

**Formulation of pest management modules of okra,  
*Abelmoschus esculentus* (L) under terai agro-ecology of  
West Bengal**

**A Thesis  
Submitted to the  
Uttar Banga Krishi Viswavidyalaya  
In partial fulfillment of the requirements for the Degree of  
Doctor of Philosophy**

**In  
AGRICULTURAL ENTOMOLOGY**

**BY  
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**A-2015-14-D**



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UTTAR BANGA KRISHI VISWAVIDYALAYA  
PUNDIBARI, COOCH BEHAR, WEST BENGAL, INDIA  
2019**

*Dedicated to*

*my beloved*

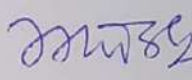
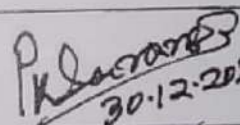
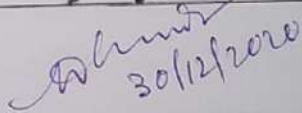
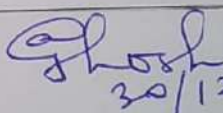
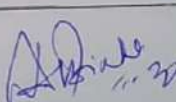
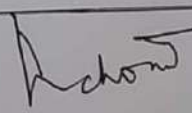
*Pishi*

*&*

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# **APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL ENTOMOLOGY**

We, the undersigned, having been satisfied with the performance of Sri Umesh Das, (Reg. no. A-2015-14-D) in the Viva-Voce examination on Final Evaluation of thesis entitled, "*Formulation of pest management modules of okra, *Abelmoschus esculentus* (L) under terai agro-ecology of West Bengal*" conducted today, the 30<sup>th</sup> December, 2020 recommend that the thesis be accepted for the award of the degree of Doctor of Philosophy (Agriculture) in Agricultural Entomology.

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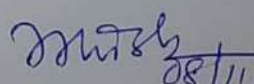
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## CERTIFICATE

This is to certify that the work recorded in the thesis entitled “**Formulation of pest management modules of okra, *Abelmoschus esculentus* (L) under terai agro-ecology of West Bengal**” submitted by Mr. Umesh Das (Reg. no. A-2015-14-D) in partial fulfillment of the requirements for the degree of *Doctor of Philosophy in Agricultural Entomology* of Uttar Banga Krishi Viswavidyalaya, is a faithful and bonafide research work carried out under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation has been duly acknowledged.

Place: Pundibari,  
Coochbehar

  
08/11/2019

Jaydeb Ghosh  
(Chairman, Advisory Committee)

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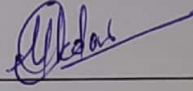
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Date:..08/11/2019  
Pundibari, West Bengal



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(Umesh Das)

## **Abstract**

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Field experiments were carried out at instructional farm, UBKV, Pundibari, Cooch Behar during two successive seasons (post-kharif and pre-kharif) to fulfill the various objectives of the present study.

Seasonal incidence studies on insect-pest of okra and their predators on cultivar Bhindi No.10 during post-kharif and pre-kharif season, the result revealed that the activity of insect-pest and predators were more during pre-kharif season in comparison to post-kharif season except aphid, coccinellid and spider. The peak incidence of insect-pests & predators viz. jassid (10.57/leaf), aphid (8.50/leaf), whitefly (4.89/leaf), fruit borer (28.43%/plant), flea beetle (1.37/plant), leaf folder (0.90/plant), semilooper (0.97/plant), coccinellid (1.27/plant) and spider (0.93/plant) were observed in 47SW, 43SW, 44SW, 45SW, 47SW, 46SW, 45SW, 45SW and 48 SW respectively, during post-kharif season. During pre-kharif season the peak incidence of insect-pests & predators viz. jassid (39.81/leaf), aphid (1.77/leaf), whitefly (1.32/leaf), mite (31.03/leaf), fruit borer (33.22%/plant), flea beetle (1.40/plant), leaf folder (0.80/plant), semilooper (1.00/plant), coccinellid (0.90/plant) and spider (0.83/plant) were observed in 18 SW, 14 SW, 14SW, 24 SW, 20SW, 18SW, 18 SW, 17SW, 18SW and 21 SW respectively.

Weather play important role in both post-kharif and pre-kharif seasons under study. During post-kharif season, jassid population and fruit borer (bored fruit %) had significantly negative correlation with maximum and minimum temperature of all weeks. During pre-kharif season under study jassid population exhibited non-significant positive influence with all environmental parameters of all the weeks except morning RH of 2-lag week which showed negative non-significant effect. In case of fruit borer the maximum temperature of current week, minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer damage.

Studies on screening of fourteen cultivars of okra revealed that two cultivars reacted as less susceptible (Kaveri and Chameli-015), nine cultivars as moderately susceptible and three cultivars as highly susceptible (Meena-117, Bhindi No.10 and Tanvi) with respect to resistance to insect-pests during post-kharif season. During pre-kharif season two cultivars considered as less susceptible (Kaveri and Chameli-015), eight cultivars as moderately susceptible and four cultivars as highly susceptible (Meena-117, Bhindi No.10, PAN-2127 and Tiger Green) with respect to resistance to insect-

pests. It is found that variety JKOH-7315 gave higher yield (12.09t/ha) and showed moderate reaction to insect-pests of okra and this variety can be cultivated in this zone.

The correlation studies among jassid, aphid and white fly population and physico-morphic characters revealed that plant height, number of leaves and branch per plant, thickness (mm) and area (cm<sup>2</sup>) of leaf had significant positive influence on pest population fluctuation while trichome density of leaves (upper and lower surface) showed significant negative correlation during post-kharif and pre-kharif season except aphid population with plant height and whitefly with number of branch/plant during post-kharif and during pre-kharif season, number of leaves and branch per plant, leaf thickness, area of leaf and trichome density of leaf surface (lower) on aphid population and number of branch per plant on jassid population had non-significant effect. The correlation between fruit borer damage and physico-morphic characters of okra fruit revealed that number of seeds/fruit had significant positive effect while trichome/cm<sup>2</sup> had significant negative effect during post-kharif season. However, only trichome/cm<sup>2</sup> had significant negative effect during pre-kharif season.

The correlation results revealed that among the various bio-chemical constituents in leaf and fruit like moisture, nitrogen, phosphorus and protein showed positive correlation with jassid, aphid, whitefly and fruit borer population fluctuation while, lipid, OD phenol, phenol, potassium and zinc, were found to have significantly negative effect during both the season except potassium and zinc on aphid population during pre-kharif season. The chlorophyll content in leaf had positive and significant effect on sucking pest of okra during both season.

Studies were conducted on the bio-efficacy and economics of pesticide modules against pest complex of okra. The insect-pests viz., jassid and fruit borer were major pests of okra crop. The module-14 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)] and module-11 [Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)] were found most effective against jassid, however, against fruit borer, module-4 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC] and module-2 [No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] were found most effective. Highest number of predator (coccinellid and spider) was observed from module-10 [Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract] followed by module-7, module-6, module-5 and module-8. The highest yield of okra fruits was obtained from

module-4 and module-2, while lowest yield was obtained from module-15 (untreated control) during post-kharif and pre-kharif season.

Among the different protection modules, the highest yield were obtained from module-4 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC] and module-2 [No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] gave at par yield of okra with 13.37, 13.04 t/ha during pre-kharif and 12.72, 12.62 t/ha during post-kharif. Therefore these two protection modules are very promising in managing insect pests of okra.

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## *List of symbols and abbreviations*

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|                  |   |                              |
|------------------|---|------------------------------|
| <i>a.i.</i>      | : | Active ingredient            |
| %                | : | Per cent                     |
| /                | : | Per                          |
| @                | : | At the rate                  |
| <sup>0</sup> C   | : | Degree Celsius               |
| cm.              | : | Centimeter                   |
| cm <sup>2</sup>  | : | Centimeter square            |
| DAA              | : | Days after application       |
| DAS              | : | Days after spray             |
| DAT              | : | Days after treatment         |
| DBA              | : | Days before application      |
| E.C.             | : | Emulsifiable concentrate     |
| EIL              | : | Economic injury level        |
| <i>et al.</i>    | : | et alia(= and others)        |
| <i>etc.</i>      | : | et cetera (=and the rest)    |
| ETL              | : | Economic threshold level     |
| Fig.             | : | Figure                       |
| g                | : | gram                         |
| ha               | : | hectare                      |
| hrs              | : | Hours                        |
| <i>i.e.</i>      | : | id est (=that is)            |
| K <sub>2</sub> O | : | Potassium                    |
| kg               | : | kilogram                     |
| L                | : | Liter                        |
| LSD              | : | Least Significant Difference |
| m <sup>2</sup>   | : | Meter square                 |
| ml               | : | Milliliter                   |
| mm               | : | Millimeter                   |
| N <sub>2</sub>   | : | Nitrogen                     |
| NEs              | : | Natural enemies              |
| No.              | : | Number                       |
| RBD              | : | Randomized block design      |
| RH               | : | Relative humidity            |
| SAS              | : | Statistical Analysis System  |
| SC               | : | Soluble concentrate          |
| SG               | : | Soluble granules             |
| SL               | : | Soluble liquid               |
| SW               | : | Standard week                |
| t                | : | Tone                         |
| <i>viz.</i>      | : | Videlicet (=namely)          |
| WG               | : | Wettable granules            |
| Wt.              | : | Weight                       |

## CHAPTER-I

## INTRODUCTION

Vegetables are an indispensable part of our diet supplying vitamins, carbohydrates and minerals needed for a balanced diet. Their value is important especially in developing countries like India, where malnutrition abounds (Randhawa, 1974 and Khan Masood *et al.*, 2001). Amongst the various vegetables grown, okra *Abelmoschus esculentus* L. (Moench) belongs to family Malvaceae is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is also suitable for cultivation as a kitchen garden crop as well as on large high-tech commercial farms beside usual cultivation. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afganistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia and the Southern United States. In India, major okra producing states are Uttar Pradesh, Bihar, West Bengal, Andhra Pradesh, Karnataka and Assam (Anon., 2004).

West Bengal is the leading state in okra sharing 18.4% of the total national production of okra production. In West Bengal, okra occupies an area of 77.40 thousand hectares with production of 913.32 thousand MT during 2016-17 (Anon., 2017). Hoogly and Burdwan are the major growing belts. It is exported to countries in the Middle-East and South-East Asia particularly Singapore, Mauritius, Malaysia, Sri Lanka and Bangladesh, Western Europe and USA. In India, the major export oriented okra producing areas are Nasik, Ozar, Saikheda, Dindoori, Kolhar, Naraingaon and Sholapur in Maharashtra.

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

Okra is known by many local names in different parts of the world. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhindi in India. It is quite popular in India because of well-known practices of its cultivation, sustainable yield and adaptability to varying moisture conditions. It is cultivated for its fibrous fruits or pods containing round, white

seeds. The fruits are harvested when immature and eaten as a vegetable. Okra fruit can be cooked in a variety of ways. The roots and stems of okra are used for cleaning the cane juice from which gur or brown sugar is prepared (Chauhan, 1972).

Okra crop is ravaged by as many as 45 species of insect-pests throughout its growth period. Among these, cotton jassid, *Amrasca biguttula biguttula* (Ishida) and shoot and fruit borers, *Earias vittella* (Fabricius), *E. insulana* (Boisduval) are quite serious and major limiting factors in okra cultivation (Mandal *et al.*, 2006). These pests are found to infest the crop throughout vegetative as well as reproductive stages causing ample reduction in yield (Satpathy and Rai, 1999. Rao and Rejendran (2003) recorded 72 spp. of insects attacking okra, of which, the sucking pests like leafhopper (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemesia tabaci* Genn.) and mite (*Tetranychus cinnabarinus* Boisd.), fruit borers Viz. *Earias vittella* (Fab.), *Earias insulana* (Bois) and *Helicoverpa armigera* (Hub) are known to cause heavy damage to the crop.

Dhandapani *et al.* (2003) documented that losses in okra due to leafhopper (*Amrasca biguttula biguttula*) and fruit borer (*Earias vittella*) were 50-52 and 49-74 per cent, respectively in India. Moreover, Pareek *et al.* (2003) has also been reported that the fruit borer complex alone was responsible to cause economic damage to the extent of 52.33 to 70.75 per cent in okra.

Misra *et al.*, (2002) reported that damage to okra crop by *Earias vittella* is done by two ways. First, the terminal portion of growing shoots is bored by caterpillars, which move down by making tunnels inside. As a result, the shoot drop downward or dry up. Second, the larvae enter the fruit by making holes rendering them unfit for human consumption.

The jassids suck the cell sap from lower surface of the leaves and inject toxic substance resulting in curling of leaves, as a result of which the plant growth is retarded. The severe infestation of the pest causes burning of leaves which fall later and results in 40-60 per cent decrease in yield. The whitefly transmits viral diseases from diseased to healthy plants as a vector (Narke and Suryawanshi, 1987)

Spider mites are becoming serious pests of many economically important crops. Quality and yield of okra crop are adversely affected by mite pests, more often damaging the crop from early vegetative stage to maturity (Ambegaonkar and Bilapate, 1984). Among the spider mites species damaging this crop, *Tetranychus urticae* Koch, *Tetranychus macfarlanei* Baker and Pritchard, *Tetranychus ludeni* Zacher and

*Tetranychus neocaledonicus* Andre are important. The red spider mite, *T. macfarlanei*, little known species (Sejalia, 1989), which is assuming serious proportions in recent times in Karnataka, Kerala, Gujarat, Punjab and West Bengal (Zeity, 2015).

Mites infest the under surface of leaves by producing profuse webbing and suck the chlorophyll contents, which lead to appearance of chlorotic spots on leaves and other damage symptoms like stippling, yellowing of leaf reported by Martinez *et al.*, 2006, which decrease photosynthesis and transpiration rate, severely affecting the crop yield up to 24% (Anon., 1996),

Due to heavy pest-load, tremendous volume of insecticides is being used to manage the insect-pest of okra. It is a matter of deep concern that fruits are plucked and marketed even after a day of spraying. Since the tender fruits of okra are taken after a little cooking, there is every possibility of retaining toxic residue in food stuff. Frequent use of synthetic pesticides indiscriminately leads to disturbance in ecosystem, disrupt delicate balance between insect-pests and their natural enemies and enhance resistance to insecticides in the pests (Kumar *et al.*, 2002). Moreover, during export there is also risk of rejection of whole consignment due to presence of pesticide residue. It is mention worthy to note here that despite leading state in okra production sharing 18.4% of the total national production of okra, West Bengal has no share in export. Export is mainly restricted in some areas of Maharashtra. This is only due to lack of endeavour to produce export quality okra in our state; mostly related with production of chemical residue free produce but here control is mainly concerned with application of chemical fertilizers, synthetic pesticides etc.

The geographical distribution, agro-ecological situations and soil characteristics of terai region not only favor cultivation of okra but also create conditions conducive for infestation of different insect-pest. In terai region too, problem of pests, crop growing and residual hazards are similar to that of other parts of the state.

