the incidence of aphid 24 hours before first spray were found statistically non-significant.

However, incidence of aphids in various treatments was found in the range of 3.01 aphids/leaf in module M7 to 4.61 aphids/leaf in module M8.

4.1.3.2 Mean aphid population at 3 days after spray.

The data presented in Table 4 and depicted in Fig 2 revealed that the data on effect of various modules on aphid population at 3 days after spray were statistically significant. All the treated module were significantly superior over unprotected control (M8). The minimum aphid population was observed in module M7 (2.41/leaf) followed by M5 (3.07/leaf) and both the treatments were found statistically at par with each other. The module M5 was found further statistically at par with module M6 (3.30/leaf) and module M3 (3.39/leaf). The module M6 which were found to be statistically at par with module M4 (3.83/leaf) and module M1 (3.89/leaf). The module M2 had accounted the aphid population to the tune of 4.46/leaf and it had exerted the statistically similar effect to that of module M1 and M4. The unprotected control M8 observed the highest population of aphids(10.34/leaf).

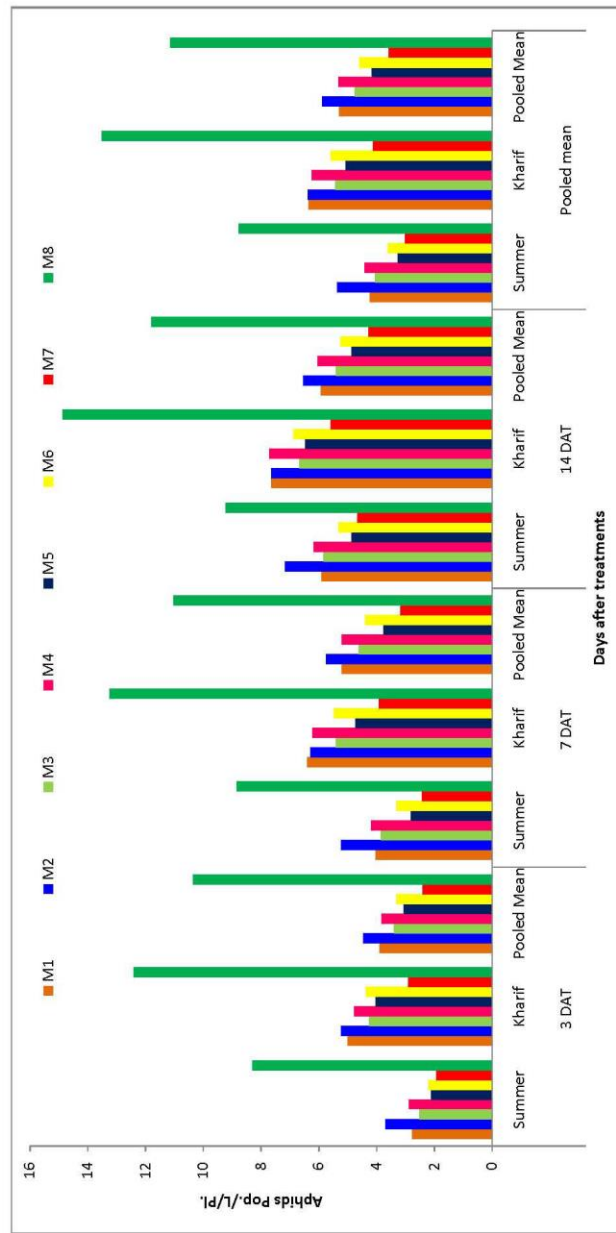


Fig. 2 Effect of various modules on comparative population of aphids on okra during summer 2014-15 and kharif season 2015-16

4.1.3.3 Mean aphid population at 7 days after spray

From the data presented in Table 4 depicted in Fig 2 all the treated module were significantly superior over untreated module. It was seen that the module M7 had registered the lowest aphid population (3.17/leaf) followed by the module M5 (3.77/leaf/aphid) and both the modules were statistically at par with each other and superior over rest of the modules. However module M5 was further statistically similar with M6 (4.40/aphids/leaf). The module M3 noticed aphid population of (4.62/leaf) showing statistically similar effectiveness to that of module M6 and superior over M4, M1, M2 and M8. Further it remained statistically at par with M4 (5.20), M1 (5.21) which were found further statistically at par with module M2 (5.75/aphids/leaf). The module M8 had shown the maximum incidence of aphids (11.03/leaf).

4.1.3.4 Mean aphid population at 14 days after spray

From the data presented in Table 4 and depicted in Fig 2 showed that data were found to be statistically significant. All the treated module were significantly superior over unprotected module (M8). The least population of aphid was recorded in module M7 (4.29/leaf) and it was found statistically at par with module M5 (4.86/leaf), M6 (5.25/leaf) and M3 (5.40/leaf). Of these module M5, M6 and M3 were further found to be statistically at par with M1 (5.93/leaf) and M4 (6.05/leaf). The treatment module M2 registered the aphid population to the extent (6.53/leaf) and appeared to be the statistically similar with M6, M3, M1 and M4. The untreated treatment i.e module M8 had recorded the maximum aphid population (11.80/leaf).

4.1.3.5 Pooled cum.mean population of aphids

It was observed from the data presented in Table 4 and depicted in Fig 2 that the results were found to be statistically significant. All the treated module were found significantly superior over unprotected control (M8). The treatment module M7 was found statistically superior over all other treatments recording the lowest aphid population (3.57/leaf). The second best module M5 noticed the aphid population to the tune of (4.17/leaf) and it was found

statistically at par with module M6 (4.60 aphids/leaf) and M3 (4.75aphids/leaf). The module M1, M4 and M2 observed the aphid population of 5.29, 5.32 and 5.87/leaf and remained statistically similar effective with Module M3 where as, module M8 had recorded the highest population of aphid (11.14/leaf).

It is clear from the above findings that module M7 was found significantly most effective in minimizing the population of aphids at 3,7 and 14 days after spraying. Next effective modules M5, M6 and M3 in second order of merit were found statistically equal among themselves at 3,7 and 14 days after spray. The module M2 was found least effective in minimizing the aphid population. It means that the module M7 was significantly most effective followed by module M5, M6 and M3 at 3, 7 and 14 days after spray. Module M2 was found least effective in minimizing the aphid population. Out of the sequential application of treatment in seven modules, module M7 was found most effective in minimizing the population of aphids during summer 2014-15 and *kharif* 2015-16 season because this module consists of seed treatment with Imidacloprid 48 FS, @ 9ml /kg soil application of neem cake @ 250kg/ha, Yellow sticky trap and sequential application of cypermethrin + dimethoate, fenpopathrin, ethion+quinalphos and lambda cyhalothrin and were applied to okra at 30,45,60 and 75 days after spraying. Further in this module there is a overall effect of synthetic pyrethroids + OP compound *i.e.* cypermethrin 25 EC @ 0.4ml/L + Dimethoate 30EC @ 2ml/L, as synthetic pyrethroids are having quick knock down effect and long residual action with systemic, stomach and contact action of dimethoate which played an important role as first application in module M7 to take care of aphids over other modules. Secondly aphid population was generally observed in initial growth stage of the okra crop.

Present findings are in confirmation with Rajashekhar et al. (2010) who reported that the module comprising of seed treatment with imidacloprid @ 3 g/kg seed + yellow sticky trap @ 25/ha and need base application of fipronil and neem oil efficacy reduced the aphid, Jassid and WF populations in okra. Bagade et.al. (2010) also reported that imidacloprid (0.004%) followed by cypermethrin (0.01%), was found promising in checking

Table:4 Effect of various modules on comparative population of aphids on okra during summer 2014-15 and *kharif* season 2015-16

Tr. No.	Treatment details	Pre.-treat. Obs. 24 hrs	3 DAT			7 DAT			14 DAT			Pooled mean		
			Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean
M1	SA.YST,Azadirachtin 1%w/w	3.67 (1.75)	2.76 (1.64)	5.01 (2.23)	3.89 (1.94)	4.03 (2.00)	6.40 (2.52)	5.21 (2.28)	5.90 (2.41)	7.63 (2.76)	5.93 (2.59)	4.23 (2.06)	6.35 (2.52)	5.29 (2.29)
M2	ST,Dim, Quin ,Fenpo, Dico+Quin.	3.19 (1.67)	3.70 (1.91)	5.22 (2.28)	4.46 (2.09)	5.22 (2.29)	6.29 (2.51)	5.75 (2.40)	7.17 (2.67)	7.64 (2.76)	6.53 (2.74)	5.36 (2.33)	6.38 (2.52)	5.87 (2.43)
M3	YST,Ace ,Quin Fenpo,Spi+Lam, Fenv.	4.05 (1.87)	2.52 (1.59)	4.26 (2.06)	3.39 (1.83)	3.84 (1.96)	5.40 (2.32)	4.62 (2.14)	5.83 (2.41)	6.66 (2.57)	5.40 (2.49)	4.06 (2.02)	5.44 (2.33)	4.75 (2.17)
M4	Tria, Fenv,Quin+ Spir,Fenpo,Lamb	3.92 (1.84)	2.87 (1.69)	4.78 (2.18)	3.83 (1.93)	4.18 (2.04)	6.22 (2.49)	5.20 (2.28)	6.17 (2.48)	7.70 (2.77)	6.05 (2.63)	4.41 (2.10)	6.23 (2.49)	5.32 (2.30)
M5	SA,YST,Thia,Fenpo, Lamb,Tria+Dico	3.61 (1.74)	2.11 (1.45)	4.03 (2.00)	3.07 (1.72)	2.81 (1.67)	4.74 (2.18)	3.77 (1.92)	4.86 (2.20)	6.46 (2.53)	4.86 (2.37)	3.26 (1.80)	5.08 (2.25)	4.17 (2.03)
M6	ST,SA,YST,Cyper, Tria,Fenpo ,Ace+Spir	3.56 (1.59)	2.21 (1.48)	4.38 (2.09)	3.30 (1.78)	3.32 (1.82)	5.48 (2.34)	4.40 (2.08)	5.31 (2.29)	6.88 (2.62)	5.25 (2.46)	3.61 (1.90)	5.58 (2.36)	4.60 (2.13)
M7	ST,SA,YST,Cyper+ Dim.,Fenpo,Ethion+ Quin,, Lamb.	3.01 (1.62)	1.93 (1.38)	2.90 (1.70)	2.41 (1.54)	2.42 (1.55)	3.91 (1.98)	3.17 (1.76)	4.67 (2.16)	5.58 (2.35)	4.29 (2.25)	3.01 (1.73)	4.13 (2.03)	3.57 (1.88)
M8	Untreated control	4.61 (1.97)	8.29 (2.88)	12.40 (3.51)	10.34 (3.19)	8.83 (2.96)	13.24 (3.62)	11.03 (3.29)	9.23 (3.03)	14.87 (3.85)	11.80 (3.44)	8.78 (2.96)	13.50 (3.66)	11.14 (3.31)
	SE (m) _t	0.19	0.09	0.12	0.07	0.10	0.10	0.07	0.12	0.12	0.09	0.06	0.09	0.05
	CD at 5%	NS	0.28	0.37	0.19	0.31	0.33	0.19	0.39	0.38	0.28	0.19	0.27	0.14
	CV%	26.36	9.21	9.46	7.96	8.63	7.51	7.02	8.59	8.00	8.63	5.38	6.20	4.89

N.B: Figures in parenthesis are square root transformation

the population of aphids and jassids infesting okra. Findings are also in agreement with Boopathi et al. (2010) reported that he okra when sprayed on schedule base at an interval of 15 days. Result could not be compared for the want of literature on combination of cypermethrin+dimethoate against aphid. Jana et.al (2006) who reported that fenpropathrin 30 EC 0.1% was the most effective dose in reducing aphid population to 90% and gave maximum higher green chilli yield (95.16 q/ha), followed by fenpropathrin 0.75% and imidacloprid 0.025%.

4.2.1 Effect of various modules on mean population of leaf hopper/leaf/ plant during summer 2014-15

4.2.1.1 Pre-treatment observation (24 hrs before spray) on leafhopper / leaf

The data presented in Table 5 showed that data on the incidence of leafhopper 24 hours before first spray during summer 2014-15 were found statistically non-significant.

However, incidence of leaf hopper in various treatments was found in the range of 0.07 leafhopper/leaf in module M6 to 0.60 leaf hopper/leaf in module M8.

4.2.1.2 Mean Leafhopper/ population at 3 days after spray

It is evident from the data presented in Table 5 and depicted in Fig 3 that the result of the effect of various modules on the population of leaf hopper was found statistically significant. All the treated modules were significantly superior over unprotected module (M8). The module M6 had recorded the minimum population of leafhopper (3.27LH/leaf) followed by M7 (3.36 LH/leaf), M5(3.66 LH/leaf) and M4 (4.36 LH/leaf) and they were found statistically at par among themselves and superior over rest of the modules. Treatment module M3 (4.54 LH/leaf) and M2 (4.53 LH/leaf) were statistically equal effective with M7, M5, M4. The treatment M1(5.19 LH/leaf) had exerted statistically similar effect to those of treated module M4 and M3 and M2. The unprotected module (M8) had registered the maximum population of leaf hopper (6.88/leaf).

4.2.1.3 Mean Leafhopper population at 7 days after spray

It is observed from the data presented in Table 5 and depicted in Fig 3 that the results were statistically significant. All the treated modules were significantly superior over unprotected module (M8). The treatment module M7 (4.16 LH/leaf) had shown the least population of leafhopper followed by M6 (4.56 LH/leaf) and M3 (5.56 LH/leaf) and they were statistically at par with each other and superior over rest of the modules. Module M6 was further found statistically similar with M3 (5.56 LH/leaf), M5 (5.83 LH/leaf), M2 (6.03 LH/leaf) and M4 (6.09 LH/leaf). The treatment module M4 was further statistically at par with M1 (7.91 LH/leaf). The untreated module M8 had accounted the highest population of leafhopper (11.33 LH/leaf).

4.2.1.4 Mean Leafhopper population at 14 days after spray

From the data presented in Table 5 and depicted in Figure 3 indicated that the results were found statistically significant. All the treated modules were significantly superior over untreated control. The minimum population of leafhopper was registered in M6 (7.40/leaf) followed by M5 (7.86/leaf), M7 (8.39/leaf) and M2 (9.15/leaf) and these treatments were found statistically similar effective. Treatment module M7 and module M2 were found further statistically at par with M4 (10.84/leaf), M1 (11.05/leaf) and M3 (11.28/leaf) and superior over (M8). The highest population of leafhopper (16.12/leaf) was noticed in unprotected control (M8).

4.2.1.5 Cu. mean population of Leafhopper

The data of cumulative mean of leaf hopper population during summer 2014 – 15 is presented in Table 5 and depicted in Figure 3 revealed that the results were found statistically significant. All the treated modules were significantly superior over untreated module. The lowest population of leaf hopper (5.07/leaf) was recorded in M6, followed by module M7 (5.31 LH/leaf) and M5 (5.79 LH/leaf) and these treatments were found statistically at par among themselves and superior over rest of the treatments. The treatment module M2 (6.57 LH/leaf) had also shown the statistically similar effectiveness with earlier treatment modules M7 and M5 and this module M2 was further found to be statistically at par with module M4 (7.09/leaf), M3 (7.13/leaf) and

M1(8.05/leaf). The untreated module M8 had registered the maximum population of leafhopper (11.44/leaf).

Table: 5 Effect of various modules on cumulative mean population of leafhopper on okra during summer 2014-15

Tr. No.	Treatment details	Cum. Mean Leaf hopper population / leaf				Cum. pooled mean
		Pre-treat.obs. Before 24 hrs	3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	0.20 (0.82)	5.19 (2.28)	7.91 (2.81)	11.05 (3.32)	8.05 (2.84)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.13 (0.79)	4.53 (2.12)	6.03 (2.45)	9.15 (3.02)	6.57 (2.56)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.33 (0.90)	4.54 (2.12)	5.56 (2.36)	11.28 (3.36)	7.13 (2.67)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.33 (0.89)	4.36 (2.09)	6.09 (2.47)	10.84 (3.28)	7.09 (2.66)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.33 (0.91)	3.66 (1.91)	5.83 (2.41)	7.86 (2.80)	5.79 (2.41)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.07 (0.75)	3.27 (1.80)	4.56 (2.12)	7.40 (2.71)	5.07 (2.25)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin,, Lamb.	0.13 (0.79)	3.36 (1.83)	4.16 (2.02)	8.39 (2.90)	5.31 (2.30)
M8	Untreated control	0.60 (1.02)	6.88 (2.61)	11.33 (3.36)	16.12 (3.99)	11.44 (3.37)
	SE (m)±	0.09	0.10	0.11	0.17	0.09
	CD at 5%	NS	0.30	0.35	0.51	0.28
	CV%	18.70	8.25	8.01	9.17	6.11

N.B: Figures in parenthesis are square root transformation

4.2.2.3 Effect of various modules on mean population of leafhopper /leaf/ plant during *Kharif* 2015-16

4.2.2.1 Pre-treatment observation (24 hrs before spray) on leafhopper / leaf

The data presented in Table 6 showed that data on the incidence of leafhopper 24 hours before first spray during kharif 2015-16 were found statistically non-significant.

However, incidence of leafhopper in various treatments was found in the range of 0.07 leafhopper /leaf in module M7 to 0.17 leaf hopper/leaf in module M8.

Table: 6 Effect of various modules on cumulative mean population of leaf hopper on okra during *kharif* 2015-16

Tr. No.	Treatment details	Pre-tret.obs. before 24 hrs	Cum. Mean Leaf hopper population / leaf			Pooled mean
			3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	0.13 (0.79)	4.27 (2.06)	9.51 (3.08)	11.22 (3.35)	8.34 (2.89)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.07 (0.75)	3.36 (1.83)	7.21 (2.68)	9.86 (3.14)	6.81 (2.61)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.12 (0.78)	2.84 (1.68)	7.36 (2.70)	9.79 (3.13)	6.66 (2.58)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.16 (0.81)	2.87 (1.69)	5.84 (2.41)	9.41 (3.07)	6.04 (2.46)
M5	SA,YST,Thia, Fenpo, Lamb, Tria+Dico	0.13 (0.79)	2.63 (1.62)	5.16 (2.27)	7.78 (2.78)	5.19 (2.28)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.08 (0.76)	1.62 (1.27)	4.45 (2.11)	7.65 (2.76)	4.57 (2.14)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin,, Lamb.	0.07 (0.75)	1.41 (1.19)	4.90 (2.21)	7.91 (2.81)	4.74 (2.18)
M8	Untreated control	0.17 (0.81)	12.35 (3.50)	15.48 (3.93)	18.47 (4.28)	15.44 (3.92)
	SE (m) $\pm$	0.03	0.08	0.10	0.13	0.09
	CD at 5%	NS	0.26	0.32	0.41	0.28
	CV%	7.31	7.92	7.74	7.33	6.10

N.B: Figures in parenthesis are square root transformation

4.2.2.2 Mean Leaf hopper/ population at 3 days after spray

The data as regard to response of various treatment modules on the leafhopper population during *kharif* 2015- 16 at 3 days after spray as presented in Table 6 and depicted in Figure 3 revealed that the result were found statistically significant. All the treated modules were significantly superior over untreated module. The treatment module M7 had recorded the lowest population of leafhopper (1.41LH/leaf), followed by model M6 (1.62 LH /leaf) and they were found statistically at par with each other and both the treatments appeared to be statistically superior over the rest of the treatments. The treatment modules M5, M3, M4 and M2 were statistically

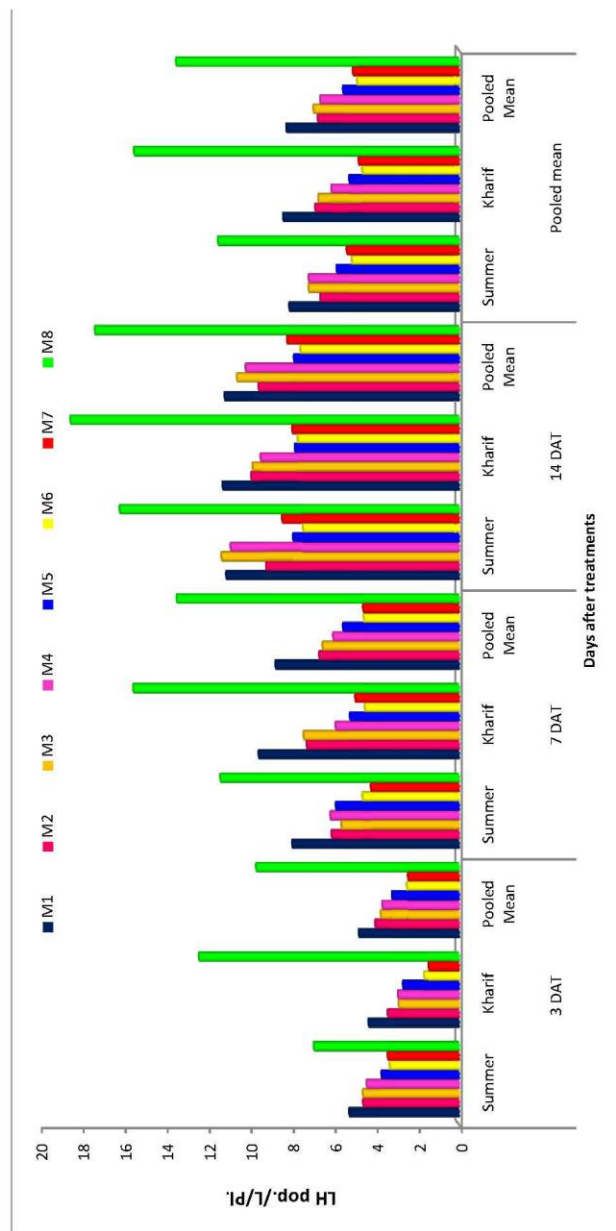


Fig. 3 Effect of various modules on comparative population of leaf hopper on okra during summer 2014-15 and kharif season 2015-16

similar effective showing the population of leafhopper to the extent of 2.63, 2.84, 2.87 and 3.36 leafhopper/leaf, respectively and superior over module M1 and M8. Of these, the later module (M2) was further found statistically at par with M1 (4.27 LH /leaf). The highest population of leafhopper was recorded in unprotected module M8 (12.35 LH /leaf).

4.2.2.3 Mean Leaf hopper population at 7 days after spray

From the data presented in Table 6 and depicted in Fig 3 it was observed that the results were found statistically significant. All the treated modules were significantly superior over untreated control. It is seen that the treatment module M6 had accounted the minimum population of leaf hopper (4.45/leaf), and was found statistically at par with the treatment modules M7(4.90 LH /leaf), Module M5 (5.16 LH /leaf) and module M4 (5.84 LH /leaf). Of these, treatments, module M4 was observed to be statistically at par with M2 (7.21 LH /leaf) and M3 (7.36 LH /leaf) whereas, the module M1 had noticed the population of leafhopper (9.51/leaf) and superior over module M8. The unprotected module M8 had observed the maximum leafhopper population (15.48 LH /leaf).

4.2.2.4 Mean Leaf hopper population at 14 days after spray

Form the data presented in Table 6 and depicted in Figure 3 it is revealed that the result were statistically significant. All the treated modules were significantly superior over untreated control. The minimum population of leaf hopper was noticed in the treatment module M6 (7.65/leaf) and it was followed by M5 (7.78LH/leaf),M7(7.91LH/leaf), M4 (9.41LH/leaf), M3 (9.79LH/leaf) and M2 (9.86LH/leaf) and all these treatments were found to be statistically at par among themselves. The treatment module M1 had registered the leaf hopper population to the tune of (11.22/leaf) which in turn was at par with module M4, M3 and M2.

The highest population of leafhopper was observed in module M8 (18.47LH/leaf).

Table: 7 Effect of various modules on comparative population of leaf hopper on okra during summer 2014-15 and *kharif* season 2015-16

Tr. No.	Treatment details	Pre-treat.obs. 24 hrs. before	3 DAT			7 DAT			14 DAT			Pooled mean		
			Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean
M1	SA.YST,Azadirachtin 1%w/w	0.16 (0.81)	5.19 (2.28)	4.27 (2.06)	4.73 (2.17)	7.91 (2.81)	9.51 (3.08)	8.71 (2.95)	11.05 (3.32)	11.22 (3.35)	11.13 (3.34)	8.05 (2.84)	8.34 (2.89)	8.19 (2.86)
M2	ST,Dim, Quin ,Fenpo,Dico+Quin.	0.10 (0.77)	4.53 (2.12)	3.36 (1.83)	3.95 (1.98)	6.03 (2.45)	7.21 (2.68)	6.62 (2.57)	9.15 (3.02)	9.86 (3.14)	9.51 (3.08)	6.57 (2.56)	6.81 (2.61)	6.69 (2.59)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	0.23 (0.84)	4.54 (2.12)	2.84 (1.68)	3.69 (1.90)	5.56 (2.36)	7.36 (2.70)	6.46 (2.53)	11.28 (3.36)	9.79 (3.13)	10.54 (3.24)	7.13 (2.67)	6.66 (2.58)	6.90 (2.62)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.25 (0.85)	4.36 (2.09)	2.87 (1.69)	3.61 (1.89)	6.09 (2.47)	5.84 (2.41)	5.96 (2.44)	10.84 (3.28)	9.41 (3.07)	10.12 (3.18)	7.12 (2.66)	6.04 (2.46)	6.57 (2.56)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.23 (0.85)	3.66 (1.91)	2.63 (1.62)	3.15 (1.77)	5.83 (2.41)	5.16 (2.27)	5.49 (2.34)	7.86 (2.80)	7.78 (2.78)	7.82 (2.79)	5.79 (2.41)	5.19 (2.28)	5.49 (2.34)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.08 (0.76)	3.27 (1.80)	1.62 (1.27)	2.45 (1.54)	4.56 (2.12)	4.45 (2.11)	4.50 (2.11)	7.40 (2.71)	7.65 (2.76)	7.52 (2.74)	5.07 (2.25)	4.57 (2.14)	4.82 (2.19)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.10 (0.77)	3.36 (1.83)	1.41 (1.19)	2.39 (1.51)	4.16 (2.02)	4.90 (2.21)	4.53 (2.12)	8.39 (2.90)	7.91 (2.81)	8.15 (2.85)	5.31 (2.30)	4.74 (2.18)	5.02 (2.24)
M8	Untreated control	0.38 (0.92)	6.88 (2.61)	12.35 (3.50)	9.62 (3.05)	11.33 (3.36)	15.48 (3.93)	13.41 (3.64)	16.12 (3.99)	18.47 (4.28)	17.30 (4.13)	11.44 (3.37)	15.44 (3.92)	13.44 (3.64)
	SE (m) $\pm$	0.06	0.10	0.08	0.07	0.11	0.10	0.09	0.17	0.13	0.14	0.09	0.09	0.09
	CD at 5%	NS	0.30	0.26	0.21	0.35	0.32	0.27	0.51	0.41	0.41	0.28	0.28	0.26
	CV%	16.78	8.25	7.92	8.69	8.01	7.74	8.46	9.17	7.33	10.65	6.24	6.10	8.01

N.B: Figures in parenthesis are square root transformation

4.2.2.5 Cu. mean population of Leafhopper

The cumulative data on leafhopper population as influenced by the various modules are presented in Table 6 and depicted in Fig 3 revealed that the result were statistically significant. All the treated modules were significantly superior over untreated module. The minimum population of leaf hopper was observed in module M6 (4.57/leaf), followed by module M7 (4.74/leaf) and module M5 (5.19/leaf) and these treatments were found to be statistically at par among themselves and module M6 was significantly superior over remaining treatment. Module M4 (6.04 /leaf) which was in turn found statistically as effective as M7 and M5. However, it was further statistically at par with M3 (6.66 LH/leaf) and M2 (6.81 LH/leaf) whereas, the treatment M1 was observed comparatively least effective (8.34 LH/leaf) and was found statistically similar with module M2. The unprotected module M8 had registered the highest population of leaf hopper (15.44/leaf).

4.2.3 Pooled effect of various modules on mean population of leaf hopper /leaf/ plant

4.2.3.1 Pre-treatment observation (24 hrs before spray) on leafhopper / leaf

The data presented in Table 7 showed that pooled mean data on the incidence of leafhopper 24 hours before first spray were found statistically non-significant.

However, incidence of leafhopper in various treatments was found in the range of 0.08 leaf hopper /leaf in module M6 to 0.38 leaf hopper/leaf in module M8. However, other sucking pests thrips, whiteflies and mites were not initiated during both the years under study.

4.2.3.2 Mean Leaf hopper/ population at 3 days after spray

From the pooled data on the effect of various modules on population of leafhopper at 3 days after spray presented in Table 7 and depicted in Fig 3, indicated that results were statistically significant. All the treated modules were significantly superior over untreated module. The minimum population of leafhopper was observed to the tune of 2.39/leaf in module M7 followed by module M6 (2.45 LH/leaf) and both the treatments

were at par with each other and appeared to be statistically superior over other remaining treatments. The treatments module M5, M4, M3 and M2 accounted the leafhopper population in order of merit to the tune of 3.15, 3.61, 3.69 and 3.95/leafhopper/leaf respectively and these treatments were found to be at par among themselves and superior to M1 and M8. The treatment module M1 had registered the comparatively highest leafhopper population to the extent of 4.73/leaf and was found to be statistically similar with module M2. The unprotected module (M8) had recorded the highest incidence of leafhopper (9.62/leaf).

4.2.3.3 Mean Leaf hopper population at 7 days after spray

The data presented in Table 7 and depicted in Fig 3 revealed that the results were statistically significant. All the treated modules were significantly superior over untreated module. The treatment module M6 had shown the lowest leafhopper population (4.50/leaf) and it was followed by module M7 (4.53LH/leaf) and module M5 (5.49 LH /leaf) and these treatments were statistically at par with each other. Module M6 and Module M7 were significantly superior over rest of the treatments except module M5 which was further found to be statistically at par with M4 (5.96 LH /leaf), M3 (6.46 LH /leaf) and M2 (6.62 LH /leaf). The treatment module M1 (8.71 LH /leaf) had noticed comparatively highest leafhopper population to the tune of (8.71 /leaf) showing comparatively less effective against leafhopper and superior to M8.

The unprotected module had shown the highest population of leaf hopper (13.41/leaf).

4.2.3.4 Mean Leaf hopper population at 14 days after spray

From the data presented in Table 7 and depicted in Fig 3 it is observed that the results were statistically significant. All the treated modules were significantly superior over untreated module. The minimum population of leaf hopper was recorded in module M6 (7.52/leaf), followed by M5 (7.82LH/leaf), M7 (8.15LH/leaf) and M2 (9.51LH/leaf) and these treatments were found to be statistically at par among themselves. Of these module M6 and module M5 were significantly superior over rest of the treatments except



Aphids (*Aphis gossypii* Glover)



Leafhopper (*Amrasca biguttula biguttula* Ishida)



Leafhopper and Whitefly *Bemisia tabaci* Gennadius

Plate 2 Sucking pests on okra crop

module M7 and M2 whereas, further module M7 and module M2 were found to be statistically at par with M4 (10.12LH/leaf) and M3 (10.54LH/leaf) and superior over M1 and M8. The treatments module M1 had registered the leafhopper population to the extent of 11.13/leaf and it was also found statistically similar effective with the M2, M4 and M3 and superior over M8. The highest population of leafhopper was noticed in the unprotected treatment module M8 (17.30/leaf).

4.2.3.5 Pooled cumulative mean population of Leafhopper

The data on pooled cumulative mean population of leaf hopper as influenced by the various modules presented in Table 7 and depicted in Fig 3 indicated that the results were statistically significant. All the treated modules were significantly superior over untreated module. The lowest population of leafhopper (4.82/leaf) was recorded in module M6 followed by M7 (5.02LH/leaf) and M5 (5.49LH/leaf) and they were statistically at par with other. Module M6 and M7 were significantly superior over remaining treatments except module M5 which was further found to be statistically at par with M4 (6.57LH/leaf) and M2 (6.69LH/leaf) and superior over M3,M1 and M8. Treatment module M3 had accounted the leafhopper population to the tune of 6.90/leaf and was statistically similar effective with M4 and M2. However, it was further statistically at par with M1 which registered the leafhopper population to the tune of 8.19/leaf. The highest population of leafhopper was accounted in unprotected module M8 (13.44/leaf).

It is clear from the above findings that Module M6 , M7 and M5 were found significantly most effective in minimizing the population of leaf hopper at 3,7 and 14 DAS. during summer and *kharif* 2015-16 seasons. While , Module M4, M2 and M3 were found to be moderately and statistically equally effective in minimizing the population of leafhopper. Module M1 was found to be least effective. The treated module M6, M7 and M5 were found significantly most effective in reducing the population of leafhopper due to the cumulative effect of seed treatment with imidacloprid, soil application of neem cake maximum catches of leafhopper in yellow sticky trap and sequential spraying of synthetic pyrethroids (particularly cypermethrin, fenpropathrin and

lambda-cyhalothrin) and systematic poisons (triazophos, acephate, quinalphos and thiamethoxam).

Table: 8 Effect of various modules on cumulative mean population of whitefly on okra during summer 14-15

Tr. No.	Treatment details	Cum. Mean Whitefly population /leaf			Cum.pool ed mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	0.97 (0.98)	1.57 (1.25)	2.08 (1.44)	1.54 (1.24)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	1.11 (1.05)	2.05 (1.43)	2.71 (1.64)	1.96 (1.40)
M3	YST,Ace ,Quin, Fenpo, Spi+ Lam,Fenv.	0.62 (0.78)	1.07 (1.03)	1.95 (1.39)	1.22 (1.10)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.54 (0.72)	0.86 (0.92)	1.60 (1.26)	1.00 (1.00)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.55 (0.74)	1.07 (1.03)	1.40 (1.18)	1.01 (1.00)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.55 (0.74)	0.93 (0.96)	1.42 (1.19)	0.96 (0.98)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin., Lamb.	1.51 (1.22)	2.34 (1.53)	2.30 (1.51)	2.05 (1.43)
M8	Untreated control	3.13 (1.76)	3.41 (1.84)	3.96 (1.99)	3.50 (1.87)
	SE (m)±	0.07	0.06	0.06	0.03
	CD at 5%	0.22	0.18	0.20	0.11
	CV%	12.59	8.44	7.85	5.20

N.B: Figures in parenthesis are square root transformation

Present findings are in agreement with Rajashekhar et al. (2010) who reported that the module comprising of seed treatment with imidacloprid @ 3 g/kg seed + yellow sticky trap @ 25/ha and need base application of fipronil and neem oil effectively reduced the population of aphid, Jassid and WF in okra. Mandal et.al (2007) reported that soil application of neem cake along with three spray of neem oil and endosulfan gave maximum protection of jassids. Kumar and Singh (2001) Bangalore

(Karnataka) reported that seed treatment with imidacloprid (Gaucho 600 FS) at 12 ml kg⁻¹ was efficient in reducing leafhopper infestation with no phytotoxic effect on okra plants Kaur (2002) who reported the superior bio-efficacy of ST with Imidacloprid @ 5g/kg and foliar spray of monocrotophos and cypermethrin in obtaining lowest population of cotton jassids. Kalyan et al. (2012) also reported that spinosad, imidacloprid, acephate and fipronil effectively control the population of jassids and whiteflies in cotton. Above findings are also supported by Bagade et.al (2010), Bagade and Ambekar, (2010) who also reported the superior efficacy of ST with imidacloprid followed by cypermethrin 0.01% against aphid and jassids. Results are also in confirmation with Mishra (2002a) who reported that imidacloprid and thiamethoxam each at 25g./ha were significantly superior in controlling aphids and jassids followed by dimethoate @ 300 g.a.i. per ha and cypermethrin 100 g.a.i. per ha.

4.3.1 Effect of various modules on mean population of whitefly /leaf/ plant during summer 2014-15

4.3.1.1 Mean whitefly population at 3 days after spray

The data presented in Table 8 and depicted in Fig 4 indicated that the results were statistically significant. All the treatment modules were significantly superior over untreated module. The treatment M4 had registered the minimum incidence of whitefly (0.54/leaf) followed by module M5 and M6 (0.55/leaf) and M3 (0.62 whitefly/leaf) and these treatments were found to be at par among themselves. Of these, module M4, M5 and M6 were significantly superior over remaining treatments except M3. The treatment module M1 had noticed the whitefly population to the extent of 0.97/leaf and statistically as equal as M3. However, it was also further statically similar to module M2 (1.11 whitefly /leaf). Module M7 (1.51 whitefly /leaf) was comparatively least effective but it was statistically as similar as M2.

The untreated module M8 had registered the highest population of whitefly to the extent of (3.13/leaf).

4.3.1.2 Mean whitefly population at 7 days after spray

It is evident from the data presented in Table 8 and depicted in Fig 4 revealed that the results were statically significant. All the treated modules were significantly superior over unprotected module M8. The minimum incidence of whitefly was observed in treatment module M4 (0.86 whitefly /leaf) followed by module M6 (0.93 whitefly /leaf), module M5 and M3 (1.07 whitefly /leaf) and they were statistically similar effective and these treatments were significantly superior over rest of the treatments. Among remaining treatments module M1 and M2 had registered whitefly population to the extent of 1.57/leaf and 2.05/leaf respectively and they were statistically equal effective, whereas, module M7 noticed whitefly population to the extent of 2.34/leaf and was statistically similar to M2 and superior over M8.

The highest population of whitefly (3.41/leaf) was observed in module untreated treatment (M8).

4.3.1.3 Mean whitefly population at 14 days after spray

The data presented in Table 8 and depicted in Fig 4 showed that the results were statistically significant. All the treatment modules were significantly superior over untreated module. The treatment module M5 had recorded the minimum incidence of whitefly (1.40/leaf) followed by module M6 (1.42 whitefly /leaf), and module M4 (1.60 whitefly /leaf) and they were found statistically similar effective. Whereas the treatment M5 exerted significantly superior effect over rest of the treatments except M6 and M4. Module M6 and M4 were further statistically at par with module M3 (1.95 whitefly /leaf) which was further statistically at par with M1 (2.08 whitefly /leaf) and Module M7 (2.30 whitefly /leaf). Module M2 had registered the highest whitefly population to the tune of (2.71/leaf) and was statically as equal as M1 and M7 and superior to module M8. The unprotected module M8 had recorded the maximum population of whitefly (3.96/leaf).

4.3.1.4 Cu. mean population of whitefly

The data on cumulative mean whitefly population during summer 2014-15 is presented in Table 8 and depicted in Fig 4 observed that the results were statistically significant. All the treated modules were

significantly superior over untreated module. The minimum incidence of whitefly was observed in Module M6 (0.96/leaf), and superior over all the treatments except M4 (1.00 whitefly/leaf) and M5 (1.01 whitefly/leaf) and they were at par with each other. Module M3 (1.22 whitefly /leaf) had also shown the statistically similar effectiveness with the treated module M5 and M4 and these modules were significantly superior over remaining treatments. The module M1 had registered comparatively minimum incidence of whitefly and it was found statistically superior over treatments module M2 (1.96 whitefly/leaf), M7 (2.05 whitefly/leaf) and unprotected module M8 (3.50/leaf) module M2 and M7 were superior to M8 and inferior to rest of the best module. The highest incidence of whitefly was recorded in untreated module M8 (3.50/leaf).

Table: 9 Effect of various modules on cumulative mean population of whitefly on okra during *kharif* 2015-16

Tr. No.	Treatment details	Cum. Mean Whitefly population /leaf			Cum. pooled mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	1.72 (1.31)	2.53 (1.58)	3.82 (1.95)	2.69 (1.64)
M2	ST,Dim, Quin ,Fenpo,Dico+Quin.	1.73 (1.31)	3.21 (1.79)	3.98 (1.99)	2.97 (1.72)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	1.20 (1.09)	1.95 (1.39)	2.96 (1.72)	2.04 (1.43)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	1.68 (1.30)	1.69 (1.30)	2.28 (1.51)	1.89 (1.37)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	1.27 (1.13)	1.73 (1.31)	2.68 (1.64)	1.90 (1.38)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.93 (0.96)	1.44 (1.20)	2.61 (1.61)	1.66 (1.29)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	2.08 (1.44)	2.48 (1.57)	3.13 (1.77)	2.56 (1.60)
M8	Untreated control	3.58 (1.88)	4.30 (2.07)	4.75 (2.17)	4.21 (2.05)
	SE (m) $\pm$	0.05	0.06	0.07	0.04
	CD at 5%	0.18	0.20	0.23	0.14
	CV%	7.84	7.45	7.35	5.08

N.B: Figures in parenthesis are square root transformation

4.3.2 Effect of various modules on mean population of whitefly /leaf/ plant during *Kharif* 2015-16

4.3.2.1 Mean whitefly population at 3 days after spray

It is indicated from the data presented in Table 9 and depicted in Fig 4 that the results were found statistically significant. All the treatment modules were significantly superior over untreated module. The treatment module M6 had noticed the minimum incidence of whitefly (0.93/leaf) followed by M3 (1.20whitefly/leaf) and M5 (1.27 whitefly/leaf) and these treatments were statistically at par among themselves. Of these, treatments M6 and M3 were found to be significantly superior over rest of the treatments except M5. Treatment module M4(1.68 whitefly/leaf), M2(1.72 whitefly /leaf) and M1(1.73 whitefly/leaf) in second order of merit had shown the statistically similar effectiveness as that of module M5. However, these three modules M4, M2 and M1 were further found statically at par with module M7 which accounted the whitefly population to the tune of 2.08/leaf. Whereas, the untreated module M8 had observed the maximum incidence of whitefly (3.58 whitefly/leaf).

4.3.2.2 Mean whitefly population at 7 days after spray

The data presented in Table 9 and depicted in Fig 4 indicated that the results were found statistically significant. All the treatment modules were significantly superior over unprotected control. The treated module M6 (1.44 whitefly/leaf) had shown the minimum incidence of whitefly, however, it was statistically at par with M4 (1.69 whitefly/leaf) M5 (1.73 whitefly/leaf) and M3 (1.95 whitefly/leaf). Of these M6, M4 and M5 were found significantly superior over remaining treatment except M3. The Module M7 (2.48 whitefly/leaf) and M1(2.53 whitefly /leaf) were statically as effective as that of module M3. The treatment module M2 had recorded highest whitefly population to the tune of 3.21/leaf and it was found comparatively less effective and superior over module M8.

The untreated module M8 had noticed the highest incidence of whitefly (4.30/leaf).

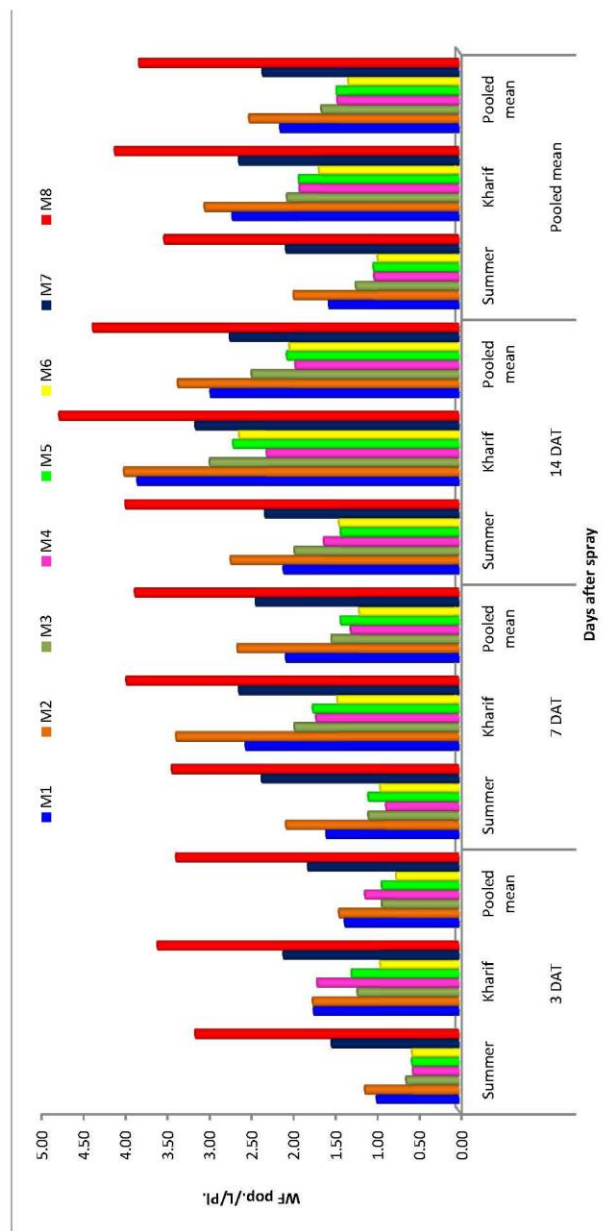


Fig- 4 Effect of various modules on comparative population of whitefly on okra during summer 2014-15 and kharif season 2015-16

4.3.2.3 Mean whitefly population at 14 days after spray

The data presented in Table 9 and depicted in Fig 4 revealed that the results were statistically significant. The minimum incidence of whitefly was recorded in Module M4 (2.28/leaf), followed by Module M6 (2.61/leaf), M5 (2.68/leaf) and M3 (2.96/leaf) and they were observed to be statistically at par among themselves and module M4 was significantly superior over rest of the treatments. Treatment module M7 (3.13/leaf) was statistically as effective as M6, M5 and M3. Although, module M1 (3.82/leaf) and module M2 (3.98/leaf) were statically at par with module M7 but they were further statistically as ineffective as that of untreated module M8 (4.75/leaf).

4.3.2.4 Cu. mean population of whitefly

It is evident from the data presented in Table 9 and depicted in Fig 4 that the results were found statistically significant. All the treatment modules were significantly superior over untreated module. The minimum incidence of whitefly was recorded in M6 (1.66/leaf) and was found statistically at par with module M4 (1.89 whitefly/leaf), module M5 (1.90 whitefly/leaf) and module M3 (2.04 whitefly/leaf) and they were significantly superior over the remaining treatments. The treatment module M7, M1 and M2 in second order of merit accounted whitefly population to the tune of 2.56/leaf, 2.69/leaf and 2.97/leaf, respectively and they were statistically at par with each other and superior over M8. However, the untreated module M8 had observed the highest incidence of whiteflies (4.21/leaf).

4.3.3 Pooled effect of various modules on mean population of whitefly /leaf/ plant

4.3.3.1 Mean whitefly population at 3 days after spray

It is observed from the data presented in Table 10 and depicted in Fig 4, that the results were statistically significant. All the treatment modules were significantly superior over untreated module. The treatment module M6 had registered the least incidence of whitefly, followed by Module M5 and M3 (0.91 whitefly /leaf) and they were statistically at par with each other. The treatment M6 was found significantly superior over rest of the treatment

except M5 and M3. The treatment Module M4 in second order of merit (1.11 whitefly /leaf) was also found to be statistically similar effective with module M5 and Module M3. However, it was further statistically at par with module M1 (1.35 whitefly /leaf). Among remaining treatments module M2 and Module M7 had noticed the whitefly incidence to the tune of 1.42 and 1.79/leaf respectively and of these two modules M2 was statistically similar with module M1. Whereas, unprotected module M8 had accounted the maximum incidence of whitefly (3.36/leaf).

4.3.3.2 Mean whitefly population at 7 days after spray

From the data presented in Table 10 and depicted in Fig 4 revealed that the various treatments modules had shown the statistically significant differences among themselves. All the treatment modules were significantly superior over untreated module. Module M6 had recorded the minimum whitefly incidence to the extent of (1.18/leaf) however, it was statistically at par with module M4 (1.28 whitefly /leaf), module M5 (1.40 whitefly /leaf) and module M3 (1.51whitefly /leaf) and these four treatments were significantly superior over remaining treatments. Treatment module M1 and M7 had observed the whitefly population to the tune of 2.05/leaf and 2.41/leaf, respectively and they were found to be statistically at par with one another. Of these two modules, M7 was further found to be statistically similar to module M2 (2.63 whitefly /leaf). The unprotected module M8 had the observed the maximum incidence of whitefly (3.85/leaf).

4.3.3.3 Mean whitefly population at 14 days after spray

It is indicated from the data presented in Table 10 and depicted in Fig 4 that results were statistically significant. All the treatment modules were significantly superior over untreated module. The minimum whitefly incidence was noticed in the treatment module M4 (1.94 whitefly/leaf), followed by module M6 (2.01 whitefly/leaf), M5 (2.04 whitefly/leaf) and M3 (2.46 whitefly/leaf) and these treatments were found statistically similar effective. The treatment module M4, M6 and M5 had exerted significantly superior effect over rest of the treatments except module M3 which was further statistically at par with module M7 (2.72 whitefly/leaf) and M1 (2.95 whitefly /leaf).

Table: 10 Effect of various modules on comparative population of whitefly on okra during summer 2014-15 and *kharif* season 2015-16

Sr. No.	Treatment details	3 DAT			7 DAT			14 DAT			Pooled mean		
		Summer	<i>Kharif</i>	Pooled Mean	Summer	<i>Kharif</i>	Pooled Mean	Summer	<i>Kharif</i>	Pooled Mean	Summer	<i>Kharif</i>	Pooled Mean
M1	SA,YST,Azadirachtin 1%w/w	0.97 (0.98)	1.72 (1.31)	1.35 (1.15)	1.57 (1.25)	2.53 (1.58)	2.05 (1.42)	2.08 (1.44)	3.82 (1.95)	2.95 (1.69)	1.54 (1.24)	2.69 (1.64)	2.12 (1.44)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	1.11 (1.05)	1.73 (1.31)	1.42 (1.18)	2.05 (1.43)	3.36 (1.83)	2.63 (1.61)	2.71 (1.64)	3.98 (1.99)	3.34 (1.82)	1.96 (1.40)	3.02 (1.74)	2.49 (1.57)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	0.62 (0.78)	1.20 (1.09)	0.91 (0.94)	1.07 (1.03)	1.95 (1.39)	1.51 (1.21)	1.95 (1.39)	2.96 (1.72)	2.46 (1.56)	1.22 (1.10)	2.04 (1.43)	1.63 (1.26)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.54 (0.72)	1.68 (1.30)	1.11 (1.01)	0.86 (0.92)	1.69 (1.30)	1.28 (1.12)	1.60 (1.26)	2.28 (1.51)	1.94 (1.39)	1.00 (1.00)	1.89 (1.37)	1.44 (1.19)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.55 (0.74)	1.27 (1.13)	0.91 (0.93)	1.07 (1.03)	1.73 (1.31)	1.40 (1.17)	1.40 (1.18)	2.68 (1.64)	2.04 (1.41)	1.01 (1.00)	1.90 (1.38)	1.45 (1.19)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.55 (0.74)	0.93 (0.96)	0.74 (0.85)	0.93 (0.96)	1.44 (1.20)	1.18 (1.08)	1.42 (1.19)	2.61 (1.61)	2.01 (1.40)	0.96 (0.98)	1.66 (1.29)	1.31 (1.13)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	1.51 (1.22)	2.08 (1.44)	1.79 (1.33)	2.34 (1.53)	2.61 (1.62)	2.41 (1.55)	2.30 (1.51)	3.13 (1.77)	2.72 (1.64)	2.05 (1.43)	2.61 (1.61)	2.33 (1.52)
M8	Untreated control	3.13 (1.76)	3.58 (1.88)	3.36 (1.98)	3.41 (1.84)	3.95 (1.99)	3.85 (1.96)	3.96 (1.99)	4.75 (2.17)	4.35 (2.08)	3.50 (1.87)	4.09 (2.02)	3.80 (1.94)
	SE (m)±	0.07	0.05	0.05	0.06	0.06	0.05	0.06	0.07	0.06	0.03	0.04	0.03
	CD at 5%	0.22	0.17	0.15	0.18	0.19	0.15	0.19	0.23	0.17	0.11	0.12	0.09
	CV%	12.59	7.84	10.39	8.44	7.41	9.25	7.85	7.35	8.79	5.20	4.72	5.68

N.B: Figures in parenthesis are square root transformation

Module M2 had accounted the highest whiteflies population to the tune of 3.34/leaf and it was statistically at par with M1. The highest incidence of whiteflies was observed in untreated module (4.35/leaf).

4.3.3.4 Pooled cu. mean population of whitefly

From the data presented in Table 10 and depicted in Fig 4 revealed that the results were found statistically significant. All the treatment modules were significantly superior over untreated module. The minimum population of whitefly was registered in module M6 (1.31/leaf), followed by module M5 (1.44 whitefly/leaf) and M4 (1.45 whitefly/leaf) and these treatments were statistically similar effective. The treatment M6 was significantly superior over rest of the treatments except M5 and M4. The treatment module M3 had observed the whitefly population to the tune of 1.69/leaf and it appeared to be statistically similar effective to M5 and M4. The treatment module M5, M4 and M3 were found to be significantly superior over other remaining treatments. The treatment module M1 had shown the whitefly incidence to the extent of (2.12 whitefly /leaf) and was statistically at par with M7 (2.33 whitefly /leaf) which was further statistically at par with module M2 (2.49 whitefly /leaf) whereas, the unprotected module had recorded the highest incidence of whitefly (3.80/leaf).

It is clear from the above findings that the treatment Module M6, M5 and M4 were found to be significantly most effective and superior over rest of the modules in minimizing the population of white fly at 3, 7 and 14 DAS during summer 2014-15 and 2015-16 seasons. However, module M3 was found to be moderately effective and statistically at par with M5 and M4. The Module M1, M7 and M2 were found to be comparatively less effective in order of merit in minimizing the population of whitefly. Module 6 and module M5 were found to be most effective in reducing the population of whitefly during summer and *kharif* seasons due to the cumulative effect of seed treatment, soil applications, YST and sequential application of the insecticidal treatments in which cypermethrin, triazophos, thiamethoxam, fenpropathrin and spiromesifen played a major role in minimizing the population of whitefly in okra.

Table: 11 Effect of various modules on cumulative mean population thrips during summer 2014-15

Tr. No.	Treatment details	Cum. Mean Thrips population / leaf			Cum. pooled mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	0.44 (0.67)	1.05 (1.02)	1.57 (1.25)	1.02 (1.01)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.54 (0.73)	0.87 (0.93)	1.92 (1.39)	1.11 (1.05)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	0.71 (0.84)	0.92 (0.96)	2.11 (1.45)	1.24 (1.11)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.90 (0.95)	0.87 (0.93)	1.72 (1.31)	1.16 (1.08)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.43 (0.65)	1.01 (1.00)	1.25 (1.12)	0.90 (0.95)
M6	ST,SA,YST,Cyper, Tria,Fenpo, Ace+Spir	0.25 (0.50)	0.67 (0.82)	1.30 (1.13)	0.74 (0.86)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin., Lamb.	0.60 (0.77)	0.82 (0.90)	1.52 (1.23)	0.98 (0.99)
M8	Untreated control	3.04 (1.72)	3.39 (1.83)	4.39 (2.08)	3.61 (1.88)
	SE (m)±	0.07	0.07	0.08	0.07
	CD at 5%	0.24	0.22	0.24	0.21
	CV%	16.12	12.29	10.10	10.83

N.B: Figures in parenthesis are square root transformation

Present findings are in agreement with Rajashekhar et al. (2010) who reported that the module comprising of seed treatment with imidacloprid @ 3 g/kg seed + yellow sticky trap @ 25/ha and need base application of fipronil and neem oil effectively reduced the population of aphid, Jassid and whitefly in okra. Ghosh et.al (2016) reported that thaimethoxam 25 WG @ 25 g.a.i. reduced the 83.88 and 96.7% population of whitefly in okra. Present findings of thiamethoxam in module M5 are supported by previous author Singh 2012a, Singh 2012b, Mohanasundaram and Sharma (2011), Venkataravanappa et al. (2012). Shivanna et al. (2011) who reported that dimehoate alone was most effective in controlling the population of leaf hopper, whitefly and thrips at 3 days after spraying in cotton which was found to be superior over imidacloprid, acetamiprid, triazophos, fenpropathrin. Kalyan et al. (2012) also reported that spinosad, imidacloprid, acephate and fipronil effectively control the population of jassids and whiteflies in cotton.

Wale and Chandele (2010) who reported that spiromesifen was very effective in managing the whitefly in okra. Sujay Anand (2010) who also reported that whitefly population was lowest in spiromesifen treated plots.

4.4.1 Effect of various modules on mean population of thrips /leaf/ plant during summer 2014-15

4.4.1.1 Mean thrips population at 3 days after spray

It is indicated from the data presented in Table 11 and depicted in Fig 5 that the results were statistically significant. All the treatments were found to be significantly superior over untreated module. The minimum incidence of thrips was noticed in treatment modules M6 (0.25/leaf), which was followed by treatment module M5,(0.43 thrips /leaf), M4 (0.44 thrips /leaf) and M2 (0.54 thrips/leaf) and these treatments were found statistically at par among themselves and module M6 was superior over M7,M3,M4 and M8.However, except module M6, the later three treated modules i.e. M5, M1 and M2 were further statistically at par with module M7 (0.60 thrips /leaf) and module M3 (0.71 thrips /leaf). The least effective treatment module M4 had accounted the thrips incidence to the tune of (0.90/leaf) and it appeared to be statically as effective as M2, M7 and M3. Whereas, the unprotected module M8 had recorded the highest incidence of thrips (3.04/leaf).

4.4.1.2 Mean thrips population at 7 days after spray

It is evident from the data presented in Table 11 and depicted in Fig 5 revealed that the results were statistically significant. All the treatments were found to be significantly superior over unprotected module. The minimum incidence of thrips was noticed in treatment module M6 (0.67 thrips /leaf), which was found to be statistically at par with module M7(0.82 M2,and M4 (0.87 thrips /leaf), Module M3 (0.92thrips /leaf), module M5 (1.01 thrips /leaf) and module M1 (1.05/thrips/leaf), respectively as against the unprotected module M8 which shown the maximum population of thrips (3.39/leaf).

4.4.1.3 Mean thrips population at 14 days after spray

From the data presented in Table 11 and depicted in Fig 5 evidence that the results were found statistically significant. All the treatments were significantly superior over unprotected module M8. The least incidence of thrips was observed in treated module M5 (1.25/leaf) followed by M6 (1.30 thrips/leaf), M7 (1.52 thrips /leaf), M1(1.57 thrips /leaf) and M4 (1.72 thrips/leaf) and these treatments were found statistically at par among themselves and module M6 were found superior to module M2, M3 and M8. However, treatments module M7, M1 and M4 except module M5 and M6, were found to be statistically similar with M2 (1.92 thrips /leaf) and M3 (2.11 thrips/leaf). The highest population of thrips was recorded in unprotected module M8 (4.39/leaf).

4.4.1.4 Cu. mean population of thrips

The cumulative mean data of the thrips incidence as presented in Table 11 and depicted in Fig.5 indicated that the results were statistically significant. All the treatments were significantly superior over untreated module (M8). The module M6 was found significantly superior over M4, M3 and M8 in recording minimum incidence of 0.74 thrips/leaf and statistically at par with module M5 M7 M1 & M2 (0.90thrips/leaf), (0.98/thrips/leaf) (1.02thrips/leaf) and (1.11thrips/leaf). The treatment module M4 and Module M3 registered the comparatively maximum thrips population to the tune of 1.16/leaf and 1.24/leaf, respectively and these two treatment had exerted the statistically similar effect as those of treatment module M5, M7, M1 and M2 whereas, the maximum population of thrips was noticed in unprotected module M8(3.61/leaf).

4.4.2 Effect of various modules on mean population of thrips/leaf/ plant during *Kharif* 2015-16

4.4.2.1 Mean thrips population at 3 days after spray

The data on cumulative mean population of thrips as influenced by various treatments as presented in Table12 and depicted in Fig 5 revealed that the results were statistically significant. All the treatments were significantly superior over untreated module. The lowest population of thrips

was recorded in module M6 (0.92/leaf) and it appeared to be significantly superior over all the treatment. The second best effective module M5 which registered the thrips population to the tune of (1.59/leaf) and it was statistically at par module M7 (2.21 thrips /leaf). The treatment M5 was found to be significantly superior over rest of the treatment except, treatment M7 and inferior to module M6. The treatment module M3 (3.01 thrips /leaf) also exhibited statistically similar effect as that of module M2(2.33 thrips /leaf) and module M1(2.78 thrips/leaf). Treatment module M4 shown the thrips least effective population to the tune of 3.20 thrips /leaf found to be statistically as effective as module M1 and module M3. The highest population of thrips was noticed in unprotected module M8 to the extent of 6.28/leaf.

Table: 12 Effect of various modules on cumulative mean population of thrips on okra during *kharif* 2015-16

Tr. No.	Treatment details	Cum. Mean Thrips population /leaf			Cum. pooled mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	2.78 (1.67)	3.56 (1.89)	5.36 (2.31)	3.90 (1.97)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	2.33 (1.51)	3.73 (1.93)	5.50 (2.34)	3.85 (1.96)
M3	YST,Ace, Quin, Fenpo,Spi+Lam,Fenv.	3.01 (1.74)	4.36 (2.09)	5.24 (2.28)	4.20 (2.05)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	3.20 (1.79)	3.68 (1.92)	5.60 (2.36)	4.16 (2.04)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	1.59 (1.25)	2.66 (1.61)	4.42 (2.09)	2.89 (1.70)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.92 (0.96)	2.56 (1.60)	3.23 (1.78)	2.23 (1.49)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	2.21 (1.48)	3.77 (1.94)	5.23 (2.27)	3.74 (1.93)
M8	Untreated control	6.28 (2.50)	7.23 (2.68)	9.51 (3.08)	7.67 (2.76)
	SE (m)±	0.07	0.08	0.13	0.07
	CD at 5%	0.24	0.25	0.39	0.23
	CV%	8.37	7.18	9.72	6.61

N.B: Figures in parenthesis are square root transformation

4.4.2.2 Mean thrips population at 7 days after spray

The data presented in Table 12 and depicted in Fig 5 revealed that the results were found statistically significant. All the treatments exerted significantly superior effect over untreated module. The treatment module M6 had observed the minimum population of thrips (2.56/leaf) followed by second best treatment module M5 (2.66 thrips/leaf) and these two treatments were significantly at par with one another and appeared to be significantly superior over remaining treatments. The treatment module M1, M4, M2, M7 and M3 in second order of merit had accounted the thrips population to the extent of 3.56, 3.68, 3.73, 3.77 and 4.36/leaf, respectively and they were at par among themselves and superior over M8. The highest population of thrips was recorded in unprotected module M8 (7.23/leaf).

4.4.2.3 Mean thrips population at 14 days after spray

It is indicated from the data presented in Table 12 and depicted in Fig 5 indicated that the result were statistically significant. All the treatments were significantly superior over untreated module. The treatment module M6 had exhibited the lowest population of thrips (3.23/leaf) and it was found to be statistically at par with module M5 (4.22/leaf) and superior to remaining modules. The treatment M6 was found significantly superior over all the treatments except treatment M5 which had exerted statistically similar effect to Module M7 (5.23/leaf), M3 (5.24/leaf), M1 (5.36/leaf), M2 (5.50/leaf) and M4 (5.60/leaf). The maximum thrips population was noticed in unprotected module M8 (9.51/leaf).

4.4.2.4 Cu. mean population of thrips

The data on cumulative mean of thrips population as mentioned in Table 12 and depicted in Fig 5 indicated that the results were statistically significant. All the treatments were statistically superior over untreated module. The treatment module M6 had shown the minimum population of thrips (2.23/leaf) and it was at par with the module M5 (2.89 thrips /leaf). The treatment M6 was found significantly superior over rest of the treatments except treatment M5 which emerged as second best effective module. The module M5 was further statistically at par with module M7 (3.74/leaf) and it

was significantly superior over remaining treatments. The module M7 was statistically at par with module M2 (3.85/leaf) M1 (3.90/leaf), M4 (4.16/leaf) and M3 (4.20/leaf). However, the maximum thrips population was noticed in the module M8 (7.67/leaf).