This situation calls for formulation of an ecologically safe, economically viable season bound self-sustainable pest management strategy of okra through simulating all the technically feasible means of control to develop crop-pest protection modules for the area under consideration. This will also trigger further researches on different crops and areas.

**Problem identified:**

- ❖ Heavy crop loss due to insect-pest accounting 40-56% in different parts of India and 38.41% in terai region.

- ❖ Despite variation in pest infestation over seasons, scanty information on pest problem and their management strategy are available.
- ❖ Pesticide biased pest control programme in vogue leading into increased cost of production vis-à-vis reduction of beneficial organism.
- ❖ Scanty information are available on about resistant of insect against physio-morphic character and chemical component of plant.

#### **Technological gap**

- ❖ Lack of effort towards pest management programme through module of pesticides.
- ❖ Non-availability of information about physio-morphic character and chemical component of plant for framing the appropriate management practices in this area.
- ❖ Non-availability of information on the effect of natural enemies against population build-up of insect pest attacking okra.

The ultimate objective of the study is to develop region-specific pest management module simulating all the technically feasible means of control and this can be achieved through working on the following specific objectives:

- ❖ Studies on the population dynamics of different pest and natural enemies of okra to find out the impact of abiotic and biotic factors on the pest population fluctuation.
- ❖ Screening of the available genotypes/cultivars of okra for resistance/susceptibility to different pests based on physical and chemical characters of the cultivars.
- ❖ Formulation of region-specific pest management modules of okra through integration of various pest management strategies in compatible way, like, mechanical, botanical, microbial and chemical.

## CHAPTER-II

### REVIEW OF LITERATURE

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Amongst the various vegetables grown, okra *Abelmoschus esculentus* L. (Moench) belongs to family Malvaceae is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. Okra crop is ravaged by as many as 45 species of insect-pests throughout its growth period. Among these, cotton jassid, *Amrasca biguttula biguttula* (Ishida) and shoot and fruit borers, *Earias vittella* (Fabricius), *E. insulana* (Boisduval) are quite serious and major limiting factors in okra cultivation (Mandal *et al.*, 2006). These pests are found to infest the crop throughout vegetative as well as reproductive stages causing ample reduction in yield (Satpathy and Rai, 1999).

The okra is grown countrywide and elsewhere throughout the year. Several workers have studied variation in the incidence and activity of crop pests in different growing seasons and places. Keeping in view the severity of insect-pests on this crop especially in the terai region of West Bengal, call for development of safe strategy of pest management is the need of the day. The present investigation has been framed to address the research need. The literature pertaining to present investigation entitled **“Formulation of pest management modules of okra, *Abelmoschus esculentus* (L) under terai agro-ecology of West Bengal”** was collected and grouped under the following heads.

#### 2.1. Seasonal incidence of different insect-pests of okra

##### 2.1.1. Sucking pests

Ecological differences influence the variation of population build up of insect-pests of okra from region to region. Rao and Rejendran, (2003) recorded that 72 *Spp.* of insects had been found to attack okra plant. Among them sucking pests like leaf hopper (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemesia tabaci* Genn.) and mite (*Tetranychus cinnabarinus* Boisd.) yielded economic damage to the crop. Harinkhere (2014) recorded that green stink bug (*N. viridula*), red spider mite (*Tetranychus* sp.), whitefly (*B. tabaci*) and jassid (*A. biguttula biguttula*) sucked the cell sap of the leaves and stem resulted in the loss of vegetative vigour of plant.

##### 2.1.1.1. Jassid (*Amrasca biguttula biguttula* Ishida)

Srinivasa (1993) reported that the population of jassid appeared in okra crop after 3 weeks of sowing (10<sup>th</sup> SW) in pre-kharif and 36<sup>th</sup> SW i.e. after 2 weeks of sowing in post-kharif crop at Dhadwad (India). Early sown crop escaped leafhopper attack but

September and October months are very much congenial for leaf hopper population build up. Kumari *et al.* (2012) observed jassid population with mean density of 4.8 per 3 leaves on the second week of April and 22.3 per 3 leaves on fourth week of May at B.H.U. Varanasi (U.P.). Kadam (2003) observed that jassid population was associated from early vegetative to late flowering and fruiting stage of crop at Raipur (C.G.). Jayasimha *et al.* (2012) studied the seasonal incidence of leafhopper *A. biguttula biguttula* (Ishida) for entire crop growth stages and recorded highest population 16.44 leaf hoppers/leaf during second fortnight of March, while lowest of 0.25 leaf hoppers/leaf in second fortnight of December at Shimoga (India). Ghosh *et al.* (1999) recorded peak population of jassid in mid June in terai region of West Bengal. The study of Gogoi and Dutta (2000) revealed maximum jassid population during the last week of May (37.53 nymphs per leaf) and middle of April (30 nymphs per leaf) at Assam (India). Mahmood *et al.* (2002) noted dynamics of *A. biguttula biguttula* from 21st May to 6<sup>th</sup> August. Lokesh and Singh (2005) reported peak infestation from 4<sup>th</sup> week of August to the 2<sup>nd</sup> week of September at Hisar (India). Ghosh and Senapati (2003) found highest jassid population (4.63/leaf) in April-May and lowest (0.50/leaf) in mid-July at terai region of West Bengal. However, Singh *et al.* (2005) recorded jassid incidence from the 3<sup>rd</sup> week of August to till the last week of December. The population increased gradually from last week of October to 3<sup>rd</sup> week of November (82.20-100.0% incidence and 1.11-1.84 jassids/leaf) and the highest jassid density was recorded in the 1<sup>st</sup> week of November at U.P. (India).

Mahmood *et al.* (2002) found positive and significant correlation of leaf hopper fluctuation with maximum and minimum temperatures and negative and non-significant relation to relative humidity and rainfall. Sunshine was also had positive but non-significant correlation with leaf hopper population. Chauhan (2014) observed leaf hopper population throughout the cropping season having negative correlation with maximum temperature and positive with morning relative humidity. Kumaranag (2015) found that leaf hopper attacked the crop from early stage and attained peak between 32<sup>nd</sup> and 34<sup>th</sup> SW and had significant positive correlation with evening relative humidity and rainfall and significant negative effect with bright sunshine hours. Nath *et al.* (2011) observed a non-significant positive correlation between jassid population and temperature, rainfall, sunshine hours and relative humidity at Jorhat (Assam). The infestation commenced on okra crop from last week of May and remained in field till final harvest *i.e.* first week of

August and peaked during first week of July *i.e.* 12<sup>th</sup> week after sowing in Mizorum as reported by Boopathi *et al.* (2011).

Das *et al.* (2003) observed that leaf hopper population commenced on 26<sup>th</sup> standard week and reached its peak intensity (69.6/25 leaves) during 30<sup>th</sup> standard week *i.e.*, last week of July. Correlation studies revealed that minimum temperature exhibited a significant positive relation, whereas maximum temperature had a significant negative correlation. At Nauni, Himachal Pradesh, Verma *et al.* (2010) observed appearance of jassid population on okra in last week of July (1.6/ plant) which peaked (2.8/ plant) in first week of August due to positive impact of maximum and minimum temperature and negative effect of relative humidity and rainfall to the jassid population build up. Dabhi *et al.* (2014) reported that temperature (maximum and minimum), vapour pressure (morning and evening), evening vapour pressure deficit and wind speed had significant positive effect on population fluctuation, while temperature range showed significant negative impact on this pest during summer season, bright sunshine hours showed significant positive impact with the population of leaf hopper and evening vapour pressure showed significant negative impact to jassid during *kharif* season.

#### **2.1.1.2. Aphid (*Aphis gossypii* Glover)**

Pathan and Bharpoda (2016) found low and sporadic incidence of aphid only during 2<sup>nd</sup> week of March (0.03/3 leaves), 4<sup>th</sup> week of March (2.68/3 leaves), 1<sup>st</sup> week of April (1.35/3 leaves) and 2<sup>nd</sup> week of April (0.03/3 leaves). The population ceased off after 2<sup>nd</sup> week of April (15<sup>th</sup> SMW) and showed highly significant negative association with bright sunshine hours. Ghosh *et al.* (2004) reported that aphid in terai region of West Bengal was active throughout the year and reached its highest population (94.08/leaf) in early August. Population of aphid showed significant positive correlation with average temperature, relative humidity and weekly rainfall on okra crop. Singh *et al.* (2005c) noticed aphid initiation from 3<sup>rd</sup> week of August that reached its peak in 3<sup>rd</sup> week of November (4.28 aphids/leaf, 92.20% incidence). While Konar *et al.* (2013) reported that in Hooghly, West Bengal aphid incidence was initiated during 2<sup>nd</sup> week of July and reached its peak (39.28 aphids/3 leaves) during 1<sup>st</sup> week of September at minimum and maximum temperature of 26.10 and 33.50°C; minimum and maximum RH of 72.57 and 97.57% respectively and 1.6 mm of rainfall. The pest persisted throughout the crop growth period with low incidence. Singh *et al.*, (2013) obtained commencement of aphid population from 4<sup>th</sup> week after sowing *i.e.*, 2<sup>nd</sup> week of September with an average population of 1.42 aphids/leaf which increased gradually and reached the peak

of 25.87 aphids per leaf during 2<sup>nd</sup> week of October at Chitrakoot (M. P.). At Palampur the aphid population appeared in 1<sup>st</sup> week of July with a density of 4.58 aphids/3leaves on okra crop that reached maximum in 3<sup>rd</sup> week of August with 94.65aphids/3 leaves and thereafter, the population started declining (Badiyala, 2007).

Shah *et al.* (2009) found the incidence of aphid in the field from 1<sup>st</sup> week of May till 1<sup>st</sup> week of September at Manipur. The peak population was recorded during last week of July. Correlation studies between aphid population and climatic parameters revealed significantly positive effect of average sunshine and windspeed, significant negative correlation with relative humidity and total rainfall. Shukla (2014) observed that the aphid population was reached to its peak (27.17 aphids/ 3 leaves) during 14<sup>th</sup> weeks after sowing (first week of July) and the population of aphids was more abundant on the crop during June and July 2011. He found positive correlation of rainfall and relative humidity and negative correlation of both maximum and minimum temperature with aphid population. The aphid population had negative and non- significant correlation with minimum temperature in February, August, September, October and March sown crop as observed by Kanjarla (2006). Whereas it had positive and significant correlation with maximum temperature in January and March sown crop but, non-significantly in July and September sown crop.

#### **2.1.1.3. Whitefly (*Bemisia tabaci* Gennadius)**

The whitefly population was found throughout the crop growing season during Kharif and Rabi (Netam *et al.*, 2007). The activity of whiteflies on okra crop started after two weeks of sowing *i.e.*, from first week of April (9.16 whieflies/3 leaves) and increased gradually upto last week of April (14.91 whiteflies/3 leaves) and there after population started declining at Raipur (C.G.). Singh *et al.* (2013) observed the activity of whiteflies on okra crop from three week after sowing *i.e.* first fortnight of September with gradual increase in the activity in the succeeding weeks with maximum population on 4<sup>th</sup> week of September at Chitrakoot, Satna (M.P.). Selvaraj *et al.* (2010) observed the maximum level of incidence of whitefly from 33<sup>rd</sup> to 36<sup>th</sup> standard week (mid august to mid October) while Netam (2003) reported from 2<sup>nd</sup> to last week of October (2.7 whitefly/plant). Harinkhere (2014) studied that whitefly population started increasing from 37<sup>th</sup> SW and reached peak (25.46 whitefly/30 leaves) on 44<sup>th</sup> SW. Nath *et al.* (2011) observed the maximum level of whitefly population (10.52/leaf) on 2<sup>nd</sup> week of August (33<sup>rd</sup> SW) during first year and during second year in 3<sup>rd</sup> week of August (34<sup>th</sup> SW) (11.66/leaf). Ghosh *et al.* (1999) reported maximum activity of whitefly (18.4/plant)

during last week of March and found active throughout the crop growth period in terai region of West Bengal. Anitha, (2007) reported that the activity of whiteflies on okra sown during fourth week of March 2006, started from first week of April 2006 with 9.16 whiteflies per 3 leaves (2nd week of sowing). There was a gradual increase in whitefly population up to last week of April (14.91 whiteflies/3 leaves) and there after population started declining. However, population was low throughout the year.

Impact of weather factors on the fluctuation of whitefly population was studied by different workers. Significantly negative impact of temperature (maximum, minimum and mean) and relative humidity (morning and evening) with whitefly population and significantly positive effect of rainfall were reported by Singh *et al.* (2013). Das *et al.* (2011) reported highly significant positive correlation between whitefly population and minimum and maximum temperature, evening and mean relative humidity, vapour pressure, wind speed and rainfall at Gujrat. Nath *et al.* (2011) observed that whitefly population had non-significant positive correlation with maximum, minimum and average temperature, rainfall, sun shine hours and relative humidity.

#### **2.1.1.4. Mite**

Gulati (2004) reported that the mite population appeared in the month of April and then attained peak in June on summer okra where in kharif crop, the population was maximum in October at Hisar (India). As per Anitha and Nandihalli (2008) peak incidence of mites was noticed during second week of May (14.61 mites/3 leaves).

Geroh and Gulati (2007) observed two peaks in the activity of *T. urticae* during first fortnight of June and first fortnight of August respectively. Among the abiotic factors, spider mite population showed significant positive correlation with maximum and minimum temperature and significant negative correlation with relative humidity. They further added that temperature of 32<sup>0</sup> and 22.5<sup>0</sup>C and relative humidity of 86.5 and 64.5 per cent were optimum for mite population for summer and kharif crops. Dhar *et al.* (2004) reported that the temperature showed a significant positive correlation, while relative humidity had significant but negative correlation with the population of mite and rainfall does not show any significant correlation. Ghosh (2013b) recorded the activity of *T. urticae* throughout the crop season at West Bengal with a peak during 23<sup>rd</sup> SW (last week of May) in summer crop and 42<sup>nd</sup> SW (first week of October) in the *kharif* okra crop and mites population showed non-significant positive correlation with temperature, maximum relative humidity, total rainfall and significant positive correlation with minimum and average relative humidity.

### 2.1.2. Internal feeder

Internal feeder, like *Earias vittella* Fab., *Earias insulana* Bois. and *Helicoverpa armigera* (Hub.) are known to cause economic damage to the crop (Rao and Rejendran, 2003). Harinkhere (2014) recorded that okra shoot and fruit borer (*E. vittella*) remained active till maturity of the crop.