4.4.3 Pooled effect of various modules on mean population of thrips /leaf/ plant

4.4.3.1 Mean thrips population at 3 days after spray

It is evident from the pooled data as regards to the effect of various treatment module against thrips as mentioned in Table 13 and depicted in Fig 5 that the results were statistically significant. All the treated modules were significantly superior over untreated modules. The module M6 was found significantly superior over all other modules in recording minimum incidence of thrips (0.59/leaf). The second best effective module M5 was found significantly superior over module M1, M3, M4 and M8 in recording comparatively minimum population of thrips (1.01/leaf) at 3 DAS and at par with M7 (1.40/leaf) and M2 (1.43/leaf). However module M3 was found to be further statistically at par with module M7 (1.40/leaf), module M2 (1.43/leaf) and M1 (1.61/leaf) and superior over M4 and M8. The least effective module M4 had shown the population of thrips (2.05/leaf) and exerted statistically similar effect to that of M1 and module M3. The untreated module M8 had exhibited the maximum thrips population to the extent of (4.66 /leaf).

4.4 .3.2 Mean thrips population at 7 days after spray

The data presented in Table 13 and depicted in Fig 5 revealed that the results were statistically significant. All the treatments were found significantly superior over untreated module. The best effective module M6 had accounted the minimum incidence of thrips (1.61 /leaf) followed by module M5 (1.83 thrips/leaf) and both the treatments were found to be statistically at par with one another. The treatment M6 was significantly superior over all other remaining treatments except M5 which approved to be the second best treatment. The module M4, M7 and M2 in second order of merit accounted the thrips incidence to the extent of 2.28, 2.29, 2.30/leaf, respectively and they were having statistically similar effect to that of M5.

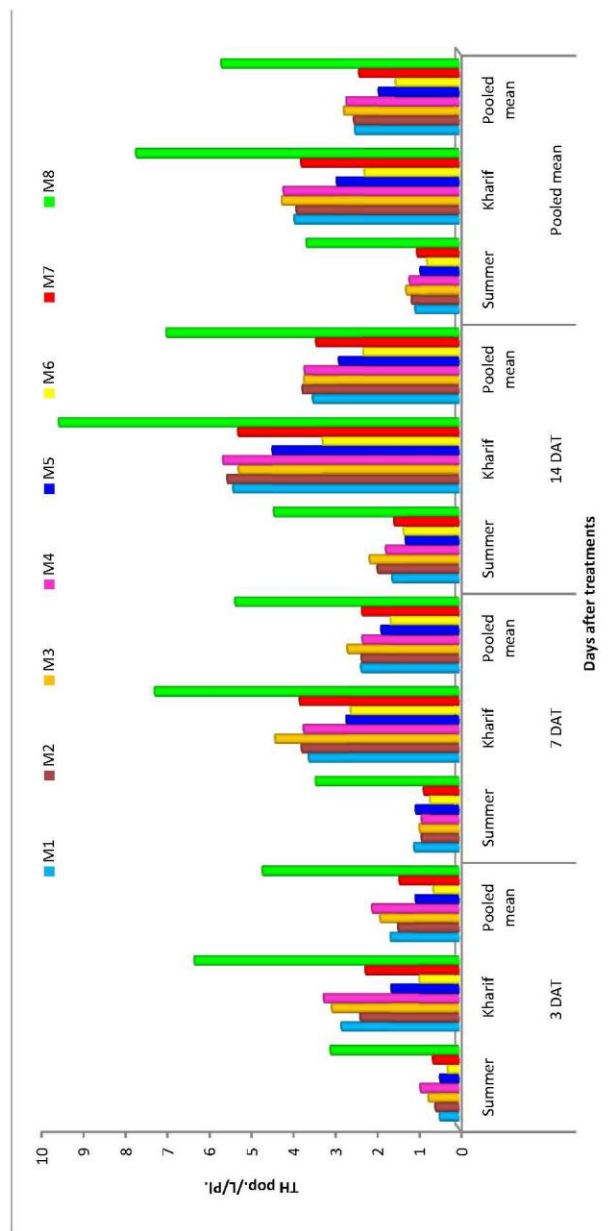


Fig- 5 Effect of various modules on comparative population of thrips on okra during summer 2014-15 and kharif season 2015- 16

However, these treatments viz., M4, M7 and M2 were further found to be statistically at par with the remaining treated modules viz., M1 (2.31thrips/leaf) and M3 (2.64 thrips/leaf), However the unprotected module M8 had observed the maximum incidence of thrips (5.31/leaf).

4.4.3.3 Mean thrips population at 14 days after spray

From the data presented in Table 13 and depicted in Fig 5 indicated that the results were statistically significant. All the treatments were found significantly superior over untreated module. The minimum incidence of thrips was accounted in best module M6 (2.26/leaf) followed by module M5 (2.84/leaf) and both the treatments were statistically similar effective against thrips. Of these two modules, the module M6 was significantly superior over rest of the treatments except treatment M5. However, second best module M5 was further found to be statistically at par with module M7(3.38 thrips/leaf) M1(3.46thrips/leaf)and M4 (3.66thrips/leaf). The treatment module M3 and M2 had estimated thrips population to the tune of 3.67/leaf and 3.71/leaf respectively, and these two treatments had exerted statistically similar effect as that of module M7, M1 and M4. The maximum incidence of thrips was recorded in the untreated module (6.95/leaf).

4.4.3.4 Pooled cu. mean population of thrips

The cumulative mean data presented in Table 13 and depicted in Fig 5 exhibited that the results were statistically significant. All the treatments were found to be significantly superior over untreated module. The best effective modules M6 had accounted the minimum incidence of thrips to the extent of 1.49/leaf, followed by the module M5 which recorded the thrips population to the tune of 1.89/leaf and both the treatments were found to be statistically at par with one another. The treatment M6 had exerted significantly superior effect over rest of the treatments except treatment M5 which appeared to be the second best treatment exhibiting significantly superior over remaining treatments except M7 (2.36/leaf) which had shown statistically similar effect to that of treatments M5. However, the module M7 was as further found to be statistically at par with module M1 (2.46/leaf), M2(2.48/leaf), M4(2.66/leaf) and M3 (2.72/leaf) as against untreated module M8 which recorded the maximum incidence of thrips (5.64/leaf).

Table: 13 Effect of various modules on comparative population of thrips on okra during summer 2014-15 and *kharif* season 2015- 16

Tr. No.	Treatment details	3 DAT			7 DAT			14 DAT			Pooled mean		
		Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean
M1	SA.YST,Azadirachtin 1%w/w	0.44 (0.67)	2.78 (1.67)	1.61 (1.17)	1.05 (1.02)	3.56 (1.89)	2.31 (1.45)	1.57 (1.25)	5.36 (2.31)	3.46 (1.76)	1.02 (1.01)	3.90 (1.97)	2.46 (1.49)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.54 (0.73)	2.33 (1.51)	1.43 (1.13)	0.87 (0.93)	3.73 (1.93)	2.30 (1.43)	1.92 (1.39)	5.50 (2.34)	3.71 (1.86)	1.11 (1.05)	3.85 (1.96)	2.48 (1.51)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	0.71 (0.84)	3.01 (1.74)	1.86 (1.29)	0.92 (0.96)	4.36 (2.09)	2.64 (1.52)	2.11 (1.45)	5.23 (2.28)	3.67 (1.86)	1.24 (1.11)	4.20 (2.05)	2.72 (1.58)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.90 (0.95)	3.20 (1.79)	2.05 (1.37)	0.87 (0.93)	3.68 (1.92)	2.28 (1.42)	1.72 (1.31)	5.60 (2.36)	3.66 (1.84)	1.16 (1.08)	4.16 (2.04)	2.66 (1.56)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.43 (0.65)	1.59 (1.25)	1.01 (0.95)	1.01 (1.00)	2.66 (1.61)	1.83 (1.30)	1.25 (1.12)	4.42 (2.09)	2.84 (1.61)	0.90 (0.95)	2.89 (1.70)	1.89 (1.32)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.25 (0.50)	0.92 (0.96)	0.59 (0.73)	0.67 (0.82)	2.56 (1.60)	1.61 (1.21)	1.30 (1.13)	3.23 (1.78)	2.26 (1.46)	0.74 (0.86)	2.23 (1.49)	1.49 (1.17)
M7	ST,SA,YST,Cyper+Dim., Fenpo,Ethion+Quin, Lamb.	0.60 (0.77)	2.21 (1.48)	1.40 (1.12)	0.82 (0.90)	3.77 (1.94)	2.29 (1.42)	1.52 (1.23)	5.24 (2.27)	3.38 (1.75)	0.98 (0.99)	3.74 (1.93)	2.36 (1.46)
M8	Untreated control	3.04 (1.72)	6.28 (2.50)	4.66 (2.11)	3.39 (1.83)	7.23 (2.68)	5.31 (2.26)	4.39 (2.08)	9.51 (3.08)	6.95 (2.58)	3.61 (1.88)	7.67 (2.76)	5.64 (2.32)
	SE (m) _±	0.07	0.07	0.07	0.07	0.08	0.05	0.08	0.13	0.08	0.07	0.07	0.05
	CD at 5%	0.24	0.23	0.20	0.22	0.24	0.13	0.24	0.39	0.23	0.21	0.23	0.15
	CV%	16.12	8.37	13.36	12.29	7.18	7.37	10.10	9.72	10.25	10.83	6.61	8.03

N.B: Figures in parenthesis are square root transformation

It is indicated from the above findings that the treatment Module M6 were found to be significantly most effective in minimizing the population of thrips at 3, 7 and 14 DAS over all other modules and at par with M5 during summer 2014-15 and *kharif* 2015-16. However, module M5 was found to be moderately effective and statistically at par with M7. The other module M1, M2, M4 in order of merit were found to be comparatively less effective in minimizing the population of thrips. Module M3 was found to be the least effective .

Module M6 was found significantly most effective over other modules against thrips during summer and *kharif* 2015-16 due to cumulative effect of imidacloprid 9ml/kg seed treatment, neem cake soil application, YST and sequential four foliar application of cypermethrin, triazophos, fenpropathrin and acephate+ spiromesifen combination.

Present findings are in confirmation with Shivanna et.al 2011 who reported the superior efficacy of fenpropathrin 30 EC @120ml per a.i. per ha in bringing down all the sucking pests viz., leafhopper , whitefly and thrips on cotton at one day after spray. Patil et.al 2018 also reported that treatment of fipronil 0.05% and fenpropathrin 0.03% found significantly superior in controlling the chilli thrips at 15 DAS. Results also supported by Kaur and singh (2013) who reported that significantly lowest mean thrips rating (0.37 to 0.72) was observed in ,Decis 2.8 EC @0.05 %, Asataf 75 SP @ 0.10%, Confidor 17.8 SL (imidacloprid) @ 0.05%, and neem Soap @ 1.0%, (0.90) as against other treatment (1.10 to 1.45) and control (1.37). Rita and sharan (2016) also reported that maximum reduction (56.00%) in thrips population was recorded with the treatment of acephate 75 % SP, followed by Imidacloprid 17.8% SL (49.66%). Results are also supported by Iqbal et.al. (2013) regarding efficacy of acephate Mahalingappa, et al (2008) indicated that fipronil 0.01 and triazophos 0.08 per cent were most effective against thrips in chillies. Krishanah (2012) reported that yellow sticky trap @ 50 per ha in cotton attracted maximum number of sucking pests like, jassids (2640) whiteflies (1166) and thrips (352).

4.5.1 Effect of various modules on mean population of mites /leaf/ plant during summer 2014-15

4.5.1.1 Mean mites population at 3 days after spray

From the data presented in Table 14 and depicted in Fig 6 observed that the results were statistically significant. All the treatments modules were found to be significantly superior over untreated module. The best effective module M6 had recorded the significantly minimum incidence of mites (1.12/leaf) and it was significantly superior over all other remaining modules and it appeared to be the most effective treatment against mites. The second best effective module M4 in second order of merit had accounted the mites incidence to the extent of (2.34mite/leaf) followed by module M7 (3.45 mite/leaf) and M1 (3.75mite/leaf) and they were at par with each other. Treatment module M3 and module M2 had exhibited the mites incidence to the tune of 4.57/leaf and 4.84/leaf, respectively, and they were statistically similar effective with those of treatments module M7 and M1. The least effective module M5 had observed the mites population to the extent of 5.91/leaf and this treatments was found statistically equal effective to module M3 and M2. The maximum mites incidence was recorded in unprotected module M8 (20.81/leaf).

4.5.1.2 Mean mites population at 7 days after spray

The data presented in Table 14 and depicted in Fig 6 indicated that the results were statistically significant. All the treatment module were significantly superior over the module untreated module. The best module M6 (2.33/leaf) had registered the lowest population of mites followed by module M4 (2.73/leaf) and they were found statistically similar with one another and appeared to be significantly superior over other remaining module. Module M3 and M7 in second order of merit had accounted mites population to the tune of (5.37/leaf) and (6.50/leaf), respectively and they were statistically at par with each other. Treatment module M1 noticed the mite population of 7.76/leaf and it was found to be statistically similar effective as module M7. However, it further remained statistically at par with module M5 (8.83/leaf) and module M2 (9.88/leaf), whereas the unprotected module M8 had exhibited the maximum population of mites (24.67/leaf).



Whitefly, *Bemisia tabaci* Gennadius



Mites *Tetranychus cinnabarinus* (Boisd)

Plate 3 Sucking pests on okra crop

Table: 14 Effect of various modules on cumulative mean population of mites on okra during summer 2014-15

Tr. No.	Treatment details	Cum. mean mites population / leaf			Cum.pooled mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	3.75 (1.93)	7.76 (2.79)	16.29 (4.03)	9.26 (3.04)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	4.84 (2.20)	9.88 (3.13)	9.82 (3.13)	8.18 (2.86)
M3	YST,Ace ,Quin, Fenpo,Spi+Lam,Fenv.	4.47 (2.11)	5.37 (2.32)	11.04 (3.32)	6.96 (2.64)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2.34 (1.52)	2.73 (1.64)	9.19 (3.03)	4.75 (2.18)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	5.91 (2.42)	8.83 (2.97)	16.07 (4.00)	10.27 (3.20)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	1.12 (1.06)	2.33 (1.50)	8.23 (2.86)	3.89 (1.97)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	3.45 (1.85)	6.50 (2.55)	8.46 (2.91)	6.14 (2.48)
M8	Untreated control	20.81 (4.54)	24.67 (4.97)	31.99 (5.60)	25.82 (5.06)
	SE (m)±	0.14	0.11	0.21	0.12
	CD at 5%	0.42	0.35	0.64	0.38
	CV%	11.07	7.22	10.10	7.39

N.B: Figures in parenthesis are square root transformation

4.5.1.3 Mean mites population at 14 days after spray

It is seen from the data presented in Table 14 and depicted in Fig 6 revealed that the results were statistically significant. All the treatment modules were significantly superior over untreated module M8. The minimum incidence of mites was noticed in the best module M6 (8.23/leaf), followed by M7 (8.46 mites/leaf), M4 (9.19mites/leaf) and M2 (9.82 mites/leaf) and M3 (11.04 mites/leaf) and these treatments were found to be statistically at par among themselves and significantly superior over other remaining modules. The least effective module M5 and M1 had observed the mites incidence to the tune of 16.07/leaf and 16.29/leaf, respectively and they were statistically

at par with one another and superior to M8. The maximum mites incidence was noticed in untreated module M8 (31.99/leaf).

4.5.1.4 Cu. mean population of mites

The data presented in Table 14 and depicted in Fig 6 revealed that the results were statistically significant. All the treated module were significantly superior over the untreated module M8. The minimum incidence of mites (3.89/leaf) was recorded in best effective module M6 followed by module M4 (4.75/leaf) and both the treatments were at par with one another. Treatment M6 had shown the significantly superior effect over all the treatments except Module M4. The next effective module M7 had noticed the mite population to the tune of 6.14/leaf and it was found to be statistically as effective as that treatment module M4 and M7 was further to be statistically at par with module M3 (6.96/leaf) and module M2 (8.18/leaf). Of these M2 was further statistically at par with module M1 (9.26/leaf) and M5 (10.27/leaf). However, the maximum incidence of mites (25.82/leaf) was noticed in untreated module M8.

4.5.2 Effect of various modules on mean population of mites /leaf/ plant during Kharif 2015-16

4.5.2.1 Mean mites population at 3 days after spray

The data presented in Table 15 and depicted in Fig 6 revealed that the results were statistically significant. All the treated modules were significantly superior over untreated module. The least population of mites was recorded in best treatment module M6 (1.63/leaf), followed by module M7 (2.10/leaf), and M4 (2.35/leaf) and these treatments were statistically at par with each other. Of these the treatments M6 was found to significantly superior over rest of the treatments except M7 and M4. Whereas module M7 and M4 were further found to be at par with module M2 (2.87/leaf). The module M4 (2.35/leaf) was found statistically at par with M2 and M5 (3.30/leaf) in recording comparatively less population of mites. However least effective module M1 (3.37/leaf) was at par with M3 (3.30/leaf) M5 and M2 and superior over M8. The maximum population of mites was registered in unprotected module M8 (10.36/leaf).

Table: 15 Effect of various modules on cumulative mean population of mites on okra during *kharif* 2015-16

Tr. No.	Treatment details	Cum. Mean Mites population / leaf			Cum. pooled mean
		3 DAT	7 DAT	14 DAT	Based on five spray
M1	SA.YST,Azadirachtin 1%w/w	3.37 (1.83)	5.12 (2.26)	9.67 (3.09)	6.05 (2.46)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	2.87 (1.69)	5.08 (2.25)	10.00 (3.16)	5.99 (2.45)
M3	YST,Ace, Quin, Fenpo,Spi+Lam,Fenv.	3.30 (1.81)	4.53 (2.13)	9.97 (3.15)	5.93 (2.44)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2.35 (1.52)	3.93 (1.98)	6.93 (2.62)	4.40 (2.10)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	3.30 (1.80)	3.92 (1.96)	6.73 (2.59)	4.67 (2.16)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	1.63 (1.27)	2.73 (1.65)	7.06 (2.65)	3.80 (1.95)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	2.10 (1.44)	4.37 (2.09)	7.49 (2.74)	4.65 (2.16)
M8	Untreated control	10.36 (3.22)	12.23 (3.50)	16.02 (4.00)	12.87 (3.59)
	SE (m)±	0.09	0.10	0.13	0.05
	CD at 5%	0.28	0.31	0.41	0.17
	CV%	8.81	8.16	7.88	4.02

N.B: Figures in parenthesis are square root transformation

4.5.2.2 Mean mites population at 7 days after spray

It is evidenced from the data presented in Table 15 and depicted in Fig 6 that the results were statistically significant. All the treated modules were found significantly superior over untreated module M8 . The minimum population of mites was noted in treatment module M6 (2.73/leaf) followed by module M5 (3.92/leaf) and both the treatments were found to be statistically at par with one another. However, treatment M6 was significantly superior over rest of the treatments except module M5 whereas, the module M5 was observed to be further statistically at par with module M4 (3.93/leaf) M7 (4.37/leaf), M3 (4.53/leaf), M2 (5.08/leaf) and M1 (5.12/leaf). However, the

unprotected module M8 had exhibited the maximum population of mites (12.23/leaf).

4.5.2.3 Mean mites population at 14 days after spray

It is observed from the data presented in Table 15 and depicted in Fig 6 that the results were statistically significant. All the treatments were found significantly superior over untreated module M8. The minimum incidence of mites was recorded in module M5 (6.73/leaf) followed by module M4 (6.93 mites/leaf), M6 (7.06 mites/leaf) and M7 (7.49 mites/leaf) and these treatments were found statistically at par among themselves. Of these, treatment M5, M4 and M6 were found significantly superior over rest of the treatments except M7. The next effective module M7 (7.49 mites/leaf) was found to be statistically similar effective with that of module M1 (9.67 mites/leaf) and M3 (9.97 mites/leaf). The module M1 (9.67 mites/leaf) in second order of merit was found statistically at par with M3 (9.97 mites/leaf) and M2 (10.00 mites/leaf). The untreated module M8 had accounted the maximum mites incidence to the extent of 16.02/leaf.

4.5.2.4 Cu. mean population of mites

The data presented in Table 15 and depicted in Fig 6 revealed that the results were statistically significant. All the treated modules were found significantly superior over untreated module. The minimum incidence of mites was exhibited in treatment module M6 (3.80/leaf), followed by the treatment module M4 (4.40/leaf) and both the treatments were statistically equal effective. The treatment M6 was found significantly superior over rest of the treatments except M4. Whereas, the treatments module M4 was further statistically at par with M7 (4.65/leaf) and M5 (4.67/leaf). However, these modules in second order of merit *i.e.* M4, M7 and M5 were observed significantly superior over other remaining treatments. The other modules M3, M2 and M1 in further order of merit shown the mites incidence to the extent of 5.93, 5.99 and 6.05/leaf respectively, and they were statistically at par with each other. However, the maximum population of mites was recorded in unprotected module, (12.87/leaf).

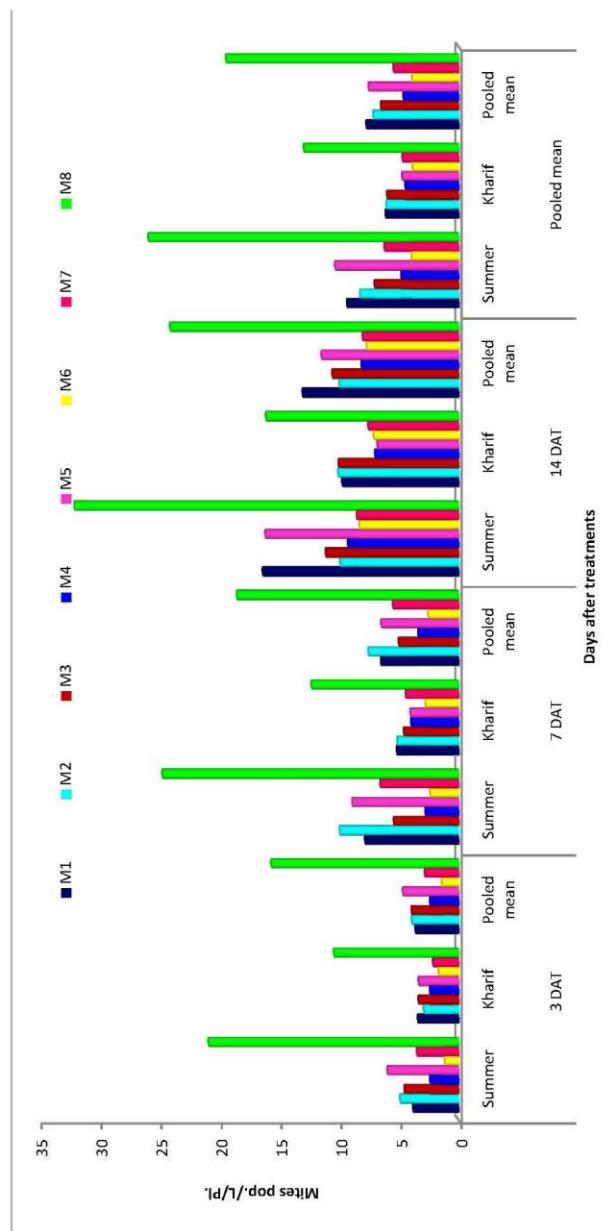


Fig- 6 Effect of various modules on comparative population of mites on okra during summer 2014-15 and kharif season 2015-16

4.5.3 Pooled effect of various modules on mean population of mites /leaf/ plant

4.5.3.1 Mean mites population at 3 days after spray

The data presented in Table 16 and depicted in Fig 6 evidenced that the results were statistically significant. All the treated modules were significantly superior over untreated module M8. The best effective module M6 (1.37/leaf) had shown the minimum incidence of mites and significantly superior over all other treatments. The second best module M4 exhibited the mite incidence to the tune of (2.35/leaf) and it was statistically at par with M7 (2.78/leaf) and it proved to be significantly superior over rest of the treatments except treatment M7. Module M7 was found further to be statistically at par with treatment M1 (3.56/leaf) but was significantly superior module M2, M3, M5 & M8. The next module in descending order is M2, M3, M5 were found equally effective as that of module M1 in recording comparatively less population of mites 3.86, 3.88 and 4.61/leaf respectively. However, the untreated module M8 exhibited the maximum incidence of mites (15.59/leaf).

4.5.3.2 Mean mites population at 7 days after spray

From the data presented in Table 16 and depicted in Fig 6 indicated that the results were statistically significant. All the treatment module were significantly superior over untreated module. The minimum incidence of mites was noticed in best effective module M6 (2.53/leaf) followed module M4 (3.33/leaf) and they were statistically at par with each other. The treated module M6 and M4 both emerged as most effective modules being significantly superior over rest of the treatments. The module M3, M7 and M5 in second order of merit had exhibited the mite population to the tune of 4.95/leaf, 5.44/leaf and 6.41/leaf, respectively and they were found to be at par with each other. However, of these, module M7 and M5 were further observed to be statistically at par with the module M1 (6.44/leaf). The least effective module M2 (7.48/leaf) had statistically similar effect to module M5 and M1.

Table: 16 Effect of various modules on comparative population of mites on okra during summer 2014-15 and *kharif* season 2015-16

Tr. No.	Treatment details	3 DAT			7 DAT			14 DAT			Pooled mean		
		Summer	Kharif	Pooled Mean	Summ er	Kharif	Pooled Mean	Summ er	Kharif	Pooled Mean	Summer	Kharif	Pooled Mean
M1	SA.YST,Azadirachtin 1%w/w	3.75 (1.93)	3.37 (1.83)	3.56 (1.88)	7.76 (2.79)	5.12 (2.25)	6.44 (2.52)	16.29 (4.03)	9.67 (3.09)	12.98 (3.56)	9.26 (3.04)	6.05 (2.46)	7.66 (2.75)
M2	ST,Dim, Quin ,Fenpo,Dico+Quin.	4.84 (2.20)	2.87 (1.69)	3.86 (1.94)	9.88 (3.13)	5.08 (2.25)	7.48 (2.69)	9.82 (3.13)	10.00 (3.16)	9.91 (3.15)	8.18 (2.86)	5.99 (2.45)	7.08 (2.65)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	4.47 (2.11)	3.30 (1.81)	3.88 (1.96)	5.37 (2.32)	4.53 (2.13)	4.95 (2.22)	11.04 (3.32)	9.97 (3.15)	10.50 (3.24)	6.96 (2.64)	5.93 (2.44)	6.45 (2.54)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2.34 (1.52)	2.35 (1.52)	2.35 (1.52)	2.73 (1.64)	3.93 (1.98)	3.33 (1.81)	9.19 (3.03)	6.93 (2.62)	8.06 (2.83)	4.75 (2.18)	4.40 (2.10)	4.58 (2.14)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	5.91 (2.42)	3.30 (1.80)	4.61 (2.11)	8.83 (2.97)	3.98 (1.96)	6.41 (2.47)	16.07 (4.00)	6.73 (2.59)	11.40 (3.29)	10.27 (3.20)	4.67 (2.16)	7.47 (2.68)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	1.12 (1.06)	1.63 (1.27)	1.37 (1.16)	2.33 (1.50)	2.73 (1.65)	2.53 (1.57)	8.23 (2.86)	7.06 (2.65)	7.64 (2.76)	3.89 (1.97)	3.80 (1.95)	3.85 (1.96)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin,, Lamb.	3.45 (1.85)	2.10 (1.44)	2.78 (1.65)	6.50 (2.55)	4.37 (2.09)	5.44 (2.32)	8.46 (2.91)	7.49 (2.74)	7.97 (2.82)	6.14 (2.48)	4.65 (2.16)	5.40 (2.32)
M8	Untreated control	20.81 (4.54)	10.36 (3.22)	15.59 (3.88)	24.67 (4.97)	12.23 (3.50)	18.45 (4.23)	31.99 (5.60)	16.02 (4.00)	24.01 (4.80)	25.82 (5.06)	12.87 (3.59)	19.35 (4.32)
	SE (m)±	0.14	0.09	0.08	0.11	0.10	0.08	0.21	0.13	0.13	0.12	0.05	0.07
	CD at 5%	0.42	0.28	0.24	0.34	0.31	0.25	0.63	0.41	0.38	0.37	0.17	0.21
	CV%	11.07	8.81	9.91	7.22	8.16	8.22	10.10	7.88	9.45	7.39	4.02	6.62

N.B: Figures in parenthesis are square root transformation

The maximum mite population to the extent of (18.45/leaf) was noticed in untreated module M8.

4.5.3.3 Mean mites population at 14 days after spray

The data presented in Table 16 and depicted in Fig 6 it is observed that the results were statistically significant. All the treatments were significantly superior over untreated module M8. The best effective module M6 had registered the minimum population of mites (7.64/leaf), followed by module M7 (7.97/leaf) and M4 (8.06/leaf) and they were found to be statistically at par with each other. The module M6 had exerted significantly superior effect over rest of the treatments except M7 and M4. The module M7 and M4 were found significantly superior over remaining treatments except M2. The treatment module M2 in second order of merit had accounted the mite population to the tune of 9.91/leaf and exerted the statistically similar effectiveness with those of module M7 and M4. However, it remained further statistically at par with the module M3 (10.50/leaf) and M5 (11.40/leaf). The least effective module M1 (12.98/leaf) was statistically at par with M3 and M5. The untreated control module M8 had exhibited the maximum mites population (24.01/leaf).

4.5.3.4 Pooled cu. mean population of mites

It is revealed from the data presented in Table 16 and depicted in Fig 6 that the results were statistically significant. All the treated modules were significantly superior over the untreated module M8. The best effective module M6 had registered the minimum incidence of mites (3.85/leaf), followed by module M4 (4.58/leaf) and both the treatments were statistically at par with one another. The treatment M6 had emerged as the most effective treatment being significantly superior over rest of the treatments except treatment M4. The treatment module M7 in second order of merit had observed the mites population of 5.40/leaf and it was statistically as similar effective as the module M4 and these treatments were significantly superior over other remaining modules. The other modules in next order of merits in descending orders viz, M3, M2, M5 and M1 had accounted the mites population to the extent of 6.45 /leaf, 7.08 /leaf, 7.47 /leaf and 7.66/leaf,

respectively. The maximum population of mites was noticed in the untreated control module M8 (19.35/leaf).

It is clear from the above findings that the treatment Module M6 and M4 were found to be significantly most effective in order of merit in minimizing the population of mites at 3,7, and 14 DAS during summer 2014-15 and kharif 2015-16 seasons. The module M7 was found to be significantly moderately effective. The other module M3, M2, M5 and M1 in third order of merit were found to be comparatively less effective in minimising the population of mites. Superiority of module M6 was due to the cumulative effect of imidacloprid 48FS @ 9ml/kg seed treatment, neem cake soil application @ 250kg/ha, YST and sequential four foliar application of cypermethrin, triazophos, fenpropathrin and acephate+ spiromesifen combination and module M4 due to five foliar application of triazophos, fenvalerate, quinalphos+spiromesifen, fenpropathrin and lambda-cyhalothrin

Present findings are in agreement with Singh et.al (2012b) who reported the use of neem cake @ 250 kg/ha before sowing was the most effective against shoot and fruit borer, *Earias vittella* F., yellow vein mosaic virus, *Bemisia tabaci* (Genn.) and red spider mite. Chinniah and Ali (2000 and Chinniah 2001) revealed that ethion (0.1 %) and fenpropathrin (0.01 %) were highly effective followed by carbosulfan (0.05 %) and bifenthrin (0.015 %). Wale and Chandele (2010) reported the superior efficacy of spiromesifen over acephate and dicofol in reducing the whitefly and mite in tomato. Efficacy of spiromesifen against mites also reported Sato et al. (2011), Saryazdi et al. (2013), Nauen et al. (2005), Jana and Somchoudhury (2006). Vijayalakshmi et al. (2015) reported that triazophos 0.08% was most effective against mites. Present findings of module M4 about efficacy of mites which was at par with module M6 in which impact of quinalphos in addition to triazophos, fenpropathrin and spiromesifen played important role in reducing mite population are in line with Ellora and Ray (2015) who reported that quinalphos (0.012 g a.i) afforded mostly cent per cent mortality of immature and adult mites over the other insecticide tested.

4.6.1 Effect of various modules on mean per cent infestation of shoot borer during summer 2014-15 (*Earias vittella*)

4.6.1. 1 Mean per cent infestation of shoot borer at 15 days after spray

From the data presented in Table 17 and depicted in Fig 7 revealed that the results were statistically significant. The best module M4 followed by module M6 (3.33 per cent) M7 (3.74 per cent) and M5 (5.02 per cent) in order of first merit recorded minimum infestation of shoot borer and they were statistically at par with each other.

Table 17: Mean per cent Infestation of Shoot & Fruit borer (SFB)
E. Vittella during Summer 2014-15

Tr. No.	Treatment details	% Inf.of SFB at early growth period		
		15DAS	30 DAS	Pooled mean
M1	SA.YST,Azadirachtin 1%w/w	9.15 (3.01)	9.35 (3.04)	9.25 (3.03)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	6.03 (2.43)	7.64 (2.75)	6.84 (2.60)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	8.21 (2.86)	8.30 (2.88)	8.26 (2.87)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	3.33 (1.77)	4.45 (2.07)	3.89 (1.94)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	5.02 (2.23)	5.20 (2.28)	5.11 (2.26)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	3.33 (1.81)	4.18 (2.02)	3.76 (1.93)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	3.74 (1.91)	4.92 (2.19)	4.33 (2.06)
M8	Untreated control	10.65 (3.26)	11.92 (3.44)	11.29 (3.36)
	SE (m)±	0.20	0.21	0.17
	CD at 5%	0.62	0.64	0.52
	CV%	14.89	14.25	12.05

N.B: Figures in parenthesis are square root transformation

These modules were significantly superior over rest of the treatments except treatments M2. However module M6 was superior to M3, M1 & M8 modules. The next effective module M2 had counted the per cent infestation of shoot and fruit borer to the extent of 6.03 and it had statistically

similar effectiveness with those of module M6, M7 and M5 and M2 modules was also in turn at par with M3 and M1. However, untreated control module M8 had recorded maximum infestation of shoot borer (10.65 %) and was statistically at par with module M3 (8.21%) and M1 (9.15 %).

4.6.1.2 Mean percent infestation of shoot borer at 30 days after spray

The data presented in Table 17 and depicted in Fig 7 revealed that the minimum infestation of Shoot and fruit borer was observed in module M6 (4.18 %), followed by M4 (4.45 %), M7 (4.92 %) and module M5 (5.20 %) and these four treatments were statistically at par with each other . The treated modules M6, M4, M7 and M8 were significantly superior over M2, M3, M1 and M8 modules. However module M6 and M4 was superior over all the remaining modules. The module M2 had counted the fruit borer infestation to the extent of 7.64 and it exerted statistically similar effectiveness with those of module M7 and M5. The module M3 (8.30%) and module M1 (9.35%) although, had appears statistically equal effective but they were found to be statistically ineffective as that of untreated module M8 which shown the maximum shoot borer infestation to the tune 11.92 per cent.

4.6.1.3 Pooled mean per cent infestation of Shoot borer (*Earias vittella*)

It is evident from the data presented in Table 17 and depicted in Fig 7 that the results were statistically significant. The module M6 (3.76%), M4 (3.89%), M7 (4.33%) and M5 (5.11%) were found significantly effective in first order of merit in recording the minimum infestation of shoot borer and superior over other remaining modules. However module M2 (6.84%) was statistically at par with module M5 (5.11%) and superior over M8. In turn M2 was also statistically at par M3 and M1. Whereas Module M3 (8.26%) and M1 (9.25%) were proved to be ineffective in recording minimum infestation of shoot borer in M6 and statistically equal to that of module M8 (11.29%).

4.6.2 Effect of various modules on mean per cent infestation of shoot borer during Kharif 2015-16 (*Earias vittella*)

4.6.2. 1 Mean per cent infestation of shoot borer at 15 days after spray

From the data presented in Table 18 and depicted in Fig 7 revealed that the results were found statistically significant. The best effective

module M6 and M7 had registered no infestation of shoot borer at 15 days after sowing, followed by module M2 (0.54 %) and M5 (0.56 %) and M4 (0.57 %) and these five treatments exerted the desirable equal effectiveness against shoot borer and appeared to be significantly superior over rest of the treatments. The next effective module M3 had accounted the shoot and fruit borer infestation to the extent of 4.46 per cent was further statistically at par with module M1 (5.42 %) and superior over module M8 which was statistically as ineffective as untreated control module (6.21 %).

Table 18: Mean Per cent Infestation of Shoot & Fruit borer (SFB)
***E. Vittella* during Kharif 2015-16**

Tr. No.	Treatment details	% Inf.of SFB at early growth period		
		15 DAS**	30 DAS*	Pooled mean
M1	SA,YST,Azadirachtin 1%w/w	5.42 (2.43)	9.93 (3.13)	7.67 (2.76)
M2	ST,Dim, Quin,Fenpo,Dico+Quin.	0.54 (1.00)	7.08 (2.65)	3.81 (1.95)
M3	YST,Ace, Quin, Fenpo, Spi+Lam,Fenv.	4.46 (2.22)	7.17 (2.68)	5.82 (2.41)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.57 (1.03)	3.22 (1.79)	1.90 (1.38)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.56 (1.00)	6.71 (2.57)	3.64 (1.90)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.00 (0.71)	2.64 (1.62)	1.32 (1.14)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.00 (0.71)	6.46 (2.53)	3.23 (1.79)
M8	Untreated control	6.21 (2.58)	11.08 (3.32)	8.64 (2.94)
	SE (m)±	0.11	0.18	0.10
	CD at 5%	0.35	0.55	0.30
	CV%	13.74	12.41	8.50

N.B: Figures in (*)indicates square root values.While (**) indicatessquare√x+0.5values

4.6.2.2 Mean per cent infestation of shoot borer at 30 days after spray

The data presented in Table 18 and depicted in Fig 7 indicated that the results were statistically significant. The best effective module M6 had recorded the minimum incidence of shoot borer (2.64%) which was statistically at par with module M4 (3.22%).These module were significantly

superior over rest of the treatments. Similarly the second effective module M7 had also exerted significantly superior effects over M1 and M8 which accounted the shoot borer infestation to the tune of 6.46 and was observed statistically as effective as module M5 (6.71 %) module M2 (7.08%) and module M3 (7.17 %). Of these, the later two modules *i.e.* M2 and M3 were further statistically at par with module M1 (9.93 per cent) which was statistically as ineffective as untreated module (11.08 %).

4.6.2.3 Cumulative mean per cent infestation of Shoot borer

The data presented in Table 18 and depicted in Fig 7 revealed that the results were statistically significant. The minimum infestation of shoot borer was recorded in Module M6 (1.32 %) followed by module M4 (1.90 %) were found to be statistically at par with each other and superior over all other remaining treatments in recording minimum infestation of shoot borer. Module M7, M5 and M2 in second order of merit had shown comparatively less infestation of shoot borer and *i.e.* (3.23 %), (3.64 %) and (3.81%), respectively and they were statistically at par with each other and these treatments were significantly superior over other rest of the modules *viz.*, M3, M1 and M8. The treatment module M3 had exhibited the shoot borer infestation to the extent of 5.82 per cent and superior over M1 and M8. The module M1 (7.67 %) was observed to be statistically as ineffective as untreated control module (8.64 %).

4.6.3 Pooled effect of various modules on mean per cent infestation of shoot borer (*Earias vittella*)

4.6.3.1 Mean per cent infestation of shoot borer at 15 days after spray

It is indicated from data presented in Table 19 and depicted in Fig 7 that the results regarding the effect of various treatments on the infestation of shoot borer was statistically significant. The minimum infestation of shoot borer was observed in module M6 (1.67 per cent), followed by M7 (1.87 per cent) and M4 (1.90 per cent) and they were found to be statistically at par with each other. Of these treatments M6 and M7 were significantly superior over all the treatments except M4. The treatment M4 had also showed significantly superior effect over rest of the treatments except M5.

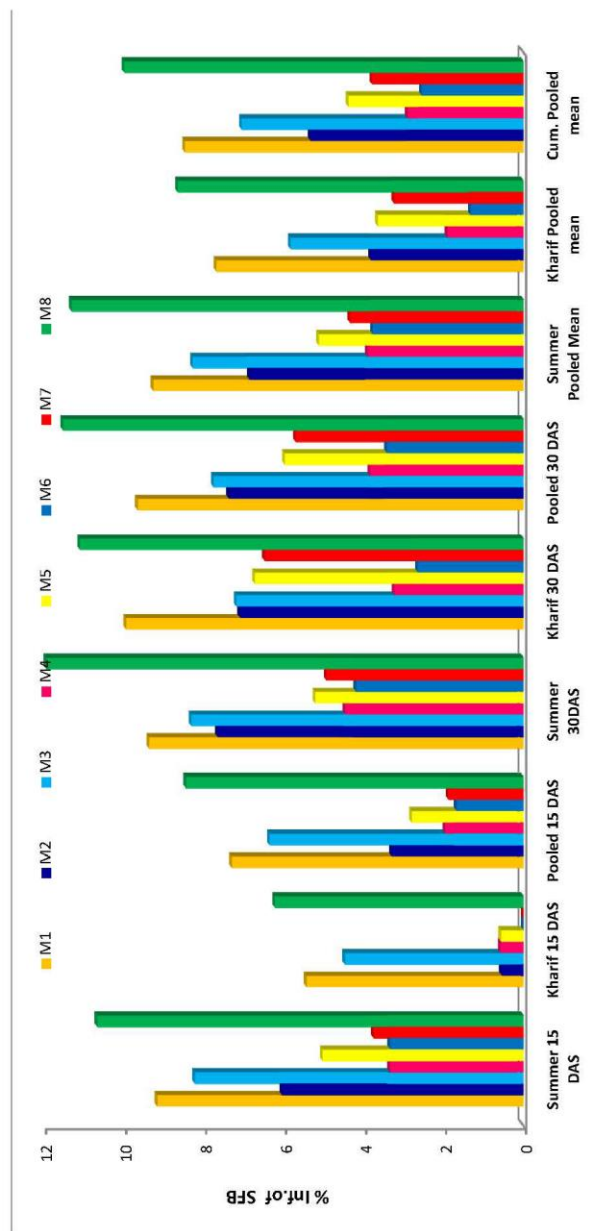


Fig. 7 Effect of various modules on per cent infestation of Shoot & Fruit Borer (*E.vittella*) on Okra during summer 2014-15 and *kharif* 2015-16

Module M5 in second order of merit had accounted the shoot borer infestation to the tune of 2.79 per cent and was statistically equal effective as that of treatment module M4. Similarly, module M2 (3.29%) infestation had exerted the statistically equal effect with module M5 and it appeared significantly superior over other remaining modules M3, M1 and M8. The module M3 had shown the shoot borer infestation to the extent of 6.34 per cent and followed by module M1 (7.29%) which was statistically as ineffective as module M8 (8.43%) which observed the highest infestation of shoot borer.

4.6.3.2 Mean per cent infestation of shoot borer at 30 days after spray

The data presented in Table 19 and depicted in Fig 7 revealed that the results were statistically significant. The minimum infestation of shoot borer was recorded in module M6 (3.41 %), followed by M4 (3.83 %) and both the treatments were at par with one another. The treatment M6 was found significantly superior over all the treatments except M4. Similarly treated module M4 which emerged as the second best modules had also exhibited significantly superior over remaining treatments except Module M7. Module M7 (5.69%) in second order of merit had exhibited statistically similar effectiveness as that of module M4, but it remained further statistically at par with module M5 (5.96 %), M2 (7.36 %) and Module M3 (7.74 %). However, module M1 (9.64%) was statistically as ineffective as the untreated control which shown the maximum (11.50 %) infestation of shoot borer.

4.6.3.3 Cum. Pooled mean per cent infestation of Shoot borer

It is observed from data of pooled mean as presented in Table 19 and depicted in Fig 7 that the results were statistically significant. The minimum infestation of shoot borer was recorded in the treatment module M6 (2.54 %), followed by M4 (2.89 %) and these two treatments were statistically at par with one another.

Table 19: Effect of various modules on per cent infestation of Shoot & Fruit Borer (*E.vittella*) on Okra during summer 2014-15 and *kharif* 2015-16

Tr.No.	Treatment details	% Inf.of SFB at early growth period								
		Summer 15DAS*	Kharif 15 DAS**	Pooled 15 DAS	Summer 30 DAS*	Kharif 30 DAS*	Pooled 30 DAS	Summer Pooled mean	Kharif Pooled mean	Cum. Pooled mean
M1	SA.YST,Azadirachtin 1%w/w	9.15 (3.01)	5.42 (2.43)	7.29 (2.72)	9.35 (3.04)	9.93 (3.13)	9.64 (3.09)	9.25 (3.03)	7.67 (2.76)	8.46 (2.90)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	6.03 (2.43)	0.54 (1.00)	3.29 (1.71)	7.64 (2.75)	7.08 (2.65)	7.36 (2.70)	6.84 (2.60)	3.81 (1.95)	5.32 (2.28)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	8.21 (2.86)	4.46 (2.22)	6.34 (2.54)	8.30 (2.88)	7.17 (2.68)	7.74 (2.78)	8.26 (2.87)	5.82 (2.41)	7.04 (2.64)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	3.33 (1.77)	0.57 (1.03)	1.95 (1.40)	4.45 (2.07)	3.22 (1.79)	3.83 (1.93)	3.89 (1.94)	1.90 (1.38)	2.89 (1.66)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	5.02 (2.23)	0.56 (1.00)	2.79 (1.62)	5.20 (2.28)	6.71 (2.57)	5.96 (2.42)	5.11 (2.26)	3.64 (1.90)	4.37 (2.08)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	3.33 (1.81)	0.00 (0.71)	1.67 (1.26)	4.18 (2.02)	2.64 (1.62)	3.41 (1.82)	3.76 (1.93)	1.32 (1.14)	2.54 (1.54)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	3.74 (1.91)	0.00 (0.71)	1.87 (1.31)	4.92 (2.19)	6.46 (2.53)	5.69 (2.36)	4.33 (2.06)	3.23 (1.79)	3.78 (1.92)
M8	Untreated control	10.65 (3.26)	6.21 (2.58)	8.43 (2.92)	11.92 (3.44)	11.08 (3.32)	11.50 (3.38)	11.29 (3.36)	8.64 (2.94)	9.97 (3.15)
	SE (m)±	0.20	0.11	0.10	0.21	0.18	0.15	0.17	0.10	0.11
	CD at 5%	0.62	0.35	0.30	0.64	0.55	0.45	0.52	0.30	0.32
	CV%	14.89	13.74	12.6	14.25	12.41	14.45	12.05	8.50	11.48

N.B: Figures in (*) indicates square root values.While (**)) indicates square√x+0.5values

Of these, module M6 was significantly superior over all the treatment except treatment M4. Similarly treatment module M4 had also exhibited the significantly superior over rest of the treatments except treatment M7. The second best effective module M7 had noticed the shoot borer infestation to the extent of 3.78 per cent and it has exerted the statistically similar effectiveness as that of module M4. However, Module M7 was further statistically at par with M5 (4.37 %). The next effective in order of merit module M2 had observed the shoot borer infestation to the tune of 5.32 per cent and it showed the statistically similar effect as that of module M5. Module M7, M5 and M2 were significantly superior over module M3, M1 and untreated module M8. The Module M3 and M1 had counted the shoot borer infestation to the extent of 7.04 and 8.46 per cent, respectively, and they were at par with each other. However, module M1 was statistically as ineffective as that of untreated module M8 which counted the highest (9.97%) shoot and fruit borer infestation.

It is clear above pooled result that the treatment module M6 was found significantly superior over all other modules and statistically at par with module M4 (2.89%) in minimizing shoot borer infestation to the extent of 2.54 % . Module M7 was found moderately effective in reducing the shoot borer infestation to the extent of 3.78 per cent and at par with module M5 (4.73 %). Module M1 was found ineffective as that of module M8.

Module M6 and M4 were found most effective in reducing the shoot borer *E.vittella* infestation due to cumulative effect of seed treatment imidacloprid 48FS @ 9ml/Kg and soil application of neem cake @250kg/ha in module M6 and foliar application of triazophos @ 2ml/L in module M4.

4.7.1 Effect of various modules on mean per cent infestation of fruit borer on number basis during summer 2014-15

4.7.1.1 Mean per cent infestation of fruit borer, *Earias.Vittella*

The data presented in Table 20 and depicted in Fig 8 revealed that the results were found statistically significant. All the treatments modules were significantly superior over untreated module M8. The module M6 had registered the minimum infestation of *E.vittella* fruit borer to the tune of (6.37 %) followed by M4 (7.38 %), M7 (8.25 %) and these modules were found to

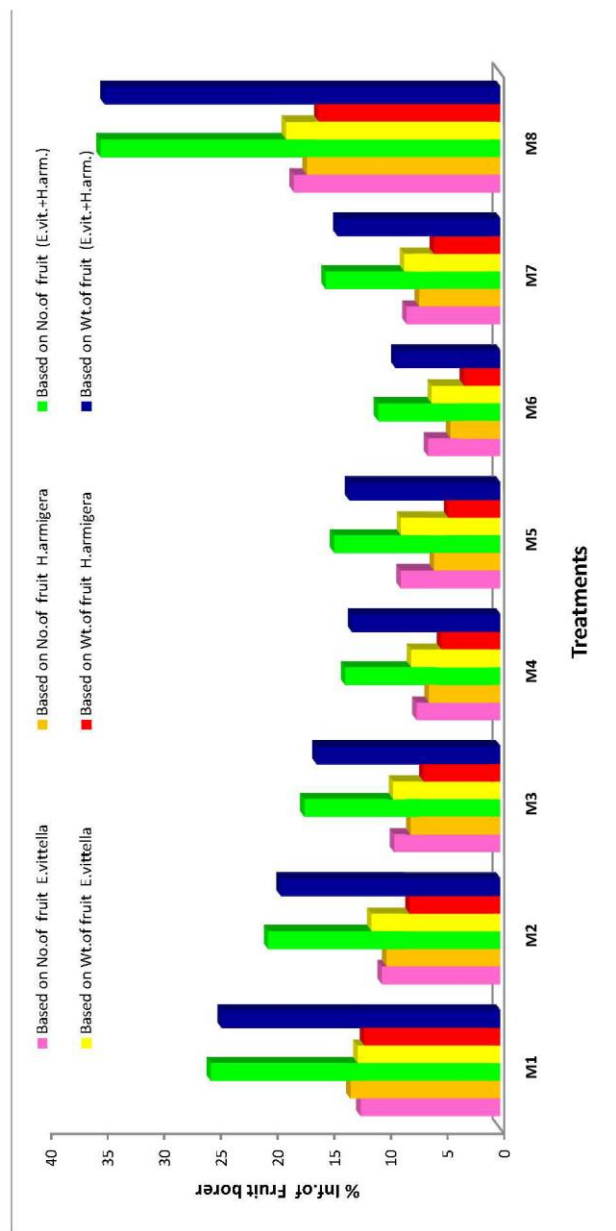


Fig. 8 Effect of various modules on per cent infestation of fruit Borer (*E.vit. + Harmig.*) on Okra based on number and weight of fruit during Summer 2014-15

be statistically at par with each other. Of these modules M6 had exerted significantly superior effect over remaining treatments except M4 and M7. The Module M4 and M7 were further found statistically at par with module M5 (8.79%) and M3 (9.37%). The module M2 had shown (10.45 %) fruit borer infestation statistically similar effectiveness with module M7 and M5 and M3 but it was further found to be statistically at par with M1 (12.32 %). The highest (18.21 %) fruit borer infestation was noticed in the untreated module M8.

4.7.1.2 Mean per cent infestation of fruit borer, *H. armigera*

It is evident from the data presented in Table 20 and depicted in Fig 8 that the results were found statistically significant. All the treated module were significantly superior over untreated module M8. The module M6 was found significantly superior over all other remaining treatments in recording minimum infestation of fruit borer *H. armigera* (4.40%) and at par with module M5 (5.85%) and M4 (6.31 %). The treatment module M7 and M3 had recorded the fruit borer infestation to the extent of 7.15 and 7.91 per cent respectively and they had exerted statistically similar effectiveness as that of Module M5 and Module M4. Treatment module M2 had shown the fruit borer infestation of (10.04 %) and it was statistically similar effective as module M3. The module M1 had accounted the fruit borer infestation of 13.23 per cent and superior to M8 and the highest per cent infestation was recorded in untreated module 17.08 per cent.

Table :20 Effect of various modules on per cent infestation of fruit Borer (*E.vit.* + *H.armig.*)on Okra based on number and weight of fruit during Summer 2014-15

Tr.No.	Treatment details	% Inf.of Fruit borer					
		Based on No.of fruit			Based on Wt.of fruit		
		<i>E.vittella</i> *	<i>H.armigera</i> *	Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**	<i>E.vittella</i> *	<i>H.armigera</i> *	Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**
M1	SA.YST,Azadirachtin 1%w/w	12.32 (3.51)	13.23 (3.62)	25.54 (30.30)	12.60 (3.55)	11.99 (3.41)	24.58 (29.66)
M2	ST,Dim, Quin ,Fenpo,Dico+Quin.	10.45 (3.23)	10.04 (3.17)	20.49 (26.91)	11.36 (3.37)	8.00 (2.83)	19.36 (26.10)
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	9.37 (3.06)	7.91 (2.81)	17.28 (24.55)	9.45 (3.07)	6.76 (2.60)	16.21 (23.73)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	7.38 (2.72)	6.31 (2.51)	13.69 (21.72)	7.87 (2.80)	5.20 (2.28)	13.07 (21.19)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	8.79 (2.96)	5.85 (2.42)	14.65 (22.49)	8.76 (2.89)	4.57 (2.14)	13.33 (21.20)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	6.37 (2.51)	4.40 (2.10)	10.77 (19.12)	6.05 (2.46)	3.18 (1.78)	9.23 (17.69)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	8.25 (2.85)	7.15 (2.64)	15.40 (22.92)	8.48 (2.91)	5.87 (2.42)	14.35 (22.25)
M8	Untreated control	18.21 (4.26)	17.08 (4.13)	35.29 (36.44)	18.90 (4.35)	16.03 (4.00)	34.93 (36.22)
	SE (m)±	0.13	0.13	1.05	0.16	0.16	1.04
	CD at 5%	0.42	0.41	3.20	0.50	0.49	3.17
	CV%	7.65	8.08	7.17	9.14	10.55	7.33

N.B: Figures in(*) indicates square root values. While (**) indicates Arc sign transformation

4.7.1.3 Cu.mean per cent infestation of fruit borer (*E.vittella* + *H.armigera*)

The data presented in Table 20 and depicted in Fig 8 that the results were statistically significant. All the treated module were significantly superior over untreated module M8. The lowest per cent infestation of fruit borer was exhibited in treatment M6 (10.77%), followed by M4 (13.60 %) and both the treatments were statistically at par with one another. The treatment M6 was found to be the most effective module in minimizing the fruit borer infestation and proved to be significantly superior over all the treatment except module M4. Treatment module M5, M7 and M3 had accounted the per cent infestation of fruit borer to the extent of 14.65, 15.40 and 17.28 % and these treatments had exerted the statistically similar effectiveness with that of Module M4. However, of these module M3 was further statistically at par with module M2 which accounted the fruit infestation of 20.49 per cent. The least effective module M1 had noticed the fruit borer infestation to the extent of 20.54. as against the untreated module which exhibited the maximum fruit borer infestation to the extent of 35.29 per cent.

4.7.2 Effect of various modules on mean per cent infestation of fruit borer on weight basis during summer 2014-15

4.7.2.1 Mean per cent infestation of fruit borer, *Earias.vittella*

The data presented in Table 20 and depicted in Fig 8 evidenced that the results were statistically significant. All the treated modules were significantly superior over untreated module. The minimum incidence of fruit borer on weight basis was noticed in treated module M6 (6.05 %), followed by module M4 (7.87%), M5 (8.76%) and M7 (8.48%) and these four treatments were statistically at par among themselves. The module M6 was most effective and significantly superior over rest of the treatments except M4, M5 and M7. The treatments M4, M5 and Module M7 were further found to be statistically at par with module M3 (9.45 %). The module M2 had exhibited fruit borer infestation to the extent of 11.36 per cent and it was found to be statistically similar effective to those of M5, M7 and M3. The least effective module M1 had accounted the fruit borer infestation to the extent of 12.60 per cent and it was statistically equal to those of module M3 and M2. The



Shoot and Fruit Borer (*Earias vittella* Fabricius)



Fruit borer (*Helicoverpa armigera* Hubner)

Plate 4 Okra shoot & fruit infested by fruit borer

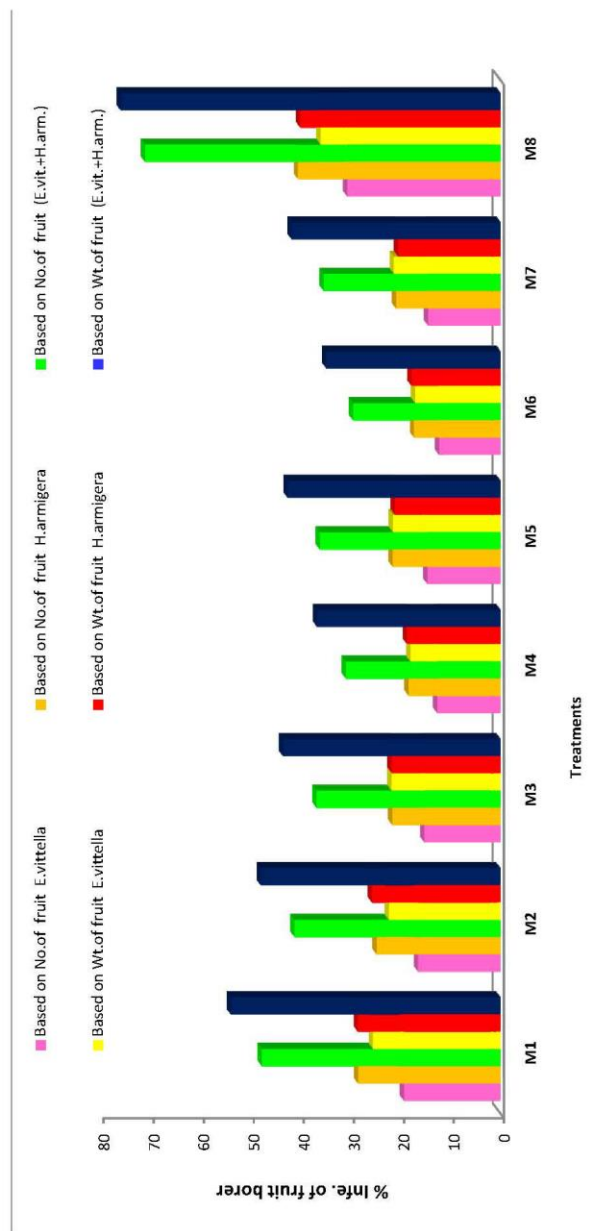


Fig. 9 Effect of various modules on per cent infestation of fruit borer (*E.vit. + H. armig.*) on okra based on number and weight of fruit during Kharif 2015-16

maximum infestation of fruit borer was noticed in the untreated module M8 (18.90 %).

4.7.2.2 Mean per cent infestation of fruit borer, *H.armigera*

It is indicated from the data presented in Table 20 and depicted in Fig 8 that the results were statistically significant. All the treatments were significantly superior over untreated module M8. The minimum infestation of fruit borer *H. armigera* was registered in treatment module M6 (3.18%), followed by M5 (4.57 %) and they were at par with one another. The treated module M6 had emerged as the most effective treatment against infestation of *H. armigera* being significantly superior over rest of the treatments except treatment M5. The treatment module M4, M7 and M3 in second order of merit had exhibited the fruit borer infestation to the tune of 5.20, 5.87 and 6.76 per cent, respectively and they exerted the statistically similar effectiveness as that of module M5. The treatment module M2 had noticed the fruit borer infestation to the tune of 8.00 per cent and it was statistically as equal as M7 and M3. The least effective module M1 had accounted the fruit borer infestation to the extent of 11.99 %. The maximum infestation of fruit borer was observed in untreated control module (16.03 %).

4.7.2.3 Cu.mean per cent infestation of fruit borer (*E. vittella* + *H. armigera*)

The data presented in Table 20 and depicted in Fig 8 that the effect of various treatments on the fruit borer complex revealed that the results were found statistically significant. All the treatments were significantly superior over untreated control module. The minimum (9.23%) infestation of fruit borer complex was recorded in treatment module M6 and it was found significantly superior over all the treatments. The second best module M4 accounted the fruit borer infestation to the tune of 13.07 per cent, and was statistically at par with module M5, M7 and M3 which registered the fruit borer infestation to the extent of 13.33, 14.35 and 16.21 per cent, respectively. The treatment module M2 had observed the fruit borer infestation to the tune of 19.36 per cent and this treatment was statistically similar with treatment module M3. The least effective module M1 had accounted the fruit borer infestation to the extent of 24.58 per cent. Whereas the highest fruit borer infestation was noticed in untreated module (34.93 %).

Table: 21 Effect of various modules on per cent infestation of fruit borer (*E.vit.* + *H.armig.*) on okra based on number and weight of fruit during *kharif* 2015-16

Tr.No.	Treatment details	% Inf.of Fruit borer					
		Based on No.of fruit			Based on Wt.of fruit		
		<i>E.vittella</i> *	<i>H.armigera</i> *	Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**	<i>E.vittella</i> *	<i>H.armigera</i> *	Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**
M1	SA.YST,Azadirachtin 1%w/w	19.21 (25.98)	28.38 (32.18)	47.59 (43.62)	25.38 (30.25)	28.39 (32.19)	53.77 (47.16)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	16.39 (23.85)	24.66 (29.76)	41.06 (39.83)	22.25 (27.99)	25.56 (30.36)	47.81 (43.73)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	15.13 (22.89)	21.52 (27.60)	36.65 (37.24)	21.72 (27.77)	21.65 (27.72)	43.37 (41.19)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	12.54 (20.72)	18.25 (25.29)	30.79 (33.70)	17.95 (25.06)	18.59 (25.54)	36.54 (37.19)
M5	SA,YST,Thia, Fenpo,Lamb,Tria+Dico	14.53 (22.38)	21.49 (27.60)	36.02 (36.88)	21.43 (27.47)	21.01 (27.26)	42.43 (40.63)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	12.20 (20.43)	17.19 (24.44)	29.38 (32.81)	16.99 (24.28)	17.69 (24.79)	34.68 (36.04)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin, Lamb.	14.39 (22.29)	20.81 (27.05)	35.21 (36.37)	21.22 (27.42)	20.40 (26.83)	41.62 (40.17)
M8	ntreated control	30.54 (33.49)	40.36 (39.44)	70.91 (57.48)	35.88 (36.80)	39.93 (39.15)	75.81 (60.67)
	SE (m)±	0.87	1.13	1.28	1.3	0.12	1.66
	CD at 5%	2.66	3.45	3.90	4.11	3.39	5.03
	CV%	6.33	6.76	5.61	8.28	6.64	6.64

N.B: Figures in(*) indicates square root values. While (**) indicates Arc sign transformation

4.8.1 Effect of various modules on mean per cent infestation of fruit borer on number basis during Kharif 2015-16

4.8.1.1 Mean per cent infestation of fruit borer, *Earias.vittella*

From the data presented in Table 21 and depicted in Fig 9 revealed that the results were statistically significant. All the treated module were significantly superior over untreated module M8. The treated module M6 had recorded the minimum infestation of shoot and fruit borer (12.20 %) on number basis and followed by module M4 (12.54 %) M7 (14.39 %) M5 (14.53 %) and M3(15.13 %) and these five treatments were found to be statistically at par with each other. Of these, module M6 and M4 were significantly superior over rest of the treatments, except M7, M5 and M3. The next effective module M2 had exhibited the fruit borer infestation to the extent of 16.39 % and it was found to be statistically similar effective with treatment module M7, M5 and M3. However, this module M2 was further statistically at par with M1 which noted the fruit borer infestation to the tune of 19.21 % and found least effective module. The maximum (30.54 %) fruit borer infestation was observed in untreated module M8.

4.8.1.2 Mean per cent infestation of fruit borer, *H. armigera*

The data presented in Table 21 and depicted in Fig 9 indicated that the results were statistically significant. All the treated modules were significantly superior over untreated module M8. The lowest infestation of *H.armigera* was observed in treatment module M6 (17.19 %) and it was followed by module M4 (18.25 %) M7 (20.81 %) and M5 (21.49 %) and M3 (21.52 %) and they were statistically at par with each other. Of these module M6 and M4 were found best and significantly superior over M2,M1 and M8. The treatment module M2 had accounted the fruit borer infestation to the tune of 24.66 per cent was statistically similar effective as those of M7, M3 and M5. Least effective module .M1 noted the fruit borer infestation to the extent of 28.38 per cent and it was found to be statistically similar effective with M2 whereas the treatment module M8 had recorded the maximum infestation of fruit borer 40.36 per cent.