#### 2.1.2.1. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hubner)

Shivashankara (2012) observed that fruit borer incidence started from vegetative stage (5<sup>th</sup> WAS), peaked in 14<sup>th</sup> WAS and continued till the harvest of the crop with a range of 0.08 to 3.20 larvae per plant. In line with this Acharya (2002) and Dangi (2004) observed okra shoot and fruit borer attack from 6<sup>th</sup> week after sowing. Netam (2003) recorded peak population (1.08 larvae/ plant) of *Earias vittella* during second week of November. Pal *et al.* (2013) observed no incidence of shoot and fruit borer at early growth stages of the crop, however, the population was started from 14<sup>th</sup> standard week *i.e.* 2<sup>nd</sup> week of April. The activity of the shoot and fruit borer was initially noticed on okra crop during the first week of August (31<sup>st</sup> SW) and continued till harvest of the crop by Kumaranag (2015). It was also reported that weather parameters together accounted for 81-93 per cent ( $R^2$  value) fluctuations in fruit damage. Dabhi *et al.* (2013) computed a regression equation considering important abiotic factors for predicting the per cent fruit damage and explained variability of 89-92 per cent in fruit damage. The fruit damage was non-significantly and negatively correlated with increase in the frequency and amount of rainfall. Sharma *et al.* (2010) noticed shoot and fruit borer infestation from 29<sup>th</sup> standard week on kharif sown okra crop at Udaipur (Rajasthan) with peak (91.6 per cent) in 45<sup>th</sup> SW. The maximum quantum of damaged fruits was found 54.3% in number basis and 54.7% in weight basis when the crop was 18 weeks old.

Selvaraj *et al.* (2010) recorded the peak incidence of spotted bollworm in 37<sup>th</sup> standard week (first September to mid October). Both maximum and minimum temperature was found to exert significant positive influence on *E.vittella*. Yadav *et al.* (2007) observed the shoot and fruit borer attack from the third week of August on 5<sup>th</sup> week old plants and continued till the fourth week of October on 12<sup>th</sup> week old plants and maximum fruit damage was recorded in the third week of September at Kanpur. Dangi and Anveta (2005) reported that fruit borer, *E. vittella* incidence commenced in 4<sup>th</sup> week of August (four weeks after sowing) by laying eggs on growing shoots. Damage to the growing shoots and to fruits started in the last week of August and 1<sup>st</sup>

week of September respectively. They also observed maximum damage of fruits (71.80% in number and 70.24% in weight basis) during last week of September. At Mohanpur, West Bengal, Naresh *et al.* (2003) found damage of *E. vittella* on okra shoots and fruits on 3<sup>rd</sup> and 6<sup>th</sup> weeks old crop with two peaks, one at the vegetative stage (2<sup>nd</sup> fortnight of August) and other at reproductive stage (2<sup>nd</sup> week of September).

Ahmad *et al.* (2000) observed peak larval population (185.7/plant) in okra fruits in 1<sup>st</sup> fortnight of July at 29.9 ± 2.9°C temperature, 84.0 ± 5.1% relative humidity (RH) and 61.4 mm precipitation, while the population was minimum (109.3) during 2<sup>nd</sup> fortnight of May when the temperature was comparatively higher 31.6 ± 7.7°C, RH was 54 ± 2.1% and rainfall absent. Mandal *et al.* (2006a) reported that maximum temperature had negative effect, while minimum temperature and relative humidity showed positive effect on larval population buildup and the fruit damage at Samastipur, Bihar. Chauhan (2014) observed fruit damage by *Earias* spp. between 31<sup>st</sup> to 36<sup>th</sup> standard meteorological weeks with 13.9 per cent fruit damage on 36<sup>th</sup> SMW and minimum temperature influenced the damage significantly and negatively. Mohanasundaram and Sharma (2011b) and Aziz *et al.* (2011) reported significant positive effect of minimum temperature on the fruit damage.

### **2.1.3. Foliage feeder**

Cotton leafroller, *Sylepta derogata* (Fabricius) is a sporadic pest and cause considerable damage to okra on the approach of congenial weather parameters. The larvae roll the margin of leaves and live within and eat the chlorophyll content making holes in leaves. Ghosh *et al.* (1999) observed peak population of leaf roller in the month of August with favourable mean weather factors (RH 90-97%, maximum temperature 29.3°C, minimum temperature 24°C) and also had positive correlation with relative humidity. Badiyala, (2011) observed that peak population of leaf roller appeared during 1<sup>st</sup> to 3<sup>rd</sup> week of August at Palampur and last week of July at Kachhiari during 2005 and 2006. Relative humidity influenced pest incidence on okra significantly positive while maximum temperature and bright sunshine hours exhibited a significant negative effect on larval population and leaf infestation.

### **2.2. Seasonal incidence of predator (Coccinellids and Spider)**

Kumaranag (2015) reported that three species of coccinellids (*Coccinella septempunctata*, *Cheilomenes sexmaculata* and *Brumoides suturalis*) were associated with sucking pests of okra crop. The peak population of coccinellids was recorded in between 33<sup>rd</sup> and 34<sup>th</sup> SW with 1.0, 1.03 and 1.57 coccinellids per plant during 2011,

2012 and 2013 respectively at Haryana (Hisar). He also found peak population of spider during 34<sup>th</sup> SW (third week of August) in 2011 and 33<sup>rd</sup> SW (Second week of August) during both 2012 and 2013 when the leafhopper population reached its peak at maximum vegetative stage of the crop. Nonita *et al.* (2006) concluded that coccinellid appeared in the field during the first week of May and continued their activities until the end of July. In Rajasthan, population build up of coccinellids on the okra started from the first week of August (1.8 and 1.7 coccinellid/plant) and reached the maximum level (6.2 and 6.4 coccinellid/plant) in the first week of October during 2002 and 2003 respectively (Meena and Kanwat 2010). They further found that minimum temperature and relative humidity had negative correlation while, maximum temperature showed non-significant positive and rainfall showed non-significant negative correlation with coccinellids population. The population of 0.15 and 0.03 coccinellid adults/plant was observed on crop during 1<sup>st</sup> (5<sup>th</sup> week after germination) and 2<sup>nd</sup> (6<sup>th</sup> week after germination) week of April and the population disappeared from the crop later on and they also found that the population of spiders started to appear on crop during 1<sup>st</sup> week of April (5<sup>th</sup> week after germination) (Pathan and Bharpoda, 2016). Kumaranag (2015) also found peak population of spider during the 34<sup>th</sup> SW (third week of August) in 2011 and 33<sup>rd</sup> SW (Second week of August) during both 2012 and 2013 when the leafhopper population reached its peak at maximum vegetative stage of the crop. The peak activity of spider (0.25 spiders/plant) was observed during 2<sup>nd</sup> week of May (19<sup>th</sup> SW, 10<sup>th</sup> week after germination). Maximum temperature and minimum temperature exhibited highly significant positive association with population fluctuation of spiders reported by Hegde *et al.* (2004).

Purohit *et al.* (2006) recorded maximum population of lady bird beetle during 3<sup>rd</sup> week of August and in the 2<sup>nd</sup> week of December during 2003 and 1<sup>st</sup> week of September and December in 2004. The coccinellid population had non-significant correlation with rainfall, rainy days, evaporation and wind velocity. Singh *et al.* (2013) observed that coccinellids appeared more or less after the 5<sup>th</sup> week of the occurrence of aphid *i.e.*, fourth week of September (39<sup>th</sup> standard week) with 0.33 coccinellids/leaf at Chitrokot and after that the population gradually increased and peaked with 2.51 coccinellids/leaf at second week of October (41<sup>st</sup> standard week). The population then decreased gradually and continued till third week of November (47<sup>th</sup> standard week). Sahito (2013) observed positive correlation between spider population and morning humidity and evening

humidity. Muchhadiya *et al.* (2014) reported negative correlation of spider population with maximum temperature.

### **2.3. Screening of okra cultivars for resistance against insect- pests**

The varietal resistance is a vital tool of integrated pest management. It is highly effective based on cost-benefit analysis and plays an important role in sustaining productivity (Dhaliwal and Arora, 2003). Plant morphology is known to play an important role in imparting resistance or susceptibility to a cultivar. Physical appearance of the plant like colour, hairiness, hardness, trichomes, surface waxes, incrustation of minerals in cuticle and anatomical adaptation of organs may affect the preference or non-preference for egg laying, feeding and development of an insect (Dhankhar, 1997). In addition, wide array of chemical substances including inorganic chemicals, primary metabolites, intermediary metabolites and secondary substances are known to render cultivars less suitable or unsuitable to a wide array of insect-pests (Dhaliwal and Arora, 2003).

#### **2.3.1. Sucking pests**

##### **2.3.1.1. Jassid (*Amrasca biguttula biguttula* Ishida)**

Hatab *et al.*, (2013) studied on performance of okra genotypes against some sucking pests like aphids, mites, whitefly, leaf miner and leafhopper. They found genotypes like Balady(B), Mansoura Red (HM) as susceptible; Roomy (R), Str.L1, Str.L3, Str.L4, Str.L6 and Str.L8 as moderate and Str.L9, Str.L5, Cairo Red (HK), Str. L6 and Str. L7 as resistant against jassids. Srinivasa and Sugeetha (2001) tested nine okra cultivars for resistance against leafhopper and registered the lowest and highest number of hoppers in KS 410 and GOH-1. However, Shakeel *et al.* (2000) reported that the population density of *A. biguttula biguttula* on Climson Spineless, T-13, Pusa Green, Perking Dwarf, Rich Green and Swat Local cultivar of okra ranged 0.9-79.4, 1.5-78.7, 2.2-85.2, 1.2-60.8, 2.1-92.2, and 1.4-60.9 jassids/plant respectively. Jalgaonkar *et al.* (2002) found that okra germplasm HIHC-068 was least affected by jassid (9.25 jassids/plant) followed by VB-9101 (9.80 jassids/plant) and the highest population was recorded on KS-410 (12.98/plant) at Dapoli.

Gadekar (2015) screened ten varieties of okra against sucking pest and found varieties Hissar Unnat and Varsha Uphar as less susceptible, Kashi Mohini (VRO-03) and Aprajita as highly susceptible and Arka Abhay, A-4, Pusa Sawani, Arka Anamika, Parbhani Kranti and Hissar Naveen as moderately susceptible to jassids. Arka Abhay, Arka Anamika, Pusa Sawani and Parbhani Kranti were reported as moderately

susceptible by Patni and Pareek (2000), Bairwa and Kanwat (2001) and Bhat *et al* (2007) against jassids. Okra Hybrid-1 was reported significantly more tolerant over Pusa Sawani against jassid at Gujarat by Patel *et al.* (2003). Solanki (2005) revealed that okra genotypes Arka Anamika, Gujarat Okra-1, AOL-99-24, JO (2K)-1, AOL-02-1 and JOL-02-12 were least susceptible, whereas JO (2K)-20, JO (2K)-19, JO (2K)-16, JO (2K)-15, JO (2K)-10, AOL-02-4, Pusa Sawani, JO (2K)-13, Gujarat Okra-2, JOL-02-5, Parbhani Kranti and JOL-1 were most susceptible to jassid. Chavda (2006) tested twenty okra genotypes at Junagadh for their susceptibility to jassid and found that genotypes Gujarat Okra-1, AOL-02-4, AOL-02-1, AOL-99-28, Gopi, AOL-99-24 were least susceptible, HRB-55, Pusa Sawani, JO-2K-20, JO-2K-17, Gujarat Okra-2, Parbhani Kranti, JO (2K)-19, JOL-2, JOL-02-12, JO (2K)-1, JO (2K)-13 and JO(2K)-14 were most susceptible, while genotypes viz., JOL-2K-18 and JOL-02-10 were found moderately susceptible. Iqbal *et al.* (2008) conducted preliminary screening of 30 okra genotypes against jassid at Faisalabad, Pakistan and found 3 genotypes (Pusa Sawani, Dera Local and Okra-3) as comparatively susceptible, 3 as intermediate susceptible (Karam-5, Sabzpari and Clean Spineless) and 3 (Makhmali, Punjab Selection and Green Wonder) as resistant. Among them Pusa Sawani showed maximum Host Plant Susceptibility Indices (HPSI) (18 per cent) and Green Wonder was found comparatively resistant with minimum HPSI (5 per cent). Sharma *et al.* (2001) added that among the different okra varieties evaluated for resistance to *A. biguttula biguttula*, Pusa Sawani was observed to be most susceptible and recorded lowest fruit yield.

#### **2.3.1.2. Aphid (*Aphis gossypii* Glover)**

Roy (1990) reported that out of 5 varieties of okra, Selection-2 was least susceptible and Selection-1 was most susceptible to *A. gossypii* at Orissa. Ghosh *et al.*, (1999) tested six okra varieties viz. Parbhani Kranti, Arka Anamika, LBH-55, H-7, Amtala hybrid and Kamdhenu at Pundibari (West Bengal) for resistance against aphid of okra. It was found that both Arka Anamika and Parbhani Kranti showed moderate resistance against aphids.

#### **2.3.1.3. Whitefly (*Bemisia tabaci* Gennadius)**

Bairwa and Kanwat (2001) found that okra varieties like Hissar Unnat, Varsha Uphar and Pusa Sawani were found least susceptible to whitefly, while varieties namely A-4, Arka Abhay, Arka Anamika, Parbhani Kranti, Hissar Naveen and Kashi Mohini were moderately susceptible. The varieties A-4, Arka Abhay, Arka Anamika, Parbhani Kranti, Hissar Naveen, and Kashi Mohini were emerged as moderately susceptible and

Aprajita emerged as highly susceptible against whitefly on okra crop at Bikaner as observed by Gadekar (2015).

#### **2.3.1.4. Mite**

Sahayaraj *et al.* (2003) reported okra varieties like EC 28427, IC 141065 and IC 90049 were found resistant and EC 329364, IC 140977 and TC 90074 as moderately resistant against mite *Tetranychus cinnabarinus* (Boisduval) in Palayamkottai, Andaman and Nicobar islands. Roseleen and Ramaraju (2011b) revealed okra variety Mahyco-10 as susceptible check harbouring maximum number of *T.urticae* mites (21.11 and 35.61 mites/cm<sup>2</sup> on field and potted plants, respectively).

#### **2.3.2. Internal feeder**

##### **2.3.2.1. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera*)**

Gautam *et al.* (2013) observed that out of one hundred germplasms, only 2 were resistant, 15 were moderately resistant, 66 were moderately susceptible and 17 were susceptible as per shoot damage scale. The minimum shoot damage was observed in germplasm 315 and maximum in Thin No. 3. Ghosh *et al.* (1999) tested six okra varieties viz. Parbhani Kranti, Arka Anamika, LBH-55, H-7, Amtala hybrid and Kamdhenu at Pundibari (West Bengal) for resistance to fruit borers and observed 7.73-10.10% fruit damage on all the varieties. However, Shukla *et al.* (1998) described that okra varieties Ankur 35 and Parbhani Kranti registered higher fruit yields at Jabalpur (Madhya Pradesh). Srinivasa and Sugeetha (2001) conducted 2 season trial at Bangalore (Karnataka) on nine okra cultivars to evaluate resistance against *Earias spp.* and observed that none of the cultivars was completely free from infestation and the most susceptible variety was GOH-1. Naresh *et al.* (2003) observed Vijaya as less susceptible cultivar based on shoot damage by *Earias spp.* however, fruit damage was found lowest in Hybrid No. 8 followed by Jaya, OH-1, Arka Abhoy, Harsha, Vijaya, Arka Anamika and Soumya at Mohanpur, West Bengal. Neeraja *et al.* (2004) recorded 21.7% fruit borer incidence in MBORH-913 to 27.6% in JNDOH-1 at Rajendranagar, Hyderabad. Singh *et al.* (2005) revealed that out of 20 okra germplasms, KS-410, A-4 and NDO-10 had lower shoot as well as fruit damage at Faizabad (Uttar Pradesh).