4.8.1.3 Cu. mean per cent infestation of fruit borer (*E. vittella* + *H. armigera*)

It is observed from the data presented in Table 21 and depicted in Fig 9 that the results were found statistically significant. All the treated module were significantly superior over untreated control module. The minimum infestation of fruit borer was recorded in module M6 (29.38%), followed by module M4 (30.79 %) and module M7 (35.21 %) and they were found to be statistically at par with each other. Of these, treatment M6 was found to be most effective and significantly superior over all the treatments except M4 and M7. The module M5 and M3 in second order of merit had registered the fruit borer infestation to the extent of 36.02 and 36.65 per cent respectively and these two treatments exhibited statistically similar effectiveness with those of Module M4 and M7. Similarly the treatment module M2 had statistically (41.06 %) similar effectiveness with Module M7, M5 and M3. However, module M2 was further found statistically at par with least effective module M1 which accounted the fruit borer infestation to the tune of 47.59 per cent as against the highest (70.91 %) fruit borer infestation was recorded in untreated module M8.

4.8.2 Effect of various modules on mean per cent infestation of fruit borer on weight basis during Kharif 2015-16

4.8.2.1 Mean per cent infestation of fruit borer, *Earias.vittella*

The data presented in Table 21 and depicted in Fig 9 indicated that the results were statistically significant. All the treatments were significantly superior over untreated module. The module M6 and module M4 were in order of merit was found significantly superior over module M1 and M8 in recording minimum infestation of fruit borer on weight basis (16.99 %) and (17.95 %) and significantly at par with M4 (17.95 %), M7 (21.22%), M5 (21.43%), M3 (21.72%) and M2 (22.25%). The least effective module M1 had exhibited the fruit borer infestation to the tune of 25.38 per cent and it was statistically as effective as module M7, M5, M3 and M2. However, the maximum fruit borer infestation was observed in untreated module M8 (35.88 %).

4.8.2.2 Mean per cent infestation of fruit borer, *H. armigera*

From the data presented in Table 21 and depicted in Fig 9 observed that the results were found statistically significant. All the treated modules were significantly superior over untreated module M8. The module M6 M4 and M7 in first order of merit were found significantly superior over M2, M1 and M8 module in recording minimum infestation of fruit borer of *H. armigera* to the tune of (17.69 %), (18.59 %) and (20.40 %) and they were statistically at par with M5 (21.01 %) and M3 (21.65 %). The next effective module M2 had shown the fruit borer infestation to the extent of 25.56 per cent and it shown statistically equal effect to treatment module M5 and M3. Least effective module M1 had accounted the fruit borer infestation to the tune of 28.39 per cent & it was statistically as equal effective as treatment module M2. The untreated module M8 recorded the maximum fruit borer infestation (39.93 %).

4.8.2.3 Cu.mean per cent infestation of fruit borer(*E. Vittella* + *H .armigera*)

It is evident from the data presented in Table 21 and depicted in Fig 9 that the result were statistically significant. All the modules were significantly superior over untreated module. The treatment module M6 was found significantly superior over module M3, M2, M1 and M8 in recording infestation found borer complex (34.68 %) and was statistically at par with M4 (36.54%), M7 (41.62%) and M5 (42.43%) and next modules in second order of merit M3 was found statistically at par with M5,M7 and M4 in recording comparatively lowest infestation of fruit borer complex (43.37%). Further module M2 (47.81%) was statistically at par with module M3, M5 and M7 in recording lowest infestation of fruit borer complex ((47.81%) and at par to M1 & M8. However, module M2 was further statistically at par with module M1 which noticed the fruit borer infestation of 53.77 per cent. Whereas, the untreated module M8 had recorded the maximum infestation of fruit borer complex to the extent of 75.81 per cent.

4.7.3 Pooled effect of various modules on mean per cent infestation of fruit borer on number basis

4.7.3.1 Mean per cent infestation of fruit borer, *E. vittella*

It is evidenced from the data presented in Table 22 and depicted in Fig 10 that the results were statistically significant. All the treated modules were significantly superior over untreated module. The minimum infestation of fruit borer was recorded in Module M6 (9.28 %), followed by Module M4 (9.96 %), M7 (11.32%) and M5 (11.66 %) and these four treatments were found to be statistically at par with each other. Module M6 was found highly effective and significantly superior over module M3, M2, M1 and M8. The treatment module M3 had noted 12.25 per cent infestation of fruit borer and was found statistically similar effective as those of that of M4, M7 and M5. The treatment module M2 had registered the fruit borer infestation to the tune of 13.42 per cent and was found to be statistically equally effective with module M7, M5 and M3. Least effective Module M1 had observed the fruit borer infestation of 15.76 per cent and was found statistically equal with M2. The maximum fruit borer infestation was noticed in untreated module M8 (24.37 %).

4.7.3.2 Mean per cent infestation of fruit borer, *H.armigera*

The data presented in Table 22 and depicted in Fig 10 revealed that the results were statistically significant. All the treated modules were significantly superior over untreated module. The minimum incidence of *H.armigera* was recorded in module M6 (10.79 %), followed by M4 (12.28%) , M7 (13.98 %) and M5 (13.67 %) and they were found to be statistically at par among themselves. Of these module M6 was found best effective and significantly superior over rest of the treatments except treatment M4, M7 and M5. The next effective module M3 had exhibited the fruit borer infestation to the tune of 14.71 per cent and was found to be statistically similar effective with those of M4, M7 and M5. The module M2 had accounted the fruit borer infestation to the tune of 17.35 per cent and it had shown the statistically similar effectiveness as those of module M7, M5 and M3.

Table : 22 Effect of various modules on per cent infestation of fruit borer (*E.vit.* + *H.armig.*) on Okra based on number of fruit (Pooled mean)

Tr.No.	Treatment details	% Inf.of Fruit borer based on number basis								
		<i>E.vittella</i> *			<i>H.armigera</i> *			Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**		
		Summer	Kharif	Pooled	Summer	Kharif	Pooled	Summer	Kharif	Pooled
M1	SA.YST,Azadirachtin 1%w/w	12.32 (3.51)	19.21 (25.98)	15.76 (14.74)	13.23 (3.62)	28.38 (32.18)	20.80 (17.90)	25.54 (30.30)	47.59 (43.62)	36.57 (36.96)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	10.45 (3.23)	16.39 (23.85)	13.42 (13.54)	10.04 (3.17)	24.66 (29.76)	17.35 (16.46)	20.49 (26.91)	41.06 (39.83)	30.77 (33.38)
M3	YST,Ace ,Quin, Fenpo,Spi+Lam,Fenv.	9.37 (3.06)	15.13 (22.89)	12.25 (12.97)	7.91 (2.81)	21.52 (27.60)	14.71 (15.21)	17.28 (24.55)	36.65 (37.24)	26.96 (30.90)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	7.38 (2.72)	12.54 (20.72)	9.96 (11.72)	6.31 (2.51)	18.25 (25.29)	12.28 (13.90)	13.69 (21.72)	30.79 (33.70)	22.24 (27.71)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	8.79 (2.96)	14.53 (22.38)	11.66 (12.67)	5.85 (2.42)	21.49 (27.60)	13.67 (15.01)	14.65 (22.49)	36.02 (36.88)	25.33 (29.69)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	6.37 (2.51)	12.20 (20.43)	9.28 (11.48)	4.40 (2.10)	17.19 (24.44)	10.79 (13.27)	10.77 (19.12)	29.38 (32.81)	20.08 (25.97)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin,, Lamb.	8.25 (2.85)	14.39 (22.29)	11.32 (12.57)	7.15 (2.64)	20.81 (27.05)	13.98 (14.84)	15.40 (22.92)	35.21 (36.37)	25.30 (29.65)
M8	Untreated control	18.21 (4.26)	30.54 (33.49)	24.37 (18.87)	17.08 (4.13)	40.36 (39.44)	28.72 (21.79)	35.29 (36.44)	70.91 (57.48)	53.10 (46.96)
	SE (m)±	0.13	0.87	0.44	0.13	1.13	0.59	1.05	1.28	0.88
	CD at 5%	0.42	2.66	1.33	0.41	3.45	1.78	3.20	3.90	2.67
	CV%	7.65	6.33	7.97	8.08	6.76	8.99	7.17	5.61	6.61

N.B: Figures in(*) indicates square root values. While (**) indicates Arc sign transformation

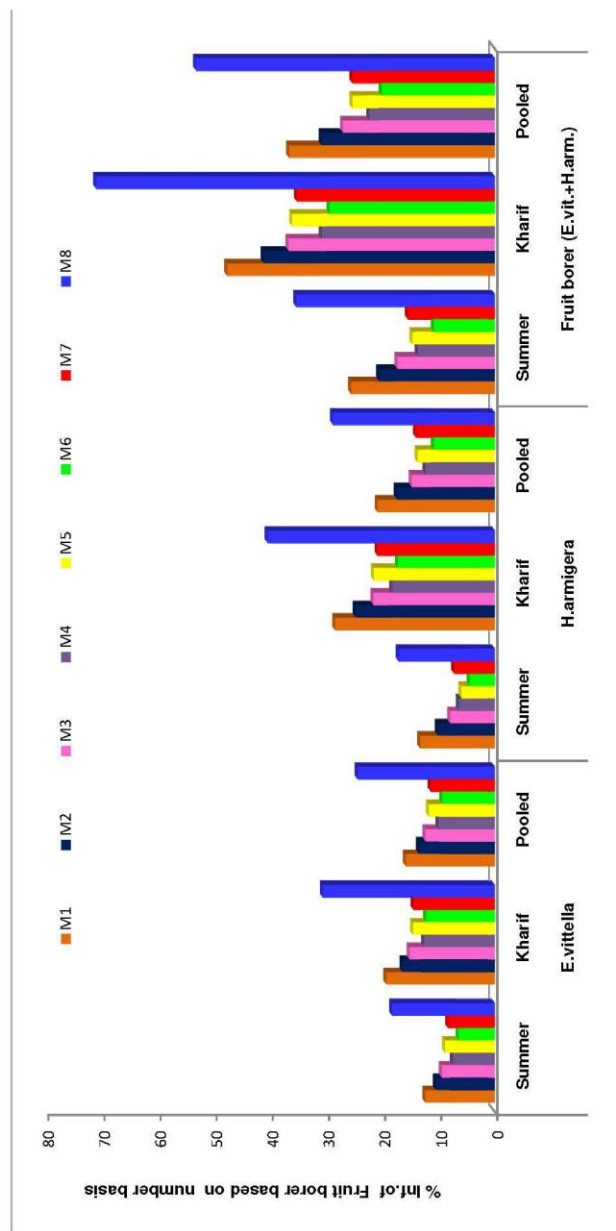


Fig.10 Effect of various modules on per cent infestation of fruit borer (*E.vit.* + *H.armig.*) on okra based on number of fruit (Pooled mean)

The least effective module M1 had observed the fruit borer infestation to the extent of 20.80 per cent and was statistically at par with M2. However, the untreated control module M8 had exhibited the highest fruit borer infestation (28.72%).

4.7.3.3 Pooled Cu.mean per cent infestation of fruit borer (*E. vittella* + *H. armigera*)

The data presented in Table 22 and depicted in Fig 10 revealed that the results were statistically significant. All the treated modules were significantly superior over untreated module M8. The minimum fruit borer infestation was noted in treatment Module M6 (20.08 %), followed by M4 (22.24 %) and both the treatments were found statistically at par with one another. The M6 emerged as the most effective module, being significantly superior over all the treatment except M4, which appeared to be the second best module against fruit borer infestation. Treatment module M7 and M5 exhibited the fruit borer infestation to the extent of 25.30 per cent and 25.33 per cent, respectively, and they were proved to be statistically equal effective to module M4. The treatment M3 had accounted the fruit borer infestation to the tune of 26.96 per cent and it observed to be statistically similar effectiveness with M7 and M5. The treated module M2 had noticed the fruit borer infestation to the tune of 30.77 per cent and had shown statistically equal effectiveness with module M3. The least effective module M1 had observed the fruit borer infestation of 36.57 per cent. The highest (53.10 %) fruit borer infestation was recorded in untreated module M8.

4.8.3 Pooled effect of various modules on mean per cent infestation of fruit borer on weight basis

4.8.3.1 Mean per cent infestation of fruit borer, *Earias.vittella*

The data on the pooled mean of per cent fruit borer infestation (weight basis) as presented in Table 23 and depicted in Fig 11 indicate that the results were found statistically significant. All the treated module were found observed to be significantly superior over untreated module. The Module M6 was found significantly superior over M2, M1 & M8 in recording minimum infestation of fruit borer (11.52 %) and was statistically at par with

M4 (12.91 %), M7 (14.85%), M5 (15.09%) and M3 (15.59 %). The next effective treatment module M2 statistically at par with M3, M5, M7 and M4 in recording comparatively lower infestation of fruit borer (16.80%). The least effective module M1 was found statistically at par with M2, M3, M5 and M7 in recording infestation of fruit borer (18.99 %). However, the highest (27.39 %) fruit borer infestation was recorded in untreated module M8.

4.8.3.2 Mean per cent infestation of fruit borer, *H. armigera*

The data as regard to the effect of various modules on fruit damage by *H. armigera* presented in Table 23 and depicted in Fig 11 indicated that the results were statistically significant. All the treated modules were significantly superior over untreated module. The treatment module M6 had accounted the minimum fruit borer infestation (10.44 %), followed by module M4 (11.90 %), module M7 (13.14 %) and module M5 (12.79%) and these treatments were statistically at par among themselves. Of these treatments, the module M6 had exhibited the significantly superiority over rest of the treatments except treatments M4, M7 and M5. The module M3 had accounted the fruit borer infestation to the tune of (14.20 %) and it exerted statistically similar effect with those of Module M4, M7 and M5. The next module M2 had noticed fruit borer infestation to the extent of (16.78 %) and it was found to be statistically similar to that module M3. The least effective module M1 had shown the fruit borer infestation to the extent of 20.19 and it was statistically equal with module M2. However, the maximum (27.98 %) infestation of fruit borer *H. armigera* was noticed in untreated control module M8.

Table : 23 Effect of various modules on per cent infestation of fruit borer (*E.vit.* + *Harmig.*) on okra based on weight of fruit during (pooled mean)

Tr.No.	Treatment details	% Inf.of Fruit borer based on weight of fruit								
		<i>E.vittella</i> *			<i>H.armigera</i> *			Fruit borer (<i>E.vit.</i> + <i>H.arm.</i>)**		
		Summer	Kharif	Pooled	Summer	Kharif	Pooled	Summer	Kharif	Pooled
M1	SA.YST,Azadirachtin 1%w/w	12.60 (3.55)	25.38 (30.25)	18.99 (16.90)	11.99 (3.41)	28.39 (32.19)	20.19 (17.80)	24.58 (29.66)	53.77 (47.16)	39.18 (38.41)
M2	ST,Dim, Quin,Fenpo,Dico+Quin.	11.36 (3.37)	22.25 (27.99)	16.80 (15.68)	8.00 (2.83)	25.56 (30.36)	16.78 (16.59)	19.36 (26.10)	47.81 (43.73)	33.58 (34.91)
M3	YST,Ace,Quin Fenpo,Spi+Lam,Fenv.	9.45 (3.07)	21.72 (27.77)	15.59 (15.42)	6.76 (2.60)	21.65 (27.72)	14.20 (15.16)	16.21 (23.73)	43.37 (41.19)	29.79 (32.46)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	7.87 (2.80)	17.95 (25.06)	12.91 (13.93)	5.20 (2.28)	18.59 (25.54)	11.90 (13.91)	13.07 (21.19)	36.54 (37.19)	24.80 (29.19)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	8.76 (2.89)	21.43 (27.47)	15.09 (15.18)	4.57 (2.14)	21.01 (27.26)	12.79 (14.70)	13.33 (21.20)	42.43 (40.63)	27.88 (30.91)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	6.05 (2.46)	16.99 (24.28)	11.52 (13.37)	3.18 (1.78)	17.69 (24.79)	10.44 (13.29)	9.23 (17.69)	34.68 (36.04)	21.96 (26.86)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	8.48 (2.91)	21.22 (27.42)	14.85 (15.16)	5.87 (2.42)	20.40 (26.83)	13.14 (14.63)	14.35 (22.25)	41.62 (40.17)	27.98 (31.21)
M8	Untreated control	18.90 (4.35)	35.88 (36.80)	27.39 (20.57)	16.03 (4.00)	39.93 (39.15)	27.98 (21.58)	34.93 (36.22)	75.81 (60.67)	55.37 (48.44)
	SE (m)±	0.16	1.3	0.72	0.16	0.12	0.56	1.04	1.66	1.10
	CD at 5%	0.50	4.11	2.18	0.49	3.39	1.69	3.17	5.03	3.34
	CV%	9.14	8.28	11.19	10.55	6.64	8.57	7.33	6.64	7.93

N.B: Figures in(*) indicates square root values. While (**) indicates Arc sign transformation

4.8.3.3 Cu.mean per cent infestation of fruit borer (*E.vittella* + *H.armigera*)

The data presented in Table 23 and depicted in Fig 11 evidence that the results as regard to the effect of various treatments against the fruit borer complex were found to be statistically significant. All the treated modules were found to be significantly superior over untreated module. The module M6 had recorded the minimum (21.96 %) infestation of fruit borer followed by module M4 (24.80 %) and both the treatments were statistically at par with each other. Module M6 was found to be most efficacious against fruit borer complex, being significantly superior over rest of the treatments except treatment M4 which appeared to be the second best treatment. The module M5, M7 and M3 had accounted the fruit borer complex infestation to the extent of 27.88, 27.98 and 29.79 per cent, respectively and they were found to be statistically similar with each other and also they had exerted statistically similar effectiveness with that of treatment module M4 against fruit borer complex. The next module M2 had accounted the fruit borer infestation to the tune of 33.58 and it was found to be statistically similar to that of module M3 whereas, the least effective module M1 accounting the fruit borer complex infestation to the extent of 39.18 per cent. However, the untreated module M8 had noticed the highest infestation of fruit borer complex (55.37 %).

It is indicated from the pooled result that module M6 was found significantly most effective in minimizing the infestation of shoot borer and fruit borer complex (*E. vittella* + *H.armigera*) on number and weight basis during both summer 2014-15 and kharif 2015-16 seasons over all other modules and statistically at par with module M4, M7, M5 and M3. Module M1 and M2 were found least effective in minimizing the infestation of fruit borer complex.

Lowest infestation of shoot borer and fruit borer complex (*E.vittella* + *H.armigera*) was observed in module M6 followed by module M4, M7, M5 and M3 due to cumulative effect of seed treatment with imidacloprid 48 FS @ 9ml/kg, soil application of neem cake @ 250kg/ha, and four sequential application of cypermethrin, triazophos, fenpropathrin, acephate+spiromesifen in module M6.

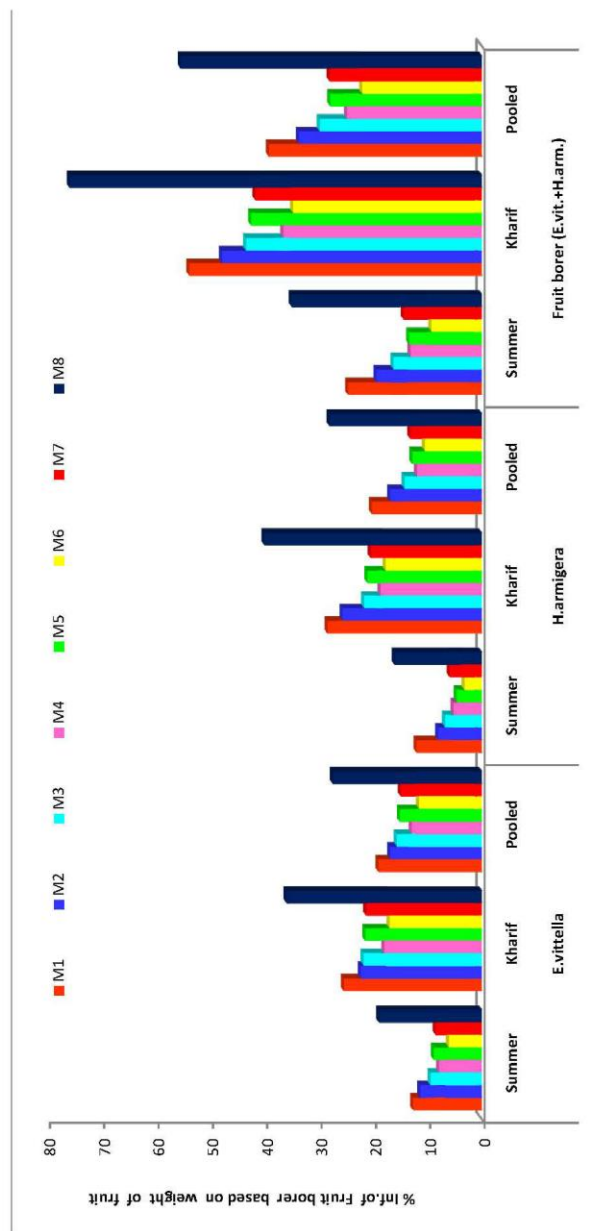


Fig. 11 Effect of various modules on per cent infestation of fruit borer (*E.vit.* + *H.armig.*) on okra based on weight of fruit (pooled mean)

Present findings are in confirmation with Birah et.al (2012b) who reported the lowest incidence of shoot borer 4.23% and fruit borer (5.64%) in module comprising of imidacloprid ST 5 gm/kg + Maize as barrier crop + infested shoot and fruit clipping + mass trapping through pheromone trap and foliar spray of neem seed extract, spinosad and karanj oil @ 45,60 and 75 days after spray as compare to untreated module. Results on seed treatment also supported by Kumar and Singh (2001), Sinha and Sharma (2007), Lal et.al. (2011), Acharya (2002). Regarding efficacy of neem cake results are in agreement with Singh et.al (2012a) who reported that module consists of use of neem cake @ 250 kg/ha before sowing in addition to deep summer ploughing , ST with imidacloprid and application of indoxcarb, thiomethoxam, hexythiazox, were most effective in reducing shoot and fruit borer infestation effectively. Similar results were obtained by several workers as singh et.al (2012b), Ghosh and khan (2010), Mandal et.al (2006). Present findings regarding efficacy of cypermethrin are in confirmation with Ambekar et.al. (2000) who reported that cypermethrin (0.01%) was the most effective in recording the lowest fruit infestation (6.57 %), and was significantly superior over other treatments. These results are supported by Patil et.al (2002), Prasad & Prasad (2004), Bagade et.al. (2005), Naik and Kumar (2014), Badiyala and Desh Raj (2013), Kaur (2002), Kamble (2014). Bajad et.al (2014). Regarding efficacy of acephate present findings are in agreement with chaudhary et.al (2008) who reported the lowest fruit damage (13.08 %) with *E. spp.* and maximum fruit yield (80.72qt/ha) with maximum net return (Rs.400,70/ ha). were recorded in module M1 comprising imidacloprid 100ml/ha, acephate 1000gm/ha and indoxcarb 500ml/ha which was comparable with module M2 (three sprays of acephate 1000g/ha) with regards to fruit damage and yield. This findings are supported by Ray and chaudhary (2000) who reported the reduction in infestation of fruit borer and gave the best cost benefit ratio 1:5.56 in acephate treatment followed by imidacloprid.

The Module M4, M7, M5 and M3 in second order of merit were found to be statistically at par with each other in which minimum 2 sprays of synthetic pyrethroids fenvalerate and fenpropathrin in M3 and M4 and

fenprothrin, and lambda-cyhalothrin in M5 and M7 with quinalphos in M3, M4 and M7 were played a major role in bringing down the infestation of fruit borer complex in okra. Naturally synthetic pyrethroids are having quick knock down effect with long residual action and yield boosting effect.

4.9.1 Effect of various modules on mean population of natural enemies /plant during summer 2014-15

Lady bird beetle population/plant

4.9.1.1 Pre-treatment observation (24 hrs.before spray) on LBB/ plant

The mean data on the incidence of LBB other predators like chrysoperla and spider were not initiated during both the experiment conducted during summer 2014-15 and kharif 2015-16.

4.9.1.2 Mean lady bird beetle population at 3 days after spray

The data presented in Table 24 and depicted Fig 12 revealed that the results were found statistically non-significant. However, the population of Lady bird beetle was observed in the range of 0.41 to 0.03 per plant being maximum in module M8 (0.41/plant) to minimum in module M7, M5 and M6 (0.04/plant).

4.9.1.3 Mean lady bird beetle population at 7 days after spray

The data presented in Table 24 and depicted in Fig 12 indicated that the results were found to be statistically non-significant. However, the population of Lady bird beetle was observed in the range of 0.67 to 0.10 per plant being maximum in module M8 (0.67/plant) to minimum in module M2 (0.10/plant).

4.9.1.4 Mean lady bird beetle population at 14 days after spray

It is observed from the data presented in Table 24 and depicted in Fig 12 that the results were found statistically non-significant. However, the population of Lady bird beetle was observed in the range of 0.60 to 0.02 per plant being maximum in module M8 (0.60/plant) to minimum in module M2 (0.02/plant).

Table: 24 Effect of various modules on natural enemies on Okra during summer 2014-15

Trea No.	Cum. Mean of NE population / Plant												Cum. pooled mean			
	3 DAT				7 DAT				14 DAT				Based on five spray			
	LBB **	Ch **	Spi **	Pred./pl *	LBB **	Ch **	Spi **	Pred./p *	LBB **	Ch **	Spi **	Pred./ pl*	LBB **	Ch **	Spi **	Pred./ pl*
M1	0.29 (0.89)	0.29 (0.89)	0.03 (0.73)	0.61 (0.78)	0.60 (1.02)	0.48 (0.98)	0.95 (1.15)	2.03 (1.39)	0.37 (0.93)	0.54 (1.00)	1.00 (1.16)	1.91 (1.24)	0.42 (0.96)	0.44 (0.97)	0.66 (0.69)	1.52 (1.19)
M2	0.08 (0.76)	0.18 (0.83)	0.02 (0.72)	0.28 (0.52)	0.10 (0.77)	0.27 (0.87)	0.14 (0.80)	0.50 (0.70)	0.02 (0.72)	0.30 (0.88)	0.23 (0.85)	0.55 (0.71)	0.07 (0.75)	0.25 (0.86)	0.17 (0.42)	0.44 (0.65)
M3	0.11 (0.78)	0.16 (0.81)	0.03 (0.73)	0.30 (0.53)	0.14 (0.80)	0.22 (0.84)	0.14 (0.80)	0.50 (0.68)	0.03 (0.73)	0.30 (0.89)	0.31 (0.90)	0.64 (0.78)	0.09 (0.77)	0.23 (0.85)	0.17 (0.41)	0.48 (0.69)
M4	0.13 (0.79)	0.31 (0.90)	0.03 (0.73)	0.47 (0.68)	0.12 (0.78)	0.14 (0.80)	0.37 (0.93)	0.63 (0.79)	0.03 (0.73)	0.41 (0.95)	0.52 (1.01)	0.96 (0.98)	0.09 (0.77)	0.28 (0.89)	0.31 (0.55)	0.69 (0.83)
M5	0.04 (0.73)	0.27 (0.88)	0.07 (0.76)	0.39 (0.62)	0.21 (0.84)	0.26 (0.87)	0.22 (0.85)	0.69 (0.83)	0.07 (0.75)	0.56 (1.03)	0.54 (1.02)	1.17 (1.08)	0.11 (0.78)	0.36 (0.93)	0.28 (0.53)	0.75 (0.86)
M6	0.04 (0.73)	0.21 (0.84)	0.05 (0.74)	0.30 (0.54)	0.33 (0.90)	0.11 (0.78)	0.54 (1.02)	0.99 (0.98)	0.05 (0.74)	0.45 (0.97)	0.74 (1.11)	1.23 (1.11)	0.14 (0.80)	0.26 (0.87)	0.44 (0.66)	0.84 (0.91)
M7	0.03 (0.73)	0.30 (0.88)	0.06 (0.75)	0.39 (0.56)	0.29 (0.89)	0.11 (0.78)	0.54 (0.99)	0.95 (0.91)	0.06 (0.74)	0.45 (0.95)	0.75 (1.08)	1.25 (1.10)	0.13 (0.79)	0.29 (0.88)	0.45 (0.57)	0.86 (0.91)
M8	0.41 (0.94)	0.47 (0.97)	0.60 (1.02)	1.48 (1.15)	0.67 (1.05)	0.56 (1.01)	0.98 (1.21)	2.21 (1.39)	0.60 (1.01)	0.78 (1.13)	1.00 (1.22)	2.38 (1.53)	0.56 (1.01)	0.60 (1.05)	0.86 (0.92)	2.02 (1.28)
SE (m) _±	0.05	0.06	0.06	0.17	0.09	0.06	0.10	0.19	0.07	0.08	0.11	0.17	0.05	0.04	0.13	0.19
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	12.21	11.82	13.89	35.50	18.92	13.86	17.94	34.24	16.61	15.47	18.65	28.35	12.31	8.77	38.42	35.77

N.B: Figures in (*) indicates square root values. While (**) indicates square $\sqrt{x+0.5}$ value5

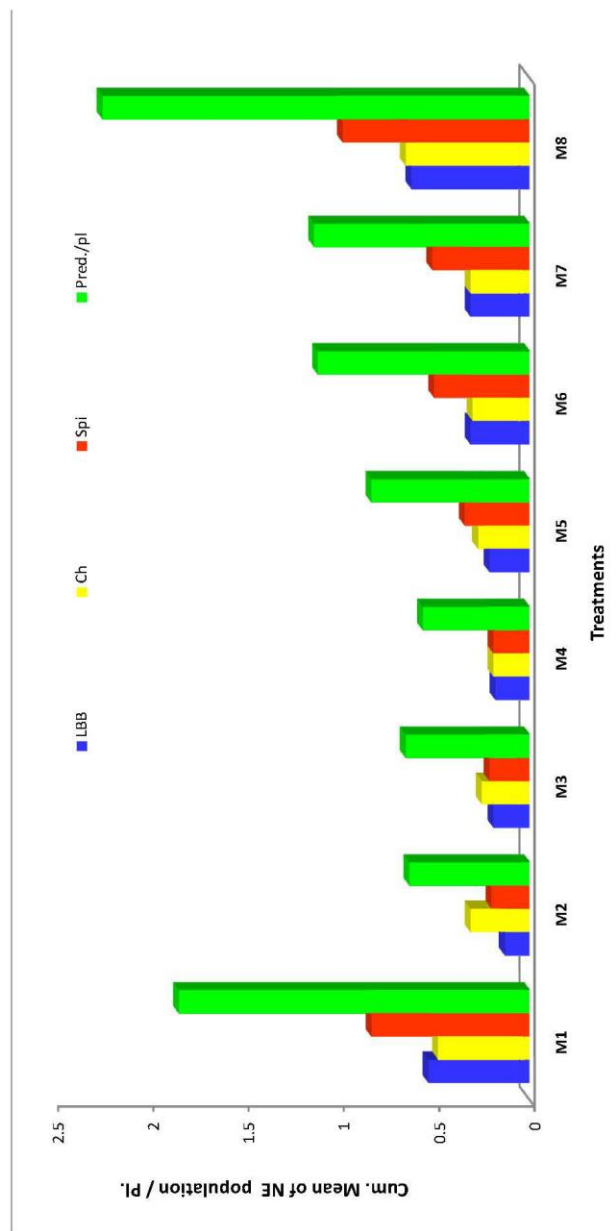


Fig. 12 Effect of various modules on natural enemies on Okra during summer 2014-15

4.9.1.5 Cu. mean population of lady bird beetle

It is indicated from the data presented in Table 24 and depicted in Fig 12 that the results were found to be statistically non-significant. However, population of lady bird beetle was observed in the range of (0.56/plant) to (0.07/plant) in descending order in sequence as M8 (0.56/plant) > M1 (0.42/plant) > M6 (0.14/plant) > M7 (0.13/plant) > M5 (0.11/plant) > M3, M4 (0.09/plant) > and M2 (0.07/plant).

Chrysopa population/plant

4.9.1.6 Mean chrysopa population at 3 days after spray

The data presented in Table 24 and depicted in Fig 12 indicate that the results were found to be non-significant. However, the population of chrysopa was observed in the range of 0.47 to 0.16 per plant being maximum in module M8 (0.47/plant) to minimum in module M3 (0.16/plant).

4.9.1.7 Mean chrysopa population at 7 days after spray

From the data presented in Table 24 and depicted in Fig 12 revealed that the results were statistically non-significant. However, the population of chrysopa was observed in the range of 0.56 to 0.11 per plant being maximum in module M8 (0.56/plant) to minimum in module M6 and M7 (0.11/plant).

4.9.1.8 Mean chrysopa population at 14 days after spray

It is revealed from the data presented in Table 24 and depicted in Fig 12 that the results were found to be statistically non-significant. However, the population of chrysopa was observed in the range of 0.78 to 0.30 per plant being maximum in module M8 (0.78/plant) to minimum in module M3 and M2 (0.30/plant).

4.9.1.9 Cu. mean population of chrysopa

It is observed from the data presented in Table 24 and depicted in Fig 12 that the data were found to be statistically non-significant. However, population of chrysopa was observed in the range of (0.60/plant) to (0.23/plant). in descending order in sequence as M8 (0.60/plant) > M1

(0.44/plant) > M5 (0.36/plant) > M4 (0.28/plant) > M7 (0.29/plant) > M6 (0.26/plant) > M2 (0.25/plant) > and M3 (0.23/plant).

Spider population/plant

4.9.1.10 Mean spider population at 3 days after spray

The data presented in Table 24 and depicted in Fig 12 reveal that the results were found to be non-significant. However, the population of spider was observed in the range of 0.60 to 0.02 per plant being maximum in module M8 (0.60/plant) to minimum in module M2 (0.02/plant).

4.9.1.11 Mean spider population at 7 days after spray

It is indicated from the data presented in Table 24 and depicted in Fig 12 that the results were found to be statistically non-significant. However, the population of spider was observed in the range of 0.98 to 0.14 per plant being maximum in module M8 (0.98/plant) to minimum in module M2 and M3 (0.14/plant).

4.9.1.12 Mean spider population at 14 days after spray

The data presented in Table 24 and depicted in Fig 12 indicated that the results were found to be statistically non-significant. However, the population of spider was observed in the range of 1.00 to 0.23 per plant being maximum in module M8 (1.00/plant) to minimum in module M2 and M3 (0.23/plant).

4.9.1.13 Cu. mean population of spider

From the data presented in Table 24 and depicted in Fig 12 observed that the results were found to be statistically non-significant. However, population of spider was observed in the range of (0.86/plant) to (0.17/plant) of in descending order in sequence as M8 (0.86/plant) > M1 (0.66/plant) > M6 (0.44/plant) > M7 (0.45/plant) > M4 (0.31/plant) > M5 (0.28/plant) > M2 and M3 (0.17/each/plant).

4.9.2 Effect of various modules on mean population of natural enemies /plant during *Kharif* 2015-16

Lady bird beetle population/plant

4.9.2.1 Mean lady bird beetle population at 3 days after spray

From the data presented in Table 25 and depicted in Fig 13 revealed that the results were statistically non-significant. However, the population of lady bird beetle was observed in the range of (0.49/plant) to (0.07/each/plant). being maximum population of lady bird beetle in module M8 (0.49/plant) to minimum population of lady bird beetle in module M6 and M5 (0.07/plant).

4.9.2.2 Mean lady bird beetle population at 7 days after spray

It is observed from the data presented in Table 25 and depicted in Fig 13 that the results were statistically non-significant. However, the population of lady bird beetle was observed in the range of (0.61/plant) to (0.12/plant) being maximum population of lady bird beetle in module M8 (0.61/plant) to minimum population of lady bird beetle in module M6 and M2 (0.12/plant).

4.9.2.3 Mean lady bird beetle population at 14 days after spray

The results as regard to the population of lady bird beetle at 14 DAS as presented in Table 25 and depicted in Fig 13 revealed that the results were statistically non-significant. However, the population of lady bird beetle was observed in the range of (0.75/plant) to (0.16/plant) being maximum population of lady bird beetle in module M8 (0.75/plant) to minimum population of lady bird beetle in module M2 (0.16/plant).

4.9.2.4 Cu. mean population of lady bird beetle

From the data presented in Table 25 and depicted in Fig 13 indicated that the results were statistically non-significant. However, population of lady bird beetle was observed in the range of (0.62/plant) to (0.18/plant) in descending order in

Table:25 Effect of various modules on natural enemies on Okra during Kharif 2015-16

Treat	Cum. Mean Popl.of Predator /Plant												Cum.pooled mean			
	3 DAT				7 DAT				14 DAT				Based on five spray			
	LBB **	Ch **	Spi **	Pred./pl *	LBB **	Ch **	Spi **	Pred./pl *	LBB **	Ch **	Spi **	Pred./pl *	LBB **	Ch **	Spi **	Pred./pl *
M1	0.33 (0.90)	0.37 (0.92)	0.25 (0.86)	0.95 (0.90)	0.60 (1.02)	0.48 (0.99)	1.03 (1.20)	2.11 (1.44)	0.65 (1.04)	0.60 (1.05)	1.20 (1.26)	2.45 (1.55)	0.53 (0.99)	0.48 (0.99)	0.83 (1.14)	1.84 (1.35)
M2	0.10 (0.78)	0.31 (0.89)	0.00 (0.71)	0.41 (0.59)	0.12 (0.79)	0.28 (0.87)	0.20 (0.83)	0.60 (0.71)	0.16 (0.81)	0.33 (0.91)	0.40 (0.93)	0.89 (0.93)	0.13 (0.79)	0.31 (0.90)	0.20 (0.83)	0.63 (0.79)
M3	0.16 (0.81)	0.18 (0.82)	0.00 (0.71)	0.34 (0.59)	0.17 (0.82)	0.23 (0.85)	0.20 (0.84)	0.60 (0.77)	0.24 (0.85)	0.33 (0.91)	0.42 (0.96)	0.99 (0.99)	0.19 (0.83)	0.25 (0.86)	0.21 (0.84)	0.65 (0.80)
M4	0.14 (0.80)	0.14 (0.80)	0.06 (0.75)	0.34 (0.58)	0.16 (0.81)	0.16 (0.81)	0.17 (0.82)	0.48 (0.69)	0.24 (0.85)	0.27 (0.88)	0.36 (0.93)	0.87 (0.92)	0.18 (0.82)	0.19 (0.83)	0.19 (0.83)	0.56 (0.75)
M5	0.07 (0.75)	0.20 (0.84)	0.12 (0.78)	0.39 (0.61)	0.24 (0.86)	0.28 (0.88)	0.28 (0.87)	0.80 (0.88)	0.33 (0.90)	0.34 (0.92)	0.63 (1.06)	1.30 (1.14)	0.21 (0.84)	0.27 (0.88)	0.34 (0.92)	0.83 (0.91)
M6	0.07 (0.75)	0.27 (0.88)	0.10 (0.77)	0.44 (0.66)	0.33 (0.91)	0.13 (0.79)	0.60 (1.05)	1.06 (1.02)	0.52 (1.00)	0.50 (0.98)	0.80 (1.14)	1.82 (1.33)	0.31 (0.90)	0.30 (0.89)	0.50 (1.00)	1.11 (1.05)
M7	0.12 (0.79)	0.32 (0.89)	0.11 (0.78)	0.55 (0.72)	0.31 (0.89)	0.13 (0.79)	0.61 (1.05)	1.05 (1.02)	0.51 (1.00)	0.50 (0.97)	0.80 (1.14)	1.81 (1.33)	0.31 (0.90)	0.31 (0.89)	0.51 (1.00)	1.13 (1.06)
M8	0.49 (0.98)	0.54 (1.02)	0.67 (1.05)	1.69 (1.25)	0.61 (1.05)	0.60 (1.02)	1.00 (1.17)	2.21 (1.37)	0.75 (1.08)	0.80 (1.10)	1.26 (1.26)	2.81 (1.60)	0.62 (1.03)	0.65 (1.04)	0.98 (1.17)	2.24 (1.36)
SE (m)±	0.07	0.09	0.07	0.15	0.09	0.08	0.12	0.19	0.12	0.11	0.12	0.17	0.08	0.08	0.09	0.16
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	13.99	17.75	16.40	37.03	19.08	15.87	21.78	32.69	22.43	20.87	20.21	24.37	35.77	16.21	16.39	28.27

N.B: Figures in (*) indicates square root values. While (**) indicates square√x+0.5 value



LBB grub



LBB adult



Spider

Plate 5 Natural enemies on okra crop

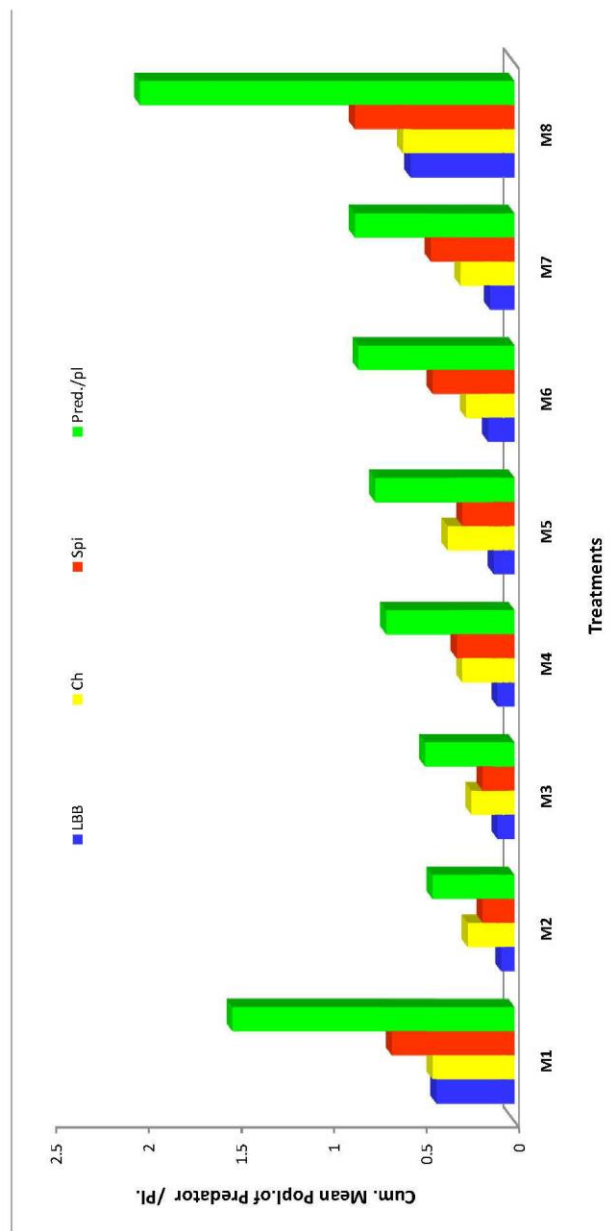


Fig. 13 Effect of various modules on natural enemies on Okra during *kharif* 2015-16

sequence as M8 (0.62/plant) > M1 (0.53/plant) > M6 and M7 (0.31/plant) > M5 (0.21/plant) > M3 (0.19/plant) > M4 (0.18/plant) > M2 (0.13/plant).

Chrysopa population/plant

4.9.2.5 Mean chrysopa population at 3 days after spray

It is evident from the data presented in Table 25 and depicted in Fig 13 that the results were found to be statistically non-significant. However, the population of chrysopa was observed in the range of (0.54/plant) to (0.14/plant) being maximum population of chrysopa in module M8 (0.54/plant) to minimum population of chrysopa in module M4 (0.14/plant).

4.9.2.6 Mean chrysopa population at 7 days after spray

From the data presented in Table 25 and depicted in Fig 13 revealed that the results were statistically non-significant. However, the population of chrysopa was observed in the range of (0.60/plant) to (0.13/plant) being maximum population of chrysopa in module M8 (0.60/plant) to minimum population of chrysopa in module M6 and M7 (0.13/each/plant).

4.9.2.7 Mean chrysopa population at 14 days after spray

It is indicative from the data presented in Table 25 and depicted in Fig 13 that the results were statistically non-significant. However, the population of chrysopa was observed in the range of (0.80/plant) to (0.27/plant) being maximum population of chrysopa in module M8 (0.80/plant) to minimum population of chrysopa in module M4 (0.27/plant).

4.9.2.8 Cu. mean population of chrysopa

The data presented in Table 25 and depicted in Fig 13 revealed that the results were statistically non-significant. However population of chrysopa was observed in the range of (0.65/plant) to (0.19/plant) of descending order in sequence as M8 (0.65/plant) > M1 (0.48/plant) > M2 and M7 (0.31/plant) > M6 (0.30/plant) > M5 (0.27/plant) > M3 (0.25/plant) > M4 (0.19/plant).

Spider population/plant

4.9.2.9 Mean spider population at 3 days after spray

It is revealed from the data presented in Table 25 and depicted in Fig 13 that no statistically significant differences among different treatments were observed as regard to spider population. However, the population of spider was observed in the range of (0.00 to 0.67/plant) being maximum population of spider in module M8 (0.67/plant). Whereas treatment modules M2 and Module M3 had not accounted any spider population .

4.9.2.10 Mean spider population at 7 days after spray

From the data presented in Table 25 and depicted in Fig 13 revealed that the results were found to be statistically non- significant. However, the population of spider was observed in the range of (1.00/plant) to (0.17/plant) being maximum population of spider in module M8 (1.23/plant) to minimum population of spider in module M4 (0.17/plant).

4.9.2.11 Mean spider population at 14 days after spray

It is seen from the data presented in Table 25 and depicted in Fig 13 that no statistically significant differences among the various treatments were found as regard to the effect against spiders. However, the population of spider was observed in the range of (1.26/plant) to (0.36/plant) being maximum population of spider in module M8 (1.26/plant) to minimum population of spider in module M4 (0.36/plant).

4.9.2.12 Cu. mean population of spider

The pooled mean data as presented in Table 25 and depicted in Fig 13 revealed that the results were statistically non-significant. However population of spider was observed in the range of (0.98/plant) to (0.19/plant) of in descending order in sequence as M8 (0.98/plant) > M1 (0.83/plant) > M7 (0.51/plant) > M6 (0.50/plant) > M5(0.34/plant) > M3 (0.21/plant) > M2 (0.20/plant). and M4 (0.19/plant).

4.10.1 Effect of various modules on mean population of predator /plant during summer 2014-15

4.10.1.1 Mean predator population at 3 days after spray

From the data presented in Table 24 and depicted in Fig 12 revealed that the results were found statistically non-significant. However, the population of predator was observed in the range of (1.48/plant) to (0.28/plant) being maximum population of predator in module M8 (1.48/plant) to minimum population of predator in module M2 (0.28/plant).

4.10.1.2 Mean predator population at 7 days after spray

From the data presented in Table 24 and depicted in Fig 12 observed that the results were statistically non-significant. However, the population of predator was observed in the range of (2.21/plant) to (0.50/plant) being maximum population of predator in module M8 (2.21/plant) to minimum population of predator in module M2 (0.50/plant).

4.10.1.3 Mean predator population at 14 days after spray

The data presented in Table 24 and depicted in Fig 12 revealed that the results were found to be statistically non-significant. However, the population of predator was observed in the range of (2.38/plant) to (0.55/plant) being maximum population of predator in module M8 (2.38/plant) to minimum population of predator in module M2 (0.55/plant).

4.10.1.4 Cu. mean population of predator

It is indicated from the data presented in Table 24 and depicted in Fig 12 that the results were statistically non-significant. However, the population of predator during summer 2014-15 was observed in the range of (2.02/plant). to (0.44/plant) in descending order in sequence as M8 (2.02/plant) > M1(1.52/plant) > M7(0.86/plant) & M6 (0.84/plant) > M5 (0.75/plant) > M4 (0.69/plant) > M3 (0.48/plant) & M2 (0.44/plant) .

4.10.2 Effect of various modules on mean population of predator /plant during *Kharif* 2015-16

4.10.2.1 Mean predator population at 3 days after spray

It is evident from the data presented in Table 25 and depicted in Fig 13 that no statistically significant effect of different treatments against the total predator complex was not observed. However, the population of predator was observed in the range of (1.69/plant) to (0.34/plant) being maximum population of predator in module M8 (1.69/plant) to minimum population of predator in module M3 & M4 (0.34/plant).

4.10.2.2 Mean predator population at 7 days after spray

From the data presented in Table 25 and depicted in Fig 13 indicated that the results were found to be statistically non-significant. However, the population of predator was observed in the range of (2.21/plant) to (0.48/plant) being maximum population of predator in module M8 (2.21/plant) to minimum population of predator in module M4 (0.48/plant).

4.10.2.3 Mean predator population at 14 days after spray

From the data presented in Table 25 and depicted Fig 13 observed that the results were found to be statistically non-significant. However, the population of predator was observed in the range of (2.81/plant) to (0.87/plant) being maximum population of predator in module M8 (2.81/plant) to minimum population of predator in module M4 (0.87/plant).

4.10.2.4 Cu. mean population of predator

It is indicative from the data presented in Table 25 and depicted in Fig 13 that the results were found to be statistically non-significant. However, the population of predator during *kharif* 2015-16 was observed in the range of (2.24/plant) to (0.56/plant) in descending order in sequence as M8 (2.24/plant) > M1 (1.84/plant) > M7 (1.13/plant) > M6 (1.11/plant) > M5 (0.83/plant) > M3 (0.65/plant) > M2 (0.63/plant) and M4 (0.56/plant).

4.10.3 Pooled effect of various modules on mean population of predator /plant

4.10.3.1 Mean predator population at 3 days after spray

It is indicative from the data presented in Table 26 and depicted in Fig 14 that the results were found to be statistically non-significant. However, the population of predator was observed in the range of (1.58/plant) to (0.32/plant) being maximum population of predator in module M8 (1.58 /plant) to minimum population of predator in module M3 (0.32/plant).

4.10.3.2 Mean predator population at 7 days after spray

From the data presented in Table 26 and depicted in Fig 14 evidenced that, the results were found to be statistically non-significant. However, the population of predator was observed in the range of (2.21/plant) to (0.55/plant) being maximum population of predator in module M8 (2.21/plant) to minimum population of predator in module M2 & M3 (0.55/plant).

4.10.3.3 Mean predator population at 14 days after spray

It is indicated from the data presented in Table 26 and depicted in Fig 14 that no significant differences were found among various treatments. However, the population of predator was observed in the range of (2.59/plant) to (0.82/plant) being maximum population of predator in module M8 (2.59/plant) to minimum population of predator in module M2 (0.72/plant).

4.10.3.4 Pooled Cu. mean population of predator

From the data presented in Table 26 and depicted in Fig 14 observed that the results were found statistically non-significant . It means that all treated modules were found equally effective in response to predator population per plant. However, Pooled cumulative mean population of predators was observed in the range of 1.86/plant to 0.41/plant

Table: 26 Pooled effect of various modules on comparative population of natural enemies on Okra during Summer 2014-15 and kharif season 2015-16

Tr. No.	Treatment details	Cum. Mean population of NE /Plant									Cum. pooled mean		
		3 DAT			7 DAT			14 DAT			Based on five spray		
		Sum	Kh	Pooled mean	Sum	Kh	Pooled mean	Sum	Kh	Pooled mean	Sum	Kh	Pooled Mean
M1	SA.YST,Azadirachtin 1%w/w	0.61 (0.78)	0.95 (0.90)	0.78 (0.84)	2.03 (1.39)	2.11 (1.44)	2.07 (1.42)	1.91 (1.24)	2.45 (1.55)	2.18 (1.39)	1.52 (1.19)	1.84 (1.35)	1.23 (1.27)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.28 (0.52)	0.41 (0.59)	0.35 (0.55)	0.50 (0.70)	0.60 (0.71)	0.55 (0.70)	0.55 (0.71)	0.89 (0.93)	0.72 (0.82)	0.44 (0.65)	0.63 (0.79)	0.43 (0.72)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	0.30 (0.53)	0.34 (0.59)	0.32 (0.56)	0.50 (0.68)	0.60 (0.77)	0.55 (0.73)	0.64 (0.78)	0.99 (0.99)	0.82 (0.88)	0.48 (0.69)	0.65 (0.80)	0.41 (0.75)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.47 (0.68)	0.34 (0.58)	0.41 (0.63)	0.63 (0.79)	0.48 (0.69)	0.56 (0.74)	0.96 (0.98)	0.87 (0.92)	0.92 (0.95)	0.69 (0.83)	0.56 (0.75)	0.51 (0.79)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.39 (0.62)	0.39 (0.61)	0.39 (0.62)	0.69 (0.83)	0.80 (0.88)	0.74 (0.85)	1.17 (1.08)	1.30 (1.14)	1.24 (1.11)	0.75 (0.86)	0.83 (0.91)	0.57 (0.89)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.30 (0.54)	0.44 (0.66)	0.37 (0.60)	0.99 (0.98)	1.06 (1.02)	1.02 (1.00)	1.23 (1.11)	1.82 (1.33)	1.53 (1.22)	0.84 (0.91)	1.11 (1.05)	0.64 (0.98)
M7	ST,SA,YST,Cyper+Dim., Fenpo,Ethion+Quin,, Lamb.	0.39 (0.56)	0.55 (0.72)	0.47 (0.64)	0.95 (0.91)	1.05 (1.02)	1.00 (0.97)	1.25 (1.10)	1.81 (1.33)	1.53 (1.21)	0.86 (0.91)	1.13 (1.06)	0.71 (0.98)
M8	Untreated control	1.48 (1.15)	1.69 (1.25)	1.58 (1.20)	2.21 (1.39)	2.21 (1.37)	2.21 (1.38)	2.38 (1.53)	2.81 (1.60)	2.59 (1.57)	2.02 (1.28)	2.24 (1.36)	1.86 (1.32)
	SE (m)±	0.17	0.15	0.11	0.19	0.19	0.24	0.17	0.17	0.14	0.19	0.16	0.09
	CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV%	35.50	37.03	26.82	34.24	32.69	16.86	28.35	24.37	29.25	35.77	28.27	21.96

N.B: Figures in parenthesis are square root transformation

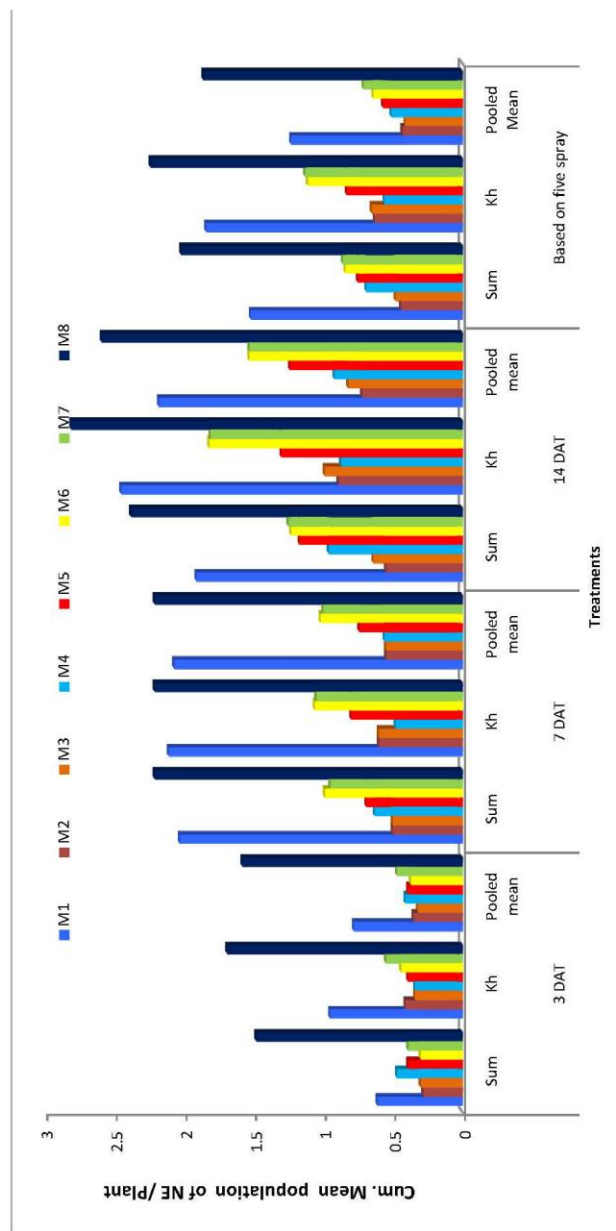


Fig. 14 Pooled effect of various modules on comparative population of natural enemies on Okra during Summer 2014-15 and *kharif* season 2015-16

in descending order in sequence as M8 (1.86/plant) > M1(1.23/plant) > M7(0.71/plant), M6 (0.64/plant) > M5 (0.57/plant) M4 (0.51/plant) > M2 (0.43/plant) & M3 (0.41/plant).

It is clear from the pooled data with respect to predator populations per plant that all the treated modules including untreated module M8 were found equally effective in maintaining the predator population per plant. It means treated modules are safer to predator populations. Numerically maximum population of predators were remain in untreated module M8 (1.86 /plant) and minimum in chemical module M3 (0.41/plant) wherein sequential five foliar application of synthetic insecticides are used. However next to untreated module M8, numerically maximum population of predator 1.23/plant was recorded in module M1 wherein Yellow sticky trap with five foliar application of azadiractin 1% w/w @ 5ml/lit was used. Comparatively numerically minimum population of predator was observed in module M3, it might be due to the last three continuous foliar application of synthetic pyrethroids viz., fenpopathrin, lambda-cyhalothrin and fenvalerate out of five applications in sequential scheduled treatment.

Present findings Sahito et al. (2011) who reported that The activities of natural enemies (Predators and parasitoids) were found maximum in control plot followed by neem oil, imidacloprid and profenophos indicating that neem oil (repellent) was the least toxic against natural enemies followed by imidacloprid (WP). Soumya (2006) also reported that neemcake and botanicals sprays like NSKE and neem Azal were found quite safe to the natural enemy fauna in chilli ecosystem. Shinde et al (2007) also reported that that neem seed powder (50 kg/ha) and NSKE 5% recorded maximum population of lady bird beetles and spiders on okra. Chakraborti (2000) also reported that neem based treatments like spraying of neem oil and NSKE were found safer to natural enemies and were on par with untreated check in chilli ecosystem. Chakraborti (2001) who also reported that the pre-sowing soil application of neem cake at 300 kg/ha was found quite safe to predatory coccinellids in mustard.

4.11.1 Comparative abundance of sucking pests , natural enemies and YMV of okra during summer 2014-15 and Kharif 2015-16

4.11.1.1 Abundance of Aphids, *Aphis gossipii* during summer 2014-15

The data presented in Table 27 and depicted in Fig 15 revealed that during summer 2014-15, the incidence of aphid started (0.87/leaf) in second week of Feb. 2015 (7th MW) and it remained active up to the 4th week of March, 2015 in (6.42/leaf) in (12th MW) and it has attained its peak (12.46/leaf) in the second week of March 2015 (10th MW) and then it's population gradually declined up to 4th week of March and then disappeared up to end of the season.

The abundance of aphid during summer 2014-15 was observed in the range (3.19 to 12.46/leaf) between 9th to 12th MW i.e. during month of March. The maximum aphid population (12.46/Leaf) was recorded during 10th MW which was favoured by 30.4⁰C and 15.1⁰C maximum and minimum temperature respectively, and 65 per cent morning relative humidity and 31 evening relative humidity 27.7 mm rainfall and 6.8 sunshine hours.

From the Table 29 it is observed that the maximum temperature had negative correlation ($r = - 0.554$) and evening relative humidity ($r = 0.559$) had significantly positive correlation with aphid population during summer 2014-15 observed. However, non significant correlation with other parameter was observed.

Abundance of Aphids, *Aphis gossipii* during Kharif 2015-16

From the data presented in Table 28 and depicted in Fig 16 observed that during *kharif* season of 2015-16, the incidence of aphid was initiated (0.4/leaf) in the second week of August in (32nd MW) later on increased gradually in last week of August and attained the peak (11.3/leaf) during and (35th MW) and later on declined to low level (0.46/leaf) up to 3rd week of September 38th MW and then suddenly disappeared up to end of season.

The abundance of aphid during *kharif* 2015-16 was observed between 34th to 36th MW during 4th week of August to 1st week of September 4.03 to 11.3/leaf. The peak population of aphid during *kharif* 2015-16 was

observed at 35th MW 11.3/leaf which was favoured by weather parameter like maximum temperature 31.4⁰C, minimum temperature 23.1⁰C, morning RH 83 per cent, evening RH 62 per cent and rainfall 16.4 mm .and 2.9 sunshine hours.

None of the weather parameter had established significantly correlation with aphid population during *kharif* 2015-16.

it is clear from above findings that the abundance of aphid population was observed in the month of March *i.e.* 9 to 12th MW (3.19 to 12.46/leaf) and in the month of August - September *i.e.* 34 to 36th MW (4.03 to 11.3/leaf), maximum at 12th MW during summer 2014-15 and 35th MW during *kharif* 2015-16 were observed, respectively. However, significantly negative correlation of maximum temperature($r = - 0.554$) and positive correlation of evening relative humidity ($r = 0.559$) with aphids population was established during summer 2014-15 and none of the relationship was established with any weather parameter during *kharif* 2015-16.

Present findings with respect to the aphid incidence during summer 2014-15 and *kharif* 2015-16 are in agreement with Prasad and logiswaram (1997) who observed that the peak activity of *A. biguttula biguttula*, *A. gossypii* occurred during winter (September-October) and summer (March-April). Konar et.al.(2013) who reported that population of aphid was increased gradually to reach its peak during first week of September (39.28 aphids/3 leaves) when minimum and maximum temperature was 26.10⁰C and 33.50⁰C; minimum and maximum R.H. was 72.57% and 97.57%, respectively with 1.6 mm rainfall and persisted throughout the crop period with low incidence during *kharif* 2010-11. Khating,et.al (2016) also reported that peak incidence of aphids was noticed in the first week of September (43.3 aphids/3leaves/plant). Chundawat and Ameta (2011) who also stated that aphid touched the peak during fourth week of August (86.5 aphids/ten plants), during *kharif* 2010-11. Nisha Shukla (2014) reported that aphids showed negative correlation with both maximum and minimum temperature and positive correlation with relative humidity during *kharif* 2013-14. Kumar et.al (2017) also reported that aphid

population was positively influenced by morning R.H ($r = 0.768$ and 0.614) during *kharif* season both the years 2014-15 and 2015-16.

4.11.1.2 Abundance of Leafhopper, *A. biguttula biguttula* (Ishida) during summer 2014-15

It is observed from Table 27 and depicted in Fig 15 that the incidence in the range of 0.13 to 27.3/leaf of leaf hopper was found throughout the season. The incidence of leaf hopper (0.13/leaf) initiated from 2nd week of February 2015 and later on gradually increased and attained its peak (27.3/leaf) in 12th MW. and later on its population declined in further successive weeks showing minimum population (4.2/leaf) in 4th week of May (21st MW). Its abundance was all most at high level during the period of 2nd week of March 2015 to last week of April 2015 i.e. between 10th to 17th MW (6.73 to 27.3/leaf).

The peak incidence of leaf hopper was noticed during 12th MW (27.3/leaf) which was favoured by weather parameter in the range of temperature between 18.1⁰C to 31.4⁰C, relative humidity 33 to 81 per cent, rainfall 15.1 mm. and 7.4 sunshine hours.

Significantly correlation of leaf hopper with any weather parameter was not observed during summer 2014-15 season.

Abundance of Leafhopper, *Amrasca biguttula biguttula* (Ishida) during *Kharif* 2015-16

It is revealed from Table 28 and depicted in Fig 16 that the incidence of leaf hopper (0.2/leaf) in 4th week of July 2015 started in 30^h MW and further gradually increased upto 36th MW and reached to (28.66/leaf) in 1st week of Sept 2015. The abundance of leaf hopper was observed between 35 to 41 MW i.e. from last week of August to 2nd week of October (6.24 to 28.66/leaf). However, peak incidence of LH was noticed at 36th MW i.e. during first week of September, (28.66LH/leaf) which was favoured by weather parameters in the range of 22.5 to 32.9⁰C Temp, 57 to 87 % RH, 22.4 mm rainfall (RF) and 7.4 bright sunshine hours. Similar trend i.e. no significant correlation of leaf hopper with any weather parameter was observed during *kharif* season 2015-16.

it is clear that the abundance of leaf hopper population was observed at high level during second week of March to last week of April *i.e.* 10th to 17th MW (6.73 to 27.3 LH/leaf), maximum in 12th MW.(27.03 LH/leaf) during summer 2014-15, whereas abundance of leaf hopper was observed during *kharif* 2015-16 in 35 to 41st MW *i.e.* from last week of August to 2nd week of October (6.24 to 28.66LH/leaf), maximum being 28.66 LH/leaf in 36th MW. No significant correlation of leaf hopper with any factor was observed during both the seasons. However bright sunshine of 7.4 hours was found common most favourable weather parameter during both the season for its multiplications.

it is clear that the abundance of leaf hopper population was observed at high level during second week of March to last week of April *i.e.* 10th to 17th MW (6.73 to 27.3 LH/leaf), maximum at 12th MW.(27.03 LH/leaf) during summer 2014-15 , whereas abundance of leaf hopper was observed during *kharif* 2015-16 in 35 to 41st MW *i.e.* from last week of August to 2nd week of October (6.24 to 28.66LH/leaf), maximum being 28.66LH/leaf in 36th MW. No significant correlation of leaf hopper with any factor was observed during both the seasons. However bright sunshine of 7.4 hours was found common most favourable weather parameter during both the season for its multiplications.

Present findings are in agreement with Gogoi and Dutta (2000) who reported jassids population last week of May and middle of April in 1999 and low rainfall period coupled with and low rainfall period coupled with bright sunshine hours favoured the development of this pest . Inee and Dutta (2000) also stated the similar results. Kumawat et al. (2000) reported that leaf hopper infestation started on 4th week of July and reached peak in second week of October. Ghosh and Senapati (2003) also reported maximum incidence of leaf hopper in October –November during *kharif* and April-May during summer season. Similar results are supported by Anita and Nadihalli (2008), Ghosal et.al (2014),Singh et.al (2015), Potai and Chandrakar (2018) . Selvaraj et al. (2010) observed no significant relationship between weather parameters and leafhopper population. Similar findings were supported by Nath et.al (2011), Meena et.al (2015).

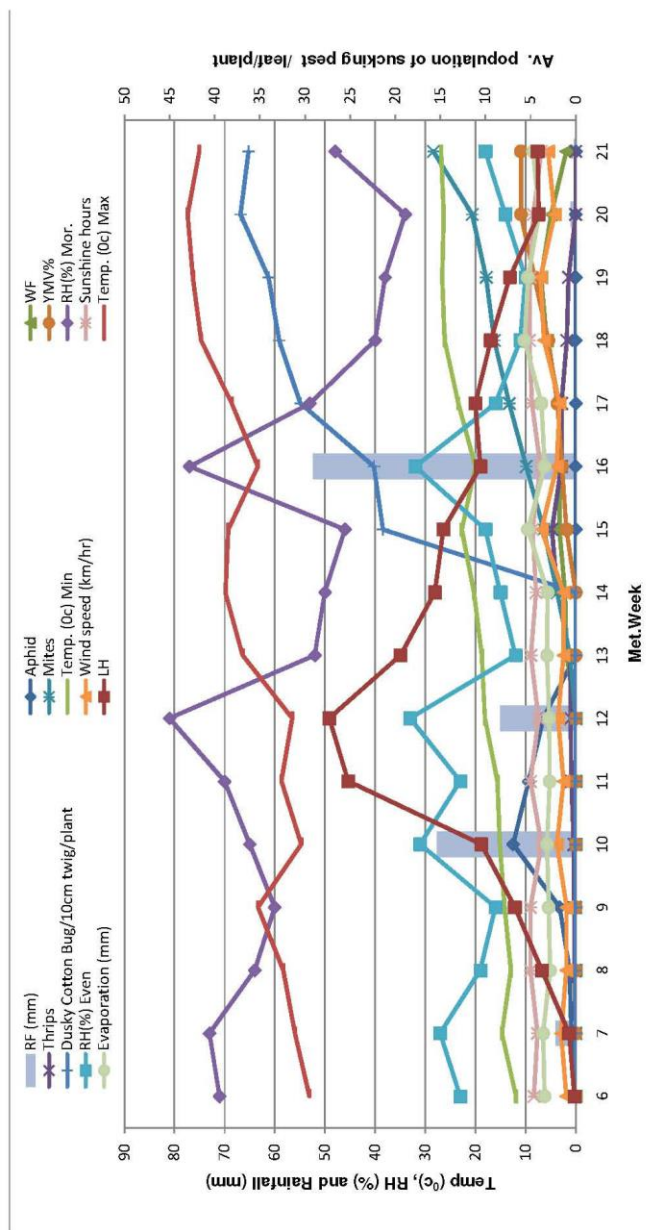


Fig.15 Population dynamic of sucking pests on Okra during summer season 2014-15

Table: 27 Population dynamic of sucking pests on Okra during summer season 2014-15

Period	Met. Week	Av. population of sucking pest /leaf/plant						Av. Popl.of Dusky Cotton Bug/10cm twig/plant	Weather parameter								DAG
		Ap.	LH	WF	Th	Mites	YMV%		Temp (°c)		Relative humidity (%)		Wind speed (km/hr)	Rain fall (mm)	Sunshine hours	Evaporation (mm)	
									Max	Min	Mor.	Even.					
5-11 Feb	6	0	0.13	0	0	0	0.00	0	29.5	11.9	71	23	1.9	0.0	8.3	6.2	7
12.-18	7	0.87	0.73	0.06	0	0	0.00	0	31.1	14.7	73	27	2.9	4.0	7.6	6.5	14
19-25	8	1.24	3.73	0	0.2	0	0.00	0	32.4	12.9	64	19	1.9	0.0	9.0	5.1	21
26-4 Mar	9	3.19	6.73	0.13	0.29	0	0.00	0	35.2	14.2	60	16	1.8	0.0	9.0	5.4	28
5-11	10	12.46	10.46	0	0.36	0	0.00	0	30.4	15.1	65	31	3.7	27.7	6.8	5.7	35
12-18	11	9.37	25.2	0	0.86	0	0.00	0	32.6	15.6	70	23	2.4	0.0	9.0	5.2	42
19-25	12	6.42	27.3	0	1	0	0.00	0	31.4	18.1	81	33	3.5	15.1	7.4	5.3	56
26-1 Apr	13	0	19.4	1.8	1.14	1.14	0.00	0	36.9	18.7	52	12	2.4	0.0	8.9	5.7	63
2-8	14	0	15.6	2.13	3.66	3.66	0.00	0	38.8	20.3	50	15	2.4	0.0	7.9	5.6	70
9-15	15	0	14.66	3.26	4.74	6.4	1.81	38.42	38.5	22.7	46	18	6.8	0.0	8.6	9.5	77
16-22	16	0	10.55	3.23	2.86	9.86	2.72	40.22	35.2	20.0	77	32	3.8	52.3	7.0	6.2	84
23-29	17	0	11.11	3.26	2.81	13.24	3.63	54.87	38.1	23.4	53	16	3.2	0.0	8.7	6.8	91
30-6 May	18	0	9.4	5.71	1.76	16.22	5.45	59.13	41.5	26.1	40	11	6.3	0.0	9.2	10.2	98
7-13	19	0	7.3	6.86	1.42	17.82	8.18	61.23	42.4	26.6	38	10	7.0	0.0	9.1	9.5	104
14-20	20	0	4.1	4.89	0	20.62	10.90	66.81	43.0	26.3	34	14	4.2	1.0	8.4	7.3	112
21-27	21	0	4.2	1.87	0	28.34	10.90	65.23	41.7	26.8	48	18	5.5	0.4	6.9	8.5	119

N.B: Pest population is of respective meteorological week while weather parameter are of previous week

4.11.1.3 Abundance of Whitefly, *Bemisia tabaci* (Gennadius) during summer 2014-15

It is indicated from Table 27 and depicted in Fig 15 that the incidence of whitefly was initiated in the 3rd week of February (7th MW) and it remained at more or less negligible level (0.06 to 0.13/leaf) up to 4th week of March (12th MW). Later on its appearance was again noticed (1.8/leaf) in the last week of March (13th MW) and further its population gradually increased in every successive week and it was found at its peak (6.86/leaf) in the 2nd week of May (19th MW). Later on it declined during further crop growth period showing minimum population of (1.87/leaf) in the 4th week of May (21st MW). The abundance of whitefly population was observed between 18th to 20th MW in the range of 4.89 to 6.86 per leaf from 1st to 3rd week of May during summer 2014-15 season. The peak incidence of whitefly was recorded at 19th MW (6.86/leaf) during second week of May which was favoured by weather parameter in the range of 26.6^oC to 42.4^oC temperature, relative humidity 10 to 38 per cent, no rainfall and 9.1 bright sunshine hours.

It indicates from Table 29 that there was significantly positive correlation with both maximum temperature ($r = 0.856$) and minimum temperature ($r = 0.866$) and wind speed ($r = 0.757$) while morning ($r = -0.773$) and evening relative humidity ($r = -0.604$) had significantly negative correlation with population of whitefly.

Abundance of Whitefly, *Bemisia tabaci* (Gennadius) during kharif 2015-16

It is stated from Table 28 and depicted in Fig 16 that the appearance of the whitefly (0.62/leaf) was noticed on okra during the first week August (31st MW). The population of whitefly gradually increased from 31st MW to its first peak at 37th MW (6.88/leaf) and it again decrease gradually up to 40th MW and it was slowly increased and again reached to its 2nd peak at 41st MW (6.18/leaf) and again declined slowly to low level 3.1/leaf. The abundance of whitefly was observed between 37th to 41st MW i.e. from second week of September to second week of October in the range of 4.33 to 6.88/leaf. The two peak of whitefly in 37th MW (6.88/leaf) favoured by temperature of 22.7 to 34.3^oC, Relative humidity 54 to 88 %, rainfall

61.6mm and 6.6 bright sunshine hours and 2nd peak in 41st MW favoured by temperature of 19.3 to 37.0°C, RH 24-71%, no rainfall and 7.6 bright sunshine hours was noticed during *kharif* 2015-16.

It evident from Table 30 that there was significantly negative correlation of WF ($r = - 0.563$) with minimum temperature and wind speed ($r = - 0.768$) with population of whitefly.

It is indicated that the abundance of whitefly population during summer 2014-15 was observed between 18th to 20th MW i.e. in the range of (4.89 to 6.86/leaf) from 1st to 3rd week of May with its peak at 19th MW (6.86/leaf) i.e. in second week of May while abundance of whitefly was observed between 37th to 41st MW i.e. from 2nd week of September to 2nd of October in range of 4.33 to 6.88/leaf with its peak at 37th (6.88/leaf) and 41st MW (6.18/leaf) during *kharif* 2015-16. Significantly positive correlation of whitefly with Max. Temp. ($R = 0.856$), Min. Temp. ($R = 0.866$), wind speed ($r = 0.757$), and negative correlation with Mor. ($r = - 0.773$) and Eve. ($r = - 0.604$) RH. was established during summer 2014-15 while, significantly negative correlation with min. Temp. ($r = - 0.563$) and wind speed ($r = - 0.768$) was established during *kharif* season 2015-16.

Present findings are in confirmation with Shivanna et al. (2011b) who reported that peak population of whitefly during second fortnight of April. Borad et al. (1993) reported that maximum incidence of whitefly was during first week of October. Kumawat et al (2000) also reported the peak activity of whitefly in 4th week of September. Similar results are supported by Chundawat and Ameta (2011), Potai and Chandrakar (2018), Anitha and Nandihalli (2008), Singh et al. (2013), Khating, et al. (2016). Regarding correlation study present findings are in confirmation with Watson et al. (2003) who reported that low rainfall caused significant outbreaks of whitefly population and dense population developed only where both humidity and temperatures were high. Temperature above 30°C increased the rate of egg laying but above 40°C reduced the length of life cycle of *B. tabaci* to less than two weeks in okra crop. Kumawat et al. (2000) also reported that maximum temperature was significantly and positively correlated with whitefly density. Siddartha et al (2017) who reported that Maximum temperature and average

temperature had significant positive effect on whitefly. Mohanasundaram and Sharma (2011b) recorded that the whitefly population showed significant positive correlation with the minimum temperature ($r = +0.994$), Singh et al. (2013) observed that whitefly showed significant negative correlation with maximum, minimum and mean temperature and morning as well as evening relative humidity. Zeshan et al. (2015) who reported that whitefly population increased with increased in temperature while decreased with the decrease in relative humidity. The contribution of maximum temperature was explained by linear regression which showed 83 to 91% variability in whitefly development.

4.11.1.4 Abudance of Thrips,*Thrips tabaci* Lind during summer 2014-15

It is indicated from Table 27 and depicted in Fig 15 that the incidence of thrips (0.2/leaf) was initiated in the 4th week of- February (8th MW). Further its population gradually increased in every successive week and it was found at its peak (4.74/leaf) in the second week of April 2015 (15th MW). Later on it declined during further crop growth period showing minimum population of (1.42/leaf) in the second week of May 2015 (19th MW) and it disappeared in further period i.e. 3rd and 4th week of May 2015.

The incidence of thrips during the summer season 2014-15 on okra crop was in the range of 0.2 to 4.74/leaf with abundance of thrips was noticed between 14 to 17th MW from 1st week of April to 4th week of April (2.81 to 4.74 thrips/leaf). The peak incidence of thrips was observed at 15th MW i.e 2nd Week of April (4.74/leaf) which was favoured by weather parameter in the range of 22.7 to 38.5°C temperature, 18 to 46 % RH, no rainfall and 8.6 sunshine hours .

It indicates from correlation study Table 29 significant correlation was not observed in between any weather parameter and thrips population.

Abudance of Thrips,*Thrips tabaci* Lind during Kharif 2015-16

It is noticed from Table 28 and depicted in Fig 16 that the thrips incidence (1.2/leaf) initiated in the second week of August (32nd MW). Later on its population gradually increased in every successive week and its was found at its peak (4.59 / leaf) in the first week of October (42nd MW). Later on it declined during further crop.

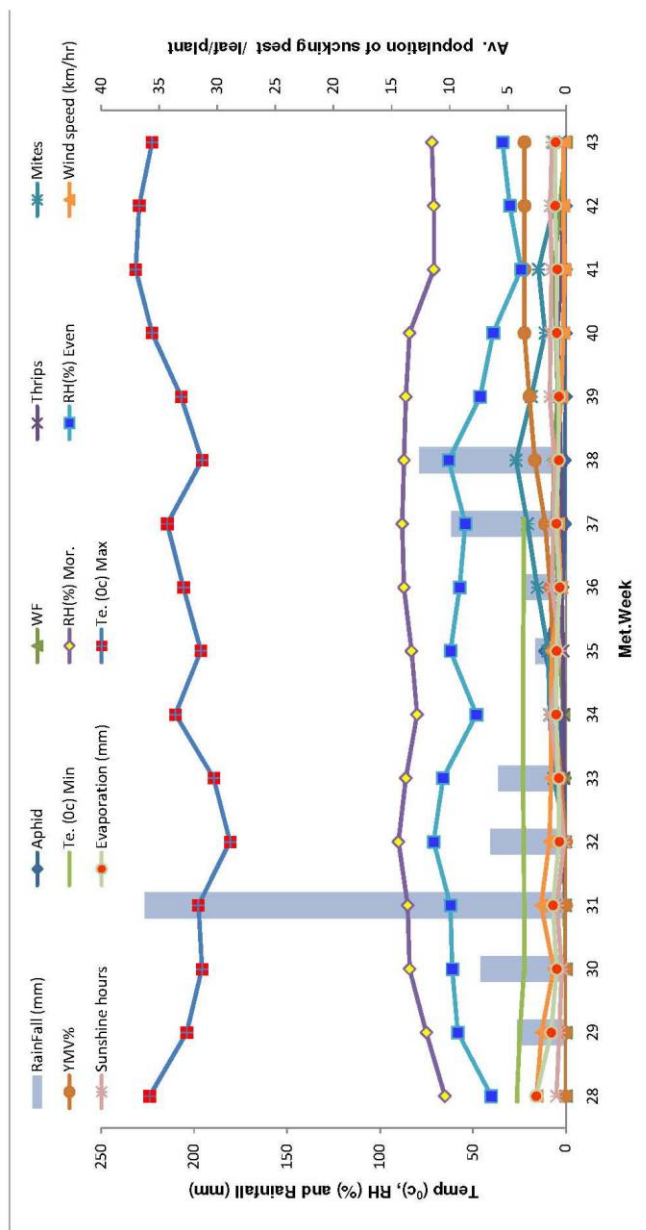


Fig. 16 Population dynamic of sucking pests on Okra during *kharif* season 2015-16

Table:28 Population dynamic of sucking pests on Okra during kharif season 2015-16

Period	Met.Week	Av. population of sucking pest /leaf/plant						Weather parameter								DAG
		Aphid	LH	WF	Thrips	Mites	YMV%	Temperature (°c)		Relative humidity(%)		Wind speed (km/hr)	Rain fall (mm)	Sunshine hours	Evaporation (mm)	
								Max	Min	Mor.	Even.					
9-15July	28	0	0	0	0	0	0.00	35.8	26.2	65	40	15.7	0.0	5.0	15.9	7
16-22	29	0	0	0	0	0	0.00	32.6	24.7	75	58	13.0	26.2	3.4	7.8	14
23-29	30	0	0.2	0	0	0.0	0.00	31.3	22.4	84	61	6.5	45.9	2.1	4.8	21
30-5 Aug	31	0	0.3	0.62	0	0	0.00	31.6	22.4	85	62	13.3	226.5	4.6	6.9	28
6-13 Aug	32	0.4	0.3	1	1.2	0	0.00	28.9	22.6	90	71	8.7	40.7	0.8	3.5	35
13-19	33	0.5	2.46	1.26	1.12	6.3	2.78	30.3	23.1	86	66	7.9	36.5	4.1	3.8	42
20-26	34	4.03	3.13	1.33	1.2	8.72	5.56	33.6	23.0	80	48	8.0	0.0	8.2	5.2	56
27-2Sept	35	11.3	15.63	3.24	1.46	9.58	6.94	31.4	23.1	83	62	7.6	16.4	2.9	5.0	63
03-Sep	36	1.76	28.66	3.87	2.33	15.33	8.33	32.9	22.5	87	57	2.6	22.4	7.4	3.3	70
Oct-16	37	0.46	18.1	6.88	2.49	20.54	11.11	34.3	22.7	88	54	4.1	61.6	6.6	5.1	77
17-23	38	0.46	15.3	6.54	2.71	26.72	16.67	31.3	22.2	87	63	4.9	78.9	6.1	3.8	84
24-30	39	0	10.66	4.33	3.39	18.49	19.44	33.1	21.3	86	46	2.4	1.4	8.5	3.7	91
1-7 Oct	40	0	10.23	5.28	4.59	11.17	22.22	35.6	20.8	84	39	1.3	0.0	8.1	4.9	98
8-14 Oct	41	0	6.24	6.18	2.17	14.71	22.20	37.0	19.3	71	24	0.7	0.0	7.6	4.6	104
15-21	42	0	4.26	3.1	1.69	6.37	22.20	36.7	19.1	71	30	1.3	0.0	8.3	5.7	112
22-28	43	0	2.66	0	0.7	6.58	22.20	35.6	19.5	72	34	1.0	0.0	7.4	5.5	119

N.B: Pest population is of respective meterological week while weather parameter are of previous week

growth period showing minimum population of (0.7/leaf) in the fourth week of October (43rd MW).

The abundance of thrips population was observed between 36 to 40th MW *i.e.* from 1st week of September to 1st week of October (2.33 to 4.59/leaf). The peak incidence of thrips was noticed at 40th MW in 1st week of October, (4.59/leaf) which was favoured by range of temperature of 20.8 to 35.6°C, relative humidity 39 to 84 % RH, no rainfall and 8.1 sunshine hours .

It is evidenced from correlation data of Table. 30 that significant negative correlation ($r = - 0.703$) of wind speed and significant positive correlation ($r = 0.586$) of sunshine hours with thrips population was observed.

It is clear that the abundance of thrips during summer 2014-15 on okra crop was observed between 14 to 17th MW *i.e.* from 1st week of April to 4th week of April in the range of 2.81 to 4.74 /leaf with its peak at 15th MW (4.74/leaf) while during kharif 2015-16 thrips population was observed between 36 to 40th MW in the range of 2.33 to 4.59 /leaf from 1st week of September to 1st week of October with its peak at 40th MW (4.59/leaf). It means that April and September month atmosphere was very suitable for the multiplication of thrips during summer and kharif seasons in Maharashtra. No significant correlation of thrips was observed with none of the weather factor during summer 2014-15 while in *kharif* 2015-16 significant negative correlation with wind speed ($r = - 0.703$) and positive correlation with bright sunshine hours ($r = 0.586$) was established.

Present findings are in line with Shivanna et al. (2011b) who reported that peak population of thrips (26.81/3leaves) were during second fortnight of April and maximum temperature showed significant positive effect on thrips . Potai and Chandrakar (2018) also stated that the thrips (*T. tabaci*) was observed from August 2016 to October 2016 on okra. Results could not be compare on correlation study for the want of scanty literature.

4.11.1.5 Abundance of Red spider mite, *Tetranychus urticae* Koch during Summer 2014-15

From the data presented in Table No. 27 and depicted in Fig 15 that the incidence of mites was initiated (1.14/leaf) in the last week of March 2015 (13th MW). Further its population gradually increased in every successive week (21st MW) reached at the last phase of the crop. 4th week of May

The population of mite was through out the season from 13th to 21st MW in the range of 1.14 to 28.34/leaf. The maximum population of mite was observed between 14th to 21st MW from 1st week of April to 4th week of May (3.66 to 28.34/leaf). The peak incidence of mite was reached at 21st MW in 4th week of May (28.34/leaf) which was favoured by temperature in the range of 26.8 to 41.7°C, RH 18 to 48%, 0.4mm rainfall and 6.9 bright sunshine hours.

It is evident from Table 29 that the population of mites had significant positive correlation with maximum temperature ($r = 0.844$) minimum temperature ($r = 0.898$), the significant negative correlation with morning relative humidity ($r = - 0.682$) and significant positive correlation with wind speed ($r = 0.681$).

Abundance of Red spider mite, *Tetranychus urticae* Koch during Kharif 2015-16

It is observed from Table No. 28 and depicted in Fig 16 that the incidence of mites was initiated (6.3/leaf) in the 3rd week of August 2015, (33rd MW) and further its population gradually increased in every successive week and it obtained its peak (26.72/leaf) in the 3rd week of September (38th MW) and its presence was more or less similar in the subsequent week but declined up to 43rd MW gradually during 4th week of October (6.58/leaf). The abundance of mites population during *kharif* season 2015-16 on okra crop was found in the range of 6.3 to 26.72/leaf. The peak incidence of mites 26.72/leaf was observed at 38th MW and decreased in the 3rd week of October which was favoured by weather parameter in the range of 22.2 to 31.3°C temperature, 63 to 87 % RH, 78.9 mm rainfall, and 6.1 bright sunshine hours.

It is revealed from the correlation study Table No. 30 that the population of mites had significantly positive correlation with maximum temperature ($r = 0.827$) and bright sunshine hours ($r = 0.702$) while significant negative correlation with minimum temperature ($r = - 0.911$), morning relative humidity ($r = - 0.737$), evening relative humidity ($r = - 0.863$) and wind speed ($r = - 0.832$).

From the above findings it is indicated that the abundance of mite during summer 2014-15 was observed between 14th to 21st MW in the range of 3.66 to 28.34/leaf from 1st week of April to 4th week of May with its peak incidence at 21st MW (28.34/leaf) while abundance of mites population during *kharif* season 2015-16 was observed between 33th to 43th MW in the range of 6.3 to 26.72/leaf from 3rd week of August to 4th week of October with its peak incidence at 38th MW (26.72/leaf). Significant positive correlation of mites with max.temp. ($r = 0.844$), min.temp. ($r = 0.898$) and negative correlation with mor. RH. ($r = - 0.682$) and WS ($r = 0.681$) during summer 2014-15 while significantly positive correlation with max. temp. ($r = 0.827$), BSH ($r = 0.702$) and negative correlation with min. temp. ($r = - 0.911$), mor. RH ($r = - 0.737$), eve. RH. ($r = - 0.863$) and WS ($r = - 0.832$) was established during *kharif* 2015-16.

April and May month during summer and middle of August to middle of October month atmosphere are very most suitable for the multiplication of mites. Hence it can be said from the abundance study that okra growers should be very must careful for undertaking plant protection measures against mites during this period.

Present findings are in confirmation with Ghosh (2013) who recorded the activity of *T. urticae* throughout the crop season at West Bengal with a peak population during 23rd SW (last week of May) in summer crop and 42nd SW (first week of October) in the *kharif* okra crop. Gulati (2004) also reported that on summer okra crop the mite population appeared in the month of April, showed an increasing trend in May and then attained a peak in the month of June while in *kharif* crop, mite population was maximum in the month of October. This findings are also supported by Anitha and Nandihali (2008). Regarding correlation study on mites present findings are also in

confirmation with Geroh and Gulati (2007) who observed that spider mite population had significant positive correlation with maximum and minimum temperature and significant negative correlation with relative humidity. Tripathi et al. (2013) also reported that positive correlation was found between temperature and mite population and negative correlation with humidity and rainfall. These findings are also supported by Kanika et.al (2013), Prasad and Singh (2003).

4.11.1.6 . Abundance of Dusky cotton bug (*Oxycarenus Laetus* KIRBY) during summer 2014-15

It is indicated from Table No. 27 and depicted in Fig 15 that the incidence of dusky cotton bug was initiated (38.42/10cm twig) in the second week of April 2014-15 (15th MW) and further its population gradually increased in every successive week (65.23/10cm twig) in the 4th week of May (21st MW) and continuous up to the end of season.

The abundance of DCB was observed between 15th to 21st MW i.e. from 2nd week of April to 4th week of May (38.42 to 66.81/10cm twig/plant) during summer 2014-15 on okra crop. The peak incidence of DCB (66.81/10cm twig/plant) was noticed in 3rd week of May i.e. 20th MW which was favoured by temperature range of 26.3 to 43.0°C, RH 14 to 34%, 1.0 mm rainfall and 8.4 sunshine hours.

It indicate from correlation study Table No. 29 that the population of DCB had strong significant positive correlation with both maximum temperature ($r = 0.832$) and minimum temperature ($r = 0.910$) and wind speed ($r = 0.764$), whereas significant negative correlation with morning relative humidity ($r = - 0.686$).

It is clear from above findings that the abundance of DCB during summer 2014-15 on okra crop was observed between 15th to 21st MW in the range of 38.42 to 65.23 nos. /10cm twig/ plant from second week of April to fourth week of May with its peak incidence at 20th MW (66.81 nos./10cm twig/plant) was noticed while there was no incidence of DCB during kharif 2015-16.

Table: 29 Correlation matrix: Effect of abiotic factors on major pests of okra during Summer 2014-15

Pests	Temperature (°c)		R.H. (%)		Wind speed (km/hr)	Rainfall (mm)	Bright Sun Shine (Hrs)	Evp(mm)
	T.Max. temp. (°C)	T. Min. temp. (°C)	Morning	Evening				
Aphid	-0.554*	-0.435	0.456	0.559*	-0.228	0.280	-0.269	-0.452
Leaf hopper	-0.105	0.004	0.220	0.188	-0.048	0.109	0.041	-0.260
White fly	0.856**	0.866**	-0.773**	-0.604**	0.757**	-0.069	0.308	0.789**
Thrips	0.421	0.484	-0.263	-0.160	0.443	0.110	-0.018	0.391
Red spider mite	0.844**	0.898**	-0.682**	-0.447	0.681**	-0.095	-0.066	0.713**
Dusky cotton bug	0.832**	0.910**	-0.686**	-0.438	0.764**	-0.036	0.061	0.794**
YVM%	0.812**	0.847**	-0.692**	-0.440	0.651**	-0.135	-0.030	0.667*

(No. of observations 16) ** significant at 1% : 0. 623 * significant at 5% :- 0.497

Significant positive correlation of DCB with both max. temp. ($r = 0.832$), min. temp ($r = 0.910$) and wind speed ($r = 0.764$), whereas negative correlation with mor. RH ($r = -0.686$) during summer 2014-15 was established.

Present findings are in partially in confirmation with Tufail Ahmad et.al. (2015) who noticed that the dusky cotton bug population was 0.6 to 11 per plant during February to March. Results could not be compared regarding correlation study on mites for the want of literature.

4.11.1.7 Incidence of Yellow Mosaic Virus during summer 2014-15

From the data presented Table 27 and depicted in Fig 15 that the incidence of yellow mosaic virus disease was initiated (1.81 per cent) in the 3rd week of April 2015 (15th MW) and further its incidence gradually increased in every successive week and remained continue up to harvest of the crop (10.90 per cent) i.e. in the 3rd and 4th week of May 2015 (20th and 21st MW).

The incidence of YMV during the summer season 2014-15 on okra crop was in the range of 1.81 to 10.90 per cent from 15th to 21st MW from 2nd week of April to 4th week of May. The peak incidence of YMV was observed during 20 and 21st MW i.e. in 3rd and 4th week of May (10.90%) which was favoured by maximum whitefly population noticed in 18 and 19th MW i.e. 5.71 & 6.86/leaf and weather parameter like temperature in the range of 26.3 to 43.0°C, RH 14 to 48 %, 0.4 to 1.0 mm rainfall and 6.9 to 8.4 sunshine hours.

It is evidenced from correlation study Table 29 that the incidence of YMV had significant positive correlation with maximum temperature ($r = 0.812$) and minimum temperature ($r = 0.847$) and wind speed ($r = 0.651$). and the significant negative correlation relationship was exhibited with morning relative humidity ($r = -0.692$).

Incidence of Yellow Mosaic Virus during kharif 2015-16

It is revealed from Table 28 and depicted in Fig 16 that the incidence of YMV was initiated (2.78 per cent) in the 3rd week of August 2014-15 (33rd MW) and further its incidence gradually increased in every successive week and remained continued upto 1st to 4th week of October

(22.20 %) during 40 to 43 MW. During 33 to 43 MW from 3rd week of August to 4th week of October. The peak incidence of YMV 22.22% during 40-43rd MW in from 1st to 4th week of October which was favoured by peak incidence of WF population 6.88 and 6.54 /leaf in 37 & 38th MW respectively and 40-43th MW peak incidence of YMV was favoured by temperature range of 19.1 to 37.0°C, RH 24 to 84 %, no rainfall and 7.4 to 8.3 bright sunshine hours.

It appears from correlation study Table 30 that the incidence of YMV was observed to have significant positive correlation with maximum temperature ($r = 0.647$) and sunshine hours ($r = 0.771$). Whereas significant negative correlation with minimum temperature ($r = - 0.823$), wind speed ($r = - 0.864$) and evening relative humidity ($r = - 0.715$).

It is indicated that the incidence of YMV on okra crop during summer season 2014-15 was observed between 15th to 21st MW in the range of 1.81 to 10.90 per cent with its peak incidence at 20th MW (10.90%) which was favoured by maximum population of whitefly in 18th and 19th MW (5.71 & 6.86/leaf), while the incidence of YMV was noticed between 33 to 43rd MW in the range of 2.78 to 22.22% with its peak in 40-43rd MW (22.22%) during *kharif* 2015-16. which was favoured by peak incidence of WF population in 37 & 38th MW (6.88 and 6.54 /leaf). Significant positive correlation with max. temp. ($r = 0.812$), min temp. ($r = 0.847$) and wind speed ($r = 0.651$) and negative correlation with mor. RH. ($r = - 0.692$) during summer 2014-15 whereas significant positive correlation with max. temp. ($r = 0.647$) and BSH ($r = 0.771$) whereas negative correlation min. temp. ($r = - 0.823$) and wind speed ($r = - 0.864$) established during *kharif* 2015-16. The peak incidence of YMV was observed in 20th MW (10.90%) during summer and 40-43rd MW (22.22%) during *kharif*, which was favoured by peak incidence of whitefly in 18th and 19th MW (5.71 & 6.86/leaf) and in 37 & 38th MW (6.88 and 6.54 /leaf). during summer 2014-15 and *kharif* 2015-16 seasons, respectively.

It means that YMV incidence was more and persisted for longer period i.e. 42-43rd MW (22.22%) during *kharif* season compared to only 20th MW (10.90%) during summer 2014-15 due to favourable temperature, humidity and bright sunshine hours.

Table: 30 Correlation matrix: Effect of abiotic factors on major pests of okra during *Kharif* 2015-16

Pests	Temperature (°c)		R.H. (%)		Wind speed (km/hr)	Rainfall (mm)	Bright Sun Shine (Hrs)	Evp(mm)
	T.Max.	T. Min.	Morning	Evening				
Aphid	-0.228	0.185	0.132	0.240	0.084	-0.135	-0.193	-0.116
Leaf hopper	-0.034	-0.036	0.389	0.138	-0.389	-0.107	0.246	-0.362
White fly	0.368	-0.563*	0.221	-0.339	-0.768**	-0.150	0.589*	-0.440
Thrips	0.241	-0.444	0.361	-0.246	-0.703**	-0.293	0.586*	-0.482
Red spider mite	0.827**	-0.911**	-0.737**	-0.863**	-0.832**	-0.486*	0.702**	0.161
YVM%	0.647**	-0.823**	-0.197	-0.715**	-0.864**	-0.391	0.771**	-0.331

(No. of observations 16) ** significant at 1% : 0. 623

* significant at 5% : 0.497

It might be due to favourable temperature range of 19.1 to 37.0°C RH 24 to 84 per cent, BSH 7.4 to 8.3 hrs during peak incidence of YMV in *kharif* 2015-16 compared to the favourable temperature range of 26.3 to 43.0°C, RH 14 to 48 per cent, rainfall 1.0 mm and BSH 6.9 to 8.4 hrs. during summer seasons.

Present findings of YMV incidence during summer are in agreement with Usha Sree et.al (2018) that incidence of YVMV was initiated in March and reached maximum in May. The correlation studies revealed that maximum and minimum temperature showed highly significant correlation ($p < 0.01$) with YVMV incidence on different okra varieties. Sharma et.al (2017) who reported that whitefly appeared first during the 13th and reached maximum during 21st standard meteorological week and positive correlation between adult whitefly population and abiotic factors viz. temperature (maximum and minimum) and sunshine hours was observed, whereas humidity (maximum and minimum) and rainfall showed a negative correlation with it. Prabu et. al (2008) revealed that minimum temperature had significant correlation with OYVMV while minimum and maximum temperature had a significant correlation with whitefly population. OYVMV incidence increased with the rise in minimum temperature and whitefly population decreased with increase in relative humidity. Pun and Doraiswamy (2000) who also reported that that morning relative humidity had a highly significant negative relationship with the disease.

Sindhumole and Manju (2013) who also indicated that whitefly population at 30 DAS (Days after sowing) had positive correlation with disease incidence at 50 DAS to final harvest and more whitefly count during 50 DAS also influenced the disease expression during the final phase of the crop. Shroff et al. (2010) reported the association of OYVM disease with whitefly population and opined that crop stage during 25 and 50 DAS period could be the most vulnerable for attack by whitefly vector to cause OYVM disease. Sanwal et al. (2013) who also reported that a single whitefly can transmit the yellow vein mosaic virus effectively however, the minimum number of whiteflies required to induce 100 per cent infection was 10 per plant. Dastoooger et al. (2011) also observed that a single whitefly was

capable of transmitting the disease although 15 whiteflies could transmit the jute leaf mosaic virus to extent of 100 per cent and showed that the maximum 15 viruliferous whiteflies required for effective transmission of jute leaf mosaic virus disease. Karri and Acharya (2012) also studied that the varieties which showed more incidence of YVMV at thirty and sixty days after sowing was found to have greater loss in yield rather than those varieties which having the same intensity of the disease at later stage of the growth. WF and YMV relationship also supported by Watson et al. (2003) also reported that temperature above 30°C increased the rate of egg laying but above 40°C reduced the length of life cycle of *B. tabaci* to less than two weeks in okra crop. Solankey et al. (2014) who reported that rainy season favours incidence of OYVMV.

Table: 30 A Correlation matrix: Effect of Whitefly population on Yellow Vein Mosaic on Okra during summer 2014-15 and Kharif 2015-16

Pests	YMV % summer 2014-15	YMV % Kharif 2015-16.
White fly	0.699**	0.857**

(No. of observations 16) **significant at 1% : 0. 623 *significant at 5% : 0.497

4.11.1.8 Correlation between whitefly population and yellow vein mosaic on okra during summer 2014-15 and kharif 2015-16

It is revealed from Table No. 30 A that there was a significant positive correlation ($r = 0.699$) between whitefly and YMV at 1% level of significance ($r = 0.623$) and strong positive correlation at 5% level of significance ($r = 0.497$) during summer 2014-15 whereas, there was a strong significant positive correlation ($r = 0.857$) relationship was established in between whitefly and YMV incidence at 1% ($r = 0.623$) and 5% ($r = 0.497$) level of significance during *kharif 2015-16*.

Present findings are in confirmation with Sindhumole and Manju (2013b) who also indicated that whitefly population at 30 DAS (Days after sowing) had positive correlation with disease incidence at 50 DAS to final

harvest and more whitefly count during 50 DAS also influenced the disease expression during the final phase of the crop. Shroff et al. (2010) reported the association of OYVM disease with whitefly population and opined that crop stage during 25 and 50 DAS period could be the most vulnerable for attack by whitefly vector to cause OYVM disease. Sanwal et al. (2013) who also reported that a single whitefly can transmit the yellow vein mosaic virus effectively however, the minimum number of whiteflies required to induce 100 per cent infection was 10 per plant. Dastoooger et al. (2011) also observed that a single whitefly was capable of transmitting the disease although 15 whiteflies could transmit the jute leaf mosaic virus to extent of 100 per cent and showed that the maximum 15 viruliferous whiteflies required for effective transmission of jute leaf mosaic virus disease. Karri and Acharya (2012) also studied that the varieties which showed more incidence of YVMV at thirty and sixty days after sowing was found to have greater loss in yield rather than those varieties which having the same intensity of the disease at later stage of the growth. WF and YMV relationship also supported by Watson et al. (2003) also reported that temperature above 30°C increased the rate of egg laying but above 40°C reduced the length of life cycle of *B. tabaci* to less than two weeks in okra crop. Solankey et al. (2014) who reported that rainy season favours incidence of OYVMV.

Incidence of natural enemies

4.11.1.9 Abundance of Lady bird beetle *Coccinella septempunctata* during summer 2014-15

It is revealed from Table 31 and depicted in Fig 17 that the incidence of LBB (0.2/plant) was initiated in the second week of February 2015 (6th MW) and it remained at same level (0.2/plant) in the third week of February 2015 (7th MW). Later on its appearance was not noticed upto the first week of April (14th MW). Later on its presence was again noticed from second week of April (15th MW) and further its population gradually increased in every successive week and it remained continuous upto (0.8/plant) in 3rd and 4th week of May (20 and 21st MW).

The population of LBB during the summer season 2014-15 on okra crop was in the range of 0.2 to 0.8/plant. The abundance of LBB

population was found between 19 to 21 of MW i.e. from 2nd week of May to 4th week of May (0.6 to 0.8/plant). The peak appearance of LBB was observed in 20 & 21st MW in 3rd & 4th week of May during summer 2014-15 (0.8/plant) which was favoured by weather parameter in the range of temperature 26.3°C to 43.0°C temperature, 14 to 34 % relative humidity, 1.0 mm rainfall and 8.4 sunshine hours.

It is evidenced from Table 33 that the population of LBB had shown significant positive correlation with both maximum temperature ($r = 0.684$) and minimum temperature ($r = 0.762$), as well as wind speed ($r = 0.592$).

Abundance of Lady bird beetle *Coccinella septempunctata* during Kharif 2015-16

It is indicated from Table 32 and depicted in Fig 18 that the population of LBB (1.50/plant) was first observed in the first week of August 2015 (31st MW). Further its population increased to the highest level (3.90/plant) in the succeeding week i.e. the second week of August (32nd MW). Later on it gradually declined during further crop growth period showing minimum population of (0.07/plant) in the 4th week of October. The population of LBB during *kharif* 2015-16 on okra crop was in the range of 0.07 to 3.90/plant. The abundance of LBB population was observed in the range between 31-33rd MW i.e. from 1st week of August to 3rd week of August (1.20-3.90/plant). The peak incidence of LBB (3.90/plant) was noticed 32nd MW during 2nd week of August which was favoured by temperature 22.6 to 28.9°C, 71 to 90 % RH, 40.7mm rainfall and 0.8 bright sunshine hours.

It is indicated from correlation study that Table 33 that the population of LBB had significantly negative correlation with maximum temperature ($r = - 0.670$), and bright sunshine hours ($r = - 0.502$), whereas significantly positive correlation with morning relative humidity ($r = 0.504$) and evening relative humidity ($r = 0.593$) and rainfall ($r = 0.545$).

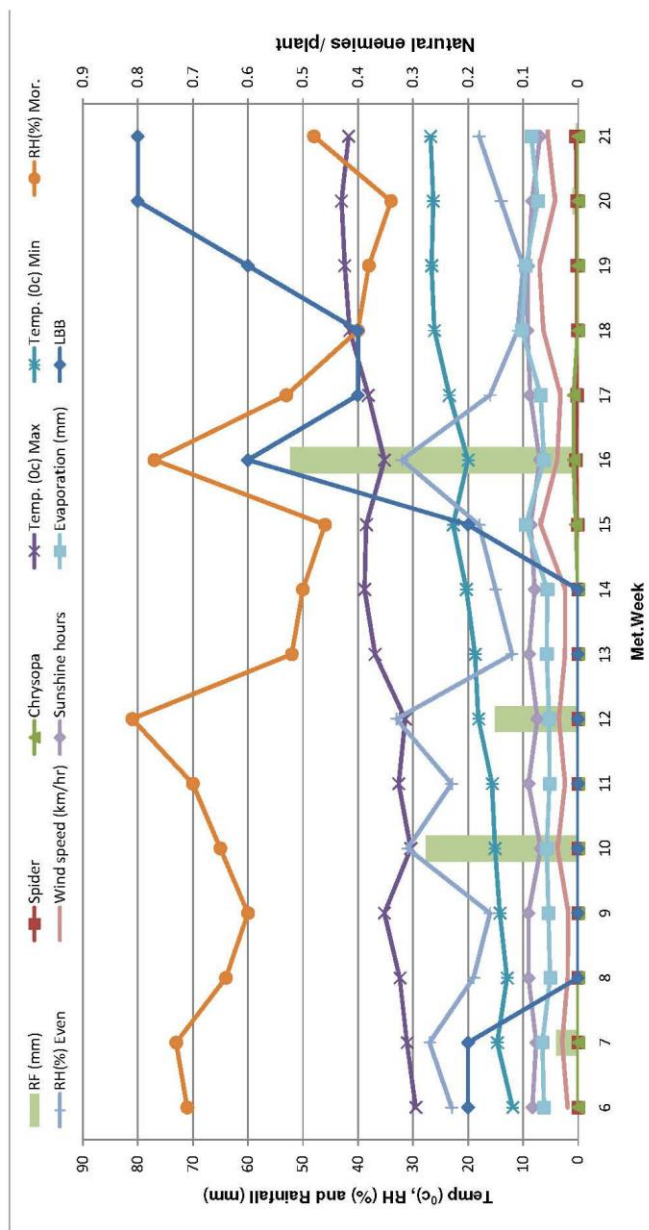


Fig. 17 Population dynamic of natural enemies on Okra during summer season 2014-15

Table :31 Population dynamic of natural enemies on Okra during summer season 2014-15

Period	Met. Week	Natural enemies / plant			Weather parameter								DAG
					Temperature (°c)		Relative humidity(%)		Wind speed (km/hr)	Rainfall (mm)	Sunshine hours	Evaporation (mm)	
		LBB	Spider	Chrysopa	Max	Min	Mor.	Even.					
5-11 Feb	6	0.2	0	0	29.5	11.9	71	23	1.9	0.0	8.3	6.2	7
12.-18	7	0.2	0	0	31.1	14.7	73	27	2.9	4.0	7.6	6.5	14
19-25	8	0	0	0	32.4	12.9	64	19	1.9	0.0	9.0	5.1	21
26-4 Mar	9	0	0	0	35.2	14.2	60	16	1.8	0.0	9.0	5.4	28
5-11	10	0	0	0	30.4	15.1	65	31	3.7	27.7	6.8	5.7	35
12-18	11	0	0	0	32.6	15.6	70	23	2.4	0.0	9.0	5.2	42
19-25	12	0	0	0	31.4	18.1	81	33	3.5	15.1	7.4	5.3	56
26-1 Apr	13	0	0	0	36.9	18.7	52	12	2.4	0.0	8.9	5.7	63
2-8	14	0	0	0	38.8	20.3	50	15	2.4	0.0	7.9	5.6	70
9-15	15	0.2	0.1	0.4	38.5	22.7	46	18	6.8	0.0	8.6	9.5	77
16-22	16	0.6	0.4	0.8	35.2	20.0	77	32	3.8	52.3	7.0	6.2	84
23-29	17	0.4	0.2	0.8	38.1	23.4	53	16	3.2	0.0	8.7	6.8	91
30-6 May	18	0.4	0.1	0	41.5	26.1	40	11	6.3	0.0	9.2	10.2	98
7-13	19	0.6	0.2	0	42.4	26.6	38	10	7.0	0.0	9.1	9.5	104
14-20	20	0.8	0.2	0	43.0	26.3	34	14	4.2	1.0	8.4	7.3	112
21-27	21	0.8	0.4	0	41.7	26.8	48	18	5.5	0.4	6.9	8.5	119

N.B: Pest population is of respective meterological week while weather parameter are of previous week

It is indicated from above findings that the abundance of LBB population was found between 19 to 21st MW in the range of 0.6 to 0.8/plant with its peak in 20 & 21st MW during summer 2014-15 while abundance of LBB population was observed between 31-33rd MW in the range of 0.2 to 3.9/plant with its peak at 32nd MW (3.9/plant) during kharif 2015-16. Significant positive correlation of LBB with max .temp. ($r = 0.684$), min. temp. ($r = 0.762$), WS ($r = 0.592$) and negative correlation with mor. RH. ($r = - 0.494$) during summer 2014-15, whereas significant negative correlation with max. temp. ($r = - 0.670$), and BSH ($r = - 0.502$), and positive correlation with mor. RH ($r = 0.504$) eve.RH. ($r = 0.593$) and rainfall ($r = 0.545$) during kharif 2015-16 was established.

Present findings are in confirmation with Anitha (2007) who observed that the Coccinellid population on summer okra crop noticed during second week 15 of April 2006. Present findings are also supported by Purohit et al., (2006) who recoded the maximum population of lady bird beetle (*Coccinella* spp.) during 3rd week of August and in the 2nd week of December during 2003 and during 1st week of September. Potai and Chandrakar (2018) who also reported that the peak activity of lady bird beetle (*Coccinella* spp.) was recorded during 3rd week of September (38th SMW) wherein maximum (32.2^oC) and minimum (24.9^oC) temperatures with morning (94 per cent) and evening (69 percent) relative humidity were prevailed. Anitha (2007) also reported that maximum population was observed during third week of July 06 (0.99 Coccinellids/plant), while the population of Coccinellids on *Kharif* crop appeared from 3rd week after sowing, i.e., second week of August 06 and reached its peak incidence during second week of October 06 (3.96 Coccinellids/plant). Meena and Kanwat (2010) who observed that the seasonal fluctuation of coccinellid beetle population on okra and build up of coccinellids on the crop starting from the first week of August (1.8 and 1.7 beetles/ plant) and reached the maximum (6.2 and 6.4 beetles/plant) in the first week of October in both the years. Singh et al. (2013) who reported that Coccinellids appeared more or less after the fifth week of the occurrence of aphid i.e. fourth week of September (39th standard week) with 0.33 Coccinellid/leaf. Khating,et.al (2016) who reported that the peak activity of

predator lady bird beetle was reported during second week of September (26 lady bird beetle/plant),

The correlation studies indicated that Vanlaldiki et.al. (2017) who reported that Correlation of seasonal incidence with maximum and minimum temperature and morning and evening relative humidity revealed a positive relationship in case of leafhoppers, whiteflies, mites, coccinellids and chrysoperla on okra crop during summer 2014-15 . Meena and Kumawat (2010) who reported that the morning and evening relative humidity and rainfall had a significant positive effect on the abundance of coccinellids. The results are supported by the studies of Purohit et al. (2006).

4.11.1.9 Abundunce of *Chrysoperla carnea* during summer 2014-15

It is stated from Table 31 and depicted in Fig 17 that the appearance of chrysopa was initiated (0.4/plant) in the 3rd week of April 2015 (15th MW) and its population increased the level upto (0.8/plant) in 3rd and 4th week of April 2014. (16th & 17th MW) and disappeared in further crop growth period. The population of chrysopa has appeared only during 15th to 17th MW during summer season 2014-15. However, incidence of chrysopa was noticed during 16th and 17th MW in 3rd and 4th week of April (0.8/plant) which was favoured by weather parameter in the range of 20⁰C to 38.1⁰C temperature 16 to 77 % RH, 52.3 mm rainfall, 7.0 to 8.7 hrs of bright sunshine.

It is appeared from correlation study Table 33 that the population of chrysopa had shown non-significant correlation with all weather parameter.

4.11.1.10 Abundunce of *Chrysoperla carnea* during *kharif* 2015-16

It is indicated from Table 32 and depicted in Fig 18 that the appearance of chrysopa (0.10/plant) was initiated in the 2nd week of August 2015 (32nd MW) and it remained continuous with slowly increasing in every successive week and reached to highest (0.60/plant) in the last week of September (39th MW). Further it again declined showing minimum population of (0.10/plant) in the second week of October (41st MW) and it disappeared in further stage of the crop up to harvest.

The appearance of chrysopa during the *kharif* season 2015-16 was below 0.5/plant except 0.60/plant in 39th MW and in the range of 0.10 to 0.60/plant from 32nd to 41st MW.

The peak occurrence of chrysopa was observed in 39th MW i.e. 4th week of September (0.60/plant) which was favoured by 21.3 to 33.1°C temperature 46 to 86 RH, 1.4 mm rainfall and 8.5 sunshine hours.

It is indicated from correlation data Table 33 that the morning RH ($r = 0.548$) had significantly positive correlation with chrysopa population. whereas non-significant correlation with other parameter was observed.

It is clear from above confirmation that the population of chrysopa was observed only during 15th to 17th MW in the range of 0.4 to 0.8/plant with its peak at 16 and 17th MW (0.8/plant) during summer 2014-15, while it was in between 32nd MW to 42nd MW in the range of 0.10 to 0.60/plant with its peak at 39th MW (0.6/plant) during *kharif* 2015-16. No significant correlation of chrysopa with any weather factor was noticed during summer 2014-15 while positive correlation relationship was established with mor. RH ($r = 0.548$) only during *kharif* 2015-16.

Present findings are in confirmation with Vanlaldiki et.al. (2017) who reported that chrysoperla was first observed from the last week and 3rd week of March and maintained a low population throughout cropping period. Anitha (2007) who reported that chrysoperla population on summer crop appeared during third week of April 06 and the peak incidence was noticed during fifth week of April 06 (0.56 grubs/plant).

4.11.1.11 Abundance of Spider population during Summer 2014-15

It is revealed that from Table 31 and depicted in Fig 17 that the appearance of spider (0.1/plant) was first noticed in the 2nd week of April 2014-15 (15th MW) Later on its appearance was observed to be increased (0.4/plant) in the third week of April (16th MW) Further its population was slowly decreased and increased but not more than 0.4/plant up to the 4th week of May (21st MW) upto harvest of crop.

The population of spider during the summer season 2014-15 on okra crop was in the range of 0.1 to 0.4/plant. Overall population of spider on

okra crop during summer season was very low ($< 0.4/\text{plant}$) maximum being in 16th & 21st MW. which was favoured by weather parameter with in the range of 20°C to 35.2°C and 26.8 to 41.7°C temperature ,32-77% and 18-48% RH, 52.3mm rainfall and 6.9-7.0 bright sunshine. However, significant positive correlation of spider population with both maximum temperature ($r = 0.574$) and minimum temperature($r = 0.679$) wind speed ($r = 0.518$) while non-significant correlation with other parameter was observed.

4.11.1.12 Abundance of Spider population during *kharif* 2015-16

It is revealed from Table 32 and depicted in Fig 18 that the appearance of spider was first noticed (0.10/plant) in the 3rd week of July 2015.(29th MW) and it was remained at similar level in the 3rd week of July 2015 (30th MW). Further its population (0.20/plant) increased in the first week of August i.e. (31st MW) and the population was maintained up to the first week of September (upto 36th MW) again it declined to 0.10 in the second week of September (37th MW). Later on its population was increased (0.30/plant) in 3rd and 4th week of September in (38th & 39th MW).Later on the spider population was declined suddenly to 0.10/plant in first and second week of October (40 and 41st MW) and the population disappeared with effect from 3rd week of October onwards (42 and 43rd MW).

The population of spider during the *kharif* season of 2015-16 was observed in the range of 0.10 to 0.30 /plant which is very low population.

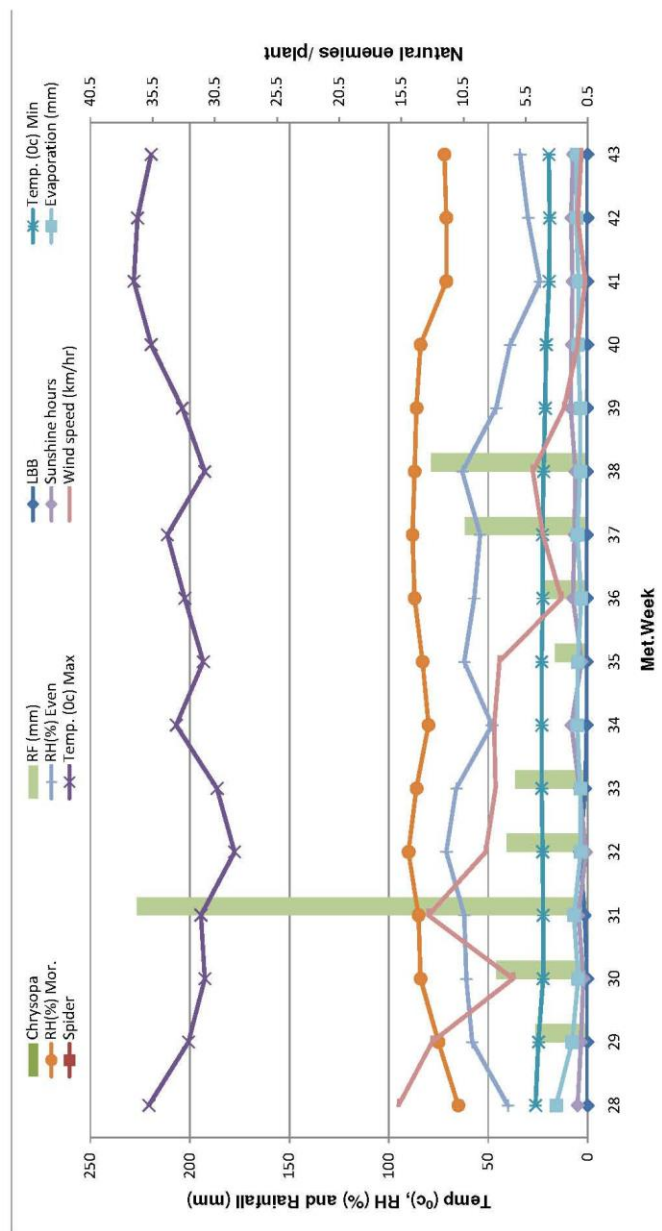


Fig. 18 Population dynamic of natural enemies on Okra during *kharif* season 2015-16

Table : 32 Population dynamic of natural enemies on Okra during *Kharif* season 2015-16

Period	Met.Week	Natural enemies / plant			Weather parameter								DAG
					Temperature (°c)		Relative humidity(%)		Wind speed (km/hr)	Rainfall (mm)	Sunshine hours	Evaporation (mm)	
		LBB	Spider	Chrysopa	Max	Min	Mor.	Even.					
9-15July	28	0.00	0.00	0.00	35.8	26.2	65	40	15.7	0.0	5.0	15.9	7
16-22	29	0.00	0.10	0.00	32.6	24.7	75	58	13.0	26.2	3.4	7.8	14
23-29	30	0.00	0.10	0.00	31.3	22.4	84	61	6.5	45.9	2.1	4.8	21
30-5 Aug	31	1.50	0.20	0.00	31.6	22.4	85	62	13.3	226.5	4.6	6.9	28
6-13 Aug	32	3.90	0.20	0.10	28.9	22.6	90	71	8.7	40.7	0.8	3.5	35
13-19	33	1.20	0.20	0.10	30.3	23.1	86	66	7.9	36.5	4.1	3.8	42
20-26	34	0.40	0.20	0.13	33.6	23.0	80	48	8.0	0.0	8.2	5.2	56
27-2Sept	35	0.40	0.20	0.10	31.4	23.1	83	62	7.6	16.4	2.9	5.0	63
03-Sep	36	0.30	0.20	0.30	32.9	22.5	87	57	2.6	22.4	7.4	3.3	70
Oct-16	37	0.20	0.10	0.40	34.3	22.7	88	54	4.1	61.6	6.6	5.1	77
17-23	38	0.20	0.30	0.40	31.3	22.2	87	63	4.9	78.9	6.1	3.8	84
24-30	39	0.20	0.30	0.60	33.1	21.3	86	46	2.4	1.4	8.5	3.7	91
1-7 Oct	40	0.10	0.10	0.20	35.6	20.8	84	39	1.3	0.0	8.1	4.9	98
8-14 Oct	41	0.10	0.10	0.10	37.0	19.3	71	24	0.7	0.0	7.6	4.6	104
15-21	42	0.10	0.00	0.00	36.7	19.1	71	30	1.3	0.0	8.3	5.7	112
22-28	43	0.07	0.00	0.00	35.6	19.5	72	34	1.0	0.0	7.4	5.5	119

Table: 33 Correlation matrix: Effect of abiotic factors on natural enemies of okra during Summer 2014-15 and *Kharif* 2015-16

Pests	Temperature (°c)		R.H. (%)		Wind speed (km/hr)	Rainfall (mm)	Bright Sun Shine (Hrs)	Evp(mm)
	T.Max. temp. (°C)	T. Min. temp. (°C)	Morning	Evening				
Summer 2014-15								
LBB	0.684**	0.762**	- 0.494	- 0.246	0.592*	0.107	- 0.167	0.624**
Chrysopa	0.088	0.210	0.116	0.184	0.115	0.481	- 0.132	0.085
Spider	0.574*	0.679**	- 0.278	- 0.056	0.518*	0.367	- 0.333	0.470
Kharif 2015-16								
LBB	- 0.670**	0.123	0.504*	0.593*	0.346	0.545*	- 0.502*	- 0.238
Chrysopa	- 0.088	- 0.088	0.548	0.106	-0.417	- 0.073	0.414	- 0.424*
Spider	- 0.672**	0.133	0.755**	0.607*	0.020	0.316	- 0.094	- 0.542*

(No. of observations 16) ** significant at 1% : 0. 623 * significant at 5% :- 0.497

The maximum (0.30/plant) was observed during 38 & 39th MW in 3rd & 4th week of September. However, correlation study data from Table 33 indicate that there was significantly positive correlation study of morning and evening relative humidity ($r = 0.755$), ($r = 0.607$) and negatively correlation of maximum temperature ($r = - 0.672$) with the spider population.

It is clear from the above findings that the overall very low population of spider on okra crop was noticed in between 15th MW and 21st MW in the range of 0.1 to 0.4/plant with its peak at 16th and 21st MW during summer 2014-15. Similarly very low population of spider was observed from 29 to 42nd MW in the range of 0.10 to 0.30 with its peak at 38 and 39th MW (0.30/plant) during the *kharif* 2015-16.

The correlation study indicated that significant positive correlation of spider with min.temp. ($r = 0.679$), max.temp ($r = 574$) and WS ($r = 0.518$) during summer 2014-15 while significant positive correlation with mor. RH. ($r = 0.755$) and eve. RH ($r = 0.607$) and negative correlation with max.temp. ($r = - 0.672$), was established during *kharif* 2015-16.

Present findings are in confirmation with Kumaranag (2015) who reported that the abundance of spiders and coccinellids was at its peak between 33rd and 34th SW (second and third week of August) during 2011-2013. Spider and coccinellids population had significant positive correlation with morning relative humidity and rainfall during 2011 and 2012 .

4.11.2 Population dynamics of fruit borer

4.11.2.1 Abundance of Fruit borer, *E. vittella* during summer 2014-15

It is revealed from Table 34 and depicted in fig 19 that the incidence of shoot and fruit borer was initiated in the shoots (1.81 per cent) in 3rd week of February (8th MW) it gradually increased and attained its peak in first week of March *i.e.* 10th MW (8.89 per cent). Later on its infestation in shoots was not observed during further crop growth period in shoots. The infestation of SFB in shoots during summer season 2014 on okra crop was in the range 1.81 to 8.89 per cent.

The peak incidence of SFB (8.89%) was observed during 10th MW in 2nd week of March which was favoured by weather parameter in the

range of 15.1 to 30.4°C temperature, relative humidity 31 to 65 %, no rainfall and 6.8 bright sunshine hours.

However, its infestation in fruits was first noticed (11.85 per cent) in second week of April (15th MW). Later on the SFB infestation in fruits was went on gradually increasing attaining its peak of fruit infestation (25.06 per cent) in the last week of April (17th MW) and then its infestation gradually decrease in every successive week accounting the lowest infestation 6.14 per cent in the 4th week of May (21st MW).

The abundance of fruit borer (*E.vittella*) was observed between 15th and 21st MW i.e. from 3rd week of April to 4th week of May (6.14% to 25.06%). Peak incidence of fruit borer *E.vittella* was noticed during 17th MW in 4th week of April (25.06%) which was favoured by weather parameter in the range of 23.4 to 38.1°C temperature, 16 to 53%RH, no rainfall and 8.7 sunshine hours.

It is indicated from correlation study in Table 36 the infestation of *Earias vittella* had significant positive correlation with both maximum temperature ($r = 0.634$) and minimum temperature ($r = 0.736$) as well as wind speed ($r = 0.590$). while significantly negative correlation with morning RH ($r = - 0.514$)

Abundance of Fruit borer *E. vittella* during *kharif* 2015-16

From the Table 35 and depicted in fig 20 that the infestation of *E. Vittella* in shoots of okra was initiated (1.2 per cent) in 4th week of July 2015.(30th MW) . Later on its infestation in fruits was gradually increased and attained the maximum infestation 7.33 per cent in 3rd week of August i.e. (33rd MW).

The infestation of SFB in shoots during *kharif* 2015 on okra crop was in the range of 1.2 to 7.33 per cent being maximum (7.33%) in 33rd MW in 3rd week of August favoured by temperature range of 23.1 to 30.3°C 66 to 86 % RH 36.5 mm rainfall and 4.0 % sunshine hours.