#### **2.3.3. Foliage feeder**

Naresh *et al.* (2003) screened 8 okra cultivars at Mohanpur (West Bengal) against leaf roller and found the order of susceptibility as Arka Anamika < Vijaya < Hybrid No.8 < OH-1 < Arka Abhoy < Jaya < Soumya < Harsha. While, Ghosh *et al.* (1999) screened six okra varieties viz. Parbhani Kranti, Arka Anamika, LBH-55, H-7, Amtala hybrid and

Kamdhenu at Pundibari (West Bengal) against leafroller, *Sylepta derogata* and found both Arka Anamika (1.07 larvae/plant) and Parbhani Kranti (0.32 larva/plant) were moderately resistant to this pest.

#### **2.4. Host plant resistant against insect pest of okra**

Plant characteristics have been recognized as important resistance factors by both plant breeders and entomologists. Each plant species has a distinctive set of defense traits ranging from morphological to phyto-chemical factors that have behavioral and physiological effect for a potential herbivore consumer (Slansky, 1990). During the preliminary stages of host acceptance the first plant organ contacted are surface hairs or trichomes. Pubescence as a resistance factor interferes with insect oviposition, attachment to the plant, feeding, colonization and ingestion. Conversely, glabrous character of leaves may also result in reduction of population in certain cases (Lukefahr *et al.*, 1965) and pubescent accessions may support more eggs than having glabrous leaves (Murugesan, 1982).

In order to prevent the infestation of the pests and to produce a quality crop, it is essential to manage the pest population with suitable measures. The resistant varieties of crops offer insect pest management at no additional cost. An insect resistant plant offer ideal prevention against insect damage, involved minimum cost of production and are eco-friendly. The use of resistant varieties is one of the most economical and effective methods of control

Morphological descriptors are the base for characterization of plant genotypes on the basis of external appearance. Further characterization of okra varieties is required for their description under plant variety protection legislation, because varietal testing for distinctness, uniformity and stability is the basis for protection for a new plant variety under Indian law (Protection of Plant Varieties and Farmer's right Act, 2011). The demand for clean and ecologically sound control envisages careful planning for rationalizing the insecticides interventions. Development of resistant varieties is an ideal component against buildup of pest population at no additional cost, compatible with other methods of pest control and free from pollution. Various biophysical and biochemical characters of the plants play an important role by providing resistance against the pest.

## **2.4.1. Physico-morphic characters of okra crop and its relation to pest population**

### **2.4.1.1. Sucking pests**

Several workers have screened out different okra germplasm for resistance to jassid under different geographical conditions. Nymphal population, injury index and susceptibility index of jassid had negative and significant relation to hair density, negative but non-significant to hair length and angle of insertion of hair and significant and positive relation to lacination index at 56 DAS (Sandhi *et al.*, 2017). In new Gangetic Alluvial Zone of West Bengal, Chatterjee *et al.* (2019) studied the effect of morphological features of okra crop on the population level of sucking pests and found that infestation of whitefly and jassid varied positively and significantly with length of fruit whereas hairiness on shoot and leaf of different okra varieties influencing population buildup of both the pests negatively and significantly. Nagar *et al.* (2017) screened different varieties of okra against sucking insect pests in Rajasthan and also found negative significant effect of hairiness on shoot, leaf and fruit on the infestation of leaf hopper and whitefly. They further reported that morphological characters like plant height and days to initiation of flowering of different okra varieties had positive significant effect on leaf hopper and whitefly infestation. Length and width of fruits had significant positive effect on leaf hopper while non-significant effect observed on whitefly infestation but number of fruits per plant had negative significant effect. Hatab *et al.*, (2013) reported that thickness of midrib had significant and positive relation to leafhopper, aphid and mite populations but negative to white fly population. They also observed significantly positive correlation between the number of hairs on leaf lamina and population of whiteflies and mites. Hairiness of the leaves influenced the population of aphids, leaf miner, whiteflies, mites and leafhopper populations to the extent of 82, 85, 89, 94 and 97 per cent, respectively. They further reported significant and negative correlation between hair density in mid-vein with leaf hoppers, aphids and leaf miners but significantly positive correlation to whitefly and mite. Influence of mid-vein hair density on different sucking pests population e.g., leaf miner, aphids, whiteflies, mite and leafhoppers was to the extent of 80, 89, 94, 97 and 98 per cent, respectively. Raghumoorthi and Kumar (2000) also reported that midrib thickness influence leaf hopper populations build up. Halder *et al.* (2016) observed that susceptible cultivar SB-10 possessed higher mid-rib thickness (1.75 mm) and leaf length (25.65 cm) as compared to tolerant genotype VROB-181 (1.58 mm and 22.43 cm). Shinde *et al.* (2014) reported cotton accessions taller in height with more number of total leaves harbored more jassid

infestation. Halder *et al.*, (2016) recorded that leaf length, plant height, angle between mid-ribs and total leaves showed a strong positive correlation and number of trichomes on leaf lamina, mid-rib and vein showed significant negative relation with jassid incidence. Sahayaraj *et al.* (2003) and Iqbal *et al.* (2011) also reported significant negative correlation between trichome density of leaf lamina and jassid incidence. Jassid infestation had positive relationship with total number of leaves as reported by Shinde *et al.* (2014). Khan *et al.* (2000) reported significant negative relation of trichome density to aphid population (*Aphis gossypii*). They also reported that aphid numbers were lowest on the terminal and young leaves as compared with matured leaves.

#### **2.4.1.2. Internal feeder**

Aziz *et al.* (2012) evaluated a diverse genetic pool of okra genotypes in Faisalabad to identify the plant physico-morphic factors that conferring resistance against *Earias* spp and reported that hair density on midrib and leaf lamina, hair length on vein and thickness of leaf lamina had positively significant correlation to *Earias* infestation with r-values of 0.94, 0.86, 0.73 and 0.48 respectively, whereas ten fruit weight, fruit yield per plant, and fruit length showed negative correlation with r-values of 0.56, 0.64 and 0.71, respectively. Plant height, number of primary branches, leaf moisture, hair length on midrib, hair density on vein, hair length on lamina, hair density on fruits, hair length on fruit, leaf area and fruit weight showed nonsignificant correlation. The results regarding multiple linear regression models along with coefficients of determination indicated that hair density on midrib exerted maximum impact (42.7%) with a negative trend on the fruit infestation caused by *Earias* spp. followed by 10 fruit weight and fruit yield per plant with 31.4 and 15.5% contribution. The  $R^2$  value was calculated to be 91.0 when the effects of all the physico-morphic plant factors were computed together. High trichome density might imparting the physical barrier for the borers rendering their non-preference over low trichomes genotypes (Halder *et al.*, 2015). They also reported negative and significant correlation between fruit width and leaf angle and okra shoot and fruit borer but there present significant positive influence of number of leaves/plant, leaf length and number of branches, fruit length, fruit weight and number of fruits/plant on borer infestation. Earlier, Sharma and Singh (2010) reported a significant negative correlation between trichome density and borer incidence in okra from Rajasthan. In Tamilnadu density, length and breadth of trichome on okra fruit along with fruit width and angel had negative significant influence on *E. vittella* infestation (Anitha and Karthika, 2018). Kamakshi and Srinivasan (2008)

also reported negative and significant impact of fruit width on the degree of infestation. Balakrishnan and Sreenivasan (2010) recorded negative association of borer infestation with plant height and suggested the selection of genotypes with reduced growth habit and minimum fruit length will help to minimize the shoot and fruit borer infestation.

#### **2.4.2. Biochemical factor against insect pest of okra**

The respective correlations between jassid nymphal population, jassid injury index and jassid susceptibility index and biochemical parameters were worked out by Sandhi *et al.* (2017) and it was revealed that the entries with higher total sugars, phenols, tannins and silica and lower levels of reducing sugars and lignin exhibited resistance against jassid. Iqbal *et al.* (2011) also reported negative correlation of total sugars and silica with jassid population but significant positive correlation with reducing sugars and lignins to jassid population. They further observed positive correlation between nitrogen, phosphorus and copper content of okra leaves and jassid population whereas, calcium and magnesium had negative impact. Harijan *et al.* (2017) revealed negative reaction of phenol and gossypol and positive effect of reducing sugar to jassid infestation in Dharwad. Roseleen and Ramaraju (2012) reported that higher concentration of protein, reducing sugars and carbohydrates in okra leaves increased *T. urticae* infestation but phenol and tannin level decreased the population. Effect of mite feeding led to significant reduction of chlorophyll content in leaf. According to Aziz *et al.* (2012) high amount of crude protein can be used as marker traits to select for resistance against *Earias* spp. They also found that mineral contents like Ca, Mn and Zn showed negative correlation but their contribution towards fruit infestation was very nominal. Higher potassium in the leaves impart resistance against leaf hopper reported by Hooda *et al.* (1997).

Moisture content in okra fruits was significantly positively correlated with larval population and per cent damage to shoot and fruit caused by *E. vitella*, while fibre and ash content in the fruits had significant and negative impact as observed by Banger *et al.* (2012). They further added that the correlation between amount of chlorophyll (a, b, total and a/b) content in the fruits and *E. vittella* infestation was non-significant indicating the negligible role of chlorophyll content in the fruits on infestation of *E. vittella*. Phenolics in a fairly large concentration could have direct toxicity to the insect. The findings of earlier workers revealed negative and non-significant correlation between total phenol content and borer incidence in okra (Halder *et al.*, 2015) and jassids (Halder *et al.*, 2016). Similar findings were noted by Iqbal (2011), Shinde *et al.* (2014) and Venkatesha

(2014). Highest total phenol content was found in VROR 157 (62.26 mg/100g) followed by VROR 160(48.35) which harboured lower borer population whereas the highly susceptible genotype SB 8 had relatively lower phenol content (40.43) as recorded by Halder *et al.* (2015). On the other Halder *et al.* (2016) found that the resistant variety VROB-181 contained highest total phenol (75.04 mg/100 g) and the susceptible genotypes, viz. SB-6 and SB-10 contained 42.61 mg/100g and 48.35 mg/100g phenol. This might be due to the fact that the phenols act as an antifeedant to insect herbivores as also reported by Simmonds (2003). Sharma and Singh (2010) observed that total sugar and crude protein were positively correlated with fruit borer infestation, whereas total phenols had negative correlation. The study made by Singh (2017) showed that significant depletion of important minerals and inorganic compounds occurred due to infestation of mite in okra leaves. Among the mineral contents; N, P, Fe and Zn was significantly positively correlated to mite infestation.

## **2.5. Efficacy of Seed treatment with different insecticides against insect pest of okra**

Seed treatment is an effective method for managing pests on okra which occur at an early stage of crop growth. Moreover, the seed treatment is superior to foliar sprays in rainy season too (Mote *et al.*, 1994). Bhargava and Bhatnagar (2001) found that the seed treatment of okra with imidacloprid 600 FS @ 9 ml/kg seed and 70 WP at 10 g/kg seed were found to be promising against jassid. Acharya *et al.* (2002) and Misra (2002) also reported similar result that seed treatment with thiamethoxam and imidacloprid both @ 25 g a.i./ha were most effective in controlling the jassid in okra. Among the different new insecticides tested against pest complex of okra, seed treatment with imidacloprid 0.04% proved to be the most effective in controlling jassid. Whereas imidacloprid 0.04% also were found effective in controlling of whitefly reported by Narangalkar (2003). Imidacloprid 17.8 SL both at 100 and 125 ml/ha afforded excellent control of leaf hoppers up to 15 days after spraying in okra cultivar Vijaya (Dey *et al.* 2005). Mote *et al.* (1994) reported that seed treatment with imidacloprid (15 g per kg seed) was found to be promising against sucking pests of okra viz. aphids, jassids, thrips, mites and whiteflies. Kumar and Singh (2001) reported 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 at Bangalore (Karnataka). Seed treatment of okra with imidacloprid (5g/ kg) reduced population of *A. biguttula biguttula* successfully at Hisar in Haryana (Lal *et al.*, 2001).

## 2.6. Efficacy of pesticides against insect pest of okra

### 2.6.1. Sucking pest

Microbial insecticides are basically biological origin including bacteria, fungi and viruses (Asokan *et al.*, 2001). Jatave (2013) tested efficacy of different microbial insecticides against jassid and revealed that among the treatments, emamectin benzoate 5% SG @ 8.5 g a.i./ha was found to be most effective as it recorded lowest jassid population (12.73 jassids/30 leaves). Janghel *et al.*, (2015) reported that application of biopesticides and bioagents at 40 DAG, aphid infestations during 2013 was found to be 0.36/plant in acetamiprid treated plot but bioagent *C. zastrowi* sillemi also reduced the population of aphid/ plant at 40 DAG. The biopesticides were also effective for control of aphid, the most effective being *V.lecanii* which recorded 1.86 and 2.06 aphids/plant and 82.16 and 82.92% reduction of aphid population during Kharif and summer respectively. The other biopesticides in order of effectiveness were *M. anisopliae*, *Neemazol* and *B.bassiana* recording (3.02 and 3.10, 4.01 and 3.92, 3.96 and 4.08 aphids/plant) during Kharif and summer respectively. Ghosh (2012) observed the efficacy of plant extracts such as *Polygonum hydropiper* L. and *Pongamia pinnata* (L.), microbial insecticides like spinosad 45 SC (*Saccharopolyspora spinosa* Mertz & Yao) and *Beauveria bassiana* Vuillemin against *B. tabaci* in okra. Significant differences were found in the efficacy of different treatments in reducing white fly populations while imidacloprid was the most effective treatment followed by the microbial insecticide spinosad. Naik *et al.* (2012) studied botanicals and mycopathogenic formulation for their efficacy against okra leaf hopper, aphids and whitefly at Navile, Shivamogga. The performance of botanicals and mycopathogenic formulation against leaf hopper revealed that the *Neemazol* @ 3.5% recorded 2.43 and 2.60 leafhoppers/3 leaves, *Neem oil* @ 2% recorded 2.63 and 3.50 leafhoppers/3 leaves and *NSKE* @ 5% recorded 3.53 and 4.00 leafhoppers /3 leaves. These three treatments were found superior among botanicals and *Beauveria bassiana* @ 2.5 g / l recorded 2.5 and 3.6 leafhoppers/3 leaves and was at par with other mycopathogens at 10 DAS of first and second spray, respectively. Results on aphids and whitefly showed that *Neemazol* @ 3.5% recorded 1.67 and 3.17 aphids/3 leaves and 2.00 and 2.63 whitefly/3 leaves, *Neem oil* @ 2% recorded 1.93 and 4.33 aphids/3 leaves and 2.17 and 3.40 whitefly/3 leaves and *NSKE* @ 5% recorded 2.00 and 6.00 aphids/3 leaves and 3.00 and 4.00 whitefly/3 leaves at 10 DAS on the first and the second spray, respectively and these were found superior among botanicals. *Verticillium lecani* @ 2.5 g/l showed 2.53 and 6.67 aphids/3 leaves and 2.80 and 3.53 whitefly/3

leaves at 10 DAS on the first and the second spray respectively and was at par with other mycopathogens.