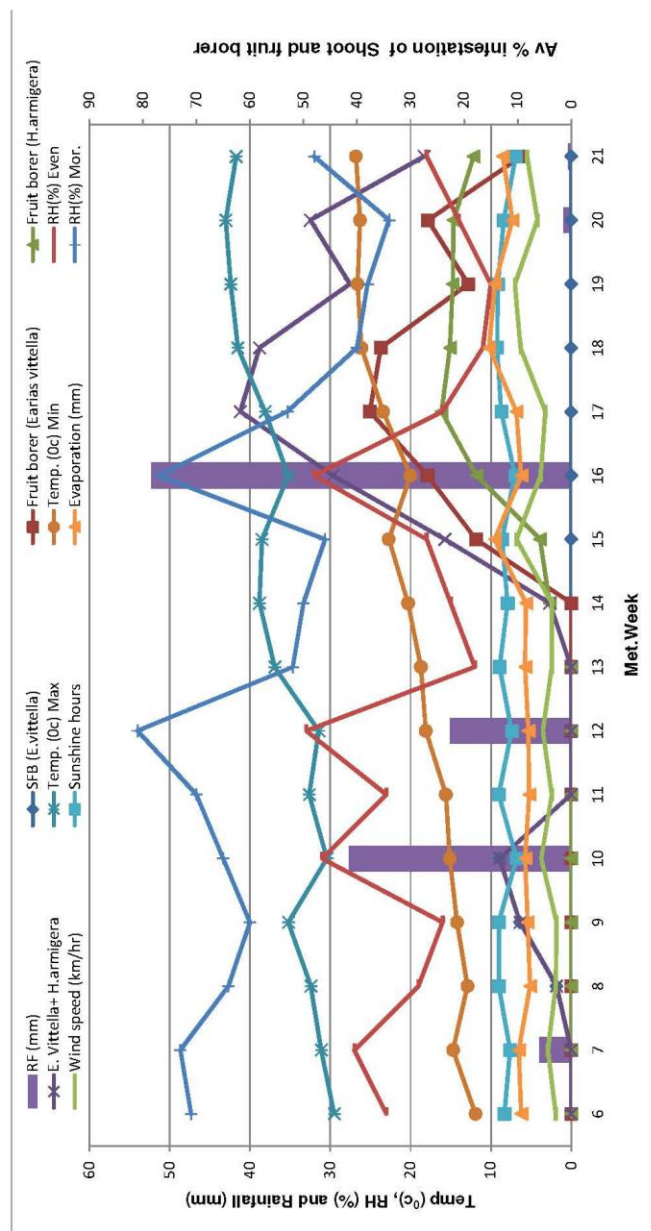


Fig. 19 Population dynamic of Shoot and Fruit borer complex pests on Okra during summer season 2014-15

Table : 34 Population dynamic of Shoot and Fruit borer complex pests on Okra during summer season 2014-15

Period	Met. Week	Av % infestation of Shoot and fruit borer				Weather parameter								
		SFB (<i>E.vittella</i>)	Fruit borer (<i>Earias vittella</i>)	Fruit borer (<i>H.armigera</i>)	<i>E. Vittella</i> + <i>H.armigera</i>	Temperature (°c)		Relative humidity(%)		Wind speed (km/hr)	Rainfall (mm)	Sunshine hours	Evaporation (mm)	DAG
						Max	Min	Mor.	Even.					
5-11 Feb	6	0	0	0	0	29.5	11.9	71	23	1.9	0.0	8.3	6.2	7
12.-18	7	0	0	0	0	31.1	14.7	73	27	2.9	4.0	7.6	6.5	14
19-25	8	1.81	0	0	1.81	32.4	12.9	64	19	1.9	0.0	9.0	5.1	21
26-4 Mar	9	6.36	0	0	6.36	35.2	14.2	60	16	1.8	0.0	9.0	5.4	28
5-11	10	8.89	0	0	8.89	30.4	15.1	65	31	3.7	27.7	6.8	5.7	35
12-18	11	0.00	0	0	0	32.6	15.6	70	23	2.4	0.0	9.0	5.2	42
19-25	12	0.00	0	0	0	31.4	18.1	81	33	3.5	15.1	7.4	5.3	56
26-1 Apr	13	0.00	0	0	0	36.9	18.7	52	12	2.4	0.0	8.9	5.7	63
2-8	14	0.00	0	2.66	2.66	38.8	20.3	50	15	2.4	0.0	7.9	5.6	70
9-15	15	0.00	11.85	3.86	15.71	38.5	22.7	46	18	6.8	0.0	8.6	9.5	77
16-22	16	0.00	17.89	11.76	29.65	35.2	20.0	77	32	3.8	52.3	7.0	6.2	84
23-29	17	0.00	25.06	16.12	41.18	38.1	23.4	53	16	3.2	0.0	8.7	6.8	91
30-6 May	18	0.00	23.72	15.07	38.79	41.5	26.1	40	11	6.3	0.0	9.2	10.2	98
7-13	19	0.00	12.82	14.72	27.54	42.4	26.6	38	10	7.0	0.0	9.1	9.5	104
14-20	20	0.00	17.83	14.63	32.46	43.0	26.3	34	14	4.2	1.0	8.4	7.3	112
21-27	21	0.00	6.14	12.14	18.28	41.7	26.8	48	18	5.5	0.4	6.9	8.5	119

N.B: Pest population is of respective meterological week while weather parameter are of previous week

The infestation of fruit borer *E.vittella* in fruits was first (11.28 per cent) observed in 3rd week of Sept 2015 (34th MW) and its infestation was at similar level up to first week of Sept (36th MW) and later on its infestation in fruits was gradually increased showing its maximum infestation (31.23 per cent) in last week of September (39th MW). Further its infestation decreasing gradually accounting the lowest infestation in fruits to the tune of 19.11 per cent in last week of October (43rd MW).

The abundance of fruit borer *E. vittella* was noticed between 34 to 43rd MW in the range of 11.28% to 31.23% i.e. from 3rd week of August to 4th week of October. Peak incidence of fruit borer *E. vittella* was observed (31.23%) during 39th MW in 4th week of Sept, which was favoured by weather parameter in the range of temperature 21.3 to 33.1⁰C, 46 to 86% RH, 1.4m rainfall and 8.5 bright sunshine hours.

It appears from correlation data Table 36 that the infestation of *E. vittella* had significant negative correlation with minimum temperature ($r = -0.704$), evening relative humidity ($r = -0.523$) and wind speed ($r = -0.827$). Whereas significant positive correlation with sunshine hours ($r = 0.729$).

It is revealed from the above findings that the abundance of fruit borer *E.vittella* was observed during summer 2014-15 between 15th and 21st MW in the range of 6.14% to 25.06% with its peak at 17th MW (25.06%), while during *kharif* 2015-16 it was noticed between 34 to 43rd MW in the range of 11.28 to 31.23 % with its peak at 39 MW (31.23%). Significant positive correlation of fruit borer *E.vittella* with max.temp. ($r = 0.634$), min.temp. ($r = 0.736$) and WS ($r = 0.590$) during summer 2014-15 and during *kharif* 2015-16 significant negative correlation with min.temp. ($r = -0.704$), eve.RH. ($r = -0.523$) and WS ($r = -0.827$) and positive correlation with BSH ($r = 0.729$) was established.

Present findings are in confirmation with Dhandge et.al (2018) who also investigated that abundance of *E.vittella* on okra showed the activity commenced from 11th SW (0.9 larvae/plant) and continued up 24th MSW (0.93 larvae/plant). Dabhi et.al (2013) who also reported that the peak infestation of fruits due to *E. vittella* observed in the 13th & 15th MSW during summer. Per cent fruit damage showed significant positive impact with BSS, temperature

(maximum and minimum) and vapour pressure deficit (morning and evening) during summer season. Potai and Chandrakar (2018) who stated that Shoot and Fruit borer, *E. vittella* observed from second week of August 2016 up to crop maturity 44th SMW with one distinct peak 40th SMW (3.54 % fruit infestation). Rajput and Tayade (2017) also reported that the occurrence of shoot and fruit borer, (*Earias vittella*) in 34th standard week (August third week) with an average population of 2.71% infestation. and then the population gradually increased and reached to its peak level by 39th standard week (October first week) with an average population of 39.44% infestation. Nenavati and Kumar (2013) reported that the occurrence of shoot and fruit borer *E.vittella* commenced from 33rd MSW (August 3rd week with 2.4 % infestation) and reached to its peak (45.7%) at 41st MSW. (October 2nd week) on okra. Mohanasundaram and Sharma (2011) who observed that the fruit borer (56.6%) during last week of August, and 3rd week of September. Archunan et.al (2018) revealed that the per cent shoot damage and fruit damage by *E. vittella* on bhendi reached peak 43rd and 42nd MSW in kharif season. Badiyala and Desh Raj (2013) who reported that peak fruit infestation (%) as well as peak larval population per fruit was observed in third to fourth week of August during the two seasons.

Present findings on correlation study of *E.vittella* are in agreement with Jagtap et al. (2007) who reported that the minimum temperature showed highest positive and evening relative humidity have negative effects on *E. vittella* on okra. Rajput and Tayade (2017) who found that shoot and fruit borer increased with increasing maximum temperature and positively correlated with maximum temperature. Dhandge et.al (2018) who indicated that maximum and minimum temperature showed significant positive correlation and bright sunshine showed negative correlation with okra shoot and fruit borer population. Archunan et.al (2018) who also reported that significantly positively correlated with minimum (0.552 and 0.698) and maximum temperature (0.629 and 0.748), whereas rainfall positively correlated with per cent shoot and fruit damage but it was non significant (0.111 and 0.297). However relative humidity (-0.178 and -0.210) and sunshine hours were exerted negatively correlated with per cent shoot

damage and fruit damage by *E. vittella* during *rabi* 2017. Muhammad et al. (2011) who found that fruit borer infestation was positively correlated with maximum and average temperature and negatively correlated with relative humidity and rainfall on both the seasons. Sharma et al. (2010) who also reported that correlation between pest population and weather parameter showed on *E. vittella* was significantly negatively correlated with mean temperature and mean relative humidity but non significant and negative correlation with rainfall in terms of larval population and per cent of infected plants. Dabhi et al. (2013) who also reported that morning and evening relative humidity had significant positive effect on fruit damage due to *E. vittella* during *kharif* season

4.11.2.2 Abundance of Fruit borer, *H. armigera* during summer 2014-15

It is observed from the data presented in Table 34 and depicted in fig 19 that the infestation of *H. armigera* as a fruit borer was initiated (2.66 per cent) during first week of April 2014-15. Then from 14th MW it gradually increased and attained the maximum infestation in the last week of April (16.12 per cent) during 17th MW. Later on its infestation was slightly decreased in further week (15.07 to 12.14%) upto 4th week of May.

The abundance of fruit borer *H.armigera* was observed between 16 and 21st MW from 3rd week of April to 4th week of May (11.76 to 16.21%). The peak incidence of fruit borer *H.armigera* was noticed during 17th MW i.e. in 4th week of April (16.21%). Which was favoured by 23.4 to 38.1⁰C, temperature, 16 to 53 % RH, no rainfall 8.7 sunshine hours.

It is evidenced from correlation study Table 36 that the infestation of fruit borer *H. armigera* had significantly positive correlation with both maximum temperature ($r= 0.792$), minimum temperature ($r = 0.868$), and wind speed ($r= 0.635$), whereas significant negative correlation with morning relative humidity ($r = -0.619$)..

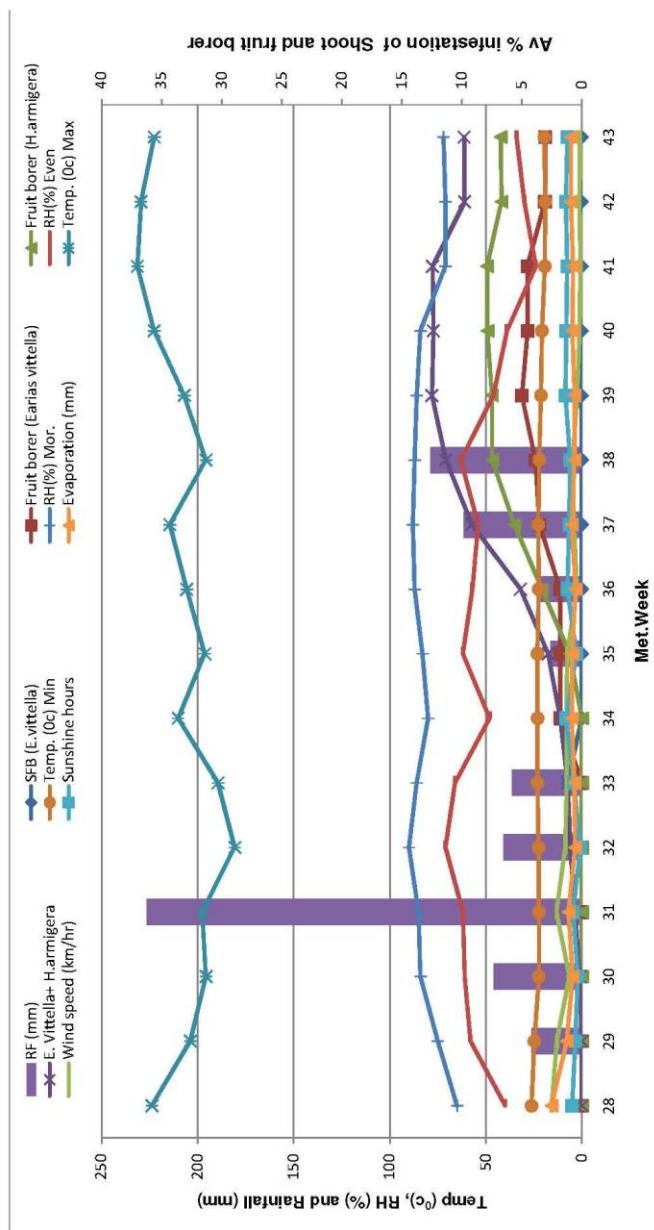


Fig. 20 Population dynamic of Shoot and Fruit borer complex pests on Okra during *kharif* season 2015-16

Table : 35 Population dynamic of Shoot and Fruit borer complex pests on Okra during *Kharif* season 2015-16

Period	Met. Week	Av % infestation of Shoot and fruit borer				Weather parameter								
		SFB (E.vittella)	Fruit borer (Earias vittella)	Fruit borer (H.armigera)	E. Vittella+ H.armigera	Temperature (°c)		Relative humidity (%)		Wind speed (km/hr)	Rainfall (mm)	Sunshine hours	Evaporation (mm)	DAG
						Max	Min	Mor.	Even.					
9-15July	28	0.00	0	0	0	35.8	26.2	65	40	15.7	0.0	5.0	15.9	7
16-22	29	0.00	0	0	0	32.6	24.7	75	58	13.0	26.2	3.4	7.8	14
23-29	30	1.2	0	0	1.2	31.3	22.4	84	61	6.5	45.9	2.1	4.8	21
30-5 Aug	31	3.5	0	0	3.5	31.6	22.4	85	62	13.3	226.5	4.6	6.9	28
6-13 Aug	32	5.9	0	0	5.9	28.9	22.6	90	71	8.7	40.7	0.8	3.5	35
13-19	33	7.33	0	0	7.33	30.3	23.1	86	66	7.9	36.5	4.1	3.8	42
20-26	34	0	11.28	0	11.28	33.6	23.0	80	48	8.0	0.0	8.2	5.2	56
27-2Sept	35	0	11.28	6.27	17.55	31.4	23.1	83	62	7.6	16.4	2.9	5.0	63
03-Sep	36	00	11.28	20.7	31.98	32.9	22.5	87	57	2.6	22.4	7.4	3.3	70
Oct-16	37	0	22.17	35.1	57.27	34.3	22.7	88	54	4.1	61.6	6.6	5.1	77
17-23	38	0	24.16	46.66	70.82	31.3	22.2	87	63	4.9	78.9	6.1	3.8	84
24-30	39	0	31.23	46.78	78.01	33.1	21.3	86	46	2.4	1.4	8.5	3.7	91
1-7 Oct	40	0	28.2	49.11	77.31	35.6	20.8	84	39	1.3	0.0	8.1	4.9	98
8-14 Oct	41	0	28.4	49.33	77.73	37.0	19.3	71	24	0.7	0.0	7.6	4.6	104
15-21	42	0	19.23	41.79	61.02	36.7	19.1	71	30	1.3	0.0	8.3	5.7	112
22-28	43	0	19.11	42.16	61.27	35.6	19.5	72	34	1.0	0.0	7.4	5.5	119

N.B: Pest population is of respective meterological week while weather parameter are of previous week

Table:- 36 Correlation analysis between weather parameters and FB per cent shoot and fruit damage by *Earias* spp & *Ha. armigera* Spp.

Weather Parameters	Earias Vittella		Ha.armigera		T FB by (Earias Vittella+ Ha.armigera)	
	Summer 15	Kharif 15	Summer 15	Kharif 15	Summer 15	Kharif 15
Max. temp. (°C)	0.634**	0.463	0.792**	0.576*	0.737**	0.546*
Min. temp. (°C)	0.736**	-0.704**	0.868**	-0.740**	0.841**	-0.738**
Morning RH (%)	-0.514*	0.088	-0.619*	-0.078	-0.565*	-0.024
Evening RH (%)	-0.286	-0.523*	-0.423	-0.611*	-0.376	-0.589*
Wind speed (km/hr)	0.590*	-0.827**	0.635**	-0.834**	0.620*	-0.842**
Rainfall (mm)	0.186	-0.294	0.043	-0.288	0.096	-0.294
Bright Sun Shine (Hrs)	0.123	0.729**	0.077	0.715**	0.200	0.729**
Evp (mm)	0.631**	-0.455	0.681**	-0.331	0.680**	-0.377

(No. of observations 16) ** significant at 1% : 0.623 * significant at 5% :-0.497

Abundance of Fruit borer, *H.armigera* during *kharif* 2015-16

It is evident from Table 35 and depicted in Fig. 20 that the infestation of *H. armigera* in okra fruits was initiated in the 5th week of August during *kharif* 2015-16. Later on its gradually increased attaining its peak 49.33 per cent in the 2nd week of October. Later on its infestation decreased to 41.79 and 42.16 per cent in 3rd week (42nd MW) and 4th week (42nd MW) of October.

The infestation of fruit borer during the *kharif* season on okra crop was in the range of 6.27 to 49.33 per cent. The abundance of fruit borer *H. armigera* was found between 35th to 43 MW in 4th week of September to 4th week of October (6.27 to 49.33%). The peak incidence of *H. armigera* fruit borer (49.33%) was noticed during 41st MW in 2nd week of October which was favoured by 19.3 to 37°C temperature, 24 to 71% RH, no rainfall and 7.6 sunshine hours.

It appears from correlation study Table 36 that the fruit borer (*H. armigera*) during the *kharif* season during 2015-16 had significant positive correlation with maximum temperature ($r = 0.576$) and bright sunshine hours ($r = 0.715$). Whereas, significant negative correlation with minimum temperature ($r = -0.740$) and evening relative humidity ($r = -0.611$).

It is indicated that the above findings that abundance of fruit borer, *H. armigera* was observed between 16 to 21st MW in the range of 11.76 to 16.21% with its peak at 17th MW (16.21%) during summer 2014-15, while it was, between 35 to 43rd MW in the range of 6.27 to 49.33% with its peak incidence at 41st MW (49.33%) during *kharif* 2015-16. Significant positive correlation of the fruit borer, *H. armigera* with both max.temp. ($r = 0.792$), min.temp. ($r = 0.868$), WS ($r = 0.635$) and negative correlation with mor.RH. ($r = -0.619$) during summer 2014-15, whereas during *kharif* 2015-16 positive correlation with max.temp. ($r = 0.576$), BSH ($r = 0.715$) and negative correlation with min.temp. ($r = -0.740$) was established.

Present findings are in confirmation with Agurla et.al. (2017) who reported that incidence of *H.armigera* was commenced in 35th SMW with peak incidence in terms of per cent fruit damage on number and weight

basis were 33.67 and 56.34 per cent, respectively at temperature 31.9°C, RH 73.5%, Rainfall 0.3 mm and sunshine 7.2 hr day⁻¹. He also found that maximum temperature and sunshine hours were positively correlated with larval population and fruit damage whereas minimum temperature, relative humidity and rain fall were negatively correlated with larval population and fruit damage. Maximum temperature was most influencing weather parameter on population dynamics of *H. armigera*.

4.11.2.3 Abundance of Fruit borer ,*E.vitt*+*H.armigera* on okra during summer 2014-15

It is evident from the data presented in Table 34 and Fig 19 that the infestation of fruit borer complex *i.e.* both due to *E.vittella* and *H.armigera* was initiated (1.81 per cent) in the 4th week of February (8th MW). Then its infestation gradually increased in first week of March 10th MW (8.89 per cent.) Later on its infestation disappeared from 11th to 13th MW and again appeared in 14th MW 1st week of April.(2.66%) and continuously increased slowly and reached at peak 41.18 % during 17th MW in 4th week of April. Then again it gradually decreased up to 27.54% in 19th MW and again increased in 20th MW to 32.46% 3rd week of May and by end of week before harvest declined to 18.28%. The abundance of per cent infestation of fruit borer complex was observed between 15 to 21st MW *i.e.* from 2nd week of April to 4th week of May (15.71% to 41.18%). The peak infestation of fruit borer complex was noticed during 17th MW in 4th week of April (41.18%) and was favoured by weather parameter in the range of 23.4 to 38.1°C , temperature, 16 to 53% relative humidity, no rainfall and 8.7 bright sunshine hours.

It is evidenced from correlation study Table 36 that during summer season 2014-15 the total fruit borer complex (*E. vittella* +*H. armigera*) had significant positive correlation with both maximum temperature ($r = 0.737$) and min temp($r = 0.841$) at 1% level of significance significantly negative correlation with RH ($r = - 0.565$) positive correlation with wind speed ($r = 0.620$) at 5 % level of significance.

Abundance of Fruit borer *E.vitt* + *H. armigera* on okra Kharif 2015-16

It is evident from the data presented in Table 35 and depicted in Fig 20 that the observation regarding the total fruit borer complex (*E.vittella* + *H.armigera*) indicates that the infestation of fruit borer complex was initiated at 1.2 per cent in 4th week of July (30th MW). Later on its infestation gradually increased in every successive week attaining the highest peak infestation in 4th week of September (78.01 per cent). Later on it infestation slowly decreased to 61.27% in last in 4th week of October i.e. upto harvest of crop .The abundance of fruit borer complex was found between 32nd and 43rd MW from 2nd week of August to 4th week of October (5.9% to 78.01%). The peak incidence of 78.01% was noticed during 39th MW in 4th week of September which was favoured by weather parameter in the range of 21.3% to 33.1⁰C temperature, 46 to 86 % RH, 1.4 mm rainfall and 8.5 bright sunshine hours

It appears from correlation study Table 36 that the total fruit borer complex infestation had significantly positive correlation with ($r = 0.546$) with maximum temperature, and bright sunshine hours ($r = 0.729$) and significant negative correlation with minimum temperature ($r = - 0.738$), evening RH ($r = - 0.589$), and wind speed ($r = - 0.842$).

It is clear from the above findings that the abundance of per cent infestation of fruit borer complex was observed between 15th and 21st MW in the range of 15.71% to 41.18% with its peak at 17th MW (41.18%) during summer 2014-15 while in kharif 2015-16 it was in between 32nd and 43rd MW in the range of 5.9% to 78.01% with its peak at 39th MW (78.01%).

Positive correlation of fruit borer complex (*E.vittella* + *H. armigera*) with max.temp. ($r = 0.737$) and min.temp. ($r = 0.841$) at 1% level of significance while significant negative correlation with mor.RH ($r = - 0.565$) and positive correlative with WS ($r = 0.620$) at 5% level of significance was established during summer 2014-15 whereas significant positive correlation with max.temp ($r = 0.546$) and BSH ($r = 0.729$) and negative correlation with min.temp. ($r = - 0.738$), eve. RH ($r = - 0.589$) and WS ($r = - 0.842$) at 5 % level was established during kharif 2015-16. It is clear from the above finding that peak incidence of fruit borer complex (*E. vittella* + *H. armigera*) was

observed at 17th MW (41.18%) and 39th MW (78.01%) during summer 2014-15 and *kharif* 2015-16, respectively while a strong positive significant correlation relationship of fruit borer complex with max. temp. was commonly observed during summer 2004-15 and *kharif* 2015-16.

Present findings regarding infestation of fruit borer (*E. vittella* + *H. armigera*) are in agreement with Siddartha et.al (2017) who reported that the population of fruit and shoot borers of okra and their relation with prevailing weather conditions during *rabi* 2014, summer and *kharif* 2015 were observed. Eggs and larvae of *Earias* spp. were noticed on five weeks old crop during all the cropping seasons while *H. armigera* was observed a week later. Larval population of *Earias* spp. (1.34 ± 0.18 larvae/plant) and *H. armigera* (0.27 ± 0.04 larvae/plant) was highest in *kharif* 2015. Jagtap (2007) revealed the population of *E. vittella*, *H. armigera*, *Condica illecta*, *Trichoplusia ni* and *S. litura* ranged from 1.0 to 8.8, 1.2 to 5.4, 0.6 to 0.8, 0.4 to 2.2 and 1.2 to 2.8 larvae per quadrat, respectively on okra. Present finding regarding correlation study are in confirmation with Pathan et.al (2018) who reported that fruit damage caused by *Helicoverpa armigera* (Hubner) Hardwick showed highly significant negative association with WS ($r = -0.73^{**}$), MinT (-0.78^{**}) and RH2 (-0.83^{**}) whereas, BSS (0.77^{**}) and MaxT (0.74^{**}) revealed highly significant positive association during *kharif*, 2014. During *kharif*, 2015; MinT (-0.70^{*}) exerted significant negative association. *Earias vittella* (Fabricius) study revealed that BSS ($r = 0.88^{**}$) and MaxT (0.86^{**}) exhibited highly significant positive impact whereas, WS (-0.75^{**}) and RH2 (-0.90^{**}) had highly significant negative association during *kharif*, 2014. Similar results also supported by Selvaraj et.al (2010) who stated that the maximum and minimum temperatures were found to exert significant positive influence on *E. Vittella* whereas *H. armigera* population showed significant positive correlation ($r = 0.606$) with maximum temperature and dewfall.

4.12 Incidence of major pest and natural enemies on summer Vis-a-Vis *kharif* on okra during 2015-16

4.12.1 Abundance of sucking pests on summer vis-a-vis *kharif* season on okra during 2014-15 and 2015-16

It is revealed from Table 37 that incidence of aphids was observed from 7th to 12th MW in the range of 0.87 to 12.46 aphids/leaf/plant with peak incidence at 10th MW (12.46 aphids/leaf) during 2nd week of March in summer 2014-15 whereas incidence of aphids was observed from 32nd MW to 38th MW in the range of 0.40 to 11.3 aphids/leaf/plant with peak incidence at 35th MW (11.3 aphids/leaf) i.e. in the 4th week of August during *kharif* season.

Incidence of leaf hopper was observed from 6th to 21st MW in the range of 0.13 to 27.3 LH/leaf/plant with peak incidence at 12th MW i.e. in the 4th week of March during summer season. The leaf hopper has cross the threshold level (< 4 LH/leaf/plant) at 11 times through out the season, whereas incidence of leaf hopper observed from 30th to 43rd MW in the range of 0.22 to 28.66/leaf/plant. with peak incidence 36th MW i.e. in the first week of Sept. during *kharif* season. The leaf hopper has cross the threshold level (< 4LH/leaf) for seven times. It means incidence of leaf hopper was more and continuous through out the crop period during summer season compared to *kharif* 2015-16.

Normal incidence of whitefly was observed from 13th to 21st MW in the range of 1.8 to 6.86 WF/leaf/plant with peak incidence (6.86WF/leaf/Pl.) at 19th MW i.e. in 2nd week of May during summer 2014-15, however, normal incidence of whitefly observed from 31st to 42nd MW in the range of 0.62 to 6.88 WF/leaf/Pl. with peak incidence at 37th MW (6.88 WF/L/Pl.) and 38th MW (6.54 WF/L/Pl.) i.e. in 2nd and 3rd

Table:37 Seasonal Incidence of sucking pests on summer vis a vis *Kharif* Okra during 2015-16

Period	Met.We ek	Av. population of sucking pest /leaf/ plant during summer 2014-15					Av. Popl.of Dusky Cotton Bug/10cm twig/plant	Period	Met.We ek	Av. population of sucking pest /leaf/plant during kharif 2015-16				
		Aphid	LH	WF	Thrips	Mites				Aphid	Leaf hopper	White Fly	Thrips	Mites
5-11 Feb	6	0	0.13	0	0	0	0	9-15July	28	0	0	0	0	0
12.-18	7	0.87	0.73	0.06	0	0	0	16-22	29	0	0	0	0	0
19-25	8	1.24	3.73	0	0.2	0	0	23-29	30	0	0.2	0	0	0.0
26-4 Mar	9	3.19	6.73	0.13	0.29	0	0	30-5 Aug	31	0	0.3	0.62	0	0
5-11	10	12.46	10.46	0	0.36	0	0	6-12	32	0.40	0.3	1.00	1.2	0
12-18	11	9.37	25.2	0	0.86	0	0	13-19	33	0.50	2.46	1.26	1.12	6.3
19-25	12	6.42	27.3	0	1	0	0	20-26	34	4.03	3.13	1.33	1.2	8.72
26-1 Apr	13	0	19.4	1.8	1.14	1.14	0	27-2Sept	35	11.3	15.63	3.24	1.46	9.58
2-8	14	0	15.6	2.13	3.66	3.66	0	3-9	36	1.76	28.66	3.87	2.33	15.33
9-15	15	0	14.66	3.26	4.74	6.4	38.42	10-16	37	0.46	18.1	6.88	2.49	20.54
16-22	16	0	10.55	3.23	2.86	9.86	40.22	17-23	38	0.46	15.3	6.54	2.71	26.72
23-29	17	0	11.11	3.26	2.81	13.24	54.87	24-30	39	0	10.66	4.33	3.39	18.49
30-6 May	18	0	9.4	5.71	1.76	16.22	59.13	1-7 Oct	40	0	10.23	5.28	4.59	11.17
7-13	19	0	7.3	6.86	1.42	17.82	61.23	8-14	41	0	6.24	6.18	2.17	14.71
14-20	20	0	4.1	4.89	0	20.62	66.81	9-15July	42	0	4.26	3.1	1.69	6.37
21-27	21	0	4.2	1.87	0	28.34	65.23	16-22	43	0	2.66	0.00	0.70	6.58

Weather parameter is given in previous week

Table: 38 Seasonal incidence of Shoot and Fruit borer on summer vis a vis Kharif Okra during 2015-16

Met. Week	Period	DAG	Av % infestation of Shoot borer	Av % infestation of Shoot and fruit borer			Met. Week	Period	DAG	Av % infestation of Shoot borer	Av % infestation of Shoot and fruit borer		
			(E.Vittella)	Earias Vittella	H.armigera	E. Vittella+ H.armigera				E.Vittella	Earias Vittella	H.armigera	E. Vittella+ H.armigera
6	5-11 Feb	8	0	0	0	0	28	9-15 July	4	0.00	0	0	0
7	12.-18	15	0	0	0	0	29	16-22	11	0.00	0	0	0
8	19-25	22	1.81	0	0	1.81	30	23-29	18	1.2	0	0	1.2
9	26-4 Mar	29	6.36	0	0	6.36	31	30-5 Aug	25	3.5	0	0	3.5
10	5-11	35	8.89	0	0	8.89	32	6-12	32	5.9	0	0	5.9
11	12-18	42	0.00	0	0	0	33	13-19	39	7.33	0	0	7.33
12	19-25	49	0.00	0	0	0	34	20-26	46	0	11.28	0	11.28
13	26-1 Apr	56	0.00	0	0	0	35	27-2 Sept	53	0	11.28	6.27	17.55
14	2-8	63	0.00	0	2.66	2.66	36	3-9	60	00	11.28	20.7	31.98
15	9-15	70	0.00	11.85	3.86	15.71	37	10-16	67	0	22.17	35.1	57.27
16	16-22	77	0.00	17.89	11.76	29.65	38	17-23	74	0	24.16	46.66	70.82
17	23-29	84	0.00	25.06	16.12	41.18	39	24-30	81	0	31.23	46.78	78.01
18	30-6 May	91	0.00	23.72	15.07	38.79	40	1-7 Oct	88	0	28.20	49.11	77.31
19	7-13	98	0.00	12.82	14.72	27.54	41	8-14	95	0	28.4	49.33	77.73
20	14-20	105	0.00	17.83	14.63	32.46	42	15-21	102	0	19.23	41.79	61.02
21	21-27	112	0.00	6.14	12.14	18.28	43	22-28	109	0	19.11	42.16	61.27

week of September during *kharif* 2015-16. It means more or less equal population of whitefly was observed during summer 2014-15 and *kharif* season 2015-16.

Incidence of thrips observed from 8th to 19th MW in the range of 0.2 to 4.74 TH/leaf/Plant. with peak incidence at 15th MW i.e. in the second week of April during summer season. whereas, during *kharif* season 2015-16, incidence of thrips observed from 32nd MW to 43rd MW in the range of 1.22 to 4.59 TH/leaf/Plant. with peak incidence at 40th MW i.e. 1st week of October. Overall very low population of thrips (< 5 TH/L/Pl.) was observed during *kharif* season 2015-16.

Incidence of mites observed from 13th to 21st MW observed in the range of 1.14 to 28.34 mites/L/Pl with peak incidence at 21st MW i.e. in the 4th week of May during summer 2014-15 whereas in *kharif* season incidence of mites was observed during 33rd to 43rd MW in the range of 6.32 to 26.72mites/leaf/Plant with peak incidence at 38th MW i.e. in the third week of September.

It is clear from the table 37 that more than 10 mites/leaf/Plant. population was observed during 17th to 21st MW for 5 times continuously i.e. from last week of April to last week of May during summer 2014-15 while more than 10 mites/leaf were observed from 36th to 41st MW for 6 times continuously in last week of August to second week of October. It means hot and dry period was observed to be more suitable for multiplication of mites population.

4.12.2 Abundance of Fruit borer on summer 2014-15 vis-a-vis *kharif* season 2015-16 on okra

It is revealed from Table 38 that infestation of shoot and fruit borer was observed from 8th to 10th MW in the range of 1.81 to 8.89 per cent infestation with peak incidence at 10th MW (8.89 %) during 2nd week of March in summer 2014-15 whereas infestation of shoot and fruit borer was observed from 30th to 33th MW in the range of 1.2 to 7.33 per cent infestation with peak incidence at 33rd MW (7.33 %) i.e. in the 3rd week of August during *kharif* season.

Infestation of fruit borer *E. Vittella* was observed from 15th to 21st MW in the range of 6.14 to 25.06 with peak incidence at 17th MW i.e. in the 4th week of March during summer season. The *E. vittella* has cross the threshold level (> 5.3%) at 7 times throughout the season, whereas Infestation of fruit borer *E.Vittella* was observed from 34th to 43rd MW in the range of 11.28 to 31.23 per cent. The peak incidence at 39th MW i.e. in the fourth week of Sept. during kharif season. The *E.vittella* has cross the threshold level (> 5.3%) for ten times. It means infestation of *E. vittella* was more during *kharif* season compared to summer season.

Infestation of fruit borer *H. armigera* was observed from 14th to 21st MW in the range of 2.66 to 16.12 with peak incidence at 17th MW i.e. in the 4th week of March during summer season. Whereas Infestation of fruit borer *H.armigera* was observed from 35th to 43rd MW in the range of 6.24 to 49.33 per cent with peak incidence at 41th MW i.e. in the second week of October during *kharif* season. It means infestation of *H. armigera* was more 3 times during *kharif* season compared to summer season.

Infestation of fruit borer complex (*E. Vittella* + *H. armigera*) was observed from 8th to 21st MW in the range of 1.81 to 41.18 with peak incidence at 17th MW i.e. in the 4th week of March during summer season. The fruit borer complex (*E. Vittella* + *H. armigera*) has cross the threshold level (> 5.3%) at 7 times throughout the season, whereas Infestation of fruit borer complex (*E. Vittella* + *H. armigera*) was observed from 30th to 43rd MW in the range of 1.2 to 78.01 per cent. with peak incidence at 39th MW i.e. in the fourth week of Sept. during kharif season. The fruit borer complex (*E.Vittella* + *H.armigera*) has cross the threshold level (> 5.3%) for ten times. It means infestation of fruit borer complex (*E. Vittella* + *H. armigera*) was approximately 2 times more during kharif season compared to summer season.

Table: 39 Seasonal incidence of natural enemies on summer vis a vis *Kharif* Okra during 2015-16

Period	Met.Week	Av. population of Natural enemies/plant			Period	Met.Week	Av. population of Natural enemies /plant			DAG
		LBB	Spider	Chrysopa			LBB	Spider	Chrysopa	
5-11 Feb	6	0.2	0	0	9-15 July	28	0.00	0.00	0.00	7
12.-18	7	0.2	0	0	16-22	29	0.00	0.10	0.00	14
19-25	8	0	0	0	23-29	30	0.00	0.10	0.00	21
26-4 Mar	9	0	0	0	30-5 Aug	31	1.50	0.20	0.00	28
5-11	10	0	0	0	6-12	32	3.90	0.20	0.10	35
12-18	11	0	0	0	13-19	33	1.20	0.20	0.10	42
19-25	12	0	0	0	20-26	34	0.40	0.20	0.13	56
26-1 Apr	13	0	0	0	27-2 Sept	35	0.40	0.20	0.10	63
2-8	14	0	0	0	3-9	36	0.30	0.20	0.30	70
9-15	15	0.2	0.1	0.4	10-16	37	0.20	0.10	0.40	77
16-22	16	0.6	0.4	0.8	17-23	38	0.20	0.30	0.40	84
23-29	17	0.4	0.2	0.8	24-30	39	0.20	0.30	0.60	91
30-6 May	18	0.4	0.1	0	1-7 Oct	40	0.10	0.10	0.20	98
7-13	19	0.6	0.2	0	8-14	41	0.10	0.10	0.10	104
14-20	20	0.8	0.2	0	15-21	42	0.10	0.00	0.00	112
21-27	21	0.8	0.4	0	22-28	43	0.07	0.00	0.00	119

4.12.3- Abundance of natural enemies in summer 2014-15 vis-a-vis kharif season 2015-16 on okra

It is revealed from Table 39 that Population of LBB, was observed from 15th to 21st MW in the range of 0.2 to 0.8/plant with its highest population was at 20th and 21st MW (0.8/plant) during 3rd and 4th week of April in summer 2014-15 whereas Population of LBB, was observed from 31st MW to 43rd MW in the range of 0.07 to 3.90 /plant with highest population at 32nd MW (3.90/plant) i.e. in the 2nd week of August during *kharif* season.

Population of chrysopa and spider were observed from 15^h to 21st MW in the range of 0.1 to 0.8 /plant with peak population not more than 0.8/plant i.e. in the 4th week of April during summer season. Population of Chrysopa were observed from 32nd to 41st MW in the range of 0.10 to 0.60/plant. with peak population of 0.60/plant throughout the season at 39th MW i.e. in the 4th week of Sept. during kharif season and spider population was observed from 29th to 41st MW in the range of 0.10 to 0.30/ plant with peak incidence at 38th and 39th MW (0.30/plant) i.e. in the 3rd and 4th week of September. It means overall population of chrysopa and spider was very low in (<0.3 to 0.6/plant).

4.13. Incidence of Yellow Vein Mosaic disease of Okra in various modules

4.13.1 Incidence of Yellow Vein Mosaic disease of Okra in various modules during summer 2014-15

Incidence of Incidence of YMV disease at 65 DAS

It is evident from the data presented in Table 40 and depicted in Fig 21 that the results were statistically significant. The treated modules M6,M5,M4,M3 and M1 did not show any incidence of yellow vein mosaic disease upto 67 Days after sowing during summer season 2014-15 and they were statistically at par with each other and significantly superior over the remaining treated modules. The remaining treated modules M2 and M7 accounted YVM incidence to the extent of 0.33 and 0.38 per cent, respectively and they were statistically at par with untreated module M8 which noticed YMV incidence to the tune of 0.44 per cent.

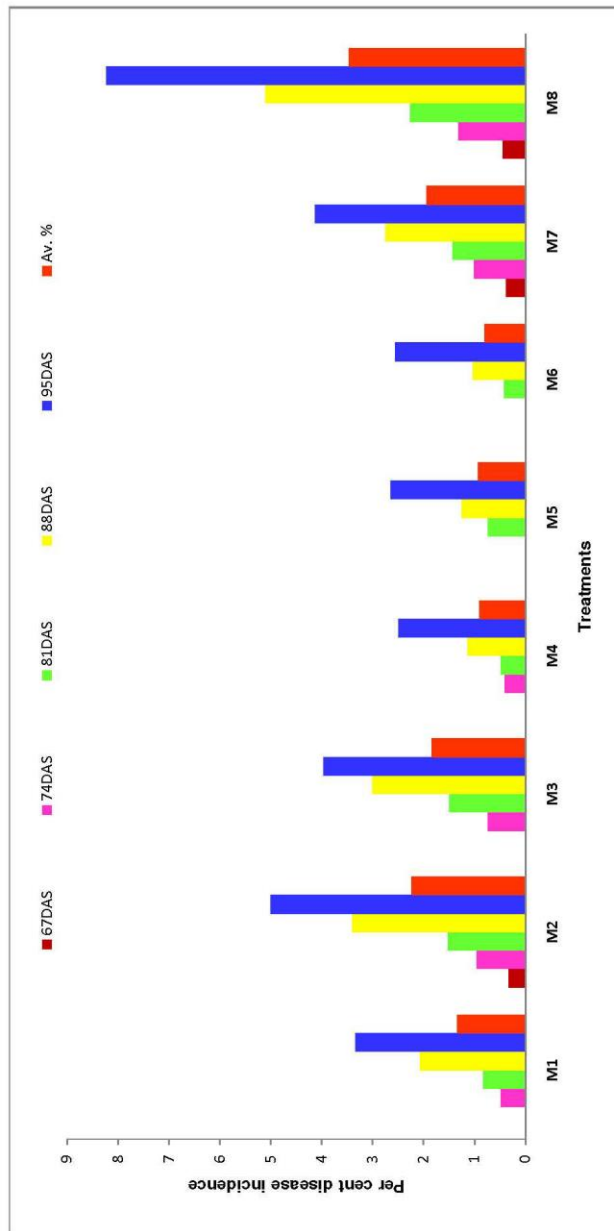


Fig. 21 Av. per cent incidence of yellow vein mosaic disease at periodic interval on okra during summer 2014-15

Table 40 Av. per cent incidence of yellow vein mosaic disease at periodic interval on okra during summer 2014-15

TR	Treatment details	67DAS**	74DAS**	81DAS**	88DAS*	95DAS*	Av %*
M1	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	0.48 (0.99)	0.83 (1.15)	2.07 (1.43)	3.34 (1.80)	1.34 (1.15)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	0.33 (0.91)	0.96 (1.19)	1.52 (1.42)	3.40 (1.83)	5.00 (2.23)	2.24 (1.49)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	0.00 (0.71)	0.74 (1.11)	1.50 (1.41)	3.00 (1.69)	3.97 (1.98)	1.84 (1.35)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.00 (0.71)	0.41 (0.95)	0.48 (0.99)	1.13 (1.06)	2.50 (1.56)	0.91 (0.95)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.00 (0.71)	0.00 (0.71)	0.74 (1.08)	1.25 (1.11)	2.65 (1.62)	0.93 (0.96)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.00 (0.71)	0.00 (0.71)	0.42 (0.96)	1.03 (1.00)	2.56 (1.56)	0.80 (0.89)
M7	ST,SA,YST,Cyper+Dim., Fenpo,Ethion+Quin, Lamb.	0.38 (0.93)	1.01 (1.23)	1.43 (1.37)	2.75 (1.66)	4.13 (2.01)	1.94 (1.39)
M8	Untreated control	0.44 (0.97)	1.32 (1.34)	2.26 (1.66)	5.11 (2.26)	8.23 (2.87)	3.47 (1.86)
	SE (m)+	0.03	0.07	0.10	0.13	0.17	0.08
	CD at 5%	0.11	0.21	0.31	0.39	0.53	0.25
	CV%	8.00	12.08	14.34	14.84	15.56	11.37

N.B: Figures in (*)indicates square root values.While (**) indicatessquare√x+0.5values

Incidence of YMV disease at 74 DAS

The data presented in Table 40 and depicted in Fig 21 revealed that the results were found to be statistically significant. No incidence of yellow vein Mosaic disease observed in treated modules M6 and M5 and they were statistically at par with each other and significantly superior over remaining treatments. The treated modules M4, M1 and M3 had noticed the incidence of yellow vein mosaic disease to the extent of 0.41, 0.48 and 0.74 per cent, respectively, and they were statistically at par with each other. The treated module M2 had accounted the incidence of YMV to the extent of 0.96 per cent and it was statistically at par with module M7 (1.01 %) and untreated module M8 (1.32%).

Incidence of YMV disease at 81 DAS

It is indicated from the data presented in Table 40 and depicted in Fig 21 that the statistically significant differences were found among different treatments. The treated module M6 had recorded the minimum incidence of yellow vein mosaic (0.42 %) followed by M4 (0.48 %), M5 (0.74 %) and M1 (0.83 %) and they were statistically found to be similarly effective against yellow vein mosaic. The untreated module M8 had accounted maximum incidence of YMV (2.26%) and was found statistically at par with M7 (1.43%), M3 (1.50%) and M2 (1.52%).

Incidence of YMV disease at 88 DAS

The data presented in Table 40 and depicted in Fig 21 evidenced that the results were found to be statistically significant. All the treatments were significantly superior over untreated control module. The minimum incidence of yellow vein mosaic disease was observed in treated module M6 (1.03 %), followed by M4 (1.13%) and M5 (1.25 %) and these three treatments were statistically at par with each other. Of these treated module M6 was significantly superior over remaining treatment except M4 and M5. Module M4 and module M5 were further found to be statistically at par with module M1 which registered the incidence of YMV to the extent of 2.07 per cent. However, this module M1 was further found to be statistically at par with module M7 (2.75 %) and M3 (3.00 %). The remaining treatment

module M2 accounted the YVM incidence to the tune of 3.40 per cent and it had exerted statistically, similar effect as those of module M7 and M3. Whereas, the highest incidence of yellow vein mosaic disease was noticed in untreated module M8 (5.11%).

Incidence of YMV disease at 95 DAS

From the data presented in Table 40 and depicted in Fig 21 indicated that the results were statistically significant. The minimum incidence of yellow vein mosaic was noticed in treated module M4 (2.50 %), followed by M6 (2.56 %), M5 (2.65 %), M1 (3.34 %), M3 (3.97 %) and M7 (4.13 %) and these six treatments were statistically similar effective with each other and superior over module M8. However, module M4, M6 and M5 was found significantly superior over M2 & M8. The treatment module M2 had counted the YMV incidence to the extent of 5.00 per cent and it was statistically as effective as M1, M3 and M7. Whereas the maximum incidence of YMV was observed in untreated module M8 (8.23%) .

Mean Per cent incidence of YMV

It is indicated from the data presented in Table 40 and depicted in Fig 21 that the statistically significant differences were observed among various treatments. All the treated modules were significantly superior over untreated module. The minimum incidence of YMV was observed in treated module M6 (0.80 %), followed by M4 (0.91 %) and M5 (0.93 %) and they were found to be statistically at par with each other. Of these, treatment M6 was significantly superior over rest of the treatment except M4 and M5. Which had also found promising in reducing yellow vein mosaic incidence shown significantly superior over remaining treatments except M1. The treated module M1 had accounted the YMV incidence to the tune (1.34 %) and observed statistically equal effective with those of module M4 and module M5. However, at same time it was further statistically at par with module M3 (1.84 %) and module M7 (1.94 %). The least effective module M2 had shown the YMV incidence to the extent of 2.24 per cent and appeared statistically similar with those of treated module M3 and M7. The highest incidence of YMV was noticed in untreated module (3.47 %).

4.13.2 Incidence of Yellow Vein Mosaic disease of Okra in various modules during *Kharif* 2015-16

Incidence of YMV disease at 46 DAS

It is observed from the data presented in Table 41 and depicted in Fig 22 that the results were statistically significant. All the treated module were significantly superior over untreated control module M8 and they were found statistically at par among themselves.

Incidence of Incidence of YMV disease at 53 DAS

The data presented in Table 41 and depicted in Fig 22 it is indicated that the results were statistically significant. All the treated modules were significantly exhibited 0.00 % incidence of YMV disease up to 53 DAS and were significantly superior over module M8 which had accounted incidence of YMV to the extent of (3.37 %).

Incidence of Incidence of YMV disease at 60 DAS

It is evident from the data presented in Table 41 and depicted in Fig 22 that the significant differences were found among the various treatments. The minimum incidence of YMV was recorded in treated module M6 (1.64 %) followed by module M4 (2.53 %) and both the modules were found to be statistically at par with one another and significantly superior over all remaining module. All the remaining module M3 M2, M7,M5 and M1 including module M8 had accounted the YMV incidence to the extent of 4.84, 4.89, 4.92, 4.97 and 5.06 respectively and they were statistically similar with each other.

Incidence of YMV disease at 67 DAS

From the data presented in Table 41 and depicted in Fig 22 revealed that the results were statistically significant. The module M6 was found significantly most effective in recording minimum incidence of YMV diseases (3.28%) and superior over all the remaining modules and statistically at par with M4 (4.89%). However module M4 was found statistically at par with M3 (6.45 %) M2 (6.52%), M5 and M7 (6.56 %), M1(6.63%) and superior over M8. The untreated module M8 had recorded maximum incidence of YMV (7.07%).

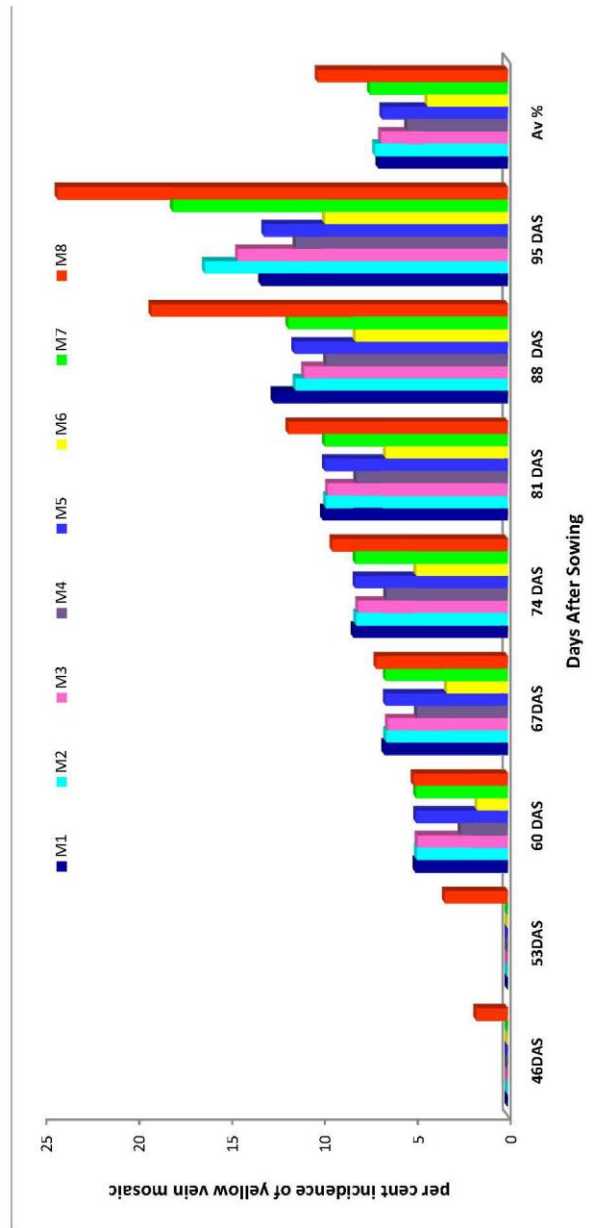


Fig. 22 Av. per cent incidence of yellow vein mosaic disease at periodic interval on okra *kharif* 2015-16

Table- 41 Av. per cent incidence of yellow vein mosaic disease at periodic interval on okra *kharif* 2015-16

TR	Treatment details	46DAS **	53DAS **	60 DAS *	67DAS *	74 DAS *	81 DAS *	88 DAS *	95 DAS *	Av % *
M1	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	0.00 (0.71)	4.97 (2.22)	6.63 (2.57)	8.29 (2.87)	9.94 (3.15)	12.60 (3.55)	13.26 (3.64)	6.96 (2.64)
M2	ST,Dim, Quin,Fenpo, Dico+Quin.	0.00 (0.71)	0.00 (0.71)	4.89 (2.20)	6.52 (2.55)	8.15 (2.85)	9.78 (3.13)	11.41 (3.38)	16.30 (4.02)	7.13 (2.67)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.00 (0.71)	0.00 (0.71)	4.84 (2.17)	6.45 (2.52)	8.06 (2.83)	9.68 (3.11)	10.96 (3.31)	14.52 (3.78)	6.81 (2.60)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.00 (0.71)	0.00 (0.71)	2.53 (1.59)	4.89 (2.20)	6.52 (2.54)	8.15 (2.84)	9.78 (3.12)	11.41 (3.36)	5.41 (2.32)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00 (0.71)	0.00 (0.71)	4.92 (2.21)	6.56 (2.56)	8.20 (2.86)	9.84 (3.13)	11.48 (3.38)	13.11 (3.60)	6.76 (2.60)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.00 (0.71)	0.00 (0.71)	1.64 (1.26)	3.28 (1.79)	4.92 (2.21)	6.56 (2.52)	8.20 (2.86)	9.84 (3.12)	4.31 (2.07)
M7	ST,SA,YST,Cyper+Dim.,Fenpo, Ethion+Quin,, Lamb.	0.00 (0.71)	0.00 (0.71)	4.92 (2.21)	6.56 (2.56)	8.20 (2.86)	9.84 (3.13)	11.79 (3.43)	18.03 (4.24)	7.42 (2.72)
M8	Untreated control	1.69 (1.47)	3.37 (1.96)	5.06 (2.24)	7.07 (2.65)	9.43 (3.06)	11.80 (3.43)	19.17 (4.36)	24.22 (4.89)	10.23 (3.16)
	SE (m)±	0.04	0.04	0.14	0.14	0.15	0.15	0.14	0.24	0.09
	CD at 5%	0.12	0.12	0.43	0.43	0.47	0.47	0.43	0.73	0.27
	CV%	8.55	8.08	12.40	10.16	9.90	8.82	7.26	10.91	6.04

N.B: Figures in (*)indicates square root values.While (**) indicatessquare√x+0.5values

Incidence of YMV disease at 74 DAS

It is revealed from the data presented in Table 41 and depicted in Fig 22 that the results were statistically significant. The module M6, was found statistically at par with M4 (6.52 %) and superior over all the module in recording minimum incidence of YMV (4.92%). The best module M4 was found statistically at par with M3 (8.06%), M2 (8.15%), M5 and M7 (8.20%), M1 (8.29%) and superior over M8. The untreated module M8 recorded highest incidence of 9.43 % and was found statistically at par with M1, M5, M7, M2 M3

Incidence of YMV disease at 81 DAS

From the data presented in Table 41 and depicted in Fig 22 indicated that the results were statistically significant. The module M6, was found statistically at par with M4 (8.15 %) and superior over all the module in recording minimum incidence of YMV (6.56%). The second best module M4 (8.15%) was found significantly superior over untreated module M8 and statistically at par with M3 (9.68%), M2 (9.78%), M5, M2 (9.84%) and M1 (9.94%). The untreated module M8 had recorded maximum incidence of YMV (11.80%) and it was found statistically at par with module M1, M5, M7, M2 and M3.

Incidence of YMV disease at 88 DAS

The data presented in Table 41 and depicted in Fig 22 revealed that the significant differences were found among different treatments. All the treated modules were significantly superior over untreated module M8. The minimum incidence of YMV was observed in treated module M6 (8.20%), followed by treated module M4 (9.78 %) and both the treatment were found to be statistically similar effective. The treatment M6 appeared to be the most effective treatment being significantly superior over rest of the treatments except modules M4. The treatment M4 was further recorded to be statistically at par with the treated modules M3, M2, M5, M7 and M1, which accounted the YMV diseases to the extent of 10.96, 11.41, 11.48, 11.79 and 12.60 per cent respectively. However, the highest (19.17 %) incidence of YMV was noticed in the untreated Module M8.

Incidence of YMV disease at 95 DAS

It is indicated from the data presented in Table 41 and depicted in Fig 22 that the results were found statistically significant. The minimum (9.84%) incidence of YMV was recorded in treated module M6 and it was found statistically at par with M4 (11.41 %), M5 (13.11 %), M1 (13.26 %), M3 (14.52 %) and superior over module M2, M7 and M8. The second best module M4 was found statistically at par with M5, M1, M3 and M2 (16.30%). The next module M8 was found statistically at par with M1, M3, M2 and M7 (18.03%) and superior to untreated module M8. The highest incidence of YMV 24.22 % was recorded in untreated module M8 had statistically at par with module M7.

Incidence of Incidence of YMV disease at Average per cent

It is indicated from the data presented in Table 41 and depicted in Fig 22 that the statistically significant differences were observed among the various treatments. All the treated modules were found to be significantly superior over untreated module. However, second best module M5 in second order of merit was found statistically at par with M3 (6.81%), M1 (6.96%), M2 (7.13%), M7 (7.42%) and superior over untreated module M8. Whereas, the maximum (10.23%) incidence of YMV was observed in untreated module M8.

4.13.3 Pooled mean incidence of YMV at 46 and 53 DAS

From the data presented in Table 42 and depicted in Fig 23 it is revealed that the results were found to be statistically significant. However pooled mean incidence of YMV at 46 and 53 days after sowing in various treated modules were found significantly superior over untreated module in recording zero incidence of YMV. Maximum incidence of YMV was observed in untreated control module M8 (0.84%) at 46 DAS and (1.68%) at 53 DAS .

Incidence of YMV at 60 DAS

It is evident from the data presented in Table 42 and depicted in Fig 23 that the significant differences among different treatments were observed. at 60 days after sowing. The minimum incidence of yellow vein mosaic was noticed in treated module M6 (0.82 %) followed by the treated module M4 (1.27 %) and both the treatments were statistically similar effective

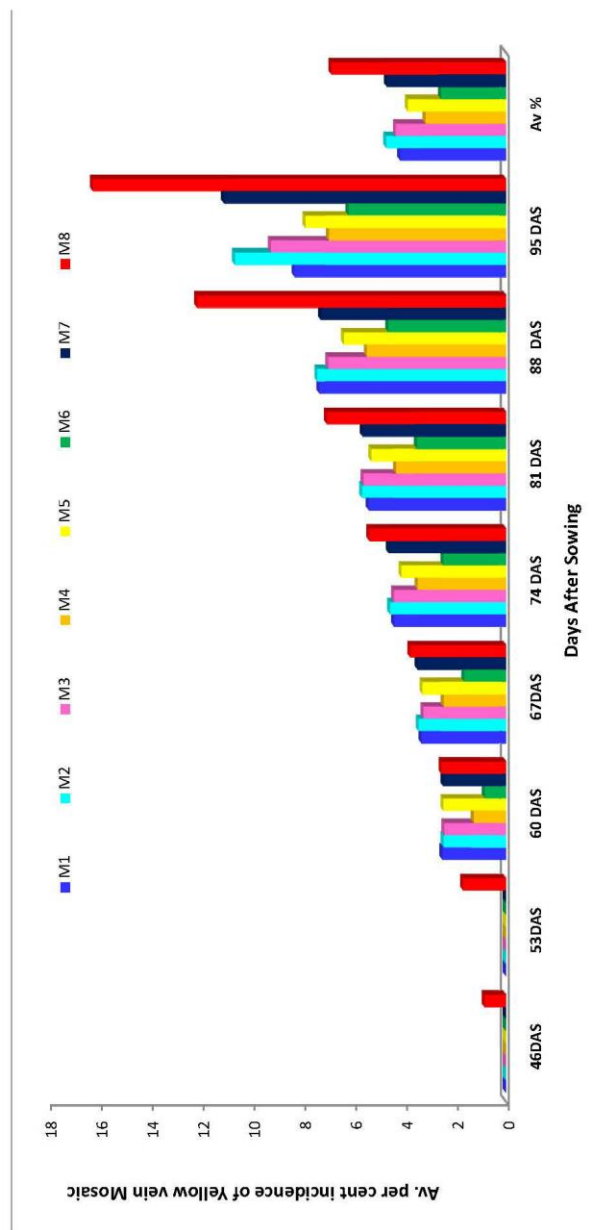


Fig. 23 Av. per cent incidence of Yellow vein Mosaic disease at periodic interval on Okra during summer 2014 and kharif 2015-16 (Pooled mean)

Table- 42 Av. per cent incidence of Yellow vein Mosaic disease at periodic interval on Okra during summer 2014 and Kharif 2015-16 (Pooled mean)

TR	Treatment details	46 DAS*	53 DAS*	60 DAS**	67 DAS**	74 DAS**	81 DAS**	88 DAS**	95 DAS**	Av %
M1	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	0.00 (0.71)	2.49 (1.46)	3.32 (1.64)	4.39 (1.93)	5.39 (2.15)	7.33 (2.49)	8.30 (2.72)	4.15 (1.89)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	0.00 (0.71)	0.00 (0.71)	2.45 (1.46)	3.43 (1.73)	4.55 (2.02)	5.65 (2.27)	7.41 (2.60)	10.65 (3.13)	4.69 (2.08)
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	0.00 (0.71)	0.00 (0.71)	2.42 (1.44)	3.23 (1.62)	4.40 (1.97)	5.59 (2.26)	6.98 (2.50)	9.24 (2.88)	4.33 (1.98)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	0.00 (0.71)	0.00 (0.71)	1.27 (1.15)	2.45 (1.45)	3.47 (1.74)	4.32 (1.92)	5.46 (2.09)	6.96 (2.46)	3.16 (1.64)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	0.00 (0.71)	0.00 (0.71)	2.46 (1.46)	3.28 (1.63)	4.10 (1.78)	5.29 (2.11)	6.37 (2.25)	7.88 (2.61)	3.85 (1.78)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.00 (0.71)	0.00 (0.71)	0.82 (0.99)	1.64 (1.25)	2.46 (1.46)	3.49 (1.74)	4.62 (1.93)	6.19 (2.34)	2.55 (1.48)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.00 (0.71)	0.00 (0.71)	2.46 (1.46)	3.47 (1.74)	4.61 (2.04)	5.63 (2.25)	7.27 (2.54)	11.08 (3.13)	4.68 (2.06)
M8	Untreated control	0.84 (1.09)	1.68 (1.33)	2.53 (1.47)	3.76 (1.81)	5.37 (2.20)	7.03 (2.55)	12.14 (3.31)	16.23 (3.88)	6.85 (2.53)
	SE (m) $\pm$	0.02	0.02	0.07	0.07	0.07	0.10	0.10	0.14	0.05
	CD at 5%	0.06	0.06	0.21	0.21	0.22	0.30	0.29	0.41	0.15
	CV%	6.43	6.28	10.69	10.69	9.57	11.57	9.51	11.61	6.49

N.B: Figures in (*) indicates square root values.While (**))indicatessquare $\sqrt{x+0.5}$ values

and significantly superior over all the remaining modules. The treated modules M3, M2, M5, M7 and M1 including untreated module M8 registered the yellow vein mosaic incidence to the extent of 2.42, 2.45, 2.46, 2.46, 2.49 and 2.53 per cent, respectively, and they were found to be statistically at par with each other.

Incidence of YMV at 67 DAS

From the data presented in Table 42 and depicted in Fig 23 it is revealed that the results were found to be statistically significant. At 67 DAS the lowest incidence of yellow vein mosaic was registered in treated module M6 (1.64 per cent), followed by treated module M4 (2.45 per cent) and both the treatments were observed to be statistically at par with one another.

Incidence of YMV at 74 DAS

From the data presented in Table 42 and depicted in Fig 23 indicated that the statistically significant differences were observed among the various treatments. At 74 DAS the minimum incidence of YMV was recorded in treated module M6 (2.46 %) and it appeared to be significantly superior over all other remaining modules. The treated modules M4, M5, M1 and M3 exhibited the YMV incidence to the extent of 3.47, 4.10, 4.39 and 4.40 per cent, respectively and they were statistically similar effective among themselves. The remaining treated modules namely M2 and M7 had noted the YMV incidence to the extent of 4.55 and 4.61 per cent, respectively and although they were statistically equal with module M1 and module M3, but they were statistically further at par with untreated module M8. Whereas the highest incidence of YVM (5.37 %) was observed.

Incidence of YMV at 81 DAS

From the data presented in Table 42 and depicted in Fig 23 revealed that the results were found to be statistically significant. At 81 DAS the minimum incidence of YMV was noted in treated module M6 (3.49 %), followed by treated module M4 (4.32 %) and these two treatments were statistically at par with one another. Of these two treatments, the module M6 was significantly superior over all the modules except module M4. The module M4 was significantly superior over rest of the treatments except



Yellow Vein Mosaic



Yellow Vein Mosaic on Okra

Plate 6 Disease symptoms of YMV on okra crop

module M5 (5.29%) and M1 (5.39%) whereas the module M3 (5.59%) ,M7 (5.63%) and M2 (5.65%) were further statistically at par with untreated module M8 in which the highest incidence of YMV was recorded (7.03 %).

Incidence of YMV at 88 DAS

It is evident from the data presented in Table 42 and depicted in Fig 23 that the results were found statistically significant. All the treated modules were significantly superior over untreated module M8. At 88 DAS the minimum incidence of Yellow vein Mosaic was observed in treated module M6 (4.62 %), followed by the module M4 (5.46 %) and both the treatments were found statistically at par with one another. The treatment M6 was found most effective, being significantly superior over rest of the treatments except treatment M4. Similarly the treatment M4 emerged as the second best treatment exerting significantly superior over remaining module except treatment M5 (6.37%). The next module M5 in third rank of module was found statistically at par with M3 (6.3%) and M7 (7.27%) and superior over module M1, M2 and M8. The treated module M3, M7, M1 and M2 registered the yellow vein mosaic incidence to the tune of 6.98, 7.27, 7.33 and 7.41 per cent respectively and they were statistically at par with each other. Of these module M3 and module M7 had exerted statistically similar effect with the treated module M5. Whereas, the maximum incidence of YVM (12.14 %) was observed in untreated module M8.

Incidence of YMV at 95 DAS

From the data presented in Table 42 and depicted in Fig 23 revealed that the results were found to be statistically significant. All the treated modules were significantly superior over untreated module M8. The treatment module M6 (6.19%), M4 (6.96%), M5 (7.88%) and M1 (8.30%) were found significantly superior over M3, M2, M7 and M8 in recording minimum incidence of YMV disease and they were statistically at par with each other. However, the module M5 was statistically at par with M1 (8.30%), M3 (9.24%) and superior over and M2 & M8. Next module M1 was further found to be statistically at par with M3 (9.24 %), M2 (10.65.%) and M7 (11.08%) respectively, which in turn M1 had shown the statistically similar effectiveness

with those of M5, M4 and M1. The highest incidence of YVM (16.23 %) was noted in untreated control module M8.

Pooled cumulative mean incidence of YMV

It is evident from the data presented in Table 42 and depicted in Fig 23 that the statistically significant differences were observed among various modules. All the treated modules were significantly superior over untreated module M8 in minimizing the incidence of YVM. Significantly module M6 was appeared to be the most effective module against producing the minimum symptoms of YVM (2.55%) and being significantly superior over all the remaining modules. The second best module M4 had exhibited the yellow vein mosaic incidence to the tune of (3.16 %), followed by treatment M5 (3.85 %) and both the treatment were at par with each other. The treatment M4 had exerted the better impact against the yellow vein mosaic and it was significantly superior over rest of the treatments except M5 which was further found to be at par with treatment M1 (4.15 %). The treatment M5 also exerted the good impact against the incidence of YVM being significantly superior over rest of the treatment except M1. Module M3 ,M7 and M2 accounted the yellow vein mosaic incidence to the extent of 4.33 %,4.68 % and 4.69% and they were statistically at par with each other and superior over untreated module. However the highest incidence of YMV was registered in untreated module M8 (6.85%).

It is indicated from the above findings that the data pertaining to pooled mean incidence of YMV recorded from 46 days to 95 days after sowing to the extent of 0.84 to 15.39 percent in all modules including untreated M8. While incidence of YMV to the tune of 0.82 to 9.65 % was recorded in other remaining treated modules from 60 days to 95 DAS .The module M6 (2.55%) followed by module M4 (3.16 %) and M5 (3.85 %) were found significantly most effective and superior over all other remaining modules in recording the minimum per cent incidence of YMV compared to maximum of 6.74 % in untreated module M8 transmitted by whitefly . It is clear from the above finding that the module M6 followed by M4 and M5 were found significantly most effective in recording minimum incidence of YMV transmitted by whitefly at 60 to 95 DAS . The module M2 was found to be the

least effective and at par with M7 and M3 in recording the minimum incidence of YMV. YMV incidence was significantly very low in module M6. Module 6, module M4 and module M5 were found to be most effective in reducing the YMV during summer and kharif seasons due to the cumulative effect of seed treatment, soil applications, YST and sequential application of the insecticidal treatments in which cypermethrin, triazophos, thiamethoxam, fenpropathrin and spiromesifen played a major role in minimizing the population of whitefly in okra and YMV.

Present findings are in confirmation with Vyas et.al (2012) who reported that seed treatment with Imidacloprid 600 FS @ 6 g/kg seed gave significantly higher protection against white fly, thereby reducing yellow vein mosaic virus incidence. Asha Shivapuri et al. (2004) reported that imidacloprid @5g/kg seed dressing proved most effective in reducing the incidence of YVMV and increased fruit yield along with one spray of monocrotophos and three sprays of endosulfan. Nagaraja (2005) who reported that seed treatment with imidacloprid (5g/kg seed) + 4 sprays of imidacloprid (0.05%) at 15 days interval gave reduction of YMV disease by 80.9 per cent with increased yield by 64.96 per cent as compared to control. Moreau and Isman (2011) who reported that adult whiteflies were most effectively trapped on yellow sticky traps compared to eggplant trap crops. Karut and Kazak (2007) evaluated yellow sticky traps in cotton crop for two years. Mean numbers of *B. tabaci*, captured on traps, were 697.8 ± 55.6 , in no-choice and 533.3 ± 47.4 , in choice studies, in each year. Khair (2014) who also reported that yellow sticky trap with castor oil along the crop canopy were found significantly most effective in trapping maximum population of whitefly (29.07,12.90,41.97) per trap per week on NE,SW and BS. Singh et al. (2013) who reported that use of neem cake @ 250 kg/ha before sowing was the most effective against shoot and fruit borer, *E. vittella* F., yellow vein mosaic virus, *Bemisia tabaci* (Genn.) and red spider mite, *Tetranychus cinnabarinus* (Boisd.) and recorded highest net returns. Tripathy et.al. (2007) who revealed that application of neem cake to okra was found beneficial in reducing the fruit borer incidence and yellow vein mosaic virus (YVMV). Singh et.al (1998) also reported the efficacy of cypermethrin 25 EC 0.02% in reducing the YMV disease in okra up to 0.44

per cent in 1994 as compared to 1.77 in 1992. and whitefly population was greatly reduced by cypermethrin 25 EC. Borah (1995) who reported that foliar application of cypermethrin (0.01%, 0.015%), deltamethrin (0.0028%, 0.0042%) and dimethoate (0.03, 0.04) were effective in reducing whitefly population. Patil et al. (1993) who reported that triazophos 40 EC at 0.6 kg a.i. per ha as the best treatment which reduced the whitefly population in cotton. Shirale Dattatray and Bidgire Uttamrao (2009) who reported that two sprays of triazophos 40EC (800 ml/ha) at 30 and 50 DAS recorded less number of whiteflies at three (0.03), seven (0.03) and ten (0.00) days after spraying with maximum yield of 12.39 q/ha in soybean for the control of yellow mosaic virus. Rao (2003) reported that fenpropathrin 30 EC @ 100 ml/acre was found consistent in reducing the population of whitefly when sprayed at 15 days interval and was at par with triazophos 40 EC @ 150 ml/acre.

Table- 43 Incidence of whitefly and yellow vein mosaic on okra (pooled mean)

Module	Treatments details	Summer 14-15		Kharif 15-16		Pooled mean	
		WF Popl. (No./leaf)	*YMV %	WF popl. (No/leaf)	YMV% *	WF popl. (No./leaf)	YMV % *
M1	SA.YST,Azadirachtin 1%w/w	1.54 (1.24)	1.34 (1.15)	2.69 (1.64)	6.96 (2.64)	2.12 (1.44)	4.15 (1.89)
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	1.96 (1.40)	2.24 (1.49)	2.97 (1.72)	6.88 (2.62)	2.49 (1.57)	4.56 (2.06)
M3	YST,Ace, Quin, Fenpo,Spi+Lam,Fenv.	1.22 (1.10)	1.84 (1.35)	2.04 (1.43)	6.81 (2.60)	1.63 (1.26)	4.33 (1.98)
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	1.00 (1.00)	0.91 (0.95)	1.89 (1.37)	5.41 (2.32)	1.44 (1.19)	3.16 (1.64)
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	1.01 (1.00)	0.93 (0.96)	1.90 (1.38)	6.76 (2.60)	1.45 (1.19)	3.85 (1.78)
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	0.96 (0.98)	0.80 (0.89)	1.66 (1.29)	4.31 (2.07)	1.31 (1.13)	2.55 (1.48)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin, Lamb.	2.05 (1.43)	1.94 (1.39)	2.56 (1.60)	6.79 (2.61)	2.33 (1.52)	4.37 (2.00)
M8	Untreated control	3.50 (1.87)	3.47 (1.86)	4.21 (2.05)	10.02 (3.16)	3.80 (1.94)	6.74 (2.51)
	SE (m)±	0.03	0.08	0.04	0.09	0.03	0.05
	CD at 5%	0.11	0.25	0.14	0.27	0.09	0.15
	CV%	5.20	11.37	5.08	6.01	5.68	6.34

N.B: Figures in (*) indicates square root values. While (**) indicates square root values

Wale and Chandele (2010) who also reported that spiromesifen was superior to acephate and dicofol in reducing the whitefly and mite in tomato. The spiromesifen was very effective in managing the whitefly in okra.

4.13.4 Relationship between whitefly and yellow vein mosaic incidence

It is observed from Table 43 that minimum cumulative mean population of whitefly observed from 0.96 WF/leaf with minimum YMV disease 0.18 per cent in module M6 to maximum 3.50 WF/leaf with YMV of 3.47 per cent in untreated module M8 during summer season 2014-15, whereas minimum cum mean population of whitefly observed from 1.66 WF/leaf with minimum YMV of 4.31 per cent in module M6 to maximum of 4.21 WF/leaf with YMV incidence of (10.02 per cent) in untreated module M8 during *kharif* 2015-16. It means that population of whitefly in all the modules were responsible for causing YMV disease and there is a definite positive relationship between whitefly and YMV.

Pooled mean data also indicated that minimum cum. mean incidence of whitefly 1.31WF/leaf with 2.55 per cent incidence of YMV in module M6 to maximum incidence of whitefly 3.80 WF/leaf with maximum cum. mean incidence of YMV disease 6.74 per cent was observed in untreated module M8 during summer and *kharif* season 2015-16. It also indicated that positive relationship between whitefly and YMV % incidence was observed in all module during summer and *kharif* season 2014-15 and 2015-16 respectively.

Present findings are in agreement with Shroff et al. (2010) who revealed that there is appositve correlation between whitefly and OYVM 25 and 50 DAS crop stage period could be the most vulnerable period for attack by whitefly vector to cause okra YVM disease. Sanwal et al. (2013) reported that a single whitefly can transmit the yellow vein mosaic virus effectively. However, the minimum number of whiteflies required to induce 100 per cent infection was 10 per plant in okra crop. Sindhumole and Manju (2013) who indicated that whitefly population at 30 DAS (Days after sowing) had positive correlation with disease incidence at 50 DAS to final harvest. Moreover, whitefly count during 50 DAS also influenced the disease expression during the final phase of the crop.

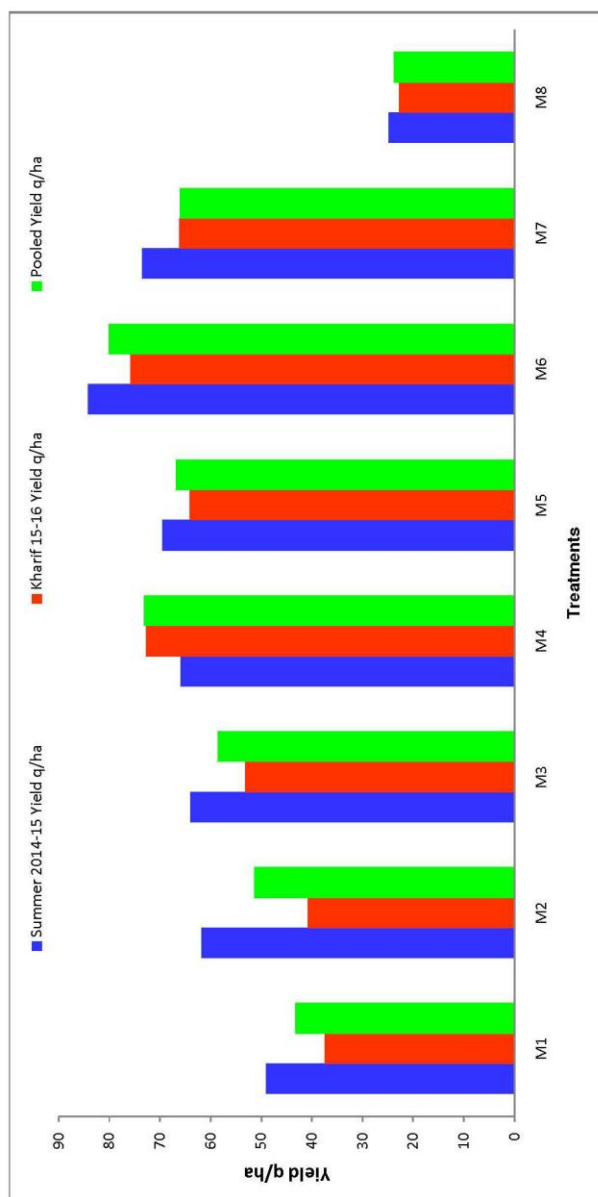


Fig. 24 Effect of various modules on comparative yield of okra during summer 2014-15 and kharif 2015-16 (pooled mean)

Table 44 Effect of various modules on comparative yield of okra during summer 2014-15 and *kharif* 2015-16 (pooled mean)

Tr. No.	Treatment details	Summer 2014-15 Yield q/ha	Kharif 15-16 Yield q/ha	Pooled Yield q/ha
		Marketable fruits		
M1	SA.YST,Azadirachtin 1%w/w	49.04	37.48	43.26
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	61.80	40.81	51.30
M3	YST,Ace, Quin, Fenpo,Spi+Lam,Fenv.	63.96	53.16	58.56
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	65.92	72.74	73.12
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	69.45	64.05	66.75
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	84.19	75.82	80.01
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	73.49	66.12	66.02
M8	Untreated control	24.85	22.81	23.83
	SE (m)±	5.95	4.77	4.32
	CD at 5%	18.05	14.48	13.09
	CV%	16.77	15.28	18.28

Dastoogeer et al. (2011) observed that even a single whitefly was capable of transmitting the disease although 15 whiteflies could transmit the jute leaf mosaic virus to extent of 100 per cent and showed that the maximum 15 viruliferous whiteflies required for effective transmission of jute leaf mosaic virus. There was found the positive correlation between number of whitefly and transmission of causal agent

This findings are also supported by Mathew and Muniyappa (1991) found that the AAP of 10 min by *B.tabaci* was sufficient for transmission of Indian cassava mosaic virus. Usha Rani et al. (2004) reported that *B.tabaci* required 24 hrs. Aquisition Access Period (AAP) to transmit soybean yellow mosaic disease to blackgram, cowpea, mungbean and soybean, where it produced typical yellow and golden mosaic symptoms. Mandal (1989) reported that minimum of 10 min AAP was sufficient to transmit Croton yellow vein mosaic virus. Similar time period was also reported for Pumpkin yellow vein mosaic virus (Babitha, 1996).

4.14 Yield of Okra

4.14.1 Yield of Okra during Summer 2014-15

From the data presented in Table 44 and depicted in Fig 24 revealed that the results were found statistically significant. All the treated module were significantly superior over untreated module M8. The treated module M6 was found significantly most effective and superior over all the remaining modules in recording highest yield of okra 84.19q / ha and statistically at par with module M4 (73.49q/ha) and M5 (69.45q/ha). Among remaining treated modules M7, M3 and M2 had registered the yield of okra fruits to the tune of 65.92, 63.96 and 61.80q/ha, respectively and they were statistically as promising as those of M4 and M5. The treatment M1 had accounted the yield of okra fruit to the tune of 49.04qt/ha and exerted statistically similar impact to those of M7, M3 and M2. However, the lowest yield of okra fruits was received in untreated module M8 (24.85 q/ha).

4.14.2 Yield of Okra during Kharif 2015-16

From the data presented in Table 44 and depicted in Fig 24 indicated that the results were found statistically significant. All the treated

modules were statistically superior over untreated module M8. The treated module M6 followed by M4, M7 and M5 in order of merit were found to be significantly most effective and superior over M3, M2, M1 and untreated module M8 in recording highest yield of okra fruit to the extent of 75.82, 72.74, 66.12 and 64.05q/ha respectively. The treatment module M7 was found significantly at par with M5 and M3 (53.16q/ha) superior over M2, M1 &M8. Module M2 was statistically at par with M3 and observed 40.81q/ha fruit yield .The least effective module M1 (37.48q/ha) was found statistically at par with M2 whereas, the lowest yield was obtained in the untreated module (22.81 q/ha).

4.14.3 Pooled Yield of Okra

It is evident from the data presented in Table 44 and depicted in Fig 24 that the significant differences were found among various treatments. All the treated modules were statistically superior over untreated module M8. The highest yield of okra fruit was recorded in the treated module M6 (80.01 q/ha), followed by M4 (73.12 q/ha) and both the treatments were found to be statistically at par with one another. The treatment M6 proved to be most promising in getting highest yield of okra fruits and it appeared to be significantly superior over remaining modules except treatment M4. Among the other treatments module, M5 and module M7 were also found promising by getting the yield of okra fruit to the tune of 66.75 and 66.02 q/ha and they were found statistically as promising as that of treatment module M4 and also they were further statistically at par with further module M3 (58.56 q/ha). The remaining treatments i.e. module M2 and module M1 had achieved the yield of okra fruit to the tune of 51.30 and 43.26 q/ha respectively and both the treatments were found to be statistically at par with one another. Of these two treatments the M2 had recorded statistically equal yield to that of module M3. The lowest yield of okra fruits was exhibited in untreated (23.83 q/ha).module M8.

From the above findings it is clear that module M6 followed by module M4 was found to be significantly most effective in recording highest yield of okra (80.01q/ha and 73.12q/ha) . The module M5 and M7 were found to be moderately effective by registering the yield of 66.75 and



Plate 7 Treated and untreated plot of okra M6,M4 & M8

66.02q/ha. Module M1 and module M2 were found to be the least effective in descending order by registering lower yield of 43.26 and 51.30 q/ha. respectively.

Highest yield of okra was observed in module M6 followed by module M5 in order of merit due to the cumulative effect of ST with imidacloprod @9ml/kg, soil application of neem cake @ 250/kg, yellow sticky trap @1/plot and four sequential foliar application of cypermethrin, triazophos, fenpopathrin, acephate+ spiromesifen in module M6 and continuous five sequential foliar application of triazophos, fenvalerate, quinalphos+ spiromesifen, fenpopathrin, lambda-cyhalothrin from 15 DAS to 75 DAS at fortnight interval in module M4. In M6 module due to the application of seed treatment and application of neem cake, YST and two rounds of synthetic pyrethroids having quick knock down effect, long residual action, yield boosting effects resulting into drastic reduction of whitefly, YMV, other sucking pests and fruit borer complex leading to highest yield in M6. However, in module M4 due to three rounds of synthetic pyrethroids viz., fenvalerate, fenpopathrin and lambda-cyhalothrin and systemic and contact action of triazophos, quinalphos and spiromesifen resulting into reduction in sucking pests, YMV and fruit borer complex leading to higher yield of okra.

Present findings are in confirmation with Praveen et.al (2007) reported that seed treatment with imidacloprid @12ml/kg seed recorded the highest seed yield of 462kg/ha among the all the seed treatment tested. He further reported that foliar spray with fenvalerate produced the highest seed yield of 799kg/ha followed by NSKE 5% (720kg/ha). Rangraman et al. (2004) also recorded the highest yield of 11,580 kg/ha marketable fruit yield of okra with imidacloprid @ 7ml/kg. Singh et al.(2013) also revealed that module consist of hand picking and destruction of infested leaves, shoots and fruits, seed treatment with imidacloprid, application of indoxacarb, thiomethoxam, hexythiazox, deep summer ploughing and use of neem cake @ 250 kg/ha before sowing was the most effective in recording maximum fruit yield of 254.00 and 232.00q/ha, respectively during 2010 and 2011. Patil et.al. (2002) reported that cypermethrin 25 EC was highly effective against okra fruit borers, recording only 15.55% fruit damage and resulting the yield of 42.11

q/ha (compared with 52.82% damage and yield of 22.88 q/ha in control plants). Naik and Kumar (2014) who reported that the highest yield was registered with cypermethrin 25 EC @ 0.05% about 88.42 q/ha which was followed by chlorpyrifos (0.05%) 85.02 q/ha and spinosad 78.52 q/ha, respectively. Choudhary et al. (2008) reported that the lowest fruit damage (13.08%) due to *Earias* spp. and maximum fruit yield (80.72 q/ha) with maximum net return (Rs. 40070/ha) were recorded in module-1 comprising imidacloprid 100 ml/ha, acephate 1000 g/ha and indoxacarb 500 ml/ha, which was comparable with module-2 (three sprays of acephate 1000 g/ha) with regards to fruit damage and yield. Jana et.al (2006) who reported that fenpropathrin 30 EC 0.1% was the most effective dose in reducing aphid population to 90% and gave maximum higher green chilli yield (95.16 q/ha) followed by fenpropathrin 0.75% and imidacloprid 0.025%.

4.15 Economics of various modules in okra

The data pertaining to Incremental cost benefit ratio (ICBR) of various treatments in okra during summer 2014-15 and *kharif* 2015-16 are presented in Table 45 to 47 and data revealed that all treatments gave significantly higher net monetary return over the untreated module.

4.15.1 Incremental cost benefit ratio in various modules in okra during Summer 2014-15

Data in respect of incremental cost benefit ratio as influenced by various treatments during summer 2014-15 were presented in Table 45 revealed that highest net monetary returns was obtained in module M6 (Rs.1,32,492/ha) wherein in ST,SA of neem cake, YST and 4 sprays of cyper, Tria, Fenpo, Ace+Spiro, were given. The next highest net monetary return obtained in order of merit in module M4 (Rs.1,15,248/ha),wherein in 5 sprays of Tria, Fen, Quin+Spir, Fen and Lamb were given, module M3 (87977/ha) wherein YST and five sprays of Ace, Quin, Fen, Spiro+Lamb and Fenv. were given, module M7 (Rs.87813/ha) wherein ST, SA, YST and 4 sprays of cyper+Dime., Fenpo, Ethion+quin, Lamb were given followed by M2

Table: 45 Economics of Various Modules on Okra during Summer 2014-15

Tr. No.	Treatments detail	Cost of Treatment (Rs./ha)		Total cost (A)	Yield (q/ha)	Increase yield over control (q/ha)	Value of increased yield (Rs. / ha) (B)	Net monetary return (Rs/ha) (C) (B-A)	ICBR (C/A)	Rank
		Cost of trap material & Insecticide	Labour + Sprayer charges							
M1	SA.YST,Azadirachtin 1%w/w	22568	4520	27088	49.04	24.19	60475	33387	1:1.23	VII
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	1843	3040	4883	61.80	36.95	92375	87492	1:17.91	II
M3	YST,Ace ,Quin, Fenpo,Spi+Lam,Fenv.	5638	4160	9798	63.96	39.11	97775	87977	1:8.98	III
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2552	3800	6352	73.49	48.64	121600	115248	1:18.14	I
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	10559	3760	14319	69.45	44.60	111500	97181	1:6.78	V
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	12098	3760	15858	84.19	59.34	148350	132492	1:8.35	IV
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	11102	3760	14862	65.92	41.07	102675	87813	1:5.91	VI
M8	Untreated control				24.85					

(Rs..87492/ha) wherein ST, with 4 sprays Dim, quin, fenpo, dico+quin followed by module M1 (Rs.33387/ha) wherein, SA, YST and 5 sprays of Aza 1% w/w were given.

The highest Incremental cost benefit ratio was obtained in module M4 (1:18.14) closely followed by module M2 (1:17.91). Next higher ICBR was obtained in order of merit in descending order in module M3 (1:8.98), M6 (1:8.35), module M5 (1:6.78), module M7 (1:5.91) and M1 (1:1.23).

From the above findings on Incremental cost benefit ratio for different modules revealed that the highest ICBR of (1:18.14) with comparatively more net monetary return of (Rs.1,15,248/ha) was obtained in module M4 followed by, higher ICBR in module M2 (1:17.91). However, comparatively moderate ICBR of 1:8.98 with NMR of Rs.87977/ha in module M3, ICBR of 1:8.35 with highest NMR of (RS.1,32,492/ha) was obtained in module M6 and ICBR of 1:6.78 with moderate NMR of Rs. 97,181/ha obtained in M5. Lowest ICBR of 1:1.23 with minimum NMR of (Rs.33387/ha) in module M1 due to higher cost of SA, YST and 5 sprays of Aza 1% w/w. However highest NMR and half ICBR *i.e.* (1:8.35) as compared to module M4 (1:18.14) and M2 (1:17.91) due to highest yield and highest cost of plant protection involved on ST, SA, YST and four sprays of insecticides cyper, Tria, Fenpo and Ace+spiro in module M6. Module M4 and M2 were found to be most effective from point of view from obtaining the highest ICBR . Module M6, M4 and M5 were found to be most effective in order of merit in obtaining highest NMR . The module M4 was found to be the economically most effective, and module M3 was found to be moderately economically effective module from NMR & ICBR point of view during summer 2014-15 and 2015-16. Highest ICBR in M4 and moderately ICBR in M6 was obtained due to higher yield in both module and low and highest cost of plant protection in M4 and M6 respectively.

Table: 46 Economics of Various Modules on Okra during *kharif* 2015-16

Tr.No.	Treatment	Cost of Treatment (Rs./ha)		Total cost (A)	Yield (q/ha)	Increase yield over control (q/ha)	Value of increased yield (Rs. / ha) (B)	Net monetary return (Rs/ha) (C) (B-A)	ICBR (C/A)	Rank
		Cost of trap material & Insecticide	Labour + Sprayer charges							
M1	SA.YST,Azadirachtin 1%w/w	22568	4520	27088	37.48	14.67	29340	2252	1:0.08	VII
M2	ST,Dim, Quin, Fenpo,Dico+Quin.	1813	3040	4853	40.81	18.00	36000	31147	1:6.41	II
M3	YST,Ace, Quin Fenpo,Spi+Lam,Fenv.	5638	4160	9798	53.16	30.35	60700	50902	1:5.20	IV
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2552	3800	6352	72.74	49.93	99860	93507	1:14.72	I
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	10559	3760	14319	64.05	41.24	82480	68161	1:4.76	VI
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	12068	3760	15828	75.82	53.01	106020	90192	1:5.70	III
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	11072	3760	14832	66.12	43.31	86620	71788	1:4.84	V
M8	Untreated control				22.81					

4.15.2 Economics of various modules in okra during *kharif* 2015-16

The data pertaining to the efficacy of various module in respect of incremental cost benefit ratio during *kharif* 2015-16 as presented in (Table 46 revealed that, the highest net monetary returns was obtained in module M4 (Rs.93,507/ha) wherein only 5 spray of Tria, Fen, quin+Spir, Fen, Lamb were given closely followed by module M6 (Rs.90,192/ha) wherein in ST,SA, YST and 4 sprays of insecticides Cyper, Tria, Fenpo, Ace+Spir were given. The next higher monetary return was recorded in order of merit in module M7 (Rs.71,788/ha), wherein ST, SA, YST and four sprays of Cyper+ Dime, Fenpo, Ethion+quin, Lamb, module M5 (Rs.68,161/ha) wherein SA,YST and 4 sprays Thia, Fenpo, Lamb, Tria+Dico and module M3 (Rs.50,902/ha) wherein YST and 5 sprays of Insecticides, followed by M2 (Rs.31,147/ha) wherein ST with 4 sprays Dim,Quin,Fenpo,Dico+Quin and lowest NMR was recorded in module M1 (Rs.2252/ha) wherein SA, YST and 5 sprays of Aza 1% w/w were given. The highest Incremental cost benefit ratio was obtained in module M4 (1:14.72) closely followed by module M2 (1:6.41). Wherein ST and 4 sprays of insecticides Viz. Dim, Quin, Fenpo, Dico+quinl costing very less in i.e. Rs. 1813/ha was involved. Next higher ICBR was obtained in order of merit in descending order in module M6 (1:5.70), M3 (1:5.20) module M7 (1:4.84) and module M5, (1:4.76) were recorded. The lowest ICBR was recorded in module M1 (1:0.08).

From the above findings on Incremental cost benefit ratio for different treatments revealed that the highest ICBR of (1:14.72) with maximum net monetary return of (Rs.93,507/ha) was obtained in module M4 followed by, highest ICBR (1:6.41) with comparatively less net monetary returns in M2 (Rs.31,147/ha). However, comparatively moderately ICBR of 1:5.70 with highest NMR of (Rs.90,192/ha) in M6, moderate ICBR of 1:5.20 with moderate NMR of (RS.50,902/ha) was obtained in module M3, followed by module M7 with moderately ICBR of 1:4.84 and highest NMR of (Rs.71,788/ha) and moderate ICBR of 1:4.76 with moderate NMR of Rs. 68,161/ha in module M5. Lowest ICBR (1:1.08) and lowest NMR of Rs. 2252/ha obtained in module M1 due to higher cost of SA,YST and 5 sprays of

Aza 1%w/w was involved with lowest yield as compare to other remaining module.

Highest NMR and highest ICBR was recorded in M4 followed by higher NMR & comparatively higher ICBR in M6 due to highest yield & comparatively lowest cost of plant protection *i.e.* Rs.2552/ha and Rs. 12068/ha 6 times cost of protection was involved in M6 compared to M4 this module. Though M2 module rank second in recording higher ICBR but rank six in respect of NMR due to comparatively lower yield as compare to the best module M4 & M6. Module M1 was found to be least effective from NMR & ICBR point of view due to minimum yield & higher cost of plant protection *i.e.*Rs.22,568/ha. The module M6 was found to be 2nd and most moderately economically effective in order of merit form NMR & ICBR point of view.during kharif 2015-16.

4.15.3 pooled incremental cost benefit ratio in various modules in okra

Pooled data in respect of ICBR as influenced by various modules during summer 2014-15 and *kharif* 2015-16 in Table 47 revealed that the highest ICBR of 1:16.46 recorded in module M4 wherein only 5 sprays of Tria,Fen,Quin+Spir,Fen,Lamb closely followed by ICBR of 1:11.70 in module M2 wherein ST and 4 sprays of insecticides Dim, Quin, Fenpo and Dico + Quin were given and equal ICBR of 1:6.98 in module M6 and M3 wherein ST,SA, YST and 4 sprays of insecticides viz., Cyper,Tria,Fenpo,Ace+Spir. and YST and 5 sprays of Insecticides viz., Ace, Quin Fen, Spi+Lam and Fenv respectively, were given. Least ICBR of 1:0.61 was recorded in module M1.Highest NMR of (Rs.1,10,562/ha) was obtained in module M6 followed by module M4 (1,04,551/ha) and module M5 (Rs.82,251/ha) wherein ST,SA,YST and 4 sprays of cyper,Triaz,Fenpo and Ace+Spiro and only 5 sprays of Triaz,FenQuin+spir,Fenv and Lamb and SA, YST 4 sprays Thia,Fenpo,Lamb, Tria+Dico, were given respectively which is more than half of Rs.5638/ha in M3.

The module M4 was found to be the most effective in recording highest ICBR with higher NMR due to obtaining of highest yield and lower plant protection cost *i.e.* Rs. 6352/ha. However though the equal ICBR of 1:6.98 is obtained in module M6 and module M3 but higher NMR was

Table: 47 Economics of Various Modules on Okra Based on pooled mean of summer 2014-2015 and Kharif 2015-16

Tr. No.	Treatment	Cost of Treatment (Rs./ha)		Total cost (A)	Yield (q/ha)	Increase yield over control (q/ha)	Value of increased yield (Rs. / ha) (B)	Net monetary return (Rs/ha) (C) (B-A)	ICBR (C/A)	Rank
		Cost of trap material & Insecticide	Labour + Sprayer charges							
M1	SA.YST,Azadirachtin 1%w/w	22568	4520	27088	43.26	19.43	43718	16630	1:0.61	VII
M2	ST,Dim, Quin ,Fenpo,Dico+Quin.	1828	3040	4868	51.30	27.47	61808	56940	1:11.70	II
M3	YST,Ace ,Quin Fenpo,Spi+Lam,Fenv.	5638	4160	9798	58.56	34.73	78143	68345	1:6.98	III
M4	Tria, Fenv, Quin+Spir,Fenpo,Lamb	2552	3800	6352	73.12	49.29	110903	104551	1:16.46	I
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	10559	3760	14319	66.75	42.92	96570	82251	1:5.74	VI
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	12083	3760	15843	80.01	56.18	126405	110562	1:6.98	IV
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	11087	3760	14847	66.02	42.19	94928	80081	1:5.39	V
M8	Untreated control				23.83					

Note:1. Labour charges-180Rs/day.2. Azadirachtin 1%w/w -Rs.1280/lit. 3. Acephate 75% SP 450/kg 4. Dimethoate 30 EC-Rs.350/Lit .5.Quinalphos 25 EC-Rs.380/Lit .6.Fenpropathrin 30 EC-Rs.1000/Lit.7.Dicofol 18.5 EC-Rs.320/Lit.8.Spiromesifen22.9 SC-Rs.3500/Lit. 9.Lambda cyhalothrin 5 EC-Rs.450/Lit.10.Fenvalerate 20EC-Rs.270/Lit.11.Triazophos 40 EC-Rs.400/Lit.12.Thiamethoxam 25 WG-Rs.3000/Kg.13Cypermethrin 25 EC-Rs.500/Lit.14Ethion 50 EC-Rs.490/Lit.15.Trap-Rs.1800/ha. 16.Imidacloprid 48 FS –RS.3000/Lit 17. 4 labour /spray/ha-180/labour.18.Hiring charges Spray pump 40/day/ha 19. Neem Cake @ Rs. 25/kg. Castor oil. Rs.140/L, 20.Labour charges for washing and smearing castor oil for 11 times i.e. 2 labour / ha. 21.Application of neem cake 2 labour /ha. 22. Price of Okra fruit- 2250Rs./q ,castor oil-700ml/ha,7ml/trap/time/week, 11times=77ml required

obtained in module M6 which is approximately double Rs.110562/ha than the module M3 (Rs.68345/ha) due to higher yield and lower plant protection cost (Rs.9798/ha) in M3 which is approximately half of plant protection cost in module M6 (Rs.15843/ha). Module M2 though rank second in obtaining ICBR but comparatively lower NMR of RS.56940/ha was obtained in module M2 as compare to other remaining best module except M1.

It is indicated from the ICBR and NMR work out in different modules during summer 2014-15 and *kharif* 2015-16 that module M4, closely followed by M6 and module M5 were found to be economically best effective module in order of merit and module M2 & M7 were found to be the moderately economically effective module. However, module M1 was found to be the least effective module from economic point of view as it has recorded lowest NMR and ICBR due to lower yield and higher cost of plant protection. However module M6 was found to be significantly most promising of all the modules in all respect of minimizing the sucking pests, fruit borer complex, YMV disease incidence and obtaining maximum yield with highest first rank NMR and third rank in ICBR due to highest yield and comparatively higher cost of plant protection (Rs. 15843/ha) due to extra plant protection cost involved in seed treatment, soil application of neem cake and use of yellow sticky trap as a IPM component in the module due to which two and half times more cost of plant protection than module M4 and approximately four times more cost than module M2 incurred in module M6. Whereas in module M4 being a completely chemical module five application of only chemical insecticides are involved due to which very low cost of plant protection (Rs.9798/ha) incurred in module M4. Out of all module tested in present investigation module M6 was found IPM base most effective and economical against all major pests and YMV disease in okra.

Present findings could not be compare for the want of literature on sequential module as such . However, some component of the module M6 in present investigation are in agreement with Singh et al. (2013) who reported that module consists of seed treatment with imidacloprid, application of indoxacarb, thiomethoxam, hexythiazox, deep summer ploughing and use of neem cake @ 250 kg/ha before sowing was the most effective in obtaining

net return higher in module (M1) which was Rs. 182340 and Rs. 165060/ha, respectively during 2010 and 2011. Pardeshi et al. (2011) who reported that the highest cost benefit ratio (1: 20.3) was obtained in the treatment of cypermethrin 0.006%, followed by profenophos + cypermethrin (1:11.9), chlorpyrifos (1:10.4), chlorpyrifos + cypermethrin (1:10.2), profenophos (1:8.7), acephate (1:5.1) and methomyl (1:4.1). Bajad et al. (2014) who reported that the highest marketable fruit yield of okra (75.33q/ha) and incremental cost benefit ratio (1:16.49) was obtained from the treatment of cypermethrin 25 EC @ 0.05 per cent. The most economically viable treatment followed by acephate 75 SP @ 0.05 per cent (74.05 q/ha) and spinosad 45 SC @ 0.015 percent (72.66q/ha). Ray and Chatterjee (2000) who reported that acephate gave the best cost benefit ratio of 1:5.58 followed by imidacloprid (1:4.63).

4.16. Phytotoxicity on okra plants.

No phytotoxicity symptoms were observed on okra plants in none of the module throughout period of experimentation during summer 2014-15 and kharif 2015-16. Kumar et al. (2001) who reported that various doses of imidacloprid and thiamethoxam had no phytotoxic effect on okra but effective against insects. Prasad Kumar (2010) who reported that critical visual observations were made for phototoxic symptoms such as injury on leaf tips or surface, wilting *etc.*, on ten randomly selected plants in plots and no phototoxic symptoms were observed in any of the treatments. It can be concluded that the application of triazophos 40 EC @ 1250 ml per ha was effective against leaf hopper, whiteflies and shoot and fruit borer of brinjal.

4.17 Effect of Yellow sticky traps catches on sucking pest during Summer 2014-15

The data presented in Table 48 to 52 as regard to the effect of yellow sticky traps on catches of sucking pests population at different height during summer 2014-15 is given below.

Catches of aphid along and above 15cm crop canopy

The maximum catches of aphid 8.79, 4.76, 13.55 and 5.52, 3.85 and 9.36 per traps were observed along crop canopy and at 15 cm

above crop canopy on NE, SW and both direction together in module M1 followed by M6 (6.15, 4.64, 10.79 and 4.61,4.21 , 8.82/traps), M7 (6.09,4.18,10.27/traps and 4.73,2.94, 7.67/traps), M5 (5.30,3.76,9.06/ traps and 3.18,3.21 and 6.39/traps) and M3 (4.42,3.82,8.24/traps and 3.42,2.64 and 6.06/traps) in descending order respectively. Similar trend was observed at both the height with respect to the trapping of aphids.

Leaf hopper

The maximum catches of leaf hopper 21.21,16.03,37.24 and 17.12,18.39 and 35.52/trap were observed along crop canopy and at 15 cm above crop canopy on NE, SW and both direction together in module M1 followed by M7 17.88, 11.82, 29.70/traps and 12.85, 14.00, 26.85/traps) ,M6 (14.76,10.12, 24.88/traps and 12.21,11.79, 24.00/traps),M5 (11.42, 10.03, 21.45/traps and 10.55, 10.15, 20.70/traps),) and M3 (10.85, 8.39 and 19.24/traps and 7.36, 9.76, 17.12/traps) in descending order respectively. Similar trend was observed at both the height with respect to the trapping of leafhopper.

Whitefly

The maximum catches of whitefly 136.52, 85.61, 222.12 and 159.03, 87.91 and 246.94 per traps along crop canopy and at 15 cm above crop canopy was observed on NE,SW and both direction together in module M1 followed by M7 130.85, 61.64, 192.48/traps and 124.42, 79.03 and 203.45 per traps M6 (108.61, 66.24, 174.85/traps and 116.64, 63.30 and 179.94/traps),M5 (102.76, 56.70, 159.45/traps and 106.33, 65.82 and 172.15/traps)and M3 (87.79, 53.15,140.94/traps and 106.15, 57.55 and 163.70/traps) in descending order, respectively.

Table: 48 Effect of Yellow Sticky traps on aphids population along crop canopy and at 15cm above crop canopy during Summer 2014-15

Tr. No.	Treatment details	Cumulative Mean population of Aphids /trap /week (Av. of 11 count) ALCC			Cum. Mean population of Aphids /trap/ Week (Av. of 11 count)) at 15cm ACC		
		NE-Direction	SW-Direction	Both Direction together	NE-Direction	SW-Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	8.79	4.76	13.55	5.52	3.85	9.36
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	4.42	3.82	8.24	3.42	2.64	6.06
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	5.30	3.76	9.06	3.18	3.21	6.39
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	6.15	4.64	10.79	4.61	4.21	8.82
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	6.09	4.18	10.27	4.73	2.94	7.67

Table: 49 Effect of Yellow Sticky traps on Leaf hopper population along crop canopy and at 15cm above crop canopy during Summer 2014-15

Tr. No.	Treatment details	Cum. Mean population of LH/ trap/Week (Av.of 11 count) ALCC			Cum. Mean population of LH /trap /Week (Av. of 11 count)) at 15cm ACC		
		NE-Direction	SW-Direction	Both Direction together	NE-Direction	SW-Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	21.21	16.03	37.24	17.12	18.39	35.52
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	10.85	8.39	19.24	7.36	9.76	17.12
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	11.42	10.03	21.45	10.55	10.15	20.70
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	14.76	10.12	24.88	12.21	11.79	24.00
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	17.88	11.82	29.70	12.85	14.00	26.85

Table :50 Effect of Yellow Sticky traps on white fly population along crop canopy and at 15cm above crop canopy during Summer 2014-15

Tr. No.	Treatment details	Cum. Mean population of White fly/ trap/Week (Av.of 11 count) ALCC			Cum. Mean population of White fly/ trap/Week (Av.of 11 count) 15cmACC		
		NE-Direction	SW-Direction	Both Direction together	NE-Direction	SW-Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	136.52	85.61	222.12	159.03	87.91	246.94
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	87.79	53.15	140.94	106.15	57.55	163.70
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	102.76	56.70	159.45	106.33	65.82	172.15
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	108.61	66.24	174.85	116.64	63.30	179.94
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	130.85	61.64	192.48	124.42	79.03	203.45

Table: 51 Effect of Yellow Sticky traps on Thrips population along crop canopy and at 15cm above crop canopy during Summer 2014-15

Tr.No.	Treatment details	Cum. Mean population of Thrips /trap /Week (Av.of 11 count) ALCC			Cum. Mean population of Thrips /trap /Week (Av.of 11 count) 15cmACC		
		NE-Direction	SW-Direction	Both Direction together	NE-Direction	SW-Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	11.39	8.21	19.61	9.15	8.64	17.79
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	8.36	5.79	14.15	5.30	6.52	11.82
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	8.55	6.82	15.36	6.88	6.24	13.12
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	9.61	6.30	15.91	7.09	7.27	14.36
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	9.76	7.24	17.00	8.18	7.64	15.82

Table: 52 Effect of Yellow Sticky traps on DCB population along crop canopy and at 15cm above crop canopy during summer 2014-15

Tr.No.	Treatment details	Cum. Mean population of DCB/trap/Week (Av.of 5 count) ALCC			Cum. Mean population of DCB/trap/Week (Av.of 5 count) 15cmACC		
		NE- Direction	SW- Direction	Both Direction together	NE-Direction	SW- Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	9.31	12.92	22.23	17.62	14.31	31.92
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	9.08	12.08	21.15	15.00	15.23	30.23
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	8.85	8.92	17.77	13.62	14.62	28.23
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	8.62	6.69	15.31	9.69	12.54	22.23
M7	ST,SA,YST,Cyper+Dime, Fenpo,Ethion+Quinal,Lamb	9.23	10.46	19.69	19.46	13.85	33.31

Similar trend was observed at both the height with respect to the trapping of whitefly. But more population of whitefly observed at 15cm height above the crop canopy in all the five modules as compared to along the crop canopy.

Thrips

The maximum catches of thrips 11.39, 8.21, 19.61 and 9.15, 8.64 and 17.79 per trap along crop canopy and at 15cm above crop canopy catches were observed on NE, SW and both direction together in module M1 followed by M7 (9.76, 7.24, 17.00 and 8.18, 7.64 and 15.82 /traps), M6 (9.61, 6.30, 15.91 and 7.09, 7.27 and 14.36/traps), M5 (8.55, 6.82, 15.36 and 6.88, 6.24 and 13.12/traps) and M3 (8.36, 5.79, 14.15, 5.30, 6.52 and 11.82/traps) in descending order respectively. Similar trend was observed at both the height with respect to the trapping of thrips. But more population of thrips observed along the crop canopy as compared to 15 cm above the crop canopy height.

Dusky Cotton Bug

The maximum catches of DCB 9.31, 12.92, 22.23 was observed along crop canopy on NE, SW and both direction together in module M1 followed by M3 (9.08, 12.08, 21.15/traps), M7 (9.23, 10.46, 19.69/trap), M5 (8.85, 8.92, 17.77/trap), M6 (8.62, 6.69, 15.31/traps) and somewhat module wise different trends was observed at 15 cm height above crop canopy. maximum catches of DCB observed in module M7 (19.46, 13.85, 33.31/traps) followed by M1 (17.62, 14.31, 31.92/traps), M3 (15.00, 15.23, 30.23/traps), M5 (13.62, 14.62, 28.23/traps), M6 (9.69, 12.54, 22.23/traps). However, more population of DCB was observed at 15cm height above the canopy compare to along the crop canopy.

4.17.1 Effect of Yellow sticky traps catches on sucking pest during Kharif 2015-16

The data presented in Table 53 to 56 as regard to the effect of yellow sticky traps on catches of sucking pests population at different height during summer *kharif* 2015-16 is given below.



Aphids on Yellow sticky trap



Whitefly on Yellow Sticky Trap



Whitefly and Leafhopper on Yellow Sticky Trap



Leaf hopper on Yellow sticky trap

Plate 8 Installation of Yellow sticky trap on okra crop

Catches of aphid along and above 15cm crop canopy

The maximum catches of aphid 37.25, 27.63 and 64.88 was observed on along crop canopy on NE, SW and both direction together in module M3 followed by M1 (38.67, 24.33 and 63.00/traps) M6 (34.96, 23.92 and 58.88/traps), M5 (36.92, 20.50 and 57.42), M7 (33.83, 23.21 and 57.04/traps) and somewhat different trends was observed at 15 cm above crop canopy. Maximum catches of aphids were observed in module M1 (15.69,15.25 and 30.94/traps) followed by M7 (13.54,12.63 and 26.17/trap), M6 (13.77,11.83 and 25.60/ trap) M3 (13.31,12.25 and 25.56/traps) and M5 (10.06, 9.21 and 19.27/traps).But comparatively more than twice population of aphid catches were observed along the crop canopy compared to 15 cm height above the crop canopy during *kharif* season.

Leaf hopper

The maximum catches of leafhopper 17.13, 23.58 and 40.71 were observed on along crop canopy on NE, SW and both direction together in module M1 followed by M7 (15.79, 21.96 and 37.75/traps), M6 (13.58,19.29 and 32.88/traps), M5 (12.63,18.92 and 31.54/traps), M3 (12.04,18.08 and 30.13/traps) and somewhat different trends was observed at 15 cm height above crop canopy. The maximum catches of leaf hopper were observed in module in M1 (10.38,14.25 and 24.63/traps) followed by M7 (10.00,12.88 and 22.88/trap), M5 (9.04, 11.67 and 20.71/trap), M6 (9.04,11.00 and 20.04/traps) and M3 (7.13,10.42 and 17.54/traps). But comparatively more than one and half times population of leafhopper catches were observed along the crop canopy compared to 15 cm height above the crop canopy.

Whitefly

The maximum catches of whitefly 22.29, 35.13 and 57.42 were observed on along crop canopy on NE, SW and both direction together in module M1 followed by M7 (21.71, 33.13 and 54.83/traps), M3 (20.79, 32.04 and 52.83/traps), M5 (19.79, 29.33 and 49.13/traps), M3 (19.17, 26.00 and 45.17 /traps) and somewhat different trends was observed at 15 cm above crop canopy.

Table:53 Effect of Yellow Sticky traps on aphids population along crop canopy and at 15cm above crop canopy during Kharif 2015-16

Tr.No.	Treatment details	Cumulative Mean population of Aphids/trap/week (Av. of 11 count) ALCC			Cum. Mean population of Aphids /trap /Week (Av. of 11 count)) 15cm ACC		
		NE- Direction	SW- Direction	Both Direction together	NE- Direction	SW- Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	38.67	24.33	63.00	15.69	15.25	30.94
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	37.25	27.63	64.88	13.31	12.25	25.56
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	36.92	20.50	57.42	10.06	9.21	19.27
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	34.96	23.92	58.88	13.77	11.83	25.60
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	33.83	23.21	57.04	13.54	12.63	26.17

**Table: 54 Effect of Sticky traps on Leaf hopper population along crop canopy and at 15cm above crop canopy during
Kharif 2015-16**

Tr.No.	Treatment details	Cum. Mean population of LH/trap/Week (Av.of 11 count) ALCC			Cum. Mean population of LH/trap/Week (Av.of 11 count) 15cmACC		
		NE- Direction	SW- Direction	Both Direction together	NE- Direction	SW- Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	17.13	23.58	40.71	10.38	14.25	24.63
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	12.04	18.08	30.13	7.13	10.42	17.54
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	12.63	18.92	31.54	9.04	11.67	20.71
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	13.58	19.29	32.88	9.04	11.00	20.04
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	15.79	21.96	37.75	10.00	12.88	22.88

Table: 55 Effect of Sticky traps on Whitefly population along crop canopy and at 15cm above crop canopy during *Kharif* 2015-16

Tr.No.	Treatment details	Cum. Mean population of Whitefly/ trap/Week (Av.of 11 count) ALCC			Cum. Mean population of Whitefly/ trap/Week (Av.of 11 count) 15cmACC		
		NE- Direction	SW- Direction	Both Direction together	NE- Direction	SW- Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	22.29	35.13	57.42	33.21	46.88	80.08
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	19.17	26.00	45.17	26.17	37.38	63.54
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	19.79	29.33	49.13	29.75	38.96	68.71
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	20.79	32.04	52.83	29.75	38.88	68.63
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	21.71	33.13	54.83	33.21	40.83	74.04

Table: 56 Effect of Sticky traps on Thrips population along crop canopy and at 15cm above crop canopy during *Kharif* 2015-16

Tr.No.	Treatment details	Cum. Mean population of Thrips/trap/Week (Av.of 11 count) ALCC			Cum. Mean population of Thrips/trap/Week (Av.of 11 count) 15cmACC		
		NE-Direction	SW-Direction	Both Direction together	NE-Direction	SW-Direction	Both Direction together
M1	SA.YST,Azadirachtin 1%w/w	4.83	5.21	10.04	3.54	3.83	7.38
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	3.00	2.75	5.75	1.96	2.38	4.33
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	3.42	3.92	7.33	2.13	2.58	4.71
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	3.58	3.88	7.46	2.17	2.92	5.08
M7	ST,SA,YST, Cyper+Dime, Fenpo,Ethion+Quinal, Lamb	4.29	4.79	9.08	3.21	3.50	6.71

The maximum catches of whitefly were observed in module M1 (33.21, 46.88 and 80.08/traps) followed by M7 (33.21, 40.83 and 74.04/trap), M5 (29.75, 38.96 and 68.71/ trap), M6 (29.75, 38.88 and 68.63 /traps) and M3 (26.17, 37.38 and 63.54/traps) respectively. But more population of whitefly observed at 15 cm height above crop canopy in all the modules as compared to catches in along the crop canopy.

Thrips

The maximum catches of thrips 4.83, 5.21 and 10.04 and 3.54, 3.83 and 7.38 per trap along crop canopy and at 15cm above crop canopy catches was observed on NE, SW and both direction together in module M1 followed by M7 (4.29, 4.79, 9.08 and 3.21, 3.50, 6.71 /traps), M6 (3.58, 3.88, 7.46 and 2.17, 2.92, 5.08/traps), M5 (3.42, 3.92, 7.33 and 2.13, 2.58 and 4.71/traps) and M3 (3.00, 2.75, 5.75 and 1.96, 2.38 and 4.33/traps). Slightly more population of thrips observed along the canopy compared to 15 cm height above the crop canopy.

Effect of Yellow sticky traps on trapping of sucking pest population at 15 cm height above crop canopy during summer 2014-15 Vs. *kharif* 2015-16 .

The data presented in Table 57 as regard to the effect of yellow sticky traps on catches of sucking pests population at 15cm height above crop canopy revealed that adult trap catches of aphid, leaf hopper, whitefly and thrips were maximum (9.36, 30.94/trap) (35.52, 24.63/trap/week), (246.94, 80.08/trap) and (17.79, 7.38trap/week) during summer 2014-15 and *kharif* 2015-16 respectively in module M1 while comparatively lower (6.06, 25.56/trap) (17.12, 17.54/trap), (163.70, 63.54/trap) and (11.82, 4.33/trap), respectively in module M3.

However, it is noticed from the above Table that overall 3 to 4 times more catches of aphid were observed during *kharif* season compared to summer. Approximately similar catches of leafhopper observed during summer and *kharif* season except one and half time more catches of leaf hopper observed during summer season in module M3. About three times

more catches of whitefly and thrips noticed during summer season compared to kharif 2015-16.

In respect of overall catches of sucking pest population, approximately more than twice catches of sucking pests population noticed during summer 2014-15 compared to *kharif* 2015-16 in descending order of merit in sequence as module M1 (309.61, 143.03/trap) > M7 (253.79, 129.8/trap) > M6 (227.12, 119.35/trap) > M5 (212.36, 113.4/trap) > M3 (198.7, 110.97/trap/week).

Effect of Yellow sticky traps on trapping of sucking pest population along crop canopy during summer 2014-15 Vs. *kharif* 2015-16 .

The data presented in Table 58 as regard to the effect of yellow sticky traps on catches of sucking pests population along crop canopy revealed that the maximum adult trap catches of aphid (13.55, 63.00/trap) leaf hopper, (37.24, 40.71/trap/week), whitefly (222.12, 57.42 /trap) and thrips (19.61, 10.04/trap/week) during summer 2014-15 and kharif 2015-16 respectively, in module M1, while comparatively lower catches of aphid (8.24, 64.88/trap,) leaf hopper (19.24, 30.13/trap), whitefly (140.94, 45.17/trap) and thrips (14.15, 5.75/trap/week) during summer 2014-15 and kharif 2015-16 respectively in module M3.

However, it is noticed from the above table that overall 5 to 8 times more catches of aphid and one to one and half times more catches of leafhopper observed during *kharif* 2015-16 season compared to summer 2014-15. Vice-versa 3 to 4 times more catches of whitefly and 2 to 3 times more catches of thrips were observed during summer 2014-15 compare to *kharif* 2015-16 season.

Similar trend was observed in respect of overall trap catches of sucking pest along the crop canopy height also. Approximately more than one and half times catches of all sucking pests noticed during summer 2014-15 compared to *kharif* 2015-16 in descending order of merit in sequence as module M1 (292.52, 171.17) > M7 (249.40, 158.70/trap) > M6 (226.43, 152.05/trap) > M5 (205.32, 145.42/trap) > M3 (182.57, 145.93/trap/week) respectively.

Table: 57 Effect of Yellow Sticky traps on Sucking pest population at 15cm above crop canopy during summer and Kharif 2015-16

Tr. No.	Treatment details	Cum. Mean population of Sucking pest trap/Week (Av. of 11 count) 15cm ACC									
		AP		LH		WF		TH		Sucking pest	
		Sum	Kh.	Sum	Kh.	Sum.	Kh.	Sum.	Kh.	Sum.	Kh.
M1	SA.YST,Azadirachtin 1%w/w	9.36	30.94	35.52	24.63	246.94	80.08	17.79	7.38	309.61	143.03
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	6.06	25.56	17.12	17.54	163.70	63.54	11.82	4.33	198.7	110.97
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	6.39	19.27	20.70	20.71	172.15	68.71	13.12	4.71	212.36	113.4
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	8.82	25.60	24.00	20.04	179.94	68.63	14.36	5.08	227.12	119.35
M7	ST,SA,YST, Cyper+Dim., Fenpo,Ethion+Quinal, Lamb	7.67	26.17	26.85	22.88	203.45	74.04	15.82	6.71	253.79	129.8

Table: 58 Effect of Yellow Sticky traps on Sucking pest population at along crop canopy during summer and Kharif 2015-16

Tr. No.	Treatment details	Cum. Mean population of Sucking pest/trap/Week (Av.of 11 count) ALCC									
		AP		LH		WF		TH		Sucking pest	
		Sum.	Kh.	Sum.	Kh.	Sum.	Kh.	Sum.	Kh.	Sum.	Kh.
M1	SA.YST,Azadirachtin 1%w/w	13.55	63.00	37.24	40.71	222.12	57.42	19.61	10.04	292.52	171.17
M3	YST,Ace,Qui,Fenpo,Spi+Lam,Fenv	8.24	64.88	19.24	30.13	140.94	45.17	14.15	5.75	182.57	145.93
M5	SA,YST,Thia,Fenpo,Lamb,Tria+Dico	9.06	57.42	21.45	31.54	159.45	49.13	15.36	7.33	205.32	145.42
M6	ST,SA,YST,Cyper,Tria,Fenpo,Ace+Spir	10.79	58.88	24.88	32.88	174.85	52.83	15.91	7.46	226.43	152.05
M7	ST,SA,YST,Cyper+Dime, Fenpo,Ethion+Quinal,Lamb	10.27	57.04	29.70	37.75	192.48	54.83	17.00	9.08	249.45	158.7

Out of the module tested for yellow sticky trap performance maximum catches of all sucking pests recorded module M1 followed by M7, M6 and so on . It might be due to the only five foliar spray of azadirachtin 1% w/w only from 15 DAS to 75 DAS and in module M7,M6 and M5 due to the IPM based module.

Overall 3 to 4 times more catches of aphid were observed during *kharif* season compared to summer. Approximately similar catches of leafhopper observed during summer and *kharif* season except one and half time more catches of leaf hopper observed during summer season in module M1. About three times more catches of whitefly and thrips noticed at 15 cm height above crop canopy during summer season compared to *kharif* 2015-16. In respect of overall catches of sucking pest population, approximately more than twice catches of sucking pests population noticed during summer 2014-15 compared to *kharif* 2015-16 in descending order of merit in sequence as module M1 (309.61,143.03/trap) > M7 (253.79, 129.8/trap) > M6 (227.12, 119.35/trap) > M5 (212.36, 113.4/trap) > M3 (198.7, 110.97/trap/week).

Overall 5 to 8 times more catches of aphid and one and half times more catches of leaf hopper observed during *kharif* 2015-16 season compared to summer 2014-15. Vice-versa 3 to 4 times more catches of whitefly and 2 to 3 times more catches of thrips were observed along the crop canopy height during summer 2014-15 compared to *kharif* 2015-16 season. Similar trend in respect of overall trap catches of sucking pest was observed along the crop canopy height also. Approximately more than one and half times catches of all sucking pests were noticed during summer 2014-15 compared to *kharif* 2015-16 in descending order of merit in sequence as module M1 (292.52, 171.17) > M7 (249.40, 158.70/trap) > M6 (226.43, 152.05/trap) > M5 (205.32, 145.42/trap) > M3 (182.57, 145.93/trap/week), respectively.

From the above findings it is inferred that YST at 15 cm height above the crop canopy was found most suitable for trapping maximum number of adults sucking pests during both summer and *kharif* seasons.

Present findings are in confirmation with Khaire (2014) revealed that treatments with Yellow sticky trap with castor oil along the crop canopy

followed by azadirachtin 10,000 ppm @ 2 ml/L, Yellow sticky trap with castor oil at 15 cm height above crop canopy followed by azadirachtin 10,000 ppm @ 2 ml/L were found significantly most effective treatments in order of merit in minimizing the infestation of sucking pest viz., aphid, leaf hopper, whitefly and thrips at 7 and 14 days after spray and in trapping maximum population of aphids (53.14, 12.06, 65.28), leaf hopper (2.36, 0.82, 3.18) and whitefly (29.07, 12.90, 41.97) per trap per week on NE, SW and BS direction together. Bhonde (2013) studied that the Bright yellow color sticky trap at 15 cm height above crop canopy + Azadirachtin 10000 ppm @ 2ml/L found significantly effective treatment in trapping maximum population of adult aphid, leaf hopper and whitefly on NE, SW and both directions of the trap. Thakare et al. (2013) reported from feeler trial that the yellow colour traps with castor oil at 15 cm height above crop canopy closely followed by blue colour traps with motor oil at 30 cm height above crop canopy, yellow colour traps with motor oil at 30 cm height above crop canopy, blue color trap with motor oil at 15 cm height above crop canopy and yellow colour traps with white grease at 15 cm height above crop canopy were found numerically most effective in trapping maximum population of aphids, leaf hopper and whitefly together on cotton crop.

Incidence of Dusky Cotton bug at 86 days after sowing

The data presented in Table 59 revealed that the results were statistically significant. The maximum population of DCB was noticed in treated module M4 (3.00 adult/10cm twig) followed by treated module M3 (4.20 adult/10cm twig) and both the treatments were found to be statistically at par with one another. The module M4 was found significantly superior over all other module except M8. The treated module M6 and M7 had observed the DCB population to the extent of 6.47 and 6.73 adult/10cm twig and they were found to be statistically similar to each other. Module M6 was further found to be statistically at par with M7(6.73 adult/10cmtwig) and M5 (7.33 adult/10cm twig), M2 (7.87adult/10cm twig) and M1 (9.13adult/10cm twig). Of these the module M1 was found to be statistically at par with untreated module (M8) which noticed the DCB to the extent of 12.20 adult/10cm twig

Incidence of Dusky Cotton bug at 93 days after sowing

The data presented in Table 59 revealed that the significant differences among various treatments were observed. All the treatments were significantly superior over untreated module. The lowest population of DCB was observed in the treated module M6 (18.60 adult/10cm twig) followed by M4 (22.00 adult/10cm twig) and both the treatments were found to be statistically at par with one another. The treated module namely, M3, M7, M1 had noticed the DCB population to the extent of 26.40, 27.47 and 28.40 adult/10cm twig respectively and they exerted statistically similar effect to that of treated module M4.

Table: 59 Effect of various modules on dusky cotton bug (oxycaranus latus) population on okra during summer 2014-15

Tr. No	Treatment details	Dusky cotton bug / 10cm terminal twig /plant at Day after sowing			
		86DAS*	93 DAS**	100 DAS**	Cum. mean**
M1	SA. YST, Azadirachtin 1%w/w	9.13 (3.02)	28.40 (32.19)	32.00 (34.44)	23.18 (28.77)
M2	ST, Dim, Quin, Fenpo, Dico + Quin.	7.87 (2.80)	37.47 (37.61)	39.07 (38.63)	28.13 (31.96)
M3	YST, Ace, Qui, Fenpo, Spi+Lam, Fenv	4.27 (2.04)	26.40 (30.91)	29.80 (33.08)	20.16 (26.67)
M4	Tria, Fen, Quin+Spir, Fenpo, Lamb	3.00 (1.72)	22.00 (27.97)	26.00 (30.62)	17.00 (24.35)
M5	SA, YST, Thia, Fenpo, Lamb, Tria+Dico	7.33 (2.68)	34.73 (36.09)	37.80 (37.63)	26.62 (31.04)
M6	ST, SA, YST, Cyper, Tria, Fenpo, Ace+Spir	6.47 (2.52)	18.60 (25.55)	25.00 (29.99)	16.69 (24.10)
M7	ST, SA, YST, Cyper+Dim., Fenpo, Ethion+Quin., Lamb.	6.73 (2.59)	27.47 (31.48)	40.87 (39.73)	25.02 (29.99)
M8	Untreated control	12.20 (3.48)	54.87 (47.79)	59.13 (50.29)	42.07 (40.43)
	SE (m)±	0.19	1.69	1.61	1.09
	CD at 5%	0.59	5.13	4.89	3.31
	CV%	12.96	8.70	7.59	6.39

N.B: Figures in (*) indicates square root values. While (**) indicates r sign transformation

The module M5 had accounted the population of DCB to the extent of 34.73 and was found to be statistically similar with M7 and M1 and it was further found to be at par with M2 which noted the DCB 37.47 population of adult/10cm twig. Whereas, the untreated module had recorded the highest (54.87adult /10cm twig) population of DCB.