Botanicals were also found effective against number of sucking pest like thrips, aphids, and whitefly (Malik *et al.*, 2003; Ahmad *et al.*, 2009). The plant extracts contains some particular compounds due to which they exhibited toxicity against sucking as well as chewing insects. Neem can disturb the chemoreceptors due to which the insects are unable to feed. It also act as repellent, larvicidal, affect egg hatching and reduce fertility in insect pest which results in their progeny inhibition (Boadu *et al.*, 2011; Lokhandan *et al.*, 2012). Kaleri *et al.* (2011) reported that neem extract was found effective regarding reduction of whitefly population (39.18%) after hing (54.48%). Plants extracts like *Polygonum hydropiper* L. @ 5% concentration was found very effective against jassids, achieving more than 60% mortality at 3 and 7 DAT. Panickar *et al.* (2003) studied that botanical insecticide, Achook alone or in combination with endosulfan provided the highest control of sucking pests. Singh *et al.* (2004) reported that NSKE was found effective against mite, *T. cinnabarinus* infesting okra. Jat and Jeyakumar (2006) recorded 20.4, 34.4 and 42.5% reduction of jassid population with 1, 2 and 3% neem oil respectively. Similarly, Mani *et al.* (2003) reported that neem products were effective against two spotted mite on okra crop. Yathiraj and Jagdish (1999) observed that plant products such as *Azadiracta indica*, *Clerodendron inermae*, *Duranta repens*, *Eucalyptus globules*, *Leucas aspera* and *Vitex negunda* were suitable for integrated management of mite, *T. urticae*. Jayakumar (2002) also found that NSKE + cow urine + garlic extract, chilli extract + cow urine, garlic extract + cow urine, neem oil + garlic extract and clerodendron extracts + *Vitex negundo* leaf extract were effective as that of oxydemeton methyl against leafhoppers on okra. Dhanalakshmi (2006) also 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. Asare-Bediako *et al.* (2014) found the maximum efficacy of neem leaf extract and garlic extract against whitefly on okra as compared to pawpaw dried leaf, bougainvillea leaf, chilli pepper fruit and mahogany bark. It was found that the superiority of garlic with maximum reduction of aphid and jassid population was noted as compared to other tested botanicals and insecticides (Natarajan *et al.*, 2000; Mousa *et al.*, 2013). Garlic extract alone or in combination with neem, ginger, tobacco, chilli and cow urine were also effective against sucking insect pests and mites of several crops reported by Lakshmanan, (2001). Iqbal *et al.* (2015) tested plant extracts of eight indigenous plants

viz., tumha (*Citrullus colosynthis* L.), datura (*Daturainnoxia* M.), neem (*Azadirachta indica* A.), castor (*Ricinus communis* L.), hing (*Ferulaasafetida* L.), eucalyptus (*Eucalyptus* spp.) bitter gourd (*Memordica chrantia* L.) and garlic (*Allium sativum* L.) for their potential insecticidal efficacy against sucking insect pests, jassid (*Amrasca bigutulla bigutulla* I.), whitefly (*Bemisia tabaci* G.) and thrips (*Thripstabaci* L.). It was revealed that, neem followed by garlic significantly reduce the mean population of jassid (6.31, 6.86 /leaf), whitefly (7.41, 8.21/leaf) and thrips (11.99, 12.43/leaf), respectively.

Kencharaddi and Balikai (2012) reported neonicotinoids as better option for managing various sucking pests and revealed that spraying of acetamiprid 20SP @ 40g a.i. per ha, imidacloprid 17.8SL @ 50g a.i. per ha and thiamethoxam 25WG @ 50g a.i. per ha were effective in controlling aphid and registered higher yields. Mohanasundaram and Sharma (2011) found that thiamethoxam @ 20 g a.i./ha and fipronil @ 50g a.i./ha had effectively reduced the sucking pests population of okra viz., leafhopper, whitefly and red spider mite. Some newer insecticides like thiamethoxam 25 WG, imidacloprid 200 SL and profenophos + cypermethrin (Rocket 44 EC) along with conventional insecticides like dimethoate 30 EC, cypermethrin 10 EC, profenophos 50 EC against okra aphid and leafhopper were evaluated and found that imidacloprid and thiamethoxam, both used @ 25 g a.i./ha proved significantly superior in controlling aphids and leafhoppers on okra compared to other insecticides as reported by Misra (2002) . Konar *et al.* (2013) observed that Imidacloprid @ 30g a.i./ha was found most effective in reducing population of aphids on okra. Bagade and Ambekar, (2010) reported that imidacloprid was the most effective in reducing the population of aphid on okra. Acharya *et al.* (2002) reported that application of imidacloprid @ 25 g a.i./ha was found effective against okra leafhopper, followed by emamectin benzoate @ 20 g a.i./ha. Ghosal *et al.* (2013) revealed that Imidacloprid 17.8 SL @ 50 g a.i. per ha was found as a most effective neonicotinoid insecticide against aphid giving 84.54 % reduction of aphid population over control. To control aphid population of okra the other two neonicotinoids viz., thiamethoxam 25WG @ 50 g a.i.per ha and acetamiprid 20SP @ 40 g a.i. per ha were also found at par with imidacloprid and showed better result than acephate 75WP and dimethoate 30EC. Considering incremental cost benefit ratio acetamiprid 20SP @ 40g a.i. per ha was found most economic over other neonicotinoids. Gaikwad (2014) evaluated the bioefficacy of some newer insecticide molecules against sucking pest complex of okra. Thiamethoxam @ 25 g a.i./ha recorded least no. of aphids (1.38aphid/leaf ) which was significantly superior over all other treatments. Fipronil @

50 g a.i. /ha was found to be at par with thiamethoxam @ 25 g a.i./ha and recorded 1.68 aphid/leaf. Spinosad @ 50 g a.i./ha and imidacloprid @ 25 g a.i./ha were at par with buprofezin @ 156 g a.i./ha and recorded 2.74 and 2.81 aphids/ 31leaves /plant, respectively. Abamectin @ 100 g a.i./ha was found to be less effective recording 4.10 aphids/ 31leaves /plant. Tamoghna *et al.* (2014) recorded that Seed treatment with imidacloprid in the early stages followed by application of NSKE alternated with organophosphates or biorationals like spinosad 45 SC, emamectin benzoate 5 SG in the later stages of the crop growth was found more effective. Misra (2002) observed that thiamethoxam 25 WG was superior over the conventional insecticides in controlling aphids. The lowest mean number of jassid (1.33/leaf) and whitefly (1.86/leaf) on okra was recorded in imidacloprid 200 SL treated plot followed by thiamethoxan 25 WG. Per cent reduction in jassid and whitefly population over control was exceeded 50 % in both the chemicals as reported by Rahman *et al.* (2009).

#### **2.6.2. Internal feeder (fruit borer complex, *Earias vittella* Fabricius and *Helicoverpa armigera* Hubner)**

Asokan *et al.*, (2001) reported that microbial insecticides are basically biological origin including bacteria, fungi and viruses. Microbial insecticides provide viable and ecofriendly alternative to chemical insecticides for the successful management of insect-pests of crops. Among these, *Bacillus thuringiensis* Berliner plays a very important role in natural mortality of the larvae. *Bacillus thuringiensis* based bio-insecticides accounts for 90-95 per cent of the world biopesticides market at present. Superiority of dipel @ 1.0 ml/L against *E. vittella* in laboratory was found by recording per cent mortality even at eight daysafter sprating (Hedge *et al.*, 2004). The emamectin benzoate @ 8.5 g a.i./ha was found to be effective in controlling the borers without exhibiting any harmful effect on natural enemies in okra ecosystem as stated by Sontakke *et al.* (2007). Dhanalakshmi and Mallapur (2010) revealed that emamectin benzoate 5 SG @ 0.2 g/l was the most superior insecticide, recorded only 7.82% fruit damage and observed the highest fruit yield (47.02q/ha) among some new pesticide molecules at Dharwad. Aulakh *et al.* (2012) revealed that all the doses of emamectin benzoate significantly reduced *E. vittella* population and also increased the fruit yield compared to standard *check* and control plot at Gurdaspur, Punjab. Aarwe *et al.* (2017) revealed the efficacy of some insecticides against shoot and fruit borer of okra at Jabalpur (M.P.) and found that among the treatments emamectin benzoate 5% SG @ 12 g a.i./ha recorded lowest fruit damage (13.61%) followed by emamectin benzoate 5% SG @ 10 g a.i./ha (16.00%) and

triazophos 40% EC @ 400 g a.i./ha (16.94%), both were found to be at par with each other. Dhaker *et al.* (2017) found that among the synthetic chemical pesticides two applications of emamectin benzoate 5 SG (200g/ha) was most effective with mean shoot damage of 9.91 per cent. Similarly, against fruit borers emamectin benzoate 5 SG (200g/ha) was most effective with 12.51 per cent fruit damage; whereas, the least effective treatment was permethrin 25 EC (500ml/ha) with mean fruit damage of 19.11 per cent. The bio- agent *Trichogramma chilonis* Ishii released at the rate of 1.0 lac per hectare followed by the bio-pesticide HaNPV [250 LE/ha] after 10 days was more effective than untreated control. Sontakke (2007) discovered a new formulation of emamectin benzoate from the secondary metabolites of a fungus and manufactured by M/s Eterna Life Science Pvt. Ltd., Hyderabad, was studied on fruit and shoot borer in Okra and they found that formulation with emamectin benzoate 5 % SG at 8.5 g a.i./ha was to be effective in controlling the borers without exhibiting any harmful effect on natural enemies. Govindan *et al.* (2014) evaluated the bio efficacy of emamectin benzoate 5 SG at four doses viz., 9, 11,13 and 15 g a.i. per ha for the control of okra fruit borers viz., *Earias vittella* Fabricius and *Helicoverpa armigera* Hubner at Puttur. The new formulation of emamectin benzoate 5 SG at 11 and 13 g a.i. per ha was highly effective and reduced the fruit damage when compared to standard check, Proclaim (emamectin benzoate 5 SG at 11g a.i.per ha) and endosulfan 35 EC @ 350 g a.i. per ha. The lowest fruit damage was recorded with the application of emamectin benzoate 5 SG at 11 g a.i.per ha and it was at par with 13 g a.i.per ha although the per cent fruit damage was less in all emamectin benzoate 5 SG doses which ultimately increased the fruit yield of okra.

Iqbal *et al.*, (2015) observed that neem showed minimum fruit damage percentage (3.38%) followed by garlic (6.67%). The maximum fruit yield (3178.7 kg/ha) was observed in neem treated plots of okra. Patel and Sojitra (1993) observed 73.26% reduction in shoot infestation by *Earias vittella* on okra with three sprays of neem based Repelon. Ramesh and Gupta (2005) found that spray combination of endosulfan + neemazal + biolep + neemazal were the most effective in getting higher seed yields of okra. Rao *et al.* (2008) revealed that lower incidence of shoot damage (1.05%) and fruit damage (16.40 %) 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%. Sarode and Gabhane (1994) reported that application of NSKE and chemicals

application alone and in combination showed a significant control of *E. vittella* comparison to the untreated control.

Sinha *et al.* (2009) evaluated the efficacy of insecticides viz. bifenthrin, endosulfan, indoxacarb, fipronil, acetamiprid, thiamethoxam, imidacloprid and chlorpyrifos + cypermethrin against *E. vittella* infestation and found that all the treatments except imidacloprid@ 20 gm/ha and endosulfan@700 gm /ha were highly effective. The treatment with 2 foliar sprays of acetamiprid and endosulfan was found most effective giving only 1.8% infestation. Kamble *et al.*, (2014) revealed that application of acephate 50 WP + imidacloprid 1.8 WP resulted in 21.06% and 19.54% infestation of fruits in number and weight basis. Jagginavar *et al.* (2009) reported that both dosages of flubendiamide 480 SC @ 90 and 72 g a.i. /ha were recorded lowest shoot damage. Katti and Swetha (2015) reported that flubendiamide 480 SC @ 60 g a.i. /ha and flubendiamide 480 SC @ 48 g a.i. /ha were superior in recording less shoot damage (8.7 and 10.00 per cent, respectively), lower fruit damage (5.70 and 9.00 per cent, respectively). Chatterjee and Samanta (2009) evaluated the field efficacy of insecticides for the control of *E. vittella* in okra and found that emamectin benzoate recorded the lowest shoot infestation, which was followed by indoxacarb, lufenuron and methoxy fenozide. Bansode *et al.* (2015) reported flubendiamide @ 60 g a.i. /ha were the most effective treatment by recording lowest (13.42 per cent) fruit infestation. Emamectin benzoate @ 9.5 g a.i. /ha also showed at par results (13.61 %). Papal and Bharpoda (2009) noted the lowest fruit damage of okra due to fruitborer (*E. vittella*) with chlorpyrifos (18.86%) and cypermethrin + quinalphos (19.97%). Chlorpyrifos (0.04 %) recorded the lowest (2.05%) percentage of damaged seeds, but was at par with all the insecticidal treatments except alpha-cypermethrin and fipronil 5 SC @ 0.005%. Flubendiamide 20 WG was evaluated against fruit borers, *Helicoverpa armigera* (Hubner) and *Spodoptera litura* (Fb.) and results indicated that among various dosages flubendiamide 20 WG @ 60g a.i. /ha recorded highest yield of okra ( 7.48 q/ha) with lowest fruit damage of 3.45% followed by flubendiamide 20 WG @ 40 g a.i./ ha (6.72q/ha), emamectin benzoate 5 SG @ 11 g a.i./ha (7.22 q/ha) and spinosad 45 SC @ 75 g a.i./ha (7.32q/ha) reported by Tatagar *et al.*, (2009). Deepak *et al.*, (2017) evaluated the bio-efficacy of insecticides viz., bifenthrin 10 EC at 80 g a. i./ ha, fipronil 5 SC at 500 g a.i./ ha, flubendiamide 480 SC at 60 g a.i./ ha, quinalphos 25 EC at 350 g a.i./ ha, profenofos 50 EC at 400 g a.i./ ha and beta-cyfluthrin 25 SC at 18.75 g a.i./ ha against shoot and fruit borer (*Earias vittella* Fab.) of okra at Hyderabad and found that

insecticidal treatments were found superior over control where, Flubendiamide at 60 g a.i./ ha recorded lowest fruit borer infestation of 14.40 % on number basis and 15.90% on weight basis. Kattia *et al.*, (2015) evaluated the efficacy of different dosages of flubendiamide 480 SC with check, cypermethrin against okra fruit and shoot borer, Raichur, Karnataka and found that both dosages of flubendiamide 480 SC @ 60 g a.i/ha and flubendiamide 480 SC @ 48 g a.i/ha were superior in recording least shoot damage (8.7 % and 10.00 %), lower fruit damage (5.70 % and 9.00 %) and higher fruit yield (113.00 q/ha and 104.00 q/ha) over check, cypermethrin.