Incidence of Dusky Cotton bug at 100 days after sowing

The data presented in Table 59 indicated that the results were statistically significant. All the treatments were found to be significantly superior over untreated module. The minimum population of DCB was registered in treated module M6 (25.00 adult /10 cm twig), followed by M4 (26.00 adult/10 cm twig), M3 (29.80 adult /10 cm twig) and M1 (32.00 adult /10 cm twig) and these treatments were found to be statistically at par among themselves. Of these M3 and M1 were further found to be statistically at par with M5 which accounted the population of DCB to the extent of 37.80 adult /10 cm twig. However, Module M5 was further found to be at par with M2 (39.07 adult/10cm twig) and M7 (40.87 adult/10cm twig) whereas the maximum population of DCB was recorded in untreated module (59.13 adult/10cm twig).

Cumulative Mean of Dusky Cotton Bug

It is indicated from the data presented in Table 59 indicated that the results were statistically significant. All the treatments were found to be significantly superior over untreated module. The minimum population of DCB was noticed in treated module M6 (16.69 adult/10cm twig), followed by Module M4 (17.00 adult /10cm twig) and M3 (20.16 adult /10cm twig) and these treatments were found to be statistically at par with one another. Of these Module M3 was further found to be statistically at par with M1 (23.18 adult /10cm twig). The treated module M7 and M5 had noted the population of DCB to the extent of 25.02 adult /10cm twig and 26.62 adult/10cm twig respectively, and they had shown statistically similar effect to that of Module M1. At the same time they were found statistically at par with module M2 that accounted the DCB to the extent of 28.13 adult /10cm twig. The untreated M8 had noticed the maximum population of DCB (42.07 adult /10cm twig).

Table : 60 Toxicity and persistence of different treatments against *A. biguttula biguttula* on okra during 2015-16

Tr.No.	Treatment	Percent corrected mortality at different intervals (days)							P	T	PTI	ORE	PT50
		1	3	5	7	10	14	21					
1	Thiamethoxam 25 WG @ 0.2g/L	100.00	100.00	100.00	94.44	94.44	38.88	22.22	21	78.57	1649.94	1	13.56
2	Quinalphos 25 EC @ 2ml/L	77.77	66.66	61.11	44.44	0.00	0.00	0.00	7	62.50	437.47	5	5.47
3	Lambda cyhalothrin 5 EC @1ml/L	83.33	88.88	66.66	55.55	22.22	0.00	0.00	10	63.33	633.28	4	6.41
4	Acephate 75 SP @ 1.6g/L	66.66	72.22	55.55	38.88	0.00	0.00	0.00	7	58.33	408.29	6	4.65
5	Dimethoate 30EC @ 2ml/L	83.33	94.44	66.66	55.55	33.33	0.00	0.00	10	83.33	833.28	3	7.50
6	Triazophos 40 EC @ 2ml/L	50.00	66.66	55.55	33.33	0.00	0.00	0.00	7	51.39	359.70	7	1.90
7	Cypermethrin 25 EC @ 0.4ml	77.77	83.33	83.33	66.66	61.11	27.77	0.00	14	66.66	933.26	2	10.79
8	Fenvalerate 0.1ml/L	66.66	55.55	38.88	16.66	0.00	0.00	0.00	7	44.44	311.06	8	2.35

Where T= Average percent mortality , P= Period of toxicity persisted,

ORE= Order of relative efficacy.

Persistent toxicity (PTI)= Persistence toxicity index (Toxicity x Period)

PT50 = Persistence toxicity in days

The order of relative persistence of the insecticides was calculated based on PT values.

The persistent (PT) values were calculated by the criterion developed by Pradhan (1967).

4.18 Persistence of insecticides after spray

The results on persistence of insecticides after spray against leaf hopper (*Amrasca biguttula biguttala*) on okra Table 60 revealed that all insecticides showed persistent toxicity to the nymph of leaf hopper on okra fruits for a period of 21 days. The percentage mortality ranges leaf hopper of for different insecticide were 50 to 100%, 55 to 100%, 55 to 100% and 16 to 94%, 22.94%, 27 to 38 %, 22% during 1st, 2nd, 3rd, 5th, 7th, 11th, 14th and 21st day of observation which revealed that all the insecticide products have high persistent toxicity. The descending order of residual toxicity against the leaf hopper on okra fruits based on Persistent Toxicity index values (PTi) was observed as (1649.94) thiamethoxam 25 WG @ 0.2g/L cypermethrin 25 EC @ 0.4ml (933.26) dimethoate 30EC @ 2ml/L (833.28) and Lambda cyhalothrin 5 EC @1ml/L (633.28).

The relative persistence (RP) computed taking into account the lowest PTi value recorded for fenvalerate 0.1ml/L (311.06) triazophos 40 EC @ 2ml/L (359.70) acephate 75 SP @ 1.6g/L (408.29) quinalphos 25 EC @ 2ml/L (437.47) on Persistent Toxicity index (PTi) values in the eight insecticide formulations can be arranged in the descending order of sequence as thiamethoxam 25 WG @ 0.2g/L > cypermethrin 25 EC @ 0.4ml > dimethoate 30EC @ 2ml/L > lambda cyhalothrin 5 EC @1ml/L > quinalphos 25 EC > acephate 75 SP @ 1.6g/L > triazophos 40 EC @ 2ml/L > fenvalerate 0.1ml/L @ 2ml/L.

Computation on PT₅₀ values to determine time duration for 50% kill on residual toxicity revealed that thiamethoxam 25 WG @ 0.2g/L recorded highest residual toxicity with PT₅₀ value of 13.56 days. It was followed by cypermethrin 25 EC @ 0.4ml (10.79days) dimethoate 30EC @ 2ml/L (7.50days) lambda cyhalothrin 5 EC @1ml/L (6.41 days) quinalphos 25 EC @ 2ml/L (5.47) acephate 75 SP @ 1.6g/L (4.65 days) triazophos 40 EC @ 2ml/L (1.90days) fenvalerate 0.1ml/L (2.35 days).Based on PT₅₀ values the seven insecticide formulations can be arranged in the descending order as thiamethoxam 25 WG @ 0.2g/L > cypermethrin 25 EC @ 0.4ml > dimethoate 30EC @ 2ml/L > lambda cyhalothrin 5 EC @1ml/L > quinalphos 25 EC >

acephate 75 SP @ 1.6g/L > triazophos 40 EC @ 2ml/L > fenvalerate 0.1ml/L@ 2ml/L after spray applications.

The thiamethoxam 25 WG @ 0.2g/L performed best registering 38.88 to 100 per cent larval mortality and recording the maximum average residual toxicity (T) and persistent toxicity index (PT) i.e. 78.57 and 649.94 per cent, (Table 60). The present results are conformity with Patel et al., (2003) who reported that two sprays of thiamethoxam at 50 g a.i./ha during the flowering stage of the crop at an interval of 15 days effectively prevented the population build up of mango leafhoppers. Similar findings were reported by Bhalala et al., (2006) that thiamethoxam 50 g a.i./ha effectively controlled the bhendi leafhopper after seven days of spray. The present results are conformity with Patel et al.2003. Based on LC50 values, thiamethoxam was most effective insecticide compared to all other insecticides used. Present results are in agreement with Sharma and Lal (2002), Bhalala et al. (2006) who reported that thiamethoxam 25 WG @50 g a.i./ha (0.00025%) effectively controlled leafhopper population.

CHAPTER V

SUMMARY AND CONCLUSIONS

Investigations on “Evaluation of various modules against major pests of okra” were undertaken during *Summer* 2014-15 and *Kharif* 2015-16 at field of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to find out effective modules against major pests and its effect on natural enemies and also to study the abundance of major pests and predators during both the seasons and YMV incidence in various modules and their economics. However due to the continuous use of same insecticide or same group of chemical pesticides, the problems like development of resistance in targeted species, harmful residues in the commodity to be consumed have arisen. Considering the above facts, present investigation was conducted to minimize the use of pesticides, residues level in final commodity, availability of relatively safer vegetable fruits for human consumptions, and to find cost effective suitable, feasible and relatively ecofriendly modules against major pest of okra.

Observations on 24 hrs before first spray as pre treatment and subsequent observation after each spray were undertaken for sucking pests like aphid, leafhopper thrips, whitefly, mites and predator i.e. lady bird beetle, chrysoperla and spider were recorded at 3, 7 and 14 days after each treatment spray. Similarly per cent infestations of fruit borer complex (*E.vittella* and *H.armigera*) were recorded at every picking. Based on yield of okra and costs of input incurred for each treatment, the ICBR was also worked out. The results thus obtained are summarized below.

1. The module M7 was found significantly most effective in minimizing the population of aphids at 3, 7 and 14 days after spraying. Next effective modules M5, M6 and M3 in second order of merit were found statistically equal among themselves at 3, 7 and 14 days after spray. Module M2 was found least effective in minimizing the aphid population.
2. The Module M6, M7 and M5 were found significantly most effective in minimizing the population of leafhopper at 3, 7 and 14 DAS during summer and *kharif* 2015-16 seasons. While, Module M4, M2 and M3

were found to be moderately and statistically equally effective in minimizing the population of leaf hopper. Module M1 was found to be least effective.

3. The treatment Module M6, M5 and M4 were found significantly most effective and superior over rest of the modules in minimizing the population of white fly at 3, 7 and 14 DAS during summer 2014-15 and 2015-16 seasons. However, module M3 was found moderately effective and statistically at par with M5 and M4. The Module M1, M7 and M2 were found comparatively less effective in order of merit in minimizing the population of whitefly.
4. The treatment Module M6 were found significantly most effective in minimizing the population of thrips at 3, 7 and 14 DAS over all other modules and at par with M5 during summer 2014-15 and *kharif* 2015-16 .However, module M5 was found moderately effective and statistically at par with M7. The other module M1, M2 and M4 in order of merit were found comparatively less effective in minimizing the population of thrips. Module M3 was found the least effective.
5. The treatment Module M6 and M4 were found significantly most effective in order of merit in minimizing the population of mites at 3, 7 and 14 DAS during summer 2014-15 and *kharif* 2015-16 seasons. The module M7 was found significantly moderately effective. The other module M3, M2, M5 and M1 in third order of merit were found comparatively less effective in minimising the population of mites.
6. The module M6 was found significantly most effective in minimizing the infestation of shoot borer and fruit borer complex (*E. vittella* + *H.armigera*) on number and weight basis during both summer 2014-15 and *kharif* 2015-16 seasons over all other modules and statistically at par with module M4, M7, M5 and M3. Module M1 and M2 were found least effective in minimizing the infestation of fruit borer complex.
7. The predator populations per plant that all the treated modules including untreated module M8 were found equally effective in maintaining the predator population per plant. It means treated modules are safer to

predator populations. Numerically maximum population of predator were remain in untreated module M8 (1.86 /plant) and minimum in chemical module M3 (0.41/plant) wherein sequential five foliar application of synthetic insecticides are used.

8. The abundance of aphid population was observed in the month of March *i.e.* 9 to 12th MW (3.19 to 12.46/leaf) and in the month of August - September *i.e.* 34 to 36th MW (4.03 to 11.3/leaf) with maximum at 12th MW during summer 2014-15 and 35th MW during *kharif* 2015-16 were observed, respectively.
9. The abundance of leaf hopper population was observed at high level during second week of March to last week of April *i.e.* 10th to 17th MW (6.73 to 27.3 LH/leaf) with maximum at 12th MW.(27.03 LH/leaf) during summer 2014-15, whereas during *kharif* 2015-16 in 35 to 41st MW *i.e.* from last week of August to 2nd week of October (6.24 to 28.66LH/leaf) with maximum 28.66LH/leaf at 36th MW.
10. The abundance of whitefly population during summer 2014-15 was observed between 18th to 20th MW *i.e.* in the range of (4.89 to 6.86/leaf) from 1st to 3rd week of May with its peak at 19th MW (6.86/leaf) *i.e.* in second week of May while abundance of whitefly was observed between 37th to 41st MW *i.e.* from 2nd week of September to 2nd of October in range of 4.33 to 6.88/leaf with its peak at 37th (6.88/leaf) and 41st MW (6.18/leaf) during *kharif* 2015-16.
11. The abundance of thrips during summer 2014-15 on okra crop was observed between 14 to 17th MW *i.e.* from 1st week of April to 4th week of April in the range of 2.81 to 4.74 /leaf with its peak at 15th MW (4.74/leaf) while during *kharif* 2015-16 between 36 to 40th MW in the range of 2.33 to 4.59 /leaf from 1st week of September to 1st week of October with its peak at 40th MW (4.59/leaf).
- 12 The abundance of mite during summer 2014-15 was observed between 14th to 21st MW in the range of 3.66 to 28.34/leaf from 1st week of April to 4th week of May with its peak incidence at 21st MW (28.34/leaf) while abundance of mites population during *kharif* season 2015-16 was

observed between 33th to 43th MW in the range of 6.3 to 26.72/leaf from 3rd week of August to 4th week of October with its peak incidence at 38th MW(26.72/leaf). April and May month during summer and middle of August to middle of October month atmosphere are very most suitable for the multiplication of mites. Hence, it can be said from the abundance study that okra growers should be very much careful for undertaking plant protection measures against mites during this period.

- 13 The incidence of YMV on okra crop during summer season 2014-15 was observed between 15th to 21st MW in the range of 1.81 to 10.90 per cent with its peak incidence at 20th MW (10.90%) while the incidence of YMV was noticed between 33 to 43rd MW in the range of 2.78 to 22.22% with its peak in 40-43rd MW (22.22%) during *kharif* 2015-16.
- 14 The abundance of LBB population was found between 19th to 21st MW in the range of 0.6 to 0.8/plant with its peak in 20 & 21st MW during summer 2014-15 while abundance of LBB population was observed between 31-33rd MW in the range of 0.2 to 3.9/plant with its peak at 32nd MW (3.9/plant) during *kharif* 2015-16.
- 15 The population of chrysopa was observed only during 15th to 17th MW in the range of 0.4 to 0.8/plant with its peak at 16 and 17th MW (0.8/plant) during summer 2014-15, while it was in between 32nd MW to 42nd MW in the range of 0.10 to 0.60/plant with its peak at 39th MW (0.6/plant) during *kharif* 2015-16.
- 16 The overall very low population of spider on okra crop was noticed in between 15th MW and 21st MW in the range of 0.1 to 0.4/plant with its peak at 16th and 21st MW during summer 2014-15, similarly very low population of spider was observed from 29 to 42nd MW in the range of 0.10 to 0.30 with its peak at 38 and 39th MW (0.30/plant) during the *kharif* 2015-16.
- 17 The abundance of fruit borer *E. vittella* was observed during summer 2014-15, between 15th and 21st MW in the range of 6.14% to 25.06% with its peak at 17th MW (25.06%), while during *kharif* 2015-16 it was noticed

between 34 to 43rd MW in the range of 11.28 to 31.23 % with its peak at 39th MW (31.23%).

- 18 The abundance of fruit borer, *H. armigera* was observed between 16 to 21st MW in the range of 11.76 to 16.21% with its peak at 17th MW (16.21%) during summer 2014-15, while it was between 35 to 43rd MW in the range of 6.27 to 49.33% with its peak incidence at 41st MW (49.33%) during *kharif* 2015-16.
- 19 The abundance of per cent infestation of fruit borer complex was observed between 15th and 21st MW in the range of 15.71% to 41.18% with its peak at 17th MW (41.18%) during summer 2014-15 while in *kharif* 2015-16 it was between 32nd and 43rd MW in the range of 5.9% to 78.01% with its peak at 39th MW. (78.01%). A strong positive significant correlation relationship of fruit borer complex with max. temp. was commonly observed during summer 2014-15 and *kharif* 2015-16.
- 20 The module M6 (2.55%) followed by module M4 (3.16 %) and M5 (3.85 %) were found significantly most effective and superior over all other remaining modules in recording the minimum per cent incidence of YMV compared to maximum of 6.74 % in untreated module M8 transmitted by whitefly .
- 21 The module M6 followed by module M4 was found significantly most effective in recording highest yield of okra (80.01q/ha and 73.12q/ha). The module M5 and M7 were found to be moderately effective by registering the yield of 66.75 and 66.02q/ha. Module M1 and module M2 were found the least effective in descending order by registering lower yield of 43.26 and 51.30 q/ha, respectively.
- 22 The module M4 closely followed by M6 and module M5 were found economically best effective module in order of merit and module M2 & M7 were found the moderately economically effective module. However module M6 was found significantly most promising of all the modules in all respect of minimizing the sucking pests, fruit borer complex, YMV disease incidence and obtaining maximum yield with highest first rank NMR (Rs. 1,10,562/ha) and third rank in ICBR (1:6.98). Out of all module

tested in present investigation module M6 was found IPM base most effective and economical against all major pests and YMV disease in okra.

- 23 Yellow Sticky Trap at 15 cm height above the crop canopy was found most suitable for trapping maximum number of adults sucking pests during both summer and *kharif* seasons.
24. Amongst the different chemicals tested in laboratory against leaf hopper *A.biguttulla biguttula.*, the treatment with thiamethoxam 25 WG @ 0.2g/L proved most effective in recording highest (1649.94) persistence toxicity followed by cypermethrin 25 EC @ 0.4ml (933.26), dimethoate 30EC @ 2ml/L (833.28) and lambda cyhalothrin 5 EC @1ml/L (633.28) PT values, respectively.

Conclusion

It is concluded from pooled mean data

- 1 Module M6 and M4 were found most effective in reducing the population of leafhopper, whitefly, mites, shoot and fruit borer and incidence of yellow vein mosaic and in obtaining higher yield of okra fruits. However, module M7 was significantly superior for arresting the population of aphids. The population of thrips was significantly reduced in module M6 and M5.
- 2 All modules were found equal in maintaining predator population on summer and *kharif* season on okra indicating safety to natural enemies.
3. Peak incidence of sucking pests (aphid, leafhopper, whitefly, thrips and mites) fruit borer and predators (LBB, Chrysopa and spider) were observed on okra from 9th April to 20th May (15-20th MW) and 2nd Sept to 7th Oct. (35- 40th MW) during summer 2014-15 and *kharif* season 2015-16, respectively.
4. The module M6 followed by M4 and M5 were found significantly most effective in recording minimum incidence of YMV transmitted by whitefly at 60 to 95 DAS. The module M2 was found to be the least effective and at par with M7 and M3 in recording the minimum incidence of YMV.

5. The module M4 followed by M2 and M6 were proved most economical by registering higher ICBR and NMR. However, highest first rank NMR and third higher rank of ICBR recorded in module M6 which is twice more NMR than in module M2. Hence, out of all module tested in present investigation module M6 was found IPM based most effective and economical against all major pests and YMV disease of okra.
6. Maximum incidence of YMV (*i.e.* 10.90% and 22.22%) was observed during 14th to 20th May (20th MW) and 1st to 22th Oct (40-43rd MW) preceding the incidence of whitefly (*i.e.* 5.71 to 6.86 and 6.54 to 6.88 whitefly/leaf) during 18-19th MW and 37-38th MW in summer and *kharif* season.
7. Yellow Sticky Trap at 15 cm height above the crop canopy was found most suitable for trapping maximum number of adults sucking pests (aphid, leafhopper, thrips and whitefly) during both summer and *kharif* seasons.

CHAPTER VI

IMPLICATIONS

The treated Module M6 consists of seed treatment with imidacloprid, soil application of neem cake, yellow sticky trap and sequential foliar application of synthetic pyrethroids particularly (cypermethrin, fenpropathrin) and systematic poisons (triazophos, acephate+ spiromesifen) was found significantly most effective over all other remaining modules against major pests of okra, YMV and in obtaining highest yield of okra.

Application of neem cake and seed treatment used in field for reducing the population of sucking pests up to the 30 days. Neem cake is having insecticidal, fungicidal, bactericidal, miticidal and nematocidal property helped in protection of sucking pests including mites and nematodes and diseases of okra. Yellow colour sticky trap as third major component in the module plays an important role in trapping of male and female adult stage of sucking pests there by reduction in fecundity and subsequently reduction in population of sucking pests. Use of cypermethrin and fenpropathrin as synthetic pyrethroids are the most effective against sucking pests and fruit borer complex due to their quick knock down effect, long residual action and yield boosting effect. Similarly use of triazophos and acephate+ spiromesifen due to their contact, systemic and acaricidal action they were found most effective in reducing the population of mites and whiteflies along with aphid, leafhopper and thrips.

Module M6 in present investigation being IPM based module was found most effective and economical against all major pests and YMV disease in okra. Hence, there is a 50 per cent reduction in use of chemical insecticide. By using this modules okra growers can avoid the monotonous and continuous use of the same group of insecticides. This module will be mostly used for okra growers for organic and IPM based plant protection of okra during both the summer and *kharif* seasons.

Peak incidence of sucking pests (aphid, leafhopper, whitefly, thrips and mites) fruit borer and predators (LBB,Crysopa and spider) was observed on okra from 9th April to 20th May (15-20th MW) and 2nd Sept to 7th Oct. (35 - 40th MW) during summer 2014-15 and *kharif* season 2015-16, it indicates the April and May month during summer and middle of August to middle of October month atmosphere are very most suitable for the multiplication of mites. Hence it can be said from the abundance study in the present investigation will be mostly useful for research, extension and okra growers for undertaking timely and economical plant protection measures in okra.

CHAPTER VII

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APPENDIX I

Weekly weather Data for the Year 2014 recorded at Agromet. Observatory, Dr. PDKV, Akola.

MW	Dates	Tmax		Tmin		BSH		WS		RH I		RH II		Evap		RF		Rainy days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A
1	01-07 Jan 2014	28.8	29.0	11.0	13.0	8.2	4.8	4.4	1.0	71	80	31	31	4.2	4.4	2.8	0.0	0.2	0.0
2	08-14	29.3	28.5	11.7	13.9	8.3	4.6	4.4	2.3	71	80	30	34	4.4	3.7	3.3	0.0	0.2	0.0
3	15-21	30.0	29.2	12.0	15.8	8.6	3.4	4.5	2.0	68	76	28	33	4.9	4.7	0.7	0.4	0.1	0.0
4	22-28	30.6	28.9	12.0	14.5	8.8	3.3	4.6	1.9	65	81	26	31	5.2	4.2	0.9	0.0	0.1	0.0
5	29 Jan-04 Feb	31.0	30.0	12.6	11.0	8.8	8.4	4.9	1.7	62	59	25	16	5.5	5.2	3.0	0.0	0.2	0.0
6	05-11	31.4	31.9	12.7	14.0	8.8	7.6	5.0	1.7	59	60	23	20	5.9	5.3	3.7	0.0	0.3	0.0
7	12-18	32.7	29.4	14.4	12.7	9.0	7.4	5.4	2.3	55	64	22	24	6.6	6.7	0.1	0.0	0.0	0.0
8	19-25	33.4	31.7	14.5	16.2	9.1	5.9	5.7	2.0	54	64	21	29	7.3	6.2	2.5	2.0	0.2	0.0
9	26 Feb-04 Mar	35.0	30.2	15.7	15.3	9.5	7.5	6.1	2.8	50	76	18	25	8.2	5.7	4.1	34.7	0.3	3.0
10	05-11	35.9	28.9	17.3	16.5	9.2	6.0	6.1	3.1	46	83	20	29	8.8	4.4	5.2	8.6	0.3	2.0
11	12-18	37.0	35.3	18.1	18.9	9.1	8.7	6.3	2.2	45	70	18	16	9.2	6.5	2.4	7.9	0.3	1.0
12	19-25	38.4	37.8	19.3	20.0	9.2	8.7	6.4	2.8	39	43	15	11	10.4	9.7	0.6	0.0	0.1	0.0
13	26 Mar-01 Apr	39.0	39.8	20.4	23.7	9.2	8.0	6.9	2.8	37	35	15	11	11.2	9.5	2.2	0.0	0.2	0.0
14	02-08	40.0	39.9	21.7	22.2	9.4	8.0	7.3	3.1	37	30	14	9	11.7	10.2	1.0	0.0	0.1	0.0
15	09-15	40.8	39.3	23.1	21.8	9.5	7.5	8.4	3.5	35	38	14	10	12.9	10.6	0.4	0.0	0.1	0.0
16	16-22	41.6	40.4	24.1	23.8	9.7	8.2	8.6	3.5	36	52	14	22	13.9	10.7	0.5	4.2	0.1	1.0
17	23-29	42.3	41.5	25.4	24.2	9.8	8.7	9.0	3.8	37	38	15	11	14.7	12.7	0.5	0.0	0.1	0.0
18	30 Apr-06 May	42.6	42.6	26.6	25.5	9.4	8.3	10.5	3.2	39	38	15	11	15.5	11.7	0.8	6.4	0.1	1.0
19	07-13	42.6	39.3	27.1	25.8	9.7	6.6	12.2	6.4	42	56	17	21	16.2	10.8	1.3	0.8	0.1	0.0
20	14-20	42.5	41.2	27.7	26.5	9.4	7.5	14.2	5.1	47	46	19	21	16.8	11.7	2.8	0.0	0.4	0.0
21	21-27	42.1	43.3	27.8	27.2	9.5	7.2	15.1	6.7	50	47	20	16	16.9	13.1	3.8	3.2	0.4	0.0
22	28-03 June	41.7	43.6	27.8	28.3	9.4	8.3	15.2	7.1	53	48	23	21	16.2	11.8	6.3	4.5	0.4	1.0
23	04-10	40.2	43.0	26.9	29.6	8.4	6.5	15.2	10.9	62	49	30	26	14.0	16.6	16.8	0.0	1.0	0.0
24	11-17	38.0	39.3	25.7	25.3	7.1	8.5	13.4	10.4	69	66	40	28	11.1	13.2	43.6	22.5	1.7	2.0
25	18-24	35.5	37.2	25.0	26.8	5.8	4.7	14.2	14.6	74	63	48	31	9.2	14.3	43.5	1.5	2.0	0.0
26	25-01 July	33.8	38.2	24.3	26.8	4.8	5.2	12.8	15.0	80	61	55	31	7.4	14.3	43.4	1.7	2.2	0.0

MW	Dates	Tmax		Tmin		BSH		WS		RHI		RHII		Evap		RF		Rainy days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A
27	02-08	33.2	36.4	24.0	26.3	4.8	4.1	12.0	12.5	81	74	58	44	6.5	11.9	39.4	1.4	2.2	0.0
28	09-15	32.3	35.1	23.8	24.7	3.8	2.8	11.2	10.0	83	84	60	51	5.5	6.8	42.8	48.6	2.5	1.0
29	16-22	31.9	30.7	23.6	23.9	4.0	1.5	10.4	8.8	84	88	63	70	5.2	3.8	52.8	45.8	2.4	6.0
30	23-29	31.3	28.2	23.3	22.6	4.0	1.2	10.8	11.4	86	90	64	68	4.8	4.7	43.4	194.2	2.6	3.0
31	30-05 Aug	30.9	31.6	23.3	24.2	3.5	3.2	10.6	7.6	86	89	67	66	4.6	6.0	49.6	16.4	2.4	1.0
32	06-12	29.9	32.2	23.0	23.6	3.2	5.9	10.9	11.9	88	87	70	48	4.1	8.3	61.0	13.7	2.8	2.0
33	13-19	30.4	33.6	23.0	23.6	4.0	6.9	12.4	9.5	87	89	67	46	4.5	7.1	35.9	6.9	2.0	2.0
34	20-26	30.4	33.8	22.8	23.6	4.1	5.6	11.9	1.9	87	92	67	57	4.3	4.1	42.5	28.9	1.9	4.0
35	27-02 Sept	30.5	29.1	22.7	22.4	4.2	2.1	9.3	4.1	87	94	66	81	4.6	5.0	42.4	73.6	2.1	5.0
36	03-09	31.0	28.8	22.5	22.7	5.3	3.3	8.6	8.7	87	93	62	65	5.3	7.0	33.6	109.2	1.5	3.0
37	10-16	32.1	30.3	22.4	22.6	6.6	4.2	8.0	7.3	85	88	57	65	5.1	5.7	22.0	0.7	1.1	0.0
38	17-23	32.9	32.5	22.4	23.1	6.8	6.0	6.4	6.4	84	90	55	56	5.2	5.2	23.7	0.5	1.4	0.0
39	24-30	33.5	34.5	22.1	20.7	7.3	8.5	5.1	1.0	84	81	50	37	5.0	4.2	24.4	2.0	1.4	0.0
40	01-07 Oct	33.7	36.5	21.2	21.1	7.6	7.4	4.8	1.4	82	73	47	29	5.4	5.2	23.4	0.0	1.1	0.0
41	08-14	34.0	36.8	19.8	20.9	8.1	5.6	4.5	1.7	78	66	40	26	5.3	5.4	13.1	0.0	0.7	0.0
42	15-21	33.7	34.5	18.3	21.8	8.2	5.6	4.6	1.4	76	76	37	37	5.3	5.6	6.1	0.0	0.4	0.0
43	22-28	33.1	31.9	16.8	18.0	8.3	4.3	4.4	1.1	74	77	34	37	5.3	4.0	7.6	0.0	0.4	0.0
44	29-04 Nov	32.7	33.8	16.0	15.9	8.4	7.9	4.1	1.3	73	68	32	21	5.3	4.7	2.3	0.0	0.2	0.0
45	05-11	32.3	33.5	15.2	16.6	8.4	6.5	3.9	1.4	71	69	32	28	5.1	5.2	3.0	0.0	0.2	0.0
46	12-18	31.6	30.0	14.6	20.4	8.3	3.2	3.9	2.2	73	87	32	46	4.8	3.5	5.3	20.1	0.2	2.0
47	19-25	31.0	31.7	13.3	12.9	8.4	7.4	3.7	0.9	72	72	30	16	4.6	4.2	7.7	0.0	0.3	0.0
48	26-02 Dec	30.5	32.2	12.8	12.4	8.4	7.2	3.6	0.6	71	75	32	15	4.4	3.6	5.5	0.0	0.3	0.0
49	03-09	30.0	30.8	11.9	10.9	8.4	8.3	3.8	0.9	71	73	30	18	4.3	4.4	1.0	0.0	0.1	0.0
50	10-16	29.6	29.5	10.9	14.4	8.4	4.7	3.6	1.5	71	74	28	33	4.2	4.6	0.8	0.9	0.1	0.0
51	17-23	29.5	26.4	10.8	6.9	8.5	8.3	3.8	1.6	70	71	29	16	4.1	5.0	0.9	0.0	0.1	0.0
52	24-31	29.1	28.6	11.1	8.3	8.3	8.6	4.5	1.5	71	69	30	16	4.2	5.2	2.6	0.0	0.2	0.0
										TOTAL RF							661.3		40

APPENDIX II

Weekly Weather data for the year 2015 recorded at Meteorological Observatory Department of Agronomy Dr. PDKV., Akola																				
Weeks	Dates	Actual				2015								Normal				1971-2010		
		T MAX (°C)		T MIN (°C)		BSH (hrs)		WS (km/hr)		RH I (%)		RH II (%)		Evap (mm)		RF (mm)		CRF (mm)	Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A		N	A
1	1-7 Jan	28.8	23.7	11.0	13.4	8.2	4.2	4.4	1.1	71	88	31	49	4.2	3.3	2.8	51.4	51.4	0.2	2.0
2	8-14	29.3	26.9	11.7	7.0	8.3	9.1	4.4	0.7	71	81	30	14	4.4	4.0	3.3	0.0	51.4	0.2	0.0
3	15-21	30.0	27.8	12.0	10.1	8.6	8.3	4.5	1.5	68	77	28	28	4.9	5.2	0.7	0.0	51.4	0.1	0.0
4	22-28	30.6	29.3	12.0	15.3	8.8	6.1	4.6	2.4	65	86	26	35	5.2	6.2	0.9	0.0	51.4	0.1	0.0
5	29-4 Feb	31.0	29.5	12.6	11.9	8.8	8.3	4.9	1.9	62	71	25	23	5.5	6.2	3.0	0.0	51.4	0.2	0.0
6	5-11	31.4	31.1	12.7	14.7	8.8	7.6	5.0	2.9	59	73	23	27	5.9	6.5	3.7	4.0	55.4	0.3	1.0
7	12-18	32.7	32.4	14.4	12.9	9.0	9.0	5.4	1.9	55	64	22	19	6.6	5.1	0.1	0.0	55.4	0.0	0.0
8	19-25	33.4	35.2	14.5	14.2	9.1	9.0	5.7	1.8	54	60	21	16	7.3	5.4	2.5	0.0	55.4	0.2	0.0
9	26-4 Mar	35.0	30.4	15.7	15.0	9.5	6.7	6.1	3.7	50	65	18	31	8.2	5.7	4.1	27.7	83.1	0.3	2.0
10	5-11	35.9	33.3	17.3	15.6	9.2	9.0	6.1	2.4	46	70	20	23	8.8	5.2	5.2	0.0	83.1	0.3	0.0
11	12-18	37.0	31.4	18.1	18.1	9.1	7.4	6.3	3.5	45	81	18	33	9.2	5.3	2.4	15.1	98.2	0.3	2.0
12	19-25	38.4	36.9	19.3	18.7	9.2	8.9	6.4	2.4	39	53	15	12	10.4	5.7	0.6	0.0	98.2	0.1	0.0
13	26-1 Apr	39.0	38.8	20.4	20.3	9.2	7.9	6.9	2.4	37	50	15	15	11.2	5.6	2.2	0.0	98.2	0.2	0.0
14	2-8 Apr	40.0	38.5	21.7	22.7	9.4	8.6	7.3	6.8	37	46	14	18	11.7	9.5	1.0	0.0	98.2	0.1	0.0
15	9-15	40.8	35.2	23.1	20.0	9.5	7.0	8.4	3.8	35	77	14	32	12.9	6.2	0.4	52.3	150.5	0.1	2.0
16	16-22	41.6	38.1	24.1	23.4	9.7	8.7	8.6	3.2	36	53	14	17	13.9	6.8	0.5	0.0	150.5	0.1	0.0
17	23-29	42.3	41.5	25.4	26.0	9.8	9.2	9.0	6.3	37	40	15	11	14.7	10.1	0.5	0.0	150.5	0.1	0.0
18	30- 6 May	42.6	42.4	26.6	26.6	9.4	9.0	10.5	7.0	39	38	15	10	15.5	9.5	0.8	0.0	150.5	0.1	0.0
19	7-13	42.6	42.9	27.1	26.2	9.7	8.4	12.2	4.2	42	34	17	14	16.2	7.3	1.3	1.0	151.5	0.1	0.0
20	14-20	42.5	41.7	27.7	27.5	9.4	6.9	14.2	5.5	47	48	19	18	16.8	8.4	2.8	0.4	151.9	0.4	0.0
21	21-27	42.1	43.5	27.8	29.0	9.5	9.8	15.1	14.9	50	55	20	18	16.9	16.6	3.8	0.0	151.9	0.4	0.0
22	28-3 Jun	41.7	43.7	27.8	29.3	9.4	8.4	15.2	10.3	53	43	23	19	16.2	14.1	6.3	0.0	151.9	0.4	0.0
23	4-10	40.2	40.9	26.9	28.3	8.4	6.5	15.2	8.1	62	53	30	26	14.0	11.5	16.8	0.0	151.9	1.0	0.0
24	11-17	38.0	36.5	25.7	23.3	7.1	6.5	13.4	9.4	69	85	40	44	11.1	8.2	43.6	53.8	205.7	1.7	2.0
25	18-24	35.5	32.8	25.0	23.6	5.8	3.0	14.2	4.7	74	86	48	53	9.2	4.4	43.5	34.3	240.0	2.0	5.0
26	25-1Jul	33.8	36.2	24.3	25.1	4.8	7.0	12.8	12.8	80	73	55	37	7.4	10.8	43.4	0.0	240.0	2.2	0.0
27	2-8	33.2	36.4	24.0	25.3	4.8	7.0	12.0	15.3	81	66	58	35	6.5	14.5	39.4	0.0	240.0	2.2	0.0
28	9-15	32.3	35.8	23.8	26.2	3.8	5.0	11.2	15.7	83	65	60	40	5.5	15.9	42.8	0.0	240.0	2.5	0.0

29	16-22	31.9	32.6	23.6	24.7	4.0	3.4	10.4	13.0	84	75	63	58	5.2	7.8	52.8	26.2	266.2	2.4	2.0
30	23-29	31.3	31.3	23.3	22.4	4.0	2.1	10.8	6.5	86	84	64	61	4.8	4.8	43.4	45.9	312.1	2.6	5.0
31	30-5 Aug	30.9	31.6	23.3	22.5	3.5	4.9	10.6	13.3	86	85	67	62	4.6	6.6	49.6	226.5	538.6	2.4	2.0
32	6-12	29.9	28.9	23.0	22.6	3.2	0.4	10.9	8.7	88	90	70	71	4.1	3.5	61.0	40.7	579.3	2.8	4.0
33	13-19	30.4	30.3	23.0	23.1	4.0	4.1	12.4	7.9	87	86	67	66	4.5	3.8	35.9	36.5	615.8	2.0	2.0
34	20-26	30.4	33.6	22.8	23.0	4.1	7.3	11.9	8.0	87	80	67	48	4.3	5.2	42.5	0.0	615.8	1.9	0.0
35	27-2 Sep	30.5	31.4	22.7	23.1	4.2	2.9	9.3	7.6	87	83	66	62	4.6	5.0	42.4	16.4	632.2	2.1	1.0
36	3-9	31.0	32.9	22.5	22.5	5.3	7.4	8.6	2.6	87	87	62	57	5.3	3.3	33.6	22.4	654.6	1.5	2.0
37	10-16	32.1	34.3	22.4	22.7	6.6	6.6	8.0	4.1	85	88	57	54	5.1	5.1	22.0	61.6	716.2	1.1	2.0
38	17-23	32.9	31.3	22.4	22.2	6.8	6.1	6.4	4.9	84	87	55	63	5.2	3.7	23.7	78.9	795.1	1.4	1.0
39	24-30	33.5	33.1	22.1	21.3	7.3	8.5	5.1	2.4	84	86	50	46	5.0	3.7	24.4	1.4	796.5	1.4	0.0
40	1-7 Oct	33.7	35.6	21.2	20.8	7.6	8.1	4.8	1.3	82	84	47	39	5.4	4.9	23.4	0.0	796.5	1.1	0.0
41	8-14	34.0	37.0	19.8	19.3	8.1	7.6	4.5	0.7	78	71	40	24	5.3	4.6	13.1	0.0	796.5	0.7	0.0
42	15-21	33.7	36.5	18.3	19.1	8.2	8.3	4.6	1.4	76	71	37	37	5.3	5.7	6.1	0.5	797.0	0.4	0.0
43	22-28	33.1	35.6	16.8	19.5	8.3	7.4	4.4	1.0	74	72	34	34	5.3	4.9	7.6	0.0	797.0	0.4	0.0
44	29-4 Nov	32.7	32.9	16.0	18.1	8.4	7.5	4.1	1.5	73	77	32	36	5.3	6.0	2.3	0.0	797.0	0.2	0.0
45	5-11	32.3	33.8	15.2	17.0	8.4	7.1	3.9	0.9	71	72	32	28	5.1	4.3	3.0	0.0	797.0	0.2	0.0
46	12-18	31.6	33.5	14.6	15.2	8.3	7.8	3.9	1.6	73	73	32	26	4.8	5.0	5.3	0.0	797.0	0.2	0.0
47	19-25	31.0	32.4	13.3	16.6	8.4	6.0	3.7	2.5	72	67	30	34	4.6	5.7	7.7	0.0	797.0	0.3	0.0
48	26-2 Dec	30.5	33.3	12.8	15.8	8.4	6.7	3.6	1.2	71	73	32	34	4.4	4.3	5.5	0.0	797.0	0.3	0.0
49	3-9	30.0	32.5	11.9	12.1	8.4	8.4	3.8	0.5	71	72	30	26	4.3	4.4	1.0	0.0	797.0	0.1	0.0
50	10-16	29.6	31.9	10.9	14.3	8.4	7.7	3.6	0.5	71	63	28	32	4.2	5.0	0.8	0.0	797.0	0.1	0.0
51	17-23	29.5	30.7	10.8	12.9	8.5	8.0	3.8	1.1	70	67	29	29	4.1	4.9	0.9	0.0	797.0	0.1	0.0
52	24-31	29.1	29.7	11.1	7.9	8.3	8.7	4.5	0.8	71	63	30	18	4.2	4.3	2.6	0.0	797.0	0.2	0.0
											TOTAL RFJanuary to Dec						797.0			37
											Total RFJune to Dec						645.1			28

Appendix – III

Cumulative effect of different modules on okra aphids at (periodic) weekly interval during summer 2014-15

Modules	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av.
M1	2.90 (1.70)	5.15 (2.26)	4.62 (2.14)	8.00 (2.81)	6.48 (2.52)	11.49 (3.33)	3.63 (1.87)	2.60 (1.54)	2.52 (1.71)	2.27 (1.50)	4.97 (2.14)
M2	6.10 (2.47)	7.77 (2.77)	4.00 (1.97))	6.72 (2.58)	7.12 (2.67)	14.03 (3.73)	5.60 (2.36)	5.90 (1.41)	3.29 (1.91)	2.43 (1.55)	6.30 (2.44)
M3	2.78 (1.66)	4.60 (2.12)	5.27 (2.29)	9.18 (3.03)	6.33 (2.50)	10.88 (3.28)	1.90 (1.36)	2.05 (1.41)	2.91 (1.83)	2.43 (1.55)	4.83 (2.10)
M4	2.65 (1.60)	4.12 (2.02)	4.78 (2.18)	8.12 (2.85)	6.46 (2.53)	13.27 (3.62)	5.04 (2.24)	3.06 (1.73)	1.96 (1.56)	2.28 (1.51)	5.17 (2.18)
M5	4.95 (2.18)	6.56 (2.54)	1.28 (1.11)	6.20 (2.47)	5.66 (2.37)	7.97 (2.81)	1.00 (0.99)	1.70 (1.29)	1.15 (1.28)	1.84 (1.34)	3.83 (1.84)
M6	3.10 (1.75)	6.56 (2.55)	4.33 (2.08)	7.10 (2.66)	5.92 (2.42)	9.24 (3.01)	2.16 (1.46)	2.27 (1.48)	1.10 (1.26)	1.37 (1.16)	4.32 (1.98)
M7	3.40 (1.83)	7.27 (2.69)	1.05 (1.01)	5.67 (2.38)	4.09 (1.98)	6.66 (2.57)	1.90 (1.36)	2.05 (1.41)	1.67 (1.47)	1.70 (1.29)	3.55 (1.80)
M8	7.67 (2.75)	8.01 (2.83)	10.82 (3.28)	11.30 (3.35)	13.70 (3.68)	17.27 (4.15)	6.47 (2.53)	5.76 (2.40)	5.50 (2.45)	3.80 (1.94)	9.03 (2.94)
SE (m)±	0.17	0.18	0.15	0.17	0.21	0.28	0.16	0.18	0.15	0.12	
CD at 5%	0.53	0.55	0.48	0.51	0.64	0.87	0.51	0.57	0.47	0.36	
CV%	15.25	12.78	13.65	10.64	14.16	15.04	16.47	19.15	16.17	14.20	

Appendix – IV

Cumulative effect of different modules on okra aphids at weekly (periodic) interval during kharif 2015-16

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	6.33 (2.50)	9.36 (3.06)	7.56 (2.74)	8.02 (2.81)	7.0 (2.63)	9.0 (3.00)	7.43 (2.71)	7.83 (2.80)	3.66 (1.91)	3.90 (1.97)	7.02 (2.61)
M2	8.57 (2.91)	11.18 (3.34)	6.12 (2.47)	7.51 (2.73)	8.3 (2.85)	11.3 (3.36)	5.85 (2.42)	5.48 (2.33)	2.63 (1.61)	2.70 (1.64)	6.96 (2.57)
M3	6.28 (2.49)	9.36 (3.04)	8.11 (2.84)	9.22 (3.01)	6.2 (2.42)	8.2 (2.84)	4.44 (2.07)	4.49 (2.07)	1.98 (1.41)	2.06 (1.42)	6.03 (2.36)
M4	6.06 (2.46)	8.32 (2.87)	7.13 (2.67)	8.43 (2.88)	7.5 (2.73)	10.0 (3.15)	7.97 (2.81)	8.93 (2.99)	2.43 (1.54)	2.78 (1.66)	6.96 (2.58)
M5	7.31 (2.70)	11.02 (3.31)	4.29 (2.07)	5.99 (2.37)	5.3 (2.26)	8.0 (2.82)	5.03 (2.24)	5.30 (2.26)	1.82 (1.34)	2.00 (1.41)	5.60 (2.28)
M6	7.08 (2.63)	10.21 (3.19)	7.00 (2.60)	7.29 (2.70)	5.7 (2.38)	8.3 (2.85)	5.97 (2.44)	6.80 (2.61)	1.67 (1.29)	1.81 (1.34)	6.18 (2.40)
M7	7.38 (2.71)	10.36 (3.21)	2.97 (1.67)	5.35 (2.26)	4.0 (2.00)	6.4 (2.50)	2.89 (1.70)	3.21 (1.78)	2.27 (1.48)	2.53 (1.59)	4.74 (2.09)
M8	11.98 (3.46)	14.87 (3.85)	16.95 (4.08)	18.87 (4.31)	23.1 (4.76)	24.4 (4.89)	9.07 (3.00)	10.36 (3.21)	5.05 (2.24)	5.90 (2.42)	14.05 (3.62)
SE (m) _±	0.17	0.16	0.24	0.28	0.27	0.27	0.15	0.19	0.11	0.09	
CD at 5%	0.52	0.51	0.72	0.86	0.84	0.83	0.46	0.59	0.35	0.28	
CV%	10.94	9.01	15.76	17.13	17.48	15.00	10.87	13.56	12.69	9.75	

Appendix – V

**Cumulative effect of different modules on okra aphids at weekly (periodic) interval during summer and kharif 2015-16
(Pooled mean)**

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	4.62 (2.10)	7.26 (2.66)	6.09 (2.44)	8.01 (2.81)	6.75 (2.58)	10.26 (3.17)	5.53 (2.29)	5.22 (2.17)	3.09 (1.81)	3.09 (1.73)	5.99 (2.38)
M2	7.34 (2.69)	9.48 (3.06)	5.06 (2.22)	7.12 (2.65)	7.69 (2.76)	12.67 (3.55)	5.73 (2.39)	5.69 (2.38)	2.96 (1.76)	2.57 (1.59)	6.63 (2.50)
M3	4.53 (2.07)	6.98 (2.58)	6.69 (2.57)	9.20 (3.02)	6.25 (2.46)	9.54 (3.06)	3.17 (1.71)	3.27 (1.74)	2.45 (1.62)	2.25 (1.49)	5.43 (2.23)
M4	4.35 (2.03)	6.22 (2.44)	5.96 (2.42)	8.28 (2.86)	6.97 (2.63)	11.66 (3.39)	6.50 (2.53)	6.00 (2.36)	2.20 (1.55)	2.53 (1.58)	6.07 (2.38)
M5	6.13 (2.44)	8.79 (2.92)	2.79 (1.59)	6.10 (2.42)	5.46 (2.32)	7.98 (2.82)	3.01 (1.61)	3.50 (1.77)	1.49 (1.31)	1.92 (1.38)	4.72 (2.06)
M6	5.09 (2.19)	8.39 (2.87)	5.67 (2.34)	7.20 (2.68)	5.79 (2.40)	8.77 (2.93)	4.06 (1.95)	4.53 (2.04)	1.38 (1.27)	1.59 (1.25)	5.25 (2.19)
M7	5.39 (2.27)	8.82 (2.95)	2.01 (1.34)	5.51 (2.32)	4.05 (1.99)	6.54 (2.53)	2.40 (1.53)	2.63 (1.60)	1.97 (1.48)	2.12 (1.44)	4.14 (1.95)
M8	9.82 (3.10)	11.44 (3.34)	13.89 (3.68)	15.09 (3.83)	18.42 (4.22)	20.81 (4.52)	7.77 (2.77)	8.06 (2.80)	5.28 (2.35)	4.85 (2.18)	11.54 (3.28)
SE (m)±	0.21	0.19	0.23	0.23	0.27	0.25	0.19	0.21	0.09	0.10	
CD at 5%	0.29	0.32	0.34	0.54	0.42	0.64	0.25	0.36	0.36	0.24	
CV%	10.11	9.28	11.85	14.44	12.82	16.13	9.96	13.85	18.09	12.52	

Appendix – VI

Cumulative effect of different modules on okra leaf hopper at weekly (periodic) interval in okra during summer 2014-15

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.73 (0.84)	1.44 (1.19)	3.40 (1.93)	4.64 (2.15)	3.42 (1.82)	9.38 (3.00)	14.14 (3.75)	17.98 (4.22)	17.84 (4.18)	21.80 (4.66)	9.48 (2.77)
M2	0.78 (0.88)	1.82 (1.34)	3.55 (2.01)	4.25 (2.00)	3.84 (1.91)	6.49 (2.51)	8.44 (2.89)	18.11 (4.25)	13.53 (3.66)	15.07 (3.83)	7.59 (2.53)
M3	0.33 (0.57)	1.29 (1.13)	1.58 (1.44)	3.89 (1.95)	5.60 (2.36)	16.33 (3.99)	8.44 (2.89)	20.31 (4.50)	11.87 (3.43)	14.58 (3.79)	8.42 (2.60)
M4	0.51 (0.71)	1.40 (1.18)	4.69 (2.27)	6.62 (2.57)	4.69 (2.15)	16.58 (4.05)	9.04 (2.89)	16.27 (3.96)	11.51 (3.38)	13.65 (3.69)	8.50 (2.68)
M5	0.80 (0.88)	2.23 (1.49)	1.01 (1.23)	2.86 (1.69)	3.33 (1.81)	6.33 (2.49)	13.02 (3.60)	14.43 (3.79)	10.98 (3.31)	13.60 (3.67)	6.86 (2.40)
M6	0.78 (0.87)	1.64 (1.28)	3.84 (2.07)	4.95 (2.22)	2.06 (1.41)	7.71 (2.75)	5.35 (2.30)	9.86 (3.13)	10.76 (3.23)	12.82 (3.55)	5.98 (2.28)
M7	0.66 (0.81)	1.66 (1.29)	0.81 (1.14)	2.31 (1.49)	3.73 (1.91)	11.04 (3.32)	7.53 (2.61)	15.42 (3.89)	8.09 (2.84)	11.54 (3.39)	6.28 (2.27)
M8	1.24 (1.11)	2.24 (1.48)	5.82 (2.50)	6.73 (2.55)	12.47 (3.50)	19.45 (4.32)	19.04 (4.35)	27.42 (5.21)	18.09 (4.25)	24.78 (4.96)	13.73 (3.42)
SE (m)±	0.08	0.07	0.13	0.19	0.22	0.34	0.33	0.30	0.27	0.27	
CD at 5%	0.24	0.23	0.22	0.59	0.69	1.03	1.00	0.91	0.84	0.82	
CV%	16.74	10.27	13.22	16.45	18.70	17.84	18.15	12.71	13.67	12.01	

Appendix – VII

Cumulative effect of different modules on okra leaf hopper at weekly (periodic) interval in okra during kharif 2015-16

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.11 (0.78)	2.19 (1.43)	2.04 (1.43)	2.12 (1.46)	4.76 (2.18)	7.42 (2.71)	21.23 (4.60)	19.52 (4.41)	19.42 (4.39)	24.86 (4.98)	10.37 (2.84)
M2	0.28 (0.87)	1.57 (1.25)	1.46 (1.21)	1.68 (1.30)	4.38 (2.09)	7.21 (2.67)	13.55 (3.68)	15.67 (3.96)	16.38 (4.04)	23.16 (4.81)	8.54 (2.59)
M3	0.04 (0.74)	1.46 (1.21)	1.55 (1.17)	2.04 (1.42)	3.62 (1.86)	6.50 (2.54)	16.25 (4.01)	17.56 (4.17)	15.35 (3.90)	21.40 (4.61)	8.58 (2.56)
M4	0.02 (0.72)	1.53 (1.23)	2.66 91.63)	4.25 (2.01)	3.33 (1.82)	6.28 (2.49)	13.04 (3.61)	15.14 (3.88)	10.14 (3.17)	19.87 (4.46)	7.63 (2.50)
M5	0.46 (0.97)	2.42 (1.56)	0.53 (0.73)	1.16 (1.08)	2.00 (1.37)	5.38 (2.29)	13.23 (3.63)	16.50 (4.06)	9.56 (3.09)	13.52 (3.65)	6.48 (2.24)
M6	0.19 (0.82)	1.68 (1.30)	2.11 (1.45)	2.38 (1.53)	1.23 (1.11)	5.29 (2.27)	10.05 (3.17)	13.28 (3.64)	8.67 (2.94)	15.61 (3.94)	6.05 (2.22)
M7	0.30 (0.89)	1.28 (1.11)	0.48 (0.69)	1.40 (1.180)	3.32 (1.78)	7.90 (2.810)	11.94 (3.45)	14.80 (3.84)	8.49 (2.91)	14.17 (3.75)	6.41 (2.24)
M8	1.56 (1.43)	2.52 (1.56)	3.44 (1.84)	5.30 (2.25)	9.10 (2.99)	13.54 (3.65)	27.29 (5.20)	31.40 (5.57)	36.01 (5.98)	39.59 (6.28)	16.98 (3.68)
SE (m)±	0.06	0.09	0.10	0.16	0.17	0.22	0.22	0.21	0.21	0.22	
CD at 5%	0.19	0.28	0.32	0.48	0.54	0.69	0.66	0.64	0.65	0.68	
CV%	12.08	11.94	14.83	18.11	16.23	14.78	9.74	8.76	9.83	8.63	

Appendix – VIII

Cumulative effect of different modules on okra leaf hopper at weekly (periodic) interval in okra during summer and kharif 2015-16 (Pooled mean)

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.42 (0.81)	1.81 (1.34)	2.72 (1.68)	3.38 (1.80)	4.09 (2.00)	8.40 (2.86)	17.68 (4.17)	18.75 (4.31)	18.63 (4.28)	23.33 (4.82)	9.92 (2.81)
M2	0.53 (0.87)	1.70 (1.30)	2.51 (1.61)	2.97 (1.65)	4.11 (2.00)	6.85 (2.59)	11.00 (3.29)	16.89 (4.11)	14.96 (3.85)	19.12 (4.32)	8.06 (2.56)
M3	0.19 (0.65)	1.37 (1.17)	1.56 (1.31)	2.96 (1.69)	4.61 (2.11)	11.42 (3.27)	12.35 (3.45)	18.94 (4.34)	13.61 (6.67)	17.99 (4.20)	8.50 (2.58)
M4	0.27 (0.71)	1.46 (1.21)	3.68 (1.95)	5.44 (2.29)	4.01 (1.99)	11.43 (3.27)	11.04 (3.25)	15.70 (3.920)	10.83 (3.27)	16.76 (4.07)	8.06 (2.59)
M5	0.63 (0.93)	2.33 (1.52)	0.77 (0.98)	2.01 (1.38)	2.67 (1.59)	5.86 (2.39)	13.13 (3.61)	15.47 (3.92)	10.27 (3.20)	13.56 (3.66)	6.67 (2.32)
M6	0.48 (0.85)	1.66 (1.29)	2.98 (1.76)	3.67 (1.88)	1.65 (1.26)	6.50 (2.51)	7.70 (2.74)	11.57 (3.39)	9.72 (3.09)	14.22 (3.75)	6.01 (2.25)
M7	0.48 (0.85)	1.47 (1.20)	0.64 (0.91)	1.86 (1.34)	3.53 (1.84)	9.47 (3.06)	9.74 (3.03)	15.11 (3.86)	8.29 (2.87)	12.86 (3.57)	6.34 (2.25)
M8	1.40 (1.27)	2.38 (1.52)	4.63 (2.17)	6.02 (2.40)	10.78 (3.25)	16.49 (3.99)	23.17 (4.77)	29.41 (5.39)	27.05 (5.11)	32.19 (5.62)	15.35 (3.55)
SE (m)±	0.08	0.08	0.13	0.17	0.17	0.24	0.27	0.23	0.15	0.25	
CD at 5%	0.11	0.18	0.23	0.42	0.48	0.74	0.64	0.61	0.67	0.54	
CV%	10.72	11.37	12.41	19.19	19.37	20.18	14.64	12.02	14.91	10.25	

Appendix – IX

Cumulative effect of different modules on okra whitefly at weekly (periodic) interval in okra during summer 2014-15

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.24 (0.49)	2.97 (1.72)	3.20 (1.79)	3.12 (1.76)	4.22 (2.04)	1.76 (1.32)	3.53 (1.87)	1.93 (1.33)
M2	0.29 (0.89)	0.60 (1.05)	0.29 (0.89)	0.18 (0.40)	3.19 (1.78)	4.63 (2.15)	3.68 (1.91)	5.53 (2.34)	3.11 (1.75)	5.92 (2.39)	2.74 (1.55)
M3	0.15 (0.80)	0.18 (0.82)	0.15 (0.80)	1.86 (1.36)	2.34 (1.52)	3.53 (1.86)	0.82 (0.90)	1.24 (1.11)	2.04 (1.42)	4.29 (2.07)	1.66 (1.27)
M4	1.16 (1.27)	0.20 (0.83)	1.16 (1.27)	1.75 (1.31)	1.14 (1.07)	1.57 (1.23)	1.23 (1.08)	2.00 (1.41)	0.75 (0.86)	2.49 (1.58)	1.34 (1.19)
M5	0.09 (0.77)	0.74 (1.11)	0.09 (0.77)	0.07 (0.26)	1.79 (1.30)	1.86 (1.33)	2.76 (1.66)	2.82 (1.68)	0.70 (0.83)	1.52 (1.23)	1.24 (1.09)
M6	1.32 (1.35)	0.26 (0.87)	1.32 (1.35)	1.83 (1.33)	1.72 (1.28)	2.03 (1.42)	1.04 (1.00)	1.70 (1.29)	0.56 (0.72)	1.27 (1.12)	1.30 (1.17)
M7	0.84 (1.14)	0.24 (0.86)	0.84 (1.14)	0.51 (0.71)	2.78 (1.66)	2.56 (1.57)	4.52 (2.12)	5.60 (2.36)	3.53 (1.86)	6.91 (2.62)	2.83 (1.60)
M8	2.34 (0.71)	0.93 (0.85)	2.34 (0.71)	2.68 (1.63)	5.61 (2.34)	5.51 (2.32)	7.63 (2.73)	9.43 (3.05)	11.45 (3.38)	12.59 (3.54)	6.05 (2.35)
SE (m)±	0.09	0.05	0.09	0.08	0.16	0.16	0.16	0.13	0.11	0.15	
CD at 5%	0.29	0.17	0.29	0.26	0.49	0.51	0.50	0.41	0.35	0.47	
CV%	15.42	10.45	15.42	16.05	17.84	17.11	17.44	12.36	13.26	13.06	

Appendix – X

Cumulative effect of different modules on okra whitefly at weekly (periodic) interval in okra during kharif 2015-16

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.00	0.00	0.06 (0.24)	0.80 (0.89)	4.00 (2.00)	8.07 (2.83)	8.94 (2.99)	7.96 (2.81)	8.82 (2.96)	9.26 (3.04)	23.95 (8.88)
M2	0.00	0.00	0.06 (0.25)	1.06 (1.03)	6.23 (2.48)	9.20 (3.03)	10.07 (3.16)	7.31 (2.70)	9.46 (3.07)	9.64 (3.09)	26.52 (9.41)
M3	0.00	0.00	0.13 (0.35)	1.13 (1.06)	3.13 (1.77)	7.31 (2.70)	4.12 (2.03)	4.09 (2.02)	8.96 (2.98)	9.27 (3.04)	19.10 (7.98)
M4	0.00	0.00	0.22 (0.46)	1.14 (1.07)	1.06 (1.03)	2.93 (1.71)	5.03 (2.24)	5.27 (2.30)	8.50 (2.90)	9.06 (3.01)	16.61 (7.36)
M5	0.00	0.00	0.06 (0.25)	0.75 (0.87)	1.18 (1.08)	3.33 (1.82)	8.34 (2.88)	7.87 (2.80)	7.36 (2.70)	7.27 (2.69)	18.08 (7.54)
M6	0.00	0.00	0.15 (0.38)	1.44 (1.20)	1.36 (1.16)	4.21 (2.05)	4.03 (2.01)	6.37 (2.52)	6.98 (2.64)	5.01 (2.24)	14.77 (7.10)
M7	0.00	0.00	0.09 (0.30)	1.11 (1.05)	2.06 (1.43)	5.70 (2.39)	9.39 (3.06)	10.95 (3.29)	9.51 (3.08)	10.23 (3.20)	24.52 (8.90)
M8	0.00	0.00	0.35 (0.59)	1.99 (1.39)	7.30 (2.70)	10.45 (3.20)	12.99 (3.57)	13.67 (3.65)	12.24 (3.50)	10.90 (3.26)	34.95 (10.93)
SE (m) $\pm$			0.02	0.07	0.10	0.14	0.17	0.11	0.15	0.14	
CD at 5%			0.07	0.22	0.30	0.42	0.53	0.57	0.46	0.44	
CV%			12.62	11.85	10.23	9.93	11.17	11.88	8.85	8.67	

Appendix – XI

Cumulative effect of different modules on okra whitefly at weekly (periodic) interval in okra during summer and kharif 2015-16 (Pooled mean)

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.00	0.11 (0.47)	0.03 (0.47)	0.52 (0.69)	3.49 (1.86)	5.63 (2.31)	6.03 (2.37)	6.09 (2.43)	5.29 (2.14)	6.39 (2.45)	3.36 (3.72)
M2	0.00	0.30 (0.47)	0.18 (0.57)	0.62 (0.71)	4.71 (2.13)	6.92 (2.59)	6.87 (2.54)	6.42 (2.52)	6.28 (2.41)	7.78 (2.74)	4.02 (1.66)
M3	0.00	0.09 (0.53)	0.14 (0.58)	1.50 (1.21)	2.74 (1.64)	5.42 (2.28)	2.47 (1.46)	2.66 (1.56)	5.50 (2.20)	6.78 (2.56)	2.74 (1.40)
M4	0.00	0.10 (0.59)	0.69 (0.87)	1.45 (1.19)	1.10 (1.05)	2.25 (1.47)	3.13 (1.66)	3.64 (1.85)	4.63 (1.88)	5.78 (2.29)	2.33 (1.28)
M5	0.00	0.37 (0.48)	0.08 (0.51)	0.41 (0.57)	1.49 (1.19)	2.60 (1.58)	5.55 (2.27)	5.34 (2.24)	4.03 (1.77)	4.40 (1.96)	2.43 (1.26)
M6	0.00	0.13 (0.55)	0.73 (0.86)	1.64 (1.27)	1.54 (1.22)	3.12 (1.73)	2.53 (1.50)	4.03 (1.91)	3.77 (1.68)	3.14 (1.68)	2.13 (1.24)
M7	0.00	0.12 (0.50)	0.47 (0.72)	0.81 (0.88)	2.42 (1.55)	4.13 (1.98)	6.96 (2.59)	8.28 (2.83)	6.52 (2.47)	8.57 (2.91)	3.87 (1.64)
M8	0.00	0.47 (0.65)	1.35 (1.13)	2.33 (1.51)	6.45 (2.52)	7.98 (2.76)	10.31 (3.15)	11.55 (3.35)	11.85 (3.44)	11.75 (3.40)	6.52 (2.19)
SE (m)±	0.00	0.02	0.03	0.09	0.15	0.13	0.17	0.14	0.12	0.13	
CD at 5%	0.00	0.03	0.16	0.14	0.26	0.37	0.34	0.39	0.3	0.37	
CV%	0.00	5.69	18.34	11.96	13.18	14.36	12.64	13.79	10.99	12.02	