Parmar and Borad (2009) observed that among the tested insecticides, indoxacarb 14.5 SC (0.0075%), emamectin benzoate 5 WG (0.001%) and diafenthiuron 75 WP (0.005%) performed better to protect the okra fruits from infestation of *H. armigera*. The plots treated with these insecticides recorded higher fruit yield of 119.91, 116.71 and 108.63q/ha respectively. Among 15 insecticides evaluated against *Earias vittella*, the fenvalerate (0.01 %) and thiodicarb (0.15 %) were the most effective treatments as reported by Dhamdhare *et al.*, (1984). Parthiban *et al.*, (2014) reported emamectin benzoate 5 WG (125 and 150 g/ha) as best insecticide and reduced more than 90 per cent population of *Earias vittella* on okra. Laichattiwar *et al.* (2014) observed that emamectin benzoate @ 0.36 g /lit was most effective in controlling fruit damage by *Earias vittella* and gave good yield. Bangar *et al.*, (2012) conducted experiment to find out the efficacy of nine insecticides along with control against shoot and fruit borer, *Earias vittella* Fabricius infesting okra. Of these, flubendiamide 0.0144% recorded lower larval population of *E. vittella* followed by indoxacarb and emamectin benzoate. Flubendiamide (76.73 q/ha) registered significantly higher fruit yield followed by cypermethrin + chlorpyrifos (64.84 q/ha).

Ray and Chatterjee (2000) evaluated the efficacy of imidacloprid, acetamiprid, acephate and profenofos against *E. vittella* on okra and revealed that they contributed 15.36, 12.42, 14.25, and 15.70% reduction of population after 3 weeks of spray. Acephate gave the best cost benefit ratio of 1:5.58 followed by imidacloprid (1:4.63). Lal *et al.* (2008) revealed the better efficacy of beta-cyfluthrin, lambda-cyhalothrin and imidacloprid against *E.vitella* in okra in comparison to the untreated control.

Choudhary *et al.* (2008) observed that the lowest fruit damage (13.08%) due to *Earias* spp. and maximum fruit yield (80.72 q/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). Kumar *et*

*al.*, (2017) evaluated some newer groups of insecticides against shoot and fruit borer of okra including untreated control. The Coragen treated plot recorded lowest fruit damage (6.29 and 6.83%) followed by Spinosad (7.17 and 7.47%) in comparison to control (30.96 and 33.14%) during *Kharif*, 2012 and *Kharif*, 2013. The maximum yield was also recorded in Coragen treated plots (118.02 and 117.10 q/ha) followed by Spinosad (115.65 and 114.85 q/ha) as compare to control (68.80 and 68.10 q/ha) during *Kharif*, 2012 and *Kharif*, 2013.

### **2.6.3. Foliage feeder**

Suganya and Selvanarayanan (2010) conducted a laboratory experiment to study the infectivity of *Beauveria bassiana* (Bals.) against tobacco caterpillar *Spodoptera litura* Fab. as influenced by two okra varieties viz. P7 and Pusa Sawani. Infectivity of *B. bassiana* at three concentrations viz. 0.1, 1.0 and 3.0 per cent was evaluated by contaminated food bioassay method. Statistically significant variation between the two okra varieties was observed with regard to the mortality of *S. litura*. When the leaf extract of the bhendi variety P 7 was amended to the culture medium of *B. bassiana*, the maximum conidial germination, sporulation and mycelial growth were recorded as against the minimum with the variety Pusa Sawani. In Legon (Ghana), sprays of *B. thuringiensis* (1g per liter) significantly decreased the population of *P. uniformis*, *S. derogata*, *E. similis*, *S. littoralis* and *S. litura* on okra (Obeng and Sackey, 2003). Taylor (1974) investigated in Nigeria that foliar applications of dipel at 0.5, 1.0 or 1.5 lb per acre successfully managed population of *S. derogata*, *A. flava* and *S. littoralis* on okra. Ghosh *et al.* (1999) reported that vertimec proved its superiority over a number of synthetic pesticides in decreasing the larval population of leafroller on okra at terai region of W.B.

Joshi and Paneru (1999) reported that the plant extracts of *Acorus calamus*, *Ageratum conyzoides*, *Azadirachta indica* and *Urtica dioica* showed potent insecticidal properties against the flea beetle. Obeng and Sackey (2003) revealed that aqueous neem seed extract (50g per litre) reduced the population of *Podagrica uniformis*, *Sylepta derogata*, *Epilachna similis* and *Spodoptera littoralis* on okra and produced higher fruit yield in Ghana. Anaso and Lale (2002) observed that okra crop sprayed with aqueous neem kernel extract recorded appreciably less population of *Podogrica spp.* and *S. derogata* at Maiduguri (Nigeria). Similar result was also found at Bhubneshwar (Orissa) where azadirachtin (3g *a.i.* per ha) was found effective (Mishra *et al.*, 2002) in managing okra leaf rollers with least infestation (1.2-2.0%) as compared to untreated check

(12.4%). In Ghana, Cobbinah and Owusu (1988) found that okra plants treated with neem seed extracts harboured lower population of *S. derogata* and *P. sjostedti*. Neem products viz. 3 per cent neem oil and 5 per cent NSKE were found effective against flea beetles, *P. uniformis* and *P. sjostedti* on okra in Lalabar (Nigeria) and gave higher yields reported by Emosairue and Ukey, (1997).

Mishra *et al.* (2002) found that significantly better reduction of *S. derogata* population on okra was obtained with the application of cypermethrin (100g/ha), profenofos (500g /ha) and rocket (profenofos + cypermethrin @440g a.i./ha). Deltamethrin provided good protection to okra crop from *Podogrica spp.* and *S. derogata* in Nigeria and gave higher yields than neem seed extracts (Anaso, 2003). Parh *et al.* (1999) tested that cypermethrin @ 12.5g a.i./ha reduced the population of *Podogrica spp.* substantially on okra plants compare to untreated one in Jos (Nigeria). Ahmed *et al.*, (1998) found that use of 0.05% malathion, monocrotophos or primphos-methyl during the vegetative stage of okra crop and 0.05% malathion or dichlorvos during flowering and fruiting stages provided adequate protection to the crop against *Podogrica spp.* at Nigeria.

## **2.7. Efficacy of pesticides against predator (coccinellid and spider) of okra**

Natural enemies viz. lady bird beetles, spiders and predatory bugs was minimum in synthetic insecticides treated fields compared to botanical (Shabozoi *et al.* 2011). Udikeri *et al.* (2004), Dhanalakshmi and Mallapur (2008) and Mohanasundarm and Sharma (2011) reported higher population of coccinellids and spiders on the cotton and okra crop treated with emamectin benzoate 5 SG. Dhanalakshmi and Mallapur (2010) reported that among different newer molecules, emamectin benzoate, spinosad and acetamiprid proved quite safe to natural enemies. Similarly Jayakumar *et al.*, (2008), Sunitha *et al.* (2010), Ghosh (2013a) revealed that neem and Bt. products were found safe to coccinellids and spiders.

## **2.8. Efficacy of management modules against insect- pests of okra**

Mishra and Mishra (2002) observed the lowest fruit borer incidence (8.6% on weight basis) in crop by applying *B. thuringiensis* sub sp. *thuringiensis* twice alternated with one malathion application. Further, Multineem and Neem max combined with malathion (11.70%) was found better than sole malathion application (13.3%) and untreated control plot (16.9%). Panickar *et al.* (2003) found that among 4 modules tested, the application of two rounds of synthetic insecticide, endosulfan (0.035%) followed by two rounds of neem based products viz., Achook (0.15% EC) (M-III) proved to be

superior against sucking pest complex and *E. vittella* infesting okra over other modules. Sardana *et al.* (2005) tested five crop protection modules viz., bio-intensive (module-I), cultural + mechanical + bio-intensive (module-II), cultural + mechanical + bio-intensive + chemical (module-III) farmers practices (module-IV) and untreated control (module-V) and found that module III comprising of releases of egg parasitoid *T. chilonis* @ 1 lakh/ha based on monitoring of pest population using pheromone trap, three spray of NSKE @ 5% intermittently with need based application of chemical pesticides and periodic removal of borer and disease affected plants was found superior over all other modules in managing the pest complex of okra crop. Rao *et al.* (2008) revealed that lower incidence of shoot damage (1.05%) and fruit damage (16.40 %) and more fruit yield (43.50 q/ha) were recorded 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 other modules.

Birah *et al.* (2012) determined that integrated pest control module viz. seed treatment with imidacloprid @ 5 g/kg seed, sowing of maize at the borders as barrier crop, weekly clipping of infested shoots and fruits, setting of pheromone trap @ 100 traps/ha, foliar spray of neem seed kernel extract @ 30 ml/l, spinosad 45 SC @0.5ml/l and karanj oil @ 30 ml/l at 45, 60 and 75 days after sowing and bio-intensive module viz. neem cake application @ 250 kg/ha at the time of sowing, sowing of maize at the borders as barrier crop, weekly clipping of infested shoots and fruits, installation of pheromone trap @ 100traps/ha for mass trapping, foliar spray of neem seed kernel extract @ 30ml/l, aqueous leaf extracts of cloves (*Syzygium aromaticum*) @ 250g/l, karanj oil @ 30 ml/l at 45, 60 and 75 days after sowing) recorded significantly lower jassid population than farmer's practices and untreated control. 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.

Verma *et al.* (2014) observed minimum average jassid population in okra 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 @ 0.4g/l at 70 DAS and foliar spray of spinosad 45 SC @ 0.3ml/l at 80 DAS in comparison to other modules. Preetha and Nadarajan (2007) conducted field experiments to test the efficacy of different IPM modules against major sucking pests of okra. The results found that bio intensive module (M2) and the

insecticide Module (M3) were equally effective against major sucking pests like thrips, leaf hopper and aphids and the insecticide module (M3) showed the lower incidence of red spider mite.

Rajashekhar *et al.* (2016) conducted an experiment to validate different IPM Modules against major pests of okra during kharif 2014 with untreated check namely Modules, M1- Low Cost Technology, M2- Bio Intensive Module – I, M3 - Bio Intensive Module - II, M4 - Dr. YSRHU Recommended Module, M5 - NCIPM, Delhi Recommended module, M6 - Bio intensive module + Insecticide Module, M7 - Insecticide Module, M8 - Control with different treatments. The results found that Insecticide Module (M7) was found best (0.30% fruit damage) which was at par with Bio intensive Module and Insecticide Module (M6).

Iqbal *et al.*, (2011) observed that various control practices, viz., host plant resistance, release of *Chrysoperla* spp., seed-treatment with imidacloprid, use of yellow sticky trap, neem seed kernel extract, spray of imidacloprid were applied singly, and in their possible combinations, at three localities on okra genotype, Punjab Selection for the control of jassid. The treatment affect alone, and in their possible combinations, showed a significant difference with one another regarding their effectiveness. A combination of treatments, viz., seed treatment, spray with imidacloprid and installation of yellow sticky traps was found most effective and resulted in a minimum population of jassid per leaf on okra. A significant decrease in the jassid-population was observed in those plots, where imidacloprid was sprayed alone, or in combination with other treatments. The seeds treated with imidacloprid, remained effective against the jassids up to 38 days after sowing. The combination of seed-treatment + spray of imidacloprid + installation of yellow sticky traps, showed a maximum yield of okra.

Chorage *et.al.*, (2012) reported that the highest yield of 36.56 q/ha was recorded in module M<sub>9</sub>, (cypermethrin 10 EC 0.005 per cent followed by NSKE 5 per cent followed by custard apple leaf extract 10 ml aqueous solution/lit) followed by module M<sub>5</sub> with yield of 36.29 q/ha (deltamethrin 0.09 per cent, followed by Neemazal 4ml /lit followed by soapnut 10 ml aqueous solution/lit), followed by module M<sub>8</sub> with yield of 36.11 q/ha (Profenofos 50 EC 0.05 %, followed by NSKE 5% then garlic and chilli extracts 10 ml aqueous solution followed by M<sub>4</sub> with yield of 35.72 q/ha (endosulfan 35 EC (0.06%) followed by *B. thuringiensis* var. *kurstaki* M @ 1.5 g /lit followed by custard apple leaf extract 10 ml aqueous solution /lit and M<sub>3</sub> with yield of 35.06 q/ha (endosulfan

35 EC (0.06%) followed by *B. thuringiensis* var. *kurstaki* @ 1.5 g /lit followed by Serni leaf extract 10 ml aqueous solution /lit) which were at par with module M<sub>9</sub>.

Dhanalakshmi (2006) revealed that, NSKE + garlic, chilli & kerosene (GCK) extract + cow urine (CU) was the most effective treatment reducing 77.80 per cent population of okra leaf hopper and found to be equally effective as that of oxydemeton methyl (81.50%). Jayakumar (2002) evaluated some indigenous components against the insect pests of okra. Among the products tested, garlic extract (8%) + chilli extract(3%) + cow urine (5%), NSKE (5%) + cow urine (10%), neem oil (2%) + garlic extract (5%) and garlic extract (10%) + cow urine (10%) exhibited minimum fruit damage as that of insecticide endosulfan. However, NSKE+ cow urine and clerodendron extract + vitex extract recorded higher B: C ratio next to endosulfan when compared to rest of the treatments.

From overall literature it is found that experiments on seasonal incidence, varietal screening, physical and chemical study of okra plants, management of insect pests by botanical, microbial and chemical means and by crop modules have been made by various scientists in different parts of our country and abroad. But in terai region of West Bengal, these types of works are very limited, only done by some scientists but works on the direction of pesticide module against management of insect bpests of okra in this region is very scanty. Therefore, the findings of the present thesis will be helpful in formation of IPM or control measures against insect pests of okra.

**3.1. Experimental site**

The research experiments were conducted at Instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during post-kharif, and pre-kharif seasons in 2015-18. The laboratory investigations were carried out in the Department of Agricultural Entomology, Agricultural Biochemistry, Soil Science, Plant Pathology and Quality Control Laboratory, UBKV, Pundibari, Cooch Behar.

**3.2. Geographical location**

The experimental domain is situated in the terai region of West Bengal between 26° 19'86"N latitude and 89°23'53"E longitude at an elevation of 43.0 m above mean sea level and the land topography is medium upland having good drainage and irrigation facilities. The terai region of West Bengal is located in sub-Himalayan plain comprising of Bhutan, Kalimpong and Kurseong hills in the north, Assam border in the East, Bihar in the West and Bangladesh in the South.