Appendix – XII

Cumulative effect of different modules on okra thrips at weekly (periodic) interval in okra during summer 2014-15

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.33 (0.58)	0.93 (0.96)	0.78 (0.88)	1.76 (1.31)	2.00 (1.41)	2.83 (1.67)	1.68 (1.47)	1.52 (1.42)	0.47 (0.67)	0.81 (0.90)	1.31 (1.13)
M2	1.54 (1.22)	2.17 (1.47)	0.67 (0.82)	1.81 (1.34)	0.93 (0.96)	2.30 (1.51)	0.33 (0.90)	1.81 (1.49)	0.86 (0.93)	1.51 (1.22)	1.39 (1.19)
M3	0.20 (0.44)	0.72 (0.85)	0.97 (0.99)	3.70 (1.92)	0.67 (0.82)	1.69 (1.30)	0.45 (0.97)	2.23 (1.64)	2.29 (1.51)	2.18 (1.46)	1.51 (1.19)
M4	0.27 (0.50)	1.67 (1.28)	1.08 (1.04)	2.18 (1.48)	2.33 (1.52)	3.42 (1.85)	0.07 (0.75)	0.48 (0.99)	0.60 (0.77)	0.86 (0.93)	1.30 (1.11)
M5	2.53 (1.59)	2.49 (1.58)	0.07 (0.27)	0.39 (0.62)	0.33 (0.57)	0.85 (0.91)	1.66 (1.42)	1.83 (1.53)	0.45 (0.66)	0.71 (0.84)	1.13 (1.00)
M6	1.40 (1.18)	1.00 (1.00)	0.93 (0.95)	3.87 (1.95)	0.69 (0.83)	0.86 (0.93)	0.00 (0.71)	0.41 (0.94)	0.31 (0.55)	0.37 (0.50)	0.98 (0.95)
M7	0.46 (0.67)	1.56 (1.25)	0.40 (0.63)	0.98 (0.99)	0.64 (0.78)	1.38 (1.16)	0.58 (1.04)	1.27 (1.32)	2.00 (1.40)	2.42 (1.55)	1.17 (1.08)
M8	4.08 (2.02)	6.26 (2.49)	3.51 (1.87)	4.12 (1.95)	4.33 (2.05)	5.69 (2.35)	2.53 (1.71)	2.81 (1.82)	2.53 (1.55)	3.04 (1.73)	3.89 (1.95)
SE (m)±	0.08	0.07	0.06	0.16	0.12	0.13	0.12	0.11	0.11	0.12	
CD at 5%	0.24	0.21	0.18	0.51	0.36	0.40	0.36	0.34	0.35	0.38	
CV%	13.66	9.22	11.13	20.17	18.74	15.73	18.44	14.17	20.22	19.19	

Appendix – XIII

Cumulative effect of different modules on okra thrips at weekly (periodic) interval in okra during kharif 2015-16

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	1.64 (1.46)	2.95 (1.86)	2.54 (1.74)	4.02 (1.98)	4.10 (2.01)	6.13 (2.48)	6.07 (2.46)	8.50 (2.91)	3.47 (1.86)	5.17 (2.27)	4.46 (2.10)
M2	2.26 (1.65)	2.73 (1.79)	1.78 (1.50)	3.13 (1.77)	5.17 (2.26)	7.63 (2.76)	5.01 (2.22)	6.97 (2.61)	4.43 (2.10)	7.04 (2.65)	4.62 (2.13)
M3	0.00 (0.71)	0.42 (0.95)	3.05 (1.88)	5.46 (2.33)	1.81 (1.31)	2.45 (1.56)	11.12 (3.33)	10.01 (3.14)	5.83 (2.38)	7.80 (2.75)	4.80 (2.03)
M4	0.00 (0.71)	0.00 (0.71)	2.54 (1.74)	6.05 (2.46)	6.40 (2.50)	9.00 (2.97)	3.83 (1.93)	5.23 (2.22)	5.63 (2.36)	7.70 (2.77)	4.64 (2.04)
M5	2.38 (1.69)	2.75 (1.77)	1.13 (1.27)	2.71 (1.63)	0.83 (0.91)	2.11 (1.45)	7.43 (2.62)	10.43 (3.21)	1.51 (1.22)	4.08 (2.02)	3.54 (1.78)
M6	0.67 (1.07)	0.72 (1.11)	3.23 (1.92)	4.47 (2.04)	2.41 (1.55)	4.16 (2.04)	3.07 (1.70)	3.53 (1.82)	3.40 (1.84)	3.25 (1.79)	2.89 (1.69)
M7	1.17 (1.29)	3.34 (1.96)	1.46 (1.38)	3.69 (1.92)	2.34 (1.53)	2.51 (1.58)	6.94 (2.62)	8.57 (2.90)	6.93 (2.61)	8.10 (2.79)	4.51 (2.06)
M8	3.17 (1.88)	4.13 (2.15)	6.23 (2.57)	7.50 (2.73)	7.83 (2.79)	9.61 (3.07)	11.43 (3.38)	15.77 (3.96)	7.48 (2.71)	10.57 (3.25)	8.37 (2.85)
SE (m)±	0.12	0.11	0.10	0.17	0.14	0.16	0.24	0.25	0.18	0.20	
CD at 5%	0.37	0.34	0.31	0.54	0.44	0.50	0.74	0.78	0.54	0.62	
CV%	16.42	12.9	10.37	14.68	13.52	12.99	16.78	15.78	14.67	13.98	

Appendix – XIV

Cumulative effect of different modules on okra thrips at weekly (periodic) interval in okra during summer and kharif 2015-16 (Pooled mean)

Moduels	22 DAS	29 DAS	37 DAS	44 DAS	52 DAS	59 DAS	67 DAS	74 DAS	82 DAS	89 DAS	Cum.Av
M1	0.99 (1.02)	1.94 (1.41)	1.66 (1.31)	2.89 (1.64)	3.05 (1.71)	4.48 (2.08)	3.87 (1.97)	5.01 (2.17)	1.97 (1.27)	2.99 (1.59)	2.98 (1.05)
M2	1.90 (1.44)	2.45 (1.63)	1.23 (1.16)	2.47 (1.55)	3.05 (1.61)	4.97 (2.14)	2.67 (1.56)	4.39 (2.05)	2.65 (1.51)	4.28 (1.94)	3.01 (1.63)
M3	0.10 (0.57)	0.57 (0.90)	2.01 (1.44)	4.58 (2.12)	1.24 (1.06)	2.07 (1.43)	5.78 (2.15)	6.12 (2.39)	4.06 (1.95)	4.99 (2.10)	3.16 (1.61)
M4	0.14 (0.60)	0.84 (0.99)	1.81 (1.39)	4.12 (1.97)	4.36 (2.01)	6.21 (2.41)	1.95 (1.34)	2.86 (1.61)	3.12 (1.57)	4.28 (1.85)	2.97 (1.62)
M5	2.46 (1.64)	2.62 (1.67)	0.60 (0.77)	1.55 (1.12)	0.58 (0.74)	1.48 (1.18)	4.55 (2.02)	6.13 (2.37)	0.98 (0.94)	2.40 (1.43)	2.34 (1.45)
M6	1.04 (1.12)	0.86 (1.05)	2.08 (1.44)	4.17 (1.99)	1.55 (1.19)	2.51 (1.48)	1.53 (1.21)	1.97 (1.38)	1.85 (1.20)	1.81 (1.14)	1.94 (1.35)
M7	0.82 (0.98)	2.45 (1.60)	0.93 (1.00)	2.34 (1.45)	1.49 (1.15)	1.94 (1.37)	3.76 (1.83)	4.92 (2.11)	4.47 (2.01)	5.26 (2.17)	2.84 (1.51)
M8	3.62 (1.95)	5.20 (2.32)	4.87 (2.22)	5.81 (2.34)	6.08 (2.42)	7.65 (2.71)	6.98 (2.55)	9.29 (2.89)	5.00 (2.13)	6.80 (2.49)	6.13 (1.97)
SE (m)±	0.08	0.06	0.05	0.13	0.11	0.11	0.12	0.15	0.10	0.12	
CD at 5%	0.25	0.18	0.15	0.39	0.32	0.34	0.37	0.45	0.29	0.35	
CV%	17.34	10.50	13.16	17.90	17.8	14.99	16.48	17.48	14.96	15.43	

Appendix – XV

Cumulative effect of different modules on okra mites at (periodic) weekly interval in okra during summer 2014-15

Moduels	44 DAS **	52 DAS **	59 DAS *	67 DAS *	74 DAS *	82 DAS *	89 DAS *	Cum.Av
M1	0.00 (0.71)	5.65 (2.45)	17.40 (4.17)	13.31 (3.64)	21.17 (4.59)	12.09 (3.46)	26.56 (5.15)	12.02 (7.39)
M2	3.32 (1.95)	3.68 (2.01)	11.32 (3.36)	20.81 (4.55)	11.85 (3.44)	15.04 (3.87)	12.79 (3.58)	9.85 (7.54)
M3	5.85 (2.49)	0.00 (0.71)	6.75 (2.56)	2.07 (1.41)	9.32 (3.05)	19.39 (4.40)	22.23 (4.71)	8.20 (7.25)
M4	3.52 (2.00)	2.80 (1.78)	7.27 (2.68)	2.41 (1.55)	9.40 (3.05)	5.72 (2.36)	16.57 (4.07)	5.96 (5.43)
M5	0.00 (0.71)	9.08 (3.08)	21.32 (4.60)	22.65 (4.75)	32.23 (5.65)	3.59 (1.86)	10.73 (3.27)	12.45 (5.36)
M6	3.07 (1.89)	2.70 (1.78)	11.17 (3.31)	3.73 (1.87)	11.90 (3.45)	2.89 (1.68)	6.77 (2.60)	5.28 (4.89)
M7	0.00 (0.71)	3.20 (1.92)	3.60 (1.89)	4.78 (2.15)	9.32 (3.05)	18.03 (4.24)	20.90 (4.57)	7.48 (5.93)
M8	8.57 (3.01)	17.47 (4.20)	29.17 (5.35)	34.00 (5.82)	38.20 (6.13)	47.20 (6.87)	52.03 (7.08)	28.33 (14.13)
SE (m)±	1.00	0.21	0.28	0.23	0.25	0.20	0.35	
CD at 5%	0.30	0.64	0.87	0.71	0.77	0.62	1.07	
CV%	10.27	16.40	14.33	12.62	10.88	9.89	14.03	

Appendix – XVI

Cumulative effect of different modules on okra mites at weekly (periodic) interval in okra during kharif 2015-16

Moduels	44 DAS **	52 DAS *	59 DAS *	67 DAS *	74 DAS *	82 DAS *	89 DAS *	Cum.Av
M1	0.00 (0.71)	2.56 (1.60)	11.25 (3.32)	7.93 (2.79)	14.13 (3.72)	9.97 (3.13)	13.29 (3.62)	3.45 (2.70)
M2	3.32 (1.95)	4.50 (2.12)	13.00 (3.60)	6.95 (2.62)	11.71 (3.37)	8.88 (2.94)	11.99 (3.46)	3.25 (2.87)
M3	5.85 (2.49)	2.19 (1.46)	8.74 (2.93)	5.29 (2.30)	9.33 (3.03)	10.65 (3.26)	15.97 (3.99)	2.76 (2.78)
M4	4.93 (2.32)	1.33 (1.15)	2.16 (1.46)	6.87 (2.60)	9.38 (3.06)	7.51 (2.71)	11.24 (3.32)	2.50 (2.37)
M5	0.00 (0.71)	1.13 (1.06)	1.90 (1.36)	7.27 (2.67)	14.77 (3.82)	7.54 (2.72)	10.24 (3.20)	3.42 (2.22)
M6	3.07 (1.89)	1.86 (1.33)	7.97 (2.77)	4.59 (2.13)	10.62 (3.25)	4.45 (2.10)	6.58 (2.54)	2.37 (2.29)
M7	0.00 (0.71)	1.34 (1.16)	2.37 (1.54)	4.61 (2.12)	12.34 (3.50)	11.54 (3.39)	15.23 (3.89)	2.65 (2.33)
M8	8.57 (3.01)	9.33 (3.03)	14.67 (3.81)	18.70 (4.32)	18.53 (4.30)	20.90 (4.56)	22.30 (4.71)	5.50 (3.96)
SE (m)±	0.10	0.13	0.24	0.18	0.25	0.24	0.23	
CD at 5%	0.31	0.39	0.75	0.55	0.76	0.72	0.71	
CV%	10.54	13.96	16.63	11.74	12.48	13.40	11.32	

N.B: Figures in (*) indicates square root values. While (**) indicatessquare√x+0.5value

Appendix – XVII

Cumulative effect of different modules on okra mites at weekly (periodic) interval in okra during summer and kharif 2015-16 (Pooled mean)

Moduels	44 DAS **	52 DAS *	59 DAS *	67 DAS *	74 DAS *	82 DAS *	89 DAS *	Cum.Av.
M1	0.00 (0.71)	4.11 (2.03)	14.33 (3.74)	10.62 (3.21)	17.65 (4.15)	11.03 (3.30)	19.93 (4.39)	7.74 (5.05)
M2	3.32 (0.95)	4.09 (2.07)	12.16 (3.48)	13.88 (3.59)	11.78 (3.40)	11.96 (3.40)	12.39 (3.52)	6.55 (5.20)
M3	5.85 (2.49)	1.10 (1.09)	7.75 (2.75)	3.68 (1.86)	9.33 (3.04)	15.02 (3.83)	19.10 (4.35)	5.48 (5.02)
M4	4.23 (2.16)	2.07 (1.46)	4.72 (2.07)	4.64 (2.07)	9.39 (3.06)	6.62 (2.54)	13.91 (3.69)	4.23 (3.09)
M5	0.00 (0.71)	5.11 (2.07)	11.61 (2.98)	14.96 (3.71)	23.50 (4.74)	5.57 (2.29)	10.49 (3.24)	7.93 (3.79)
M6	3.07 (1.89)	2.28 (1.55)	9.57 (3.04)	4.16 (2.00)	11.26 (3.35)	3.67 (1.89)	6.68 (2.57)	3.82 (3.59)
M7	0.00 (0.71)	2.27 (1.54)	2.98 (1.71)	4.70 (2.13)	10.83 (3.28)	14.79 (3.82)	18.07 (4.23)	5.06 (4.13)
M8	8.57 (3.01)	13.40 (3.62)	21.92 (4.58)	26.35 (5.07)	28.37 (5.22)	34.05 (5.71)	37.17 (5.90)	16.91 (9.05)
SE (m) _±	0.01	0.13	0.28	0.21	0.23	0.21	0.28	
CD at 5%	0.30	0.45	0.54	0.46	0.56	0.47	0.66	
CV%	14.65	19.01	14.49	12.73	12.17	11.52	13.54	

Appendix – XVIII

Picking wise per cent infestation of *E.vittella* on number basis during summer 2014-15

TR	Module	Days after sowing												
		53	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	4.11	3.41	8.69	8.39	8.44	6.35	5.75	7.93	5.89	34.76	27.67	26.39	12.32
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	4.76	6.49	8.74	2.89	4.67	3.30	2.21	7.49	2.92	30.72	26.70	24.50	10.45
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	1.59	1.55	2.15	8.02	6.13	5.27	4.39	6.65	2.52	28.43	25.11	20.63	9.37
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	3.78	3.30	7.50	1.17	3.91	1.53	1.77	3.22	1.68	24.13	21.65	18.31	7.66
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	1.75	2.26	4.17	9.04	8.47	8.54	6.91	2.97	1.60	21.40	21.01	17.38	8.79
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	2.91	2.62	4.73	2.43	4.13	2.68	1.89	2.05	1.48	17.65	20.18	13.69	6.37
M7	ST,SA,YST,Cyper+Dim.,Fenp o,Ethion+Quin,, Lamb.	1.71	1.75	2.56	6.52	5.73	3.38	2.69	4.86	2.04	25.61	23.65	18.46	8.25
M8	Untreated control	4.95	7.86	11.2 4	15.86	12.5 7	8.57	13.33	23.61	6.72	39.49	37.36	36.94	18.21
	SE (m) $\pm$	0.18	0.21	0.25	0.19	0.26	0.19	0.22	0.20	0.12	2.66	2.05	2.80	0.13
	CD at 5%	0.56	0.64	0.77	0.59	0.8	0.58	0.68	0.62	0.39	8.07	6.23	8.5	0.42
	CV%	18.6 1	20.1 8	19.1 8	14.06	18.1 7	15.75	19.03	14.22	13.28	14.62	11.82	17.62	7.65

Appendix – XVIX

Picking wise per cent infestation of *E.vittella* on weight basis during summer 2014-15

TR	Module	Days after sowing												
		53	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA,YST,Azadirachtin 1%w/w	5.90	7.52	8.12	7.52	10.33	4.15	5.26	9.73	5.70	34.09	31.45	22.06	12.65
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	6.60	8.89	10.2 0	4.78	7.45	2.95	2.20	9.29	4.67	30.12	27.27	21.87	11.36
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	2.08	2.15	2.22	7.33	9.40	3.47	3.28	5.69	2.71	29.63	24.16	21.29	9.45
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	5.37	5.26	6.87	2.18	4.13	1.57	1.53	5.07	2.44	21.60	20.35	18.02	7.87
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	2.78	3.61	2.70	8.77	13.68	8.13	6.96	4.91	2.10	20.77	13.35	15.62	8.62
M6	ST,SA,YST,Cyper,Tria,Fenp o, Ace+Spir	4.17	5.06	5.34	4.71	5.90	2.10	1.67	3.94	1.69	12.32	12.75	12.93	6.05
M7	ST,SA,YST,Cyper+Dim.,Fen po,Ethion+Quin,, Lamb.	2.08	3.37	2.33	5.67	7.89	2.95	2.25	5.57	2.59	26.16	22.12	18.73	8.48
M8	Untreated control	7.41	9.72	11.4 5	17.03	16.37	9.28	9.91	24.3 7	6.41	41.67	37.09	36.13	18.90
	SE (m)±	0.22	0.26	0.28	0.34	0.23	0.17	0.23	0.28	0.15	1.18	1.23	1.83	0.16
	CD at 5%	0.69	0.79	0.85	1.04	0.72	0.51	0.71	0.86	0.47	3.58	3.75	5.55	0.5
	CV%	19.36	19.7 6	20.9	23.43	13.9	14.84	21.6 1	17.8 7	14.94	6.6	7.47	11.82	9.14

Appendix – XX

Picking wise per cent infestation of *E.vittella* on number basis Kharif 2015-16

TR	Module	Days after sowing												
		53	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	0.00	0.00	0.00	0.00	11.64	27.11	30.37	53.67	32.28	27.99	30.21	17.26	19.21
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.00	0.00	0.00	0.40	8.66	22.53	25.00	42.98	26.28	22.06	24.23	24.58	16.39
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.00	0.00	0.00	0.00	10.51	24.17	29.67	37.36	24.43	20.24	22.78	12.36	15.13
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.00	0.00	0.00	0.00	4.18	18.39	21.82	36.52	18.84	17.17	19.07	14.52	12.54
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00	0.00	0.00	0.00	15.12	24.17	32.32	35.43	16.84	16.19	18.00	16.32	14.53
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.00	0.00	0.00	0.00	4.82	21.10	24.92	34.02	15.58	14.65	17.02	14.21	12.19
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.00	0.00	0.00	1.39	9.96	22.87	29.58	37.11	19.22	18.62	21.58	12.36	14.39
M8	Untreated control	0.00	0.00	0.00	7.92	16.12	36.54	52.20	61.02	46.82	45.36	44.31	56.23	30.54
	SE (m)±				0.37	0.81	6.46	10.3	9.78	6.37	4.47	6.05	5.23	2.66
	CD at 5%	0.00	0.00	0.00	0.00	11.64	27.11	30.37	53.67	32.28	27.99	30.21	17.26	19.21
	CV%	0.00	0.00	0.00	0.40	8.66	22.53	25.00	42.98	26.28	22.06	24.23	24.58	16.39

Appendix – XXI

Picking wise per cent infestation of *E.vittella* on weight basis during Kharif 2015-16

TR	Module	Days after sowing												
		53	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA,YST,Azadirachtin 1%w/w	0.00	0.00	0.00	0.00	12.80	32.08	55.56	47.73	32.32	67.19	31.30	25.64	25.38
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.00	0.00	0.00	3.33	9.66	27.60	50.00	32.65	30.37	66.72	25.32	21.36	22.25
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.00	0.00	0.00	0.00	10.72	30.31	53.90	30.53	29.67	61.03	25.14	19.36	21.72
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.00	0.00	0.00	0.00	4.51	23.47	41.39	29.66	25.00	48.24	24.88	18.24	17.95
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00	0.00	0.00	0.00	12.80	33.58	67.20	29.55	24.92	47.95	23.59	17.54	21.43
M6	ST,SA,YST,Cyper,Tria,Fenp o, Ace+Spir	0.00	0.00	0.00	0.00	4.77	26.08	48.61	23.25	21.82	41.26	21.82	16.24	16.99
M7	ST,SA,YST,Cyper+Dim.,Fen po,Ethion+Quin,, Lamb.	0.00	0.00	0.00	10.00	9.44	30.26	51.89	29.73	29.58	50.58	24.93	18.24	21.22
M8	Untreated control	0.00	0.00	0.00	13.94	14.69	34.71	87.30	49.58	52.20	72.03	48.81	57.28	35.88
	SE (m)+				0.06	0.28	1.19	5.78	3.04	2.28	3.10	1.43	1.31	1.36
	CD at 5%				0.18	0.87	3.63	17.53	9.24	6.91	9.41	4.35	4.00	4.13
	CV%				6.83	16.34	6.29	19.69	14.89	11.81	10.95	7.79	7.88	8.32

Appendix – XXII

Picking wise per cent infestation of *H. armigera* on number basis during summer 2014-15

TR.	Modules	Days after sowing				
		79DAS	85DAS	87DAS	91DAS	Mean
		11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	18.27	10.67	4.73	19.25	13.23
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	16.93	7.33	4.58	11.33	10.04
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	16.30	6.12	3.28	5.93	7.91
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	13.25	4.28	2.25	5.45	6.31
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	12.12	4.01	2.17	5.11	5.85
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	9.61	1.79	1.54	4.67	4.40
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	14.85	5.42	2.44	5.90	7.15
M8	Untreated control	28.57	12.52	6.06	21.19	17.08
	SE (m)±	0.20	0.25	0.16	0.29	0.13
	CD at 5%	0.62	0.76	0.49	0.88	0.41
	CV%	9.01	17.86	15.77	17.03	8.08

Appendix – XXIII

Picking wise per cent infestation of *H. armigera* on weight basis during summer 2014-15

Tr.	Modules	Days after sowing				
		79DAS	85DAS	87DAS	91DAS	Mean
		11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	22.95	12.25	4.65	8.09	11.99
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	15.68	6.10	4.06	6.16	8.00
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	14.48	4.51	2.43	5.60	6.76
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	10.45	3.66	1.86	4.84	5.20
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	9.31	2.89	1.28	4.80	4.57
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	7.39	1.58	1.20	2.56	3.18
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	12.52	3.70	2.26	5.01	5.87
M8	Untreated control	23.06	15.14	7.68	18.24	16.03
	SE (m)±	0.25	0.19	0.15	0.18	0.16
	CD at 5%	0.77	0.57	0.46	0.54	0.49
	CV%	11.89	14.08	15.69	12.46	10.55

Appendix – XXIV

Picking wise per cent infestation of *H.armigera* on number basis during kharif 2015-16

S.N.	Modules	Days after sowing												
		53DAS	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	40.66	25.57	40.84	55.85	38.64	16.39	8.25	24.67	17.61	23.60	22.05	26.39	28.38
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	40.93	29.48	41.55	44.79	29.27	12.15	5.16	22.46	17.58	16.48	16.87	18.25	24.58
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	27.74	9.55	26.96	55.35	34.58	15.52	6.67	19.37	17.30	14.16	13.81	17.24	21.52
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	34.45	24.78	40.41	30.40	16.68	10.99	3.03	14.25	11.03	10.06	10.95	11.96	18.25
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	28.40	20.50	31.44	56.40	41.70	18.17	9.55	10.52	10.67	9.82	10.16	10.54	21.49
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	32.53	21.00	34.45	32.54	24.71	12.15	3.70	10.38	8.05	7.97	9.10	9.69	17.19
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	27.84	13.39	29.17	53.49	33.90	13.30	6.23	18.66	12.92	13.76	12.83	13.63	20.76
M8	Untreated control	57.68	63.82	53.89	68.82	45.75	19.47	16.62	26.91	31.76	36.52	37.91	25.21	40.36
	SE (m)±	3.57	2.61	3.05	4.47	3.55	1.38	0.23	2.60	1.75	1.22	1.01	1.27	1.13
	CD at 5%	10.84	7.94	9.26	13.6	10.78	4.19	0.69	7.91	5.33	3.72	3.07	3.87	3.45
	CV%	16.87	15.22	14.12	17.3	17.71	10.63	15.07	18.11	13.3	9.1	7.47	9.33	6.76

Appendix – XXV

Picking wise per cent infestation of *H.armigera* on weight basis during kharif 2015-16

S.N.	TR.No.	Days after sowing												
		53DAS	56	58	64	66	70	74	76	79	85	87	91	
		3	4	5	6	7	8	9	10	11	12	13	14	% Mean
M1	SA.YST,Azadirachtin 1%w/w	34.06	33.74	40.63	57.28	45.69	9.93	13.20	18.98	19.48	26.09	22.81	18.59	28.37
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	35.76	34.74	43.84	51.74	28.95	6.98	8.61	16.82	18.38	24.64	19.96	16.24	25.56
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	22.02	6.39	31.80	56.23	35.90	8.86	12.22	16.46	19.32	17.77	14.38	18.47	21.65
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	31.36	29.27	38.46	40.75	15.81	6.46	5.56	11.88	10.03	15.49	7.75	10.25	18.59
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	25.06	19.35	34.06	62.07	47.32	10.00	10.41	8.35	9.05	10.43	6.64	9.36	21.01
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	27.52	19.35	36.57	45.64	24.75	6.73	8.33	8.15	8.23	12.37	6.15	8.46	17.69
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	24.98	16.51	31.80	52.87	35.58	8.86	10.68	13.44	10.61	17.06	11.15	11.25	20.40
M8	Untreated control	79.56	63.04	54.74	63.89	49.53	15.79	28.39	21.15	37.87	31.66	32.21	27.48	42.11
	SE (m)±	3.03	3.59	2.65	2.69	4.34	0.25	0.4	0.37	1.49	2.6	1.8	0.16	1.12
	CD at 5%	9.2	10.91	8.04	8.17	13.17	0.77	1.23	1.14	5.54	7.91	5.46	0.49	3.39
	CV%	15.45	20.16	11.93	9.88	20.92	14.85	21	17.59	11.11	17.58	14.22	7.47	6.64

Appendix – XXVI

Spray-wise effect of various modules on aphid population on Okra during summer 2014-15

Tr.N O.	Treatment details	Number of aphids/ leaf															
		Pre-treat. obs.	I SPRAY			II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT *	7 DAT *	14DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT **	14 DAT *
M ₁	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	0.80 (0.89)	2.90 (1.70)	5.15 (2.26)	2.43 (1.52)	4.62 (2.14)	8.00 (2.81)	3.91 (1.96)	6.48 (2.52)	11.49 (3.33)	4.80 (2.14)	3.63 (1.87)	2.60 (1.54)	1.86 (1.35)	2.52 (1.71)	2.27 (1.50)
M ₂	ST,Dim, Quin, Fenpo, Dico+Quin.	0.01 (0.71)	2.83 (1.67)	6.10 (2.47)	7.77 (2.77)	2.14 (1.44)	4.00 (1.97)	6.72 (2.58)	4.06 (2.00)	7.12 (2.67)	14.03 (3.73)	6.14 (2.46)	5.60 (2.36)	4.90 (2.21)	3.33 (1.81)	3.29 (1.91)	2.43 (1.55)
M ₃	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.25 (0.86)	0.73 (0.85)	2.78 (1.66)	4.60 (2.12)	3.16 (1.78)	5.27 (2.29)	9.18 (3.03)	3.28 (1.77)	6.33 (2.50)	10.88 (3.28)	3.54 (1.86)	1.90 (1.36)	2.05 (1.41)	1.91 (1.37)	2.91 (1.83)	2.43 (1.55)
M ₄	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.31 (0.88)	0.33 (0.57)	2.65 (1.60)	4.12 (2.02)	2.90 (1.70)	4.78 (2.18)	8.12 (2.85)	4.07 (2.01)	6.46 (2.53)	13.27 (3.62)	5.31 (2.30)	5.04 (2.24)	3.06 (1.73)	1.73 (1.31)	1.96 (1.56)	2.28 (1.51)
M ₅	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.01 (0.71)	1.85 (1.35)	4.95 (2.18)	6.56 (2.54)	1.80 (1.33)	1.28 (1.11)	6.20 (2.47)	2.98 (1.71)	5.66 (2.37)	7.97 (2.81)	3.16 (1.77)	1.00 (0.99)	1.70 (1.29)	0.75 (0.83)	1.15 (1.28)	1.84 (1.34)
M ₆	ST,SA,YST,Cyper,Tria,Fenpo Ace+Spir	0.01 (0.71)	0.80 (0.89)	3.10 (1.75)	6.56 (2.55)	2.89 (1.70)	4.33 (2.08)	7.10 (2.66)	3.27 (1.79)	5.92 (2.42)	9.24 (3.01)	3.58 (1.88)	2.16 (1.46)	2.27 (1.48)	0.50 (0.70)	1.10 (1.26)	1.37 (1.16)
M ₇	ST,SA,YST,Cyper+Dim.,Fenp o,Ethion+Quin,, Lamb.	0.01 (0.71)	1.70 (1.29)	3.40 (1.83)	7.27 (2.69)	1.18 (1.08)	1.05 (1.01)	5.67 (2.38)	2.21 (1.48)	4.09 (1.98)	6.66 (2.57)	3.54 (1.86)	1.90 (1.36)	2.05 (1.41)	1.00 (0.99)	1.67 (1.47)	1.70 (1.29)
M ₈	Untreated control	0.28 (0.87)	5.13 (2.27)	7.67 (2.75)	8.01 (2.83)	9.42 (3.05)	10.82 (3.28)	11.30 (3.35)	12.94 (3.60)	13.70 (3.68)	17.27 (4.15)	10.16 (3.18)	6.47 (2.53)	5.76 (2.40)	3.77 (1.93)	5.50 (2.45)	3.80 (1.94)
SE (m)±		0.07	0.09	0.17	0.17	0.14	0.15	0.17	0.17	0.21	0.28	0.20	0.16	0.18	0.12	0.15	0.12
CD at 5%		NS	0.29	0.53	0.55	0.44	0.48	0.52	0.53	0.64	0.87	0.63	0.51	0.57	0.39	0.48	0.37
CV%		16.02	13.71	15.25	9.01	14.72	13.65	10.64	14.85	14.16	15.04	16.39	16.47	19.26	17.26	16.17	14.20

N.B: Figures in (*) indicates square root values. While (**) indicates square root x+0.5 values

Appendix – XXVII

Effect of various modules on aphid population on okra during kharif 2015-16

Tr. No.	Treatment details	Number of aphids / leaf															
		Pre.tret.	I SPRAY			II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *
M ₁	SA.YST,Azadirachtin 1%w/w	7.33 (2.80)	4.84 (2.19)	6.33 (2.50)	9.36 (3.06)	6.34 (2.50)	7.56 (2.74)	8.02 (2.81)	4.60 (2.14)	7.03 (2.63)	9.02 (3.00)	6.18 (2.41)	7.43 (2.71)	7.83 (2.80)	3.12 (1.76)	3.66 (1.91)	3.90 (1.97)
M ₂	ST,Dim, Quin, Fenpo, Dico+Quin.	6.38 (2.62)	7.26 (2.65)	8.57 (2.91)	11.18 (3.34)	4.79 (2.13)	6.12 (2.47)	7.51 (2.73)	6.52 (2.52)	8.25 (2.85)	11.31 (3.36)	5.24 (2.29)	5.85 (2.42)	5.48 (2.33)	2.41 (1.55)	2.63 (1.61)	2.70 (1.64)
M ₃	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	7.85 (2.89)	4.22 (2.05)	6.28 (2.49)	9.36 (3.04)	7.03 (2.65)	8.11 (2.84)	9.22 (3.01)	4.57 (2.12)	6.17 (2.42)	8.19 (2.84)	3.62 (1.88)	4.44 (2.07)	4.49 (2.07)	1.87 (1.37)	1.98 (1.41)	2.06 (1.42)
M ₄	Tria, Fenv, Quin+Spir, Fenpo,Lamb	7.52 (2.79)	3.27 (1.81)	6.06 (2.46)	8.32 (2.87)	5.60 (2.32)	7.13 (2.67)	8.43 (2.88)	5.15 (2.26)	7.49 (2.73)	10.04 (3.15)	7.57 (2.74)	7.97 (2.81)	8.93 (2.99)	2.32 (1.52)	2.43 (1.54)	2.78 (1.66)
M ₅	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	7.20 (2.76)	6.19 (2.48)	7.31 (2.70)	11.02 (3.31)	3.60 (1.88)	4.29 (2.07)	5.99 (2.37)	3.81 (1.93)	5.25 (2.26)	8.00 (2.82)	4.81 (2.17)	5.03 (2.24)	5.30 (2.26)	1.75 (1.31)	1.82 (1.34)	2.00 (1.41)
M ₆	ST,SA,YST,Cyper,Tria,Fen po, Ace+Spir	7.10 (2.46)	4.69 (2.15)	7.08 (2.63)	10.21 (3.19)	6.02 (2.44)	7.00 (2.60)	7.29 (2.70)	4.29 (2.02)	5.66 (2.38)	8.31 (2.85)	5.70 (2.38)	5.97 (2.44)	6.80 (2.61)	1.21 (1.10)	1.67 (1.29)	1.81 (1.34)
M ₇	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	6.00 (2.53)	4.89 (2.21)	7.38 (2.71)	10.36 (3.21)	2.10 (1.43)	2.97 (1.67)	5.35 (2.26)	2.64 (1.62)	4.01 (2.00)	6.42 (2.50)	2.62 (1.60)	2.89 (1.70)	3.21 (1.78)	2.23 (1.46)	2.27 (1.48)	2.53 (1.59)
M ₈	Untreated control	8.93 (3.07)	11.77 (3.43)	11.98 (3.46)	14.87 (3.85)	15.28 (3.87)	16.95 (4.08)	18.87 (4.31)	21.51 (4.60)	23.13 (4.76)	24.36 (4.89)	9.12 (3.01)	9.07 (3.00)	10.36 (3.21)	4.31 (2.04)	5.05 (2.24)	5.90 (2.42)
	SE (m)±	0.36	0.14	0.17	0.16	0.26	0.27	0.28	0.24	0.27	0.27	0.22	0.15	0.19	0.13	0.11	0.09
	CD at 5%	NS	0.44	0.52	0.51	0.79	0.73	0.87	0.75	0.84	0.83	0.68	0.46	0.60	0.40	0.36	0.29
	CV%	23.08	10.77	10.94	9.01	18.76	15.76	17.13	17.89	17.48	15.00	16.70	10.87	13.56	15.22	12.69	9.75

N.B: Figures in (*)indicates square root values.

Appendix – XXVIII

Effect of various modules on white fly population on okra during summer 2014-15

Tr. No.	Treatment details	Number of White fly /leaf													
		I SPRAY	II SPRAY				III SPRAY			IV SPRAY			V SPRAY		
		14DAT **	3 DAT **	7 DAT **	14 DAT *	3 DAT **	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	
M1	SA.YST,Azadirachtin 1%w/w	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.24 (0.49)	0.37 (0.93)	2.97 (1.72)	3.20 (1.79)	2.98 (1.72)	3.12 (1.76)	4.22 (2.04)	1.51 (1.22)	1.76 (1.32)	2.53 (1.57)	
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.60 (1.05)	0.16 (0.81)	0.29 (0.89)	0.18 (0.40)	0.19 (0.83)	3.19 (1.78)	4.63 (2.15)	3.02 (1.72)	3.68 (1.91)	5.53 (2.34)	2.19 (1.48)	3.11 (1.75)	2.59 (1.61)	
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.18 (0.82)	0.34 (0.91)	0.15 (0.80)	1.86 (1.36)	0.20 (0.83)	2.34 (1.52)	3.53 (1.86)	0.62 (0.78)	0.82 (0.90)	1.24 (1.11)	1.95 (1.38)	2.04 (1.42)	2.95 (1.66)	
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.20 (0.83)	0.50 (1.00)	1.16 (1.27)	1.75 (1.31)	0.00 (0.71)	1.14 (1.07)	1.57 (1.23)	1.59 (1.23)	1.23 (1.08)	2.00 (1.41)	0.62 (0.76)	0.75 (0.86)	2.49 (1.58)	
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.74 (1.11)	0.02 (0.72)	0.09 (0.77)	0.07 (0.26)	0.16 (0.81)	1.79 (1.30)	1.86 (1.33)	2.25 (1.50)	2.76 (1.66)	2.82 (1.68)	0.33 (0.57)	0.70 (0.83)	1.52 (1.23)	
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.26 (0.87)	1.42 (1.38)	1.32 (1.35)	1.83 (1.33)	0.08 (0.76)	1.72 (1.28)	2.03 (1.42)	1.01 (1.00)	1.04 (1.00)	1.70 (1.29)	0.22 (0.47)	0.56 (0.72)	1.27 (1.12)	
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Et hion+Quin,, Lamb.	0.24 (0.86)	0.53 (1.00)	0.84 (1.14)	0.51 (0.71)	0.32 (0.90)	2.78 (1.66)	2.56 (1.57)	3.62 (1.89)	4.52 (2.12)	5.60 (2.36)	3.09 (1.74)	3.53 (1.86)	2.57 (1.58)	
M8	Untreated control	0.93 (1.19)	2.16 (1.61)	2.34 (1.67)	2.68 (1.63)	3.90 (2.07)	4.94 (2.20)	5.51 (2.32)	5.28 (2.29)	5.96 (2.44)	6.76 (2.60)	4.30 (2.07)	3.78 (1.94)	3.90 (1.97)	
	SE (m)+	0.05	0.08	0.09	0.08	0.08	0.15	0.16	0.12	0.10	0.11	0.10	0.12	0.14	
	CD at 5%	0.17	0.26	0.29	0.26	0.26	0.46	0.51	0.39	0.31	0.34	0.31	0.38	0.43	
	CV%	10.45	14.83	15.42	16.05	15.50	16.78	17.11	14.79	11.22	10.67	14.64	16.20	15.89	

N.B: Figures in (*) indicates square root values. While (**) indicates square root values

Appendix – XXIX

Effect of various modules on whitefly population on okra during kharif 2015-16

Tr. No.	Treatment details	Number of White fly /leaf											
		II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		3 DAT **	7 DAT **	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *
M1	SA.YST,Azadirachtin 1%w/w	0.08 (0.29)	0.06 (0.24)	0.80 (0.89)	0.88 (0.94)	4.00 (2.00)	8.07 (2.83)	3.92 (1.98)	5.94 (2.42)	7.96 (2.81)	3.72 (1.91)	2.66 (1.58)	2.26 (1.50)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.08 (0.27)	0.06 (0.25)	1.06 (1.03)	1.17 (1.08)	6.23 (2.48)	9.20 (3.03)	5.28 (2.28)	6.96 (2.61)	7.31 (2.70)	2.12 (1.45)	2.79 (1.67)	2.31 (1.52)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.15 (0.39)	0.13 (0.35)	1.13 (1.06)	0.83 (0.91)	3.13 (1.77)	7.31 (2.70)	2.80 (1.67)	4.12 (2.03)	4.09 (2.02)	2.23 (1.48)	2.40 (1.51)	2.27 (1.51)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.17 (0.41)	0.22 (0.46)	1.14 (1.07)	0.21 (0.46)	1.06 (1.03)	2.93 (1.71)	5.05 (2.25)	5.03 (2.24)	5.27 (2.30)	2.99 (1.73)	2.17 (1.46)	2.06 (1.43)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.04 (0.20)	0.06 (0.25)	0.75 (0.87)	0.34 (0.58)	1.18 (1.08)	3.33 (1.82)	3.89 (1.96)	5.68 (2.37)	7.87 (2.80)	2.09 (1.45)	1.74 (1.31)	1.47 (1.20)
M6	ST,SA,YST,Cyper,Tria,Fenpo , Ace+Spir	0.22 (0.47)	0.15 (0.38)	1.44 (1.20)	0.66 (0.81)	1.36 (1.16)	4.21 (2.05)	2.33 (1.52)	4.03 (2.01)	6.37 (2.52)	1.46 (1.20)	1.64 (1.27)	1.01 (0.98)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.08 (0.28)	0.09 (0.30)	1.11 (1.05)	0.70 (0.83)	2.06 (1.43)	5.70 (2.39)	5.76 (2.39)	6.39 (2.53)	7.28 (2.70)	3.85 (1.96)	3.84 (1.96)	1.57 (1.24)
M8	Untreated control	0.24 (0.49)	0.35 (0.59)	1.99 (1.39)	2.32 (1.51)	7.30 (2.70)	10.45 (3.20)	10.56 (3.21)	8.71 (2.94)	8.74 (2.94)	4.80 (2.18)	5.12 (2.25)	2.57 (1.60)
	SE (m)±	0.02	0.02	0.07	0.07	0.10	0.14	0.16	0.14	0.12	0.12	0.15	0.07
	CD at 5%	0.08	0.07	0.22	0.21	0.30	0.43	0.49	0.42	0.37	0.37	0.47	0.24
	CV%	13.59	12.62	11.85	13.80	10.23	9.93	12.89	10.13	8.16	12.55	16.56	9.91

N.B: Figures in (*) indicates square root values.While (**) indicates square root values

Appendix – XXX

Effect of various modules on thrips population on okra during summer 2014-15

Tr. No.	Treatment details	Number of Thrips / leaf															
		Pre .tret	I SPRAY			II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT *	7 DAT *	14 D AT *	3 DAT **	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT **	7 DAT **	14 DAT **	3 DAT *	7 DAT *	14 DAT *
M1	SA.YST,Azadirachtin 1%w/w	0.00	0.10 (0.32)	0.33 (0.58)	0.93 (0.96)	0.64 (1.06)	0.78 (0.88)	1.76 (1.31)	0.84 (0.91)	2.00 (1.41)	2.83 (1.67)	0.19 (0.83)	1.68 (1.47)	1.52 (1.42)	0.44 (0.67)	0.47 (0.67)	0.81 (0.90)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.00	0.64 (0.80)	1.54 (1.22)	2.17 (1.47)	0.41 (0.95)	0.67 (0.82)	1.81 (1.34)	0.82 (0.89)	0.93 (0.96)	2.30 (1.51)	0.00 (0.71)	0.33 (0.90)	1.81 (1.49)	0.82 (0.91)	0.86 (0.93)	1.51 (1.22)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.00	0.34 (0.58)	0.20 (0.44)	0.72 (0.85)	0.77 (1.13)	0.97 (0.99)	3.70 (1.92)	0.19 (0.44)	0.67 (0.82)	1.69 (1.30)	0.13 (0.80)	0.45 (0.97)	2.23 (1.64)	2.11 (1.45)	2.29 (1.51)	2.18 (1.46)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.00	0.07 (0.26)	0.27 (0.50)	1.67 (1.28)	1.13 (1.28)	1.08 (1.04)	2.18 (1.48)	2.78 (1.66)	2.33 (1.52)	3.42 (1.85)	0.00 (0.71)	0.07 (0.75)	0.48 (0.99)	0.51 (0.71)	0.60 (0.77)	0.86 (0.93)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00	0.27 (0.52)	2.53 (1.59)	2.49 (1.58)	0.37 (0.93)	0.07 (0.27)	0.39 (0.62)	0.13 (0.36)	0.33 (0.57)	0.85 (0.91)	1.14 (1.27)	1.66 (1.42)	1.83 (1.53)	0.24 (0.48)	0.45 (0.66)	0.71 (0.84)
M6	ST,SA,YST,Cyper,Tria,Fenpo , Ace+Spir	0.00	0.10 (0.32)	1.40 (1.18)	1.00 (1.00)	0.71 (1.10)	0.93 (0.95)	3.87 (1.95)	0.23 (0.47)	0.69 (0.83)	0.86 (0.93)	0.00 (0.71)	0.00 (0.71)	0.41 (0.94)	0.20 (0.45)	0.31 (0.55)	0.37 (0.50)
M7	ST,SA,YST,Cyper+Dim.,Fenp o,Ethion+Quin,, Lamb.	0.00	0.20 (0.44)	0.46 (0.67)	1.56 (1.25)	0.52 (1.01)	0.40 (0.63)	0.98 (0.99)	0.07 (0.27)	0.64 (0.78)	1.38 (1.16)	0.47 (0.99)	0.58 (1.04)	1.27 (1.32)	1.71 (1.29)	2.00 (1.40)	2.42 (1.55)
M8	Untreated control	0.00	0.89 (0.94)	4.08 (2.02)	6.26 (2.49)	3.20 (1.90)	3.51 (1.87)	4.12 (1.95)	4.19 (1.96)	4.33 (2.05)	5.69 (2.35)	3.47 (1.97)	2.53 (1.71)	2.81 (1.82)	3.47 (1.84)	2.53 (1.55)	3.04 (1.73)
	SE (m)±		0.03	0.08	0.07	0.08	0.06	0.16	0.15	0.12	0.13	0.07	0.12	0.11	0.09	0.11	0.12
	CD at 5%		0.11	0.25	0.22	0.27	0.18	0.51	0.48	0.37	0.40	0.24	0.36	0.35	0.29	0.36	0.38
	CV%		11.46	13.66	9.22	13.09	11.13	20.17	31.30	18.74	15.73	13.77	18.44	14.17	19.98	20.22	19.19

N.B: Figures in (*) indicates square root values. While (**))indicatessquare√x+0.5values

Appendix – XXXI

Effect of various modules on thrips population on okra during kharif 2015-16

Sr. No.	Treatment details	Number of Thrips / leaf															
		Pre.tret.	I SPRAY			II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT **	7 DAT **	14 DAT **	3 DAT **	7 DAT **	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *
M1	SA.YST,Azadirachtin 1%w/w	0.00	0.94 (1.20)	1.64 (1.46)	2.95 (1.86)	1.57 (1.44)	2.54 (1.74)	4.02 (1.98)	4.17 (2.04)	4.10 (2.01)	6.13 (2.48)	4.77 (2.18)	6.07 (2.46)	8.50 (2.91)	2.45 (1.56)	3.47 (1.86)	5.17 (2.27)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.00	0.80 (1.14)	2.26 (1.65)	2.73 (1.79)	0.50 (0.99)	1.78 (1.50)	3.13 (1.77)	2.97 (1.69)	5.17 (2.26)	7.63 (2.76)	4.11 (1.98)	5.01 (2.22)	6.97 (2.61)	3.25 (1.79)	4.43 (2.10)	7.04 (2.65)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.00	0.00 (0.71)	0.00 (0.71)	0.42 (0.95)	2.14 (1.61)	3.05 (1.88)	5.46 (2.33)	1.47 (1.21)	1.81 (1.31)	2.45 (1.56)	6.40 (2.51)	11.12 (3.33)	10.01 (3.14)	5.07 (2.24)	5.83 (2.38)	7.80 (2.75)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.00	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	4.67 (2.26)	2.54 (1.74)	6.05 (2.46)	5.76 (2.40)	6.40 (2.50)	9.00 (2.97)	2.57 (1.60)	3.83 (1.93)	5.23 (2.22)	3.02 (1.74)	5.63 (2.36)	7.70 (2.77)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00	0.76 (1.12)	2.38 (1.69)	2.75 (1.77)	0.00 (0.71)	1.13 (1.27)	2.71 (1.63)	0.36 (0.60)	0.83 (0.91)	2.11 (1.45)	5.30 (2.28)	7.43 (2.62)	10.43 (3.21)	1.51 (1.22)	1.51 (1.22)	4.08 (2.02)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.00	0.00 (0.71)	0.67 (1.07)	0.72 (1.11)	2.27 (1.66)	3.23 (1.92)	4.47 (2.04)	1.07 (1.03)	2.41 (1.55)	4.16 (2.04)	0.16 (0.40)	3.07 (1.70)	3.53 (1.82)	1.11 (1.05)	3.40 (1.84)	3.25 (1.79)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	0.00	0.34 (0.92)	1.17 (1.29)	3.34 (1.96)	0.69 (1.09)	1.46 (1.38)	3.69 (1.92)	0.60 (0.77)	2.34 (1.53)	2.51 (1.58)	3.60 (1.89)	6.94 (2.62)	8.57 (2.90)	5.81 (2.40)	6.93 (2.61)	8.10 (2.79)
M8	Untreated control	0.00	1.03 (1.23)	3.17 (1.88)	4.13 (2.15)	5.33 (2.41)	6.23 (2.57)	7.50 (2.73)	6.70 (2.58)	7.83 (2.79)	9.61 (3.07)	9.07 (3.01)	11.43 (3.38)	15.77 (3.96)	9.23 (3.04)	7.48 (2.71)	10.57 (3.25)
	SE (m)±		0.03	0.12	0.11	0.08	0.10	0.17	0.09	0.14	0.16	0.18	0.24	0.25	0.11	0.18	0.20
	CD at 5%		0.10	0.37	0.34	0.27	0.32	0.54	0.28	0.44	0.51	0.56	0.74	0.79	0.35	0.55	0.62
	CV%		6.24	16.42	12.9	10.13	10.37	14.68	10.30	13.52	12.99	16.25	16.78	15.78	10.73	14.67	13.98

N.B: Figures in (*) indicates square root values .While (**) indicates square root x0.5 values

Appendix – XXXII

Effect of various modules on mites population on okra during summer 2014-15

Tr. No.	Treatment details	Number of Mites / leaf										
		II SPRAY	III SPRAY				IV SPRAY			V SPRAY		
		14 DAT **	3 DAT **	7 DAT **	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	
M1	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	0.95 (1.20)	5.65 (2.45)	17.40 (4.17)	10.58 (3.31)	13.31 (3.64)	21.17 (4.59)	3.46 (1.85)	12.09 (3.46)	26.56 (5.15)	
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	3.32 (1.95)	2.09 (1.59)	3.68 (2.01)	11.32 (3.36)	7.28 (2.78)	20.81 (4.55)	11.85 (3.44)	9.97 (3.13)	15.04 (3.87)	12.79 (3.58)	
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	5.85 (2.49)	0.00 (0.71)	0.00 (0.71)	6.75 (2.56)	2.60 (0.71)	2.07 (1.41)	9.32 (3.05)	17.88 (4.23)	19.39 (4.40)	22.23 (4.71)	
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	3.52 (2.00)	0.00 (0.71)	2.80 (1.78)	7.27 (2.68)	4.60 (0.71)	2.41 (1.55)	9.40 (3.05)	9.36 (3.05)	5.72 (2.36)	16.57 (4.07)	
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00 (0.71)	8.00 (2.91)	9.08 (3.08)	21.32 (4.60)	13.99 (3.79)	22.65 (4.75)	32.23 (5.65)	1.65 (1.27)	3.59 (1.86)	10.73 (3.27)	
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	3.07 (1.89)	0.00 (0.71)	2.70 (1.78)	11.17 (3.31)	1.80 (1.26)	3.73 (1.87)	11.90 (3.45)	3.37 (1.83)	2.89 (1.68)	6.77 (2.60)	
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+ Quin,, Lamb.	0.00 (0.71)	0.00 (0.71)	3.20 (1.92)	3.60 (1.89)	2.80 (1.75)	4.78 (2.15)	9.32 (3.05)	11.17 (3.33)	18.03 (4.24)	20.90 (4.57)	
M8	Untreated control	8.57 (3.01)	12.74 (3.61)	17.47 (4.20)	29.17 (5.35)	29.73 (5.47)	34.00 (5.82)	38.20 (6.13)	40.77 (6.35)	47.20 (6.87)	52.03 (7.08)	
	SE (m)±	1.00	0.14	0.21	0.28	0.22	0.23	0.25	0.23	0.20	0.35	
	CD at 5%	0.30	0.44	0.64	0.87	0.69	0.71	0.77	0.71	0.62	1.07	
	CV%	10.27	16.79	16.40	14.33	15.94	12.62	10.88	13.03	9.89	14.03	

N.B: Figures in (*) indicates square root values. While (**) indicates square root x+0.5 values

Appendix – XXXIII

Effect of Various Modules on Mites population on Okra during kharif 2015-16

Tr.No.	Treatment details	Number of Mites / leaf									
		II SPRAY	III SPRAY			IV SPRAY			V SPRAY		
		14 DAT **	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *
M1	SA.YST,Azadirachtin 1%w/w	0.00 (0.71)	1.95 (1.56)	2.56 (1.60)	11.25 (3.32)	7.25 (2.69)	7.93 (2.79)	14.13 (3.72)	4.27 (2.04)	9.97 (3.13)	13.29 (3.62)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	3.32 (1.95)	3.17 (1.91)	4.50 (2.12)	13.00 (3.60)	4.69 (2.16)	6.95 (2.62)	11.71 (3.37)	3.64 (1.90)	8.88 (2.94)	11.99 (3.46)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	5.85 (2.49)	1.26 (1.32)	2.19 (1.46)	8.74 (2.93)	3.15 (1.74)	5.29 (2.30)	9.33 (3.03)	7.71 (2.77)	10.65 (3.26)	15.97 (3.99)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	4.93 (2.32)	0.64 (1.06)	1.33 (1.15)	2.16 (1.46)	4.17 (2.04)	6.87 (2.60)	9.38 (3.06)	4.61 (2.12)	7.51 (2.71)	11.24 (3.32)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.00 (0.71)	0.97 (1.21)	1.13 (1.06)	1.90 (1.36)	6.87 (2.60)	7.27 (2.67)	14.77 (3.82)	5.37 (2.29)	7.54 (2.72)	10.24 (3.20)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	3.07 (1.89)	2.15 (1.61)	1.86 (1.33)	7.97 (2.77)	2.69 (1.62)	4.59 (2.13)	10.62 (3.25)	1.67 (1.28)	4.45 (2.10)	6.58 (2.54)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	0.00 (0.71)	0.37 (0.93)	1.34 (1.16)	2.37 (1.54)	2.47 (1.55)	4.61 (2.12)	12.34 (3.50)	5.57 (2.29)	11.54 (3.39)	15.23 (3.89)
M8	Untreated control	8.57 (3.01)	7.39 (2.80)	9.33 (3.03)	14.67 (3.81)	15.03 (3.80)	18.70 (4.32)	18.53 (4.30)	19.03 (4.34)	20.90 (4.56)	22.30 (4.71)
	SE (m) _±	0.10	0.09	0.13	0.24	0.24	0.18	0.25	0.25	0.24	0.23
	CD at 5%	0.31	0.28	0.39	0.75	0.75	0.55	0.76	0.77	0.72	0.71
	CV%	10.54	10.42	13.96	16.63	18.99	11.74	12.48	18.54	13.40	11.32

N.B: Figures in (*) indicates square root values. While (**) indicates square root x+0.5 value

Appendix – XXXIV

Effect of Various Modules on Leaf hopper population on Okra during Summer 2014-15

Tr. No.	Treatment details	Number of Leaf hopper /leaf																
		Pre.t	I SPRAY				II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT **	7 DAT *	14 DAT *	3 DAT *	7 DAT **	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	
M1	SA.YST,Azadirachtin 1%w/w	0.20 (0.82)	0.15 (0.81)	0.73 (0.84)	1.44 (1.19)	2.69 (1.57)	3.40 (1.93)	4.64 (2.15)	4.62 (2.13)	3.42 (1.82)	9.38 (3.00)	5.04 (2.22)	14.14 (3.75)	17.98 (4.22)	13.47 (3.67)	17.84 (4.18)	21.80 (4.66)	
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.13 (0.79)	0.24 (0.86)	0.78 (0.88)	1.82 (1.34)	1.84 (1.34)	3.55 (2.01)	4.25 (2.00)	4.18 (2.00)	3.84 (1.91)	6.49 (2.51)	4.91 (2.20)	8.44 (2.89)	18.11 (4.25)	11.51 (3.38)	13.53 (3.66)	15.07 (3.83)	
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.33 (0.90)	0.02 (0.72)	0.33 (0.57)	1.29 (1.13)	1.75 (1.32)	1.58 (1.44)	3.89 (1.95)	5.24 (2.29)	5.60 (2.36)	16.33 (3.99)	6.17 (2.48)	8.44 (2.89)	20.31 (4.50)	9.51 (3.04)	11.87 (3.43)	14.58 (3.79)	
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.33 (0.89)	0.02 (0.72)	0.51 (0.71)	1.40 (1.18)	3.02 (1.73)	4.69 (2.27)	6.29 (2.51)	4.64 (2.15)	4.69 (2.15)	16.58 (4.05)	5.24 (2.29)	9.04 (2.95)	16.27 (3.96)	8.87 (2.97)	11.51 (3.38)	13.65 (3.69)	
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.33 (0.91)	0.26 (0.87)	0.80 (0.88)	2.09 (1.45)	1.37 (1.17)	1.01 (1.23)	2.86 (1.69)	3.42 (1.82)	3.33 (1.81)	6.33 (2.49)	4.62 (2.13)	13.02 (3.60)	14.43 (3.79)	8.64 (2.90)	10.98 (3.31)	13.60 (3.67)	
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.07 (0.75)	0.17 (0.82)	0.78 (0.87)	1.64 (1.28)	2.77 (1.65)	3.84 (2.07)	4.95 (2.22)	1.84 (1.35)	2.06 (1.41)	7.71 (2.75)	2.93 (1.71)	5.35 (2.30)	9.86 (3.13)	8.62 (2.91)	10.76 (3.23)	12.82 (3.55)	
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin,, Lamb.	0.13 (0.79)	0.15 (0.80)	0.66 (0.81)	1.66 (1.29)	0.60 (0.77)	0.81 (1.14)	2.31 (1.49)	2.73 (1.65)	3.73 (1.91)	11.04 (3.32)	5.82 (2.40)	7.53 (2.61)	15.42 (3.89)	7.52 (2.74)	8.09 (2.84)	11.54 (3.39)	
M8	Untreated control	0.60 (1.02)	0.33 (0.91)	1.24 (1.11)	2.24 (1.49)	3.26 (1.79)	5.82 (2.50)	6.73 (2.55)	5.38 (2.31)	12.47 (3.50)	19.45 (4.32)	8.71 (2.93)	19.04 (4.35)	27.42 (5.21)	16.71 (4.06)	18.09 (4.25)	24.78 (4.96)	
	SE (m)±	0.09	0.04	0.08	0.06	0.14	0.14	0.20	0.17	0.23	0.34	0.17	0.31	0.30	0.25	0.28	0.27	
	CD at 5%	NS	0.11	0.24	0.18	0.43	0.42	0.59	0.52	0.69	1.03	0.51	0.93	0.91	0.76	0.85	0.83	
	CV%	18.70	7.66	16.74	8.04	17.37	13.22	16.39	15.13	18.70	17.84	12.63	16.84	12.71	13.47	13.67	12.01	

N.B: Figures in (*) indicates square root values. While (**) indicates square root values +0.5

Appendix – XXXV

Effect of various modules on leaf hopper population on okra during kharif 2015-16

Tr.No.	Treatment details	Number of Leaf hopper /leaf															
		Pre.tret	I SPRAY			II SPRAY			III SPRAY			IV SPRAY			V SPRAY		
		1 DBS	3 DAT **	7 DAT **	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *	3 DAT *	7 DAT *	14 DAT *
M1	SA.YST,Azadirachtin 1%w/w	0.13 (0.79)	0.04 (0.74)	0.11 (0.78)	2.19 (1.48)	1.86 (1.33)	2.04 (1.43)	2.12 (1.46)	2.64 (1.62)	4.76 (2.18)	7.42 (2.71)	5.16 (2.26)	21.23 (4.60)	19.52 (4.41)	11.65 (3.41)	19.42 (4.39)	24.86 (4.98)
M2	ST,Dim, Quin, Fenpo, Dico+Quin.	0.07 (0.75)	0.02 (0.72)	0.28 (0.87)	1.57 (1.25)	0.86 (0.93)	1.46 (1.21)	1.68 (1.30)	1.55 (1.23)	4.38 (2.09)	7.21 (2.67)	4.33 (2.08)	13.55 (3.68)	15.67 (3.96)	10.04 (3.17)	16.38 (4.04)	23.16 (4.81)
M3	YST,Ace ,Quin Fenpo, Spi+Lam,Fenv.	0.12 (0.78)	0.00 (0.71)	0.04 (0.74)	1.46 (1.21)	1.45 (1.20)	1.55 (1.17)	2.04 (1.42)	0.55 (0.73)	3.62 (1.86)	6.50 (2.54)	5.21 (2.26)	16.25 (4.01)	17.56 (4.17)	6.96 (2.64)	15.35 (3.90)	21.40 (4.61)
M4	Tria, Fenv, Quin+Spir, Fenpo,Lamb	0.16 (0.81)	0.00 (0.71)	0.02 (0.72)	1.53 (1.23)	2.26 (1.50)	2.66 (1.63)	4.25 (2.01)	0.86 (0.93)	3.33 (1.82)	6.28 (2.49)	4.18 (2.04)	13.04 (3.61)	15.14 (3.88)	7.02 (2.64)	10.14 (3.17)	19.87 (4.46)
M5	SA,YST,Thia,Fenpo,Lamb, Tria+Dico	0.13 (0.79)	0.22 (0.85)	0.46 (0.97)	2.34 (1.53)	0.60 (0.77)	0.53 (0.73)	1.16 (1.08)	1.33 (1.15)	2.00 (1.37)	5.38 (2.29)	4.46 (2.11)	13.23 (3.63)	16.50 (4.06)	6.52 (2.55)	9.56 (3.09)	13.52 (3.65)
M6	ST,SA,YST,Cyper,Tria,Fenpo, Ace+Spir	0.08 (0.76)	0.02 (0.72)	0.19 (0.82)	1.68 (1.30)	1.93 (1.39)	2.11 (1.45)	2.38 (1.53)	0.59 (0.77)	1.23 (1.11)	5.29 (2.27)	2.38 (1.54)	10.05 (3.17)	13.28 (3.64)	3.19 (1.79)	8.67 (2.94)	15.61 (3.94)
M7	ST,SA,YST,Cyper+Dim.,Fenpo,Ethion+Quin., Lamb.	0.07 (0.75)	0.17 (0.80)	0.30 (0.89)	1.28 (1.11)	0.17 (0.40)	0.48 (0.69)	1.40 (1.18)	0.53 (0.72)	3.32 (1.78)	7.90 (2.81)	3.17 (1.78)	11.94 (3.45)	14.80 (3.84)	3.03 (1.74)	8.49 (2.91)	14.17 (3.75)
M8	Untreated control	0.17 (0.81)	0.38 (0.93)	1.56 (1.43)	2.52 (1.56)	2.60 (1.61)	3.44 (1.84)	5.30 (2.25)	5.70 (2.35)	9.10 (2.99)	13.54 (3.65)	18.16 (4.23)	27.29 (5.20)	31.40 (5.57)	34.93 (5.90)	36.01 (5.98)	39.59 (6.28)
	SE (m)±	0.03	0.04	0.06	0.09	0.08	0.11	0.16	0.13	0.18	0.23	0.16	0.22	0.21	0.12	0.22	0.23
	CD at 5%	NS	0.12	0.19	0.28	0.26	0.33	0.49	0.41	0.54	0.70	0.48	0.67	0.64	0.36	0.65	0.70
	CV%	7.31	9.35	12.08	11.82	12.78	14.83	18.11	19.58	16.23	14.78	12.06	9.74	8.76	6.88	9.83	8.63

N.B: Figures in (*) indicates square root values. While (**) indicates square root x 0.5 values