**3.3. Soil**

Soils of the region under consideration can be classified into two broad tracts: (a) Old Himalayan Pediment Plains (b) Teesta Flood Plains formed mostly from the Himalayan detritus. Soils of the region comprises dark brown top soil, 1-3 feet deep, which is in general sandy loam in texture, medium to strong acidic in nature, rich in raw humus content, porous, low water retention capacity, medium to high total nitrogen content, low to medium K content and poor secondary micronutrients.

**3.4. Climate**

The terai region of West Bengal is characterized by typical humid climate with distinct features of high rainfall (annual average more than 3000mm) and high relative humidity (average maximum 95% and average minimum 65%). Lion share of the total rainfall about 80% received during rainy months from June to September. Maximum and minimum temperature varies from 24-33.2° C respectively. The weekly bright sunshine hours per day remain more or less steady from the beginning of the year up to early June, *i.e.* just before arrival of South-West monsoon. A sharp fall has been observed thereafter which continues up to early October. Average duration of bright sunny days is more than 8 hours during November to March. The whole area is humid and warm except having a spell of winter during the months of November-February.

### 3.5. Meteorological data

The meteorological data viz. Maximum temperature, Minimum temperature, Maximum RH and Minimum RH and rainfall were collected from the Department of Agro-meteorology and Physics, U.B.K.V. from 2015 to 2017.

**Fig. 1: Meteorological data of post-kharif season, 2015 and 2016**

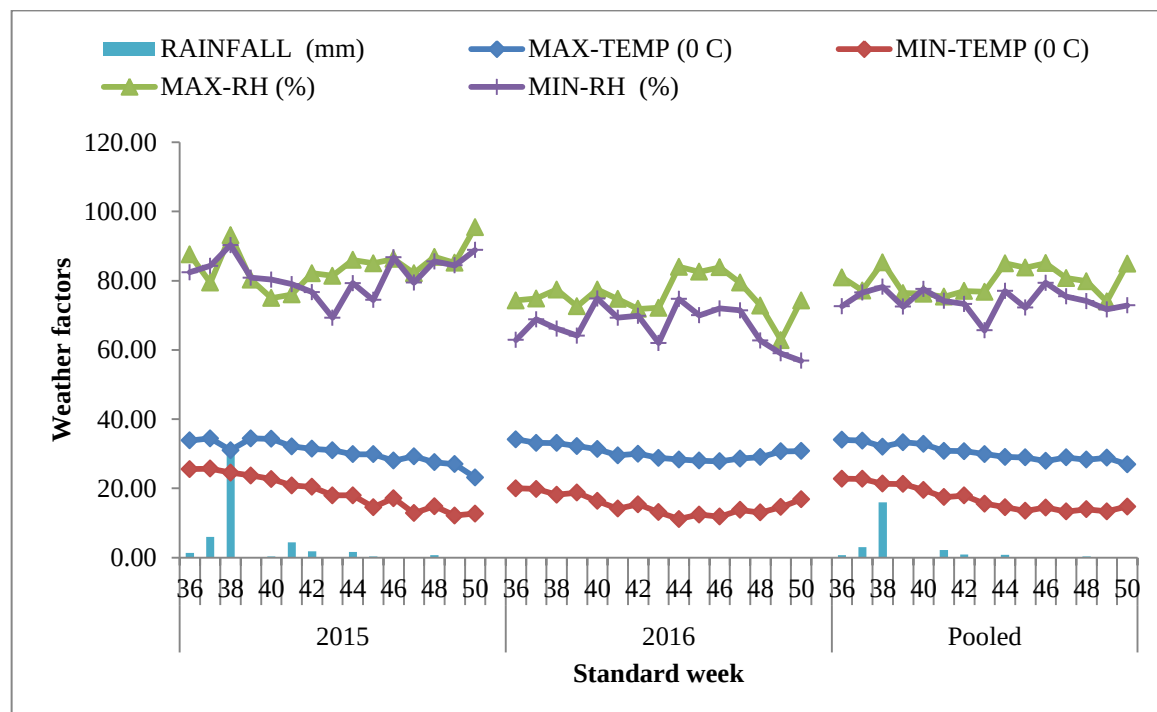
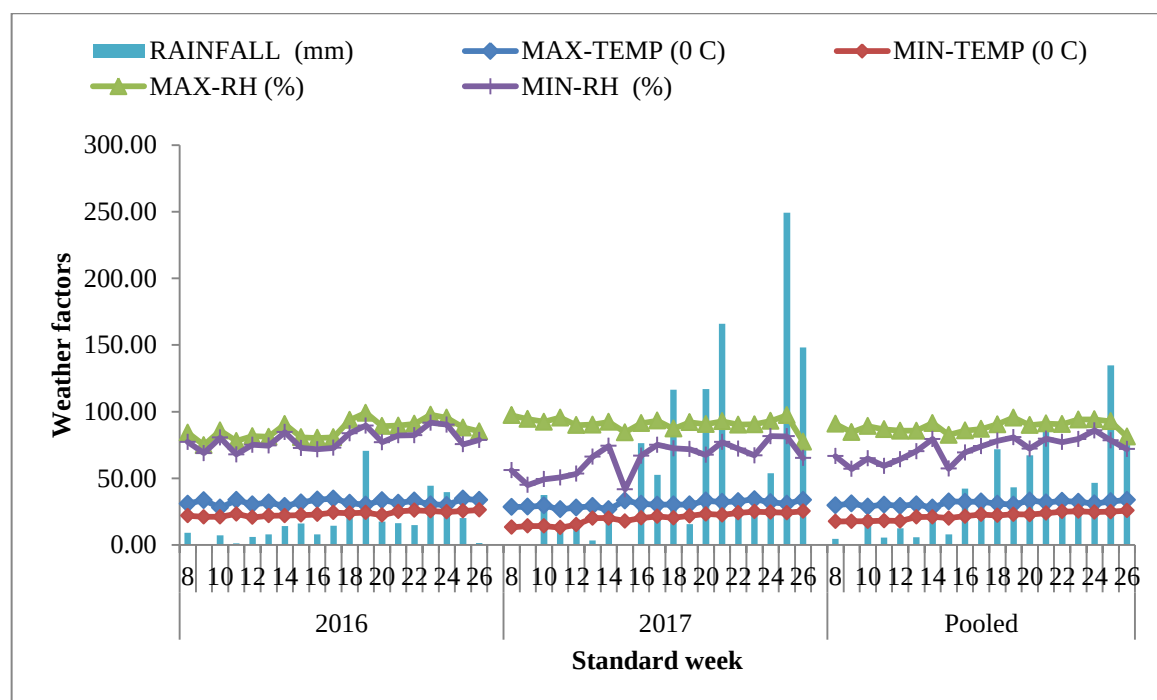


**Fig. 2: Meteorological data of pre-kharif season, 2016 and 2017**



### 3.6. Materials

#### 3.6.1. Plant materials

The experiment was conducted on okra plant (*Abelmoschus esculentus* L) and the varieties on which it was conducted are as follows

**Table 1: Okra cultivars evaluated for pest infestation during different seasons**

| Sl. No | Cultivars       | Source                                          |
|--------|-----------------|-------------------------------------------------|
| C-1.   | Arka Anamika    | Durga seed farm, Chandigarh                     |
| C-2.   | Subarna         | I & B seeds pvt. Ltd., Bangalor                 |
| C-3.   | Aparupa DG      | Debgiri agro products pvt. Ltd., Kolkata        |
| C-4.   | Tiger Green     | Pahuja seeds pvt. Ltd., Delhi                   |
| C-5.   | JKOH-7315       | Navakar Enterprises, Indore                     |
| C-6.   | Prabhani Kranti | Pahuja seeds pvt. Ltd., Delhi                   |
| C-7.   | Basanti         | East West seeds india pvt. Ltd., Haryana        |
| C-8.   | Miss-717        | Maharashtra hybrid seeds co. (Mahyco), Mumbai   |
| C-9.   | Meena-117       | Meena hybrid seed pvt. Ltd., Mumbai             |
| C-10.  | Bhindi No.-10   | Maharashtra hybrid seeds co. (Mahyco), Mumbai   |
| C-11.  | PAN-2127        | Pan seeds pvt. Ltd., Kolkata                    |
| C-12.  | Tanvi           | Namdhari seeds pvt. Ltd., Bangalor              |
| C-13.  | Kaveri          | Kaveri seed company Ltd., Telangana             |
| C-14.  | Chameli-015     | East West seed international pvt. Ltd., Haryana |

#### 3.6.2. Equipment:

|    |                                                                  |    |                                                                                             |
|----|------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------|
| a. | Microscope (Model : BX41TF, Software Dewinder Caliper Pro)       | b. | Centrifuge (Sigma 2-16 KL) 10000 rpm                                                        |
| c. | Spectrophotometer 1(Microvis Spectrophotometer Double beam 2800) | d. | Spectrophotometer 2 (UV-1800 Spectrophotometer serial number A116353-05305 Shimazolu Corp.) |
| e. | pH meter (Eutech Instruments Ph 700)                             | f. | Chlorophyll meter (SPAD)                                                                    |

#### 3.6.3. Miscellaneous materials

In addition to the aforementioned materials, weighing balance, water bath, muslin cloth, Aluminum tags, Binocular, Brush, Drier, Glass vials etc.

### 3.7 Methods

#### 3.7.1: Studies on the population dynamics of different pest and natural enemies of okra as well as to find out the impact of abiotic and biotic factors on the pest population fluctuation.

The population dynamics of different pest and natural enemies of okra were carried out in relation with the abiotic and biotic factors. Bhindi No. 10 cultivar of okra was taken into consideration for population dynamics during post-kharif and pre-kharif season. The seeds were sown in a plot having size of 3m x 3m with spacing of 60cm x 40cm. The crop was grown under usual recommended fertilizer dosages of 120: 60: 60

kg NPK per ha with proper agronomic practices in three replications without adopting any plant protection measures.

Observations on different insect pests and their natural enemies on okra were recorded at 7 days interval starting from 7 days after germination or initiation of pests to maturity. Five plants were randomly selected from each plot for each observation.

**Table 2: Observations of the pests infesting okra and their predators**

|                                         |                                                                                                                                              |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Jassid, Whitefly, Aphid and Mite        | Leaves ( mean of 3 leaves each from upper, middle and lower canopy) per plant                                                                |
| Semilooper, Leaf roller and Flea beetle | No. of insects per plant                                                                                                                     |
| Fruit borer complex                     | % damage:<br>$P = \left[ \frac{\text{No. of damaged fruits}}{\text{No. of healthy fruit} + \text{No. of damaged fruits}} \right] \times 100$ |
| Coccinellid and Spiders                 | No. of predators per plant                                                                                                                   |

**Statistical analysis:** Correlation analysis was done by in statistical software SAS (Version 9.2) with transformed values whichever applicable for interpretation of data.

### 3.7.2: Screening of the available genotypes/cultivars of okra for resistant/susceptibility against different insect-pests based on physical and chemical characters of the cultivars.

Studies were carried out during 2015 (post-kharif) and 2016 (pre-kharif) to screen out okra genotypes. Fourteen cultivars of okra were sown in the experimental area under instructional farm of UBKV Pundibari, Cooch Behar (West Bengal). Experiments were laid down in a Randomized Block Design (RBD) with three replications having a spacing of 60cm x 40cm. The plot size was maintained at 3 m × 3 m during both study seasons. The 14 cultivars of okra were grown under usual recommended fertilizer dosages of 120: 60: 60 kg NPK per ha with proper agronomic practices in three replications without adopting any plant protection measures.

**Table 3: Methods for recording data of the pests attacking okra and their predators**

|                             |                                                                                                                                       |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Jassid, Whitefly and Aphids | Average of 3 leaves (each from upper, middle and lower canopy)/plant                                                                  |
| Fruit borer complex         | % damage<br>$P = \left[ \frac{\text{No. of damaged fruits}}{\text{No. of healthy} + \text{No. of damaged fruits}} \right] \times 100$ |

### 3.7.2.1: Statistical Analysis

The data obtained on insect populations from experimental field were subjected to analysis of variance after transforming into  $\sqrt{x+0.5}$ . The mean insect populations at peak of okra cultivars recorded during the crop season were categorized on the basis of the following formula given by Nagar *et al* (2017).

$$\bar{x} \pm \sigma$$

Where,

$\bar{x}$  = Mean of peak population

$\sigma$  = Standard deviation of insect population

| Sl No. | Mean population per plant/ leaves        | Category               |
|--------|------------------------------------------|------------------------|
| 1.     | Below $\bar{x} - \sigma$                 | Less susceptible       |
| 2.     | $\bar{x} - \sigma$ to $\bar{x} + \sigma$ | Moderately susceptible |
| 3.     | Above $\bar{x} + \sigma$                 | Highly susceptible     |

### 3.7.2.2: Physio-morphic plant characters

The following physio-morphic characters of the plant were studied at 60 days crop. Fourteen okra (*Abelmoschus esculentus*) cultivars representing different reaction groups were studied for their morphological characters namely plant height (cm), number of branches/plant, number of leaf/plant, number of fruit/plant, number of flower/plant, length and breadth/fruit, number of seeds/fruit, area of the leaf lamina (cm<sup>2</sup>). Leaves from each entry were sampled at 60 days of crop growth. Leaf thickness (mm) was measured from middle of each leaf using Vernier Calipers. Trichome density was recorded as number per cm<sup>2</sup> leaf area under a stereo-binocular microscope in the laboratory.

### 3.7.2.3: Biochemical analysis of okra cultivars

For biochemical analysis leaves from middle canopy were taken and leaf samples were drawn separately from each of these 14 cultivars at 60 days. Fresh leaves were sampled preferably before 9 am in the morning for analysis of different bio-chemicals like proteins, phenols, OD phenol and lipid. For macro (NPK) and micro (zinc) nutrient analysis, leaves were taken from the middle canopy (full-grown leaves) of the plants, from each plot. These samples were washed with distilled water and dried in an electric oven, run at 65 °C for 72 hours. Same procedure followed for the biochemical analysis of different medium size of fruit. The oven-dried material ground and the samples were stored in dry polythene bags for further use.

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**The analysis of bio-chemicals was done by the following procedures.**

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|                       |                                                            |
|-----------------------|------------------------------------------------------------|
| Total protein (mg/gm) | : Lowry method (1951)                                      |
| Lipid (%)             | : Bligh and Dyer method (1959)                             |
| Total Phenol (mg/gm)  | : Bray and Thorpe method (1954)                            |
| OD Phenol (mg/gm)     | : Mahadevan and Sridhar method (1986)                      |
| Total chlorophyll (%) | : Chlorophyll meter (SPAD)                                 |
| Nitrogen (%)          | : Modified Kjeldahl method as described by Jackson, (1967) |
| Phosphorus (%)        | : Jackson (1967)                                           |
| Potassium (%)         | : Jackson (1967)                                           |
| Zinc (mg/kg)          | : Page <i>et al</i> , (1982)                               |

---

**3.7.2.4: Moisture (%) of leaves and fruit**

Leaves from middle canopy were taken from plants in each plot. All the leaves under experiment were cleaned with a muslin cloth, weighed and kept into a drying oven at 65°C for 72 hours. After drying, the leaves were weighed again and the moisture percentage was calculated according to the following formula:

$$\text{Moisture \%} = \frac{\text{Wt. of fresh leaves} - \text{Wt. of dry leaves}}{\text{Wt. of fresh leaves}} \times 100$$

**3.7.2.5: Determination of total protein content in the leaves and fruits of okra:****Reagents:**

1. **Solution A:** 2% sodium carbonate in 0.1 N sodium hydroxide solutions. Dissolve 20 g Na<sub>2</sub>CO<sub>3</sub> and 4g NaOH in 500 ml distilled water and make up the volume to one litre.
2. **Solution B:** Prepare just prior to its use by mixing equal volume of a. 1% copper sulphate solution and b. 2% sodium potassium tartarate (Rochelle salt) solution.
3. **Solution C:** Alkaline cupric tartarate solution. Prepare just prior to its use by mixing 50 ml of solution B. If precipitate is formed by mixing then discard the solution.
4. **Solution D:** Folin- Ciocalteu reagent

**Procedure:****A. Extraction of protein from plant material**

- ✓ After thorough mixing, representative sample weighting 0.1 gm is extracted with 5 ml of 0.1 M phosphate buffer. pH 7.5 using pestle & mortar at 4<sup>0</sup>C (Extraction is generally carried out with same buffer used for the enzyme assay).
- ✓ Extracted material is transferred to centrifuge tube.

- ✓ Centrifuge the homogenate for 15 min at 10,000 rpm at 4°C.
- ✓ Decant the supernatant and discard the residue.
- ✓ Add equal volume of 15% TCA to the supernatant which will precipitate the protein and keep the solution overnight at room temperature.
- ✓ Centrifuge the above solution at 3,000 rpm for 10 min.
- ✓ Discard the supernatant. Dissolve the precipitate in 0.1 N NaOH and make up the volume to 10 ml with 0.1 N NaOH. This solution is used further for protein estimation.

#### **B. Estimation of solution protein**

- ✓ 0.1 ml sample taken in test tube
- ✓ Make up the volume to 1 ml with water. A tube containing 1 ml distilled water serves as a blank.
- ✓ Add 5 ml of solution C, mix well by vortex mixer and wait for 10 min.
- ✓ Add 0.5 ml of 1 N Folin reagent (Solution D), mix well using a vortex mixer. Blue colour will develop immediately; keep all the tube at room temperature for 30 min.
- ✓ Took observation at 660 nm using spectrophotometer.

#### **3.7.2.6: Determination of phenol content in the leaves and fruits of okra**

##### **Reagents:**

1. 80% Ethanol
2. Folin-Ciocalteu reagent (FCR)
3. 20% Na<sub>2</sub>CO<sub>3</sub>
4. Standard (100 mg catechol in 100 ml of water). Dilute 10 times for working standard.

##### **Procedure:**

- ✓ Weigh exactly 0.5 to 1g of the sample and grind it with a pestle and mortar in 10times volume of 80% ethanol.
- ✓ Centrifuge the homogenate at 10,000 rpm for 20 min. save the supernatant. Re-extract the residue with five times the volume of 80% ethanol, centrifuge and pool the supernatants.
- ✓ Evaporate the supernatant to dryness.
- ✓ Dissolve the residue in a known volume of distilled water (5ml).
- ✓ Pipette out different aliquots (0.2 to 2ml) into test tubes.
- ✓ Make up the volume in each tube to 3ml with water.

- ✓ Add 0.5ml of Folin-Ciocalteu reagent.
- ✓ After 3 min, add 2 ml of 20%  $\text{Na}_2\text{CO}_3$  solution to each tube.
- ✓ Mix thoroughly. Place the tubes in a boiling water for exactly one min, cool and measure the absorbance at 650nm against a reagent blank.
- ✓ Prepare a standard curve using different concentrations of catechol.

### **3.7.2.7: Determination of OD phenol content in the leaves and fruits of okra**

#### **Reagents:**

1. 80% Ethanol
2. 0.5N HCl
3. 1N NaOH
4. Arnow's reagent: Dissolve 10 gm of sodium nitrite ( $\text{NaNO}_2$ ) and 10 gm of sodium molybdate ( $\text{NaMoO}_4$ ) in 100 ml of water.
5. Standard catechol :100 mg Catechol /100 ml of water
6. Working standard: Dilute the standard catechol solution, 1:10 with water (100 ug/ml)

#### **Procedure:**

- ✓ Weigh exactly 0.5 to 1g of the sample and grind it with a pestle and mortar in 10-time volume of 80% ethanol.
- ✓ Centrifuge the homogenate at 10,000 rpm for 20 min. save the supernatant. Re-extract the residue with five times the volume of 80% ethanol, centrifuge and pool the supernatants.
- ✓ Evaporate the supernatant to dryness.
- ✓ Dissolve the residue in a known volume of distilled water (5ml).
- ✓ Pipette out different aliquots (0.2 to 1ml) into test tubes.
- ✓ Make up the volume in each tube to 1ml with water.
- ✓ Add-1 ml of 0.05N HCl, 1ml of Arnow's reagent, 10ml of water and 2ml of 1 N NaOH. Mix thoroughly (pink colour appears).
- ✓ Maintain the reagent blank similarly without the extract.
- ✓ Measure the absorbance at 515 nm

### **3.7.2.8: Determination of lipids content in the leaves and fruits of okra**

#### **Reagents:**

1. Chloroform : methanol (10:20, V/V)
2. Chloroform

#### **Procedure:**

- ✓ Homogenize about 0.5g of biological material in a blender for 2 min in a mixture of chloroform: methanol.

- ✓ Add 10 ml of chloroform and homogenize further for an additional 1 min.
- ✓ Add 10ml water and homogenize further for 1 min.
- ✓ Filter on a Buchner funnel (using vacuum) through Whatman No. 1 filter paper.
- ✓ Transfer quantitatively into a pre-weighed conical flask.
- ✓ Evaporate in a 40-50°C water bath under a stream of nitrogen gas.
- ✓ Add 5ml of chloroform 3 times to dissolve the lipids. Evaporate and dry the flask
- ✓ Weigh the flask.

#### **3.7.2.9: Determination of nitrogen (%) in leaves and fruit of okra**

0.5 g of the dried leaf and fruit-tissue powder from each sample was taken to determine the total nitrogen percentage by modified Kjeldahl method as described by Jackson, (1967). In this method plant samples were digested in  $\text{H}_2\text{SO}_4$  at a temperature  $370^\circ\text{C}$ . The rate of digestion was accelerated by using  $\text{K}_2\text{SO}_4$ ,  $\text{CuSO}_4$  and selenium powder in the ratio of 100:10:1. On completion of digestion, 40% NaOH was added to the digested material for distillation. The distilled ammonia was absorbed in boric acid mixed indicator and titrated with standard  $\text{H}_2\text{SO}_4$ .

#### **3.7.2.10: Determination of phosphorus in leaves and fruit of okra**

The estimation of phosphorus was carried out by digesting of plant sample (0.5 gm) in a mixture of nitric acid and perchloric acid (9:4). The digest was filtered and the phosphorus in the digested form was estimated by Vanado-molybdate yellow color method. The reading was measured in Spectrophotometer (Systronic type) at 420 nm as described by Jackson (1967).

#### **3.7.2.11: Determination of potassium in leaves and fruit of okra**

Total potassium in plant sample was estimated by flame photometer as proposed by Jackson (1967)

#### **3.7.2.12: Determination of zinc in leaves and fruit of okra**

Total zinc was determined by digesting plant sample (0.5gm) in mixture of nitric acid and perchloric acid (9:4). The digest was filtered and made to known volume. Zinc in the digest was estimated by the Atomic Absorption Spectrophotometer (Model: Perkin Elmer, Analyst 200) method as described by Page *et al*, (1982).

**Plate 1: Field view of different cultivars against insect-pests of okra**





**Statistical analysis:** One way ANOVA was performed for each of the parameters and separation of the means was done by using the Least Significant Difference (LSD) test at 5% significant level. The bio-chemicals of leaf and fruit were analyzed by using CRD test. Statistical software SAS (Version 9.2) was used for data analysis with transformed value.

**3.7.3: Formulation of region-specific pest management modules of okra through integration of various pest management strategies like mechanical, botanical, microbial and chemical:**

**Table 4: Experimental details for formulation of region-specific pest management modules**

| Details of the experiments |   |                               |
|----------------------------|---|-------------------------------|
| Design                     | : | Randomized Block Design (RBD) |
| Number of treatment        | : | Fifteen (15)                  |
| Number of replication      | : | Three (3)                     |
| Plot size                  | : | 3x3 m <sup>2</sup>            |
| Plant to plant distance    | : | 40 cm                         |
| Row to row distance        | : | 60 cm                         |

**Table 5: Details of insecticides/traps and their sources**

| Sl. No | Nature of insecticides | Name of insecticides/traps                      | Doses                                                                                                  | Source                                    |
|--------|------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------|
| 1.     | Botanicals             | Agniastra                                       | 25ml/lit                                                                                               | Hand made                                 |
|        |                        | Neem oil (0.03% EC)                             | 3ml/lit                                                                                                | T. Stanes and Ltd., Coimbatore            |
|        |                        | Neem leaf extract                               | 7ml/lit                                                                                                | Hand made                                 |
| 2.     | Organic                | Jiwamrita                                       | 200 lit/acre                                                                                           | Hand made                                 |
|        |                        | Bijamrita                                       | For 100kg of seed treatment (5kg cow dunk, 5lit. cow urine, 50gm lime, 1 hand full soil, 20lit. water) | Hand made                                 |
| 3.     | Bio-pesticide          | <i>Beauveria bassiana</i>                       | 5gm/lit                                                                                                | T. Stance and company limited, Tamil nadu |
|        |                        | Emamectin benzoate 5% SG                        | 0.5gm/lit                                                                                              | Paramount agritechnologies, Bhopal        |
| 4.     | Mechanical             | Pheromone trap (Helilure and Ervit lure)        | 5 traps/ ha                                                                                            | Pheromone chemicals, Hyderabad            |
|        |                        | Yellow sticky trap                              | 15/ha                                                                                                  | Hand made                                 |
| 5.     | Synthetic              | Imidacloprid 17.8% SL                           | 0.3ml/lit                                                                                              | Bayer India Ltd., Mumbai                  |
|        |                        | Thiomethaxam 25% WG                             | 0.33gm/lit                                                                                             | RPH Crop science Pvt. Ltd                 |
|        |                        | Lancer Gold (Acephate 50%+Imidacloprid 1.8% SP) | 2gm/lit                                                                                                | Willowood Pvt. Ltd. Kolkata               |
|        |                        | Flubendamide 39.35% SC                          | 0.3ml/lit                                                                                              | Bayer India Ltd., Mumbai                  |
|        |                        | Thiodicarb 75% WP                               | 2gm/lit                                                                                                | Bayer India Ltd., Mumbai                  |
|        |                        | Chloropyriphos 20% EC                           | 2ml/lit                                                                                                | Indian agro chemicals, Ahmedabad          |

**Table 6: Details of the pesticide modules tested for management of different pests of okra**

| Modules     | Seed treatment        | Fertilizers /manure | First spray                                     | Second spray                                    |
|-------------|-----------------------|---------------------|-------------------------------------------------|-------------------------------------------------|
| <b>M-1</b>  | -                     | NPK                 | Imidacloprid 17.8% SL                           | Thiodicarb 75% WP                               |
| <b>M-2</b>  | -                     | NPK                 | Thiomethaxam 25% WG                             | Flubendamide 39.35% SC                          |
| <b>M-3</b>  | Chloropyriphos 20% EC | NPK                 | Thiomethaxam 25% WG                             | Thiodicarb 75% WP                               |
| <b>M-4</b>  | Imidacloprid 17.8% SL | NPK                 | Imidacloprid 17.8% SL                           | Flubendamide 39.35% SC                          |
| <b>M-5</b>  | Bijamrita             | NPK                 | Agniastra                                       | Agniastra                                       |
| <b>M-6</b>  | Bijamrita             | NPK                 | Neem oil (0.03% EC)                             | Neem oil (0.03% EC)                             |
| <b>M-7</b>  | -                     | NPK                 | Neem oil (0.03% EC)                             | Neem leaf extract                               |
| <b>M-8</b>  | Bijamrita             | Jiwamrita           | Agniastra                                       | Agniastra                                       |
| <b>M-9</b>  | Bijamrita             | NPK                 | Imidacloprid 17.8% SL                           | Thiodicarb 75% WP                               |
| <b>M-10</b> | Bijamrita             | NPK                 | Neem leaf extract                               | Neem leaf extract                               |
| <b>M-11</b> | Chloropyriphos 20% EC | NPK                 | Lancer Gold (Acephate 50%+Imidacloprid 1.8% SP) | Lancer Gold (Acephate 50%+Imidacloprid 1.8% SP) |
| <b>M-12</b> | Bijamrita             | NPK                 | Agniastra                                       | Emamectin benzoate 5% SG                        |
| <b>M-13</b> | Bijamrita             | NPK                 | Emamectin benzoate 5% SG                        | <i>Beauveria bassiana</i>                       |
| <b>M-14</b> | Imidacloprid 17.8% SL | NPK                 | Lancer Gold (Acephate 50%+Imidacloprid 1.8% SP) | Lancer Gold (Acephate 50%+Imidacloprid 1.8% SP) |
| <b>M-15</b> | Untreated             | NPK                 | -                                               | -                                               |

Yellow sticky trap and pheromone trap are installed in the field to monitor and assess the population of jassid and fruit borer respectively for initiation of management schedule.

### **3.7.3.1. Methods for recording data of pests and predators of okra**

Observations to be taken on the number of different pests and natural enemies from 5 randomly selected plants in each replication. The jassid population was recorded at one day before spray, 1, 3, 7 and 14 days after spray. The fruit borer complex was recorded at one day before, 3, 7 and 14 days after spray. The predators (coccinellid and spider) were recorded at one day before and 14 days after spray.

**Table 7: Data to be recorded for the pests attacking okra:**

|                         |                                                                                                                                       |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Jassid                  | Average of 3 leaves (each from upper, middle and lower canopy) per plant                                                              |
| Coccinellids and Spider | No. of insects/ plant                                                                                                                 |
| Fruit borer complex     | % damage<br>$P = \left[ \frac{\text{No. of damaged fruits}}{\text{No. of healthy} + \text{No. of damaged fruits}} \right] \times 100$ |

**Percent reduction of the pests attacking okra (Henderson and Tilton formula, 1955)**

$$P = \left( 1 - \left[ \frac{\text{PrUT} \times \text{PoT}}{\text{PrT} \times \text{PoUT}} \right] \right) \times 100$$

Where,

P= % population reduction

PrUT= pre-treatment population in the untreated plot

PoT= post treatment population with treated plot

PrT= pre-treatment population in the treated plot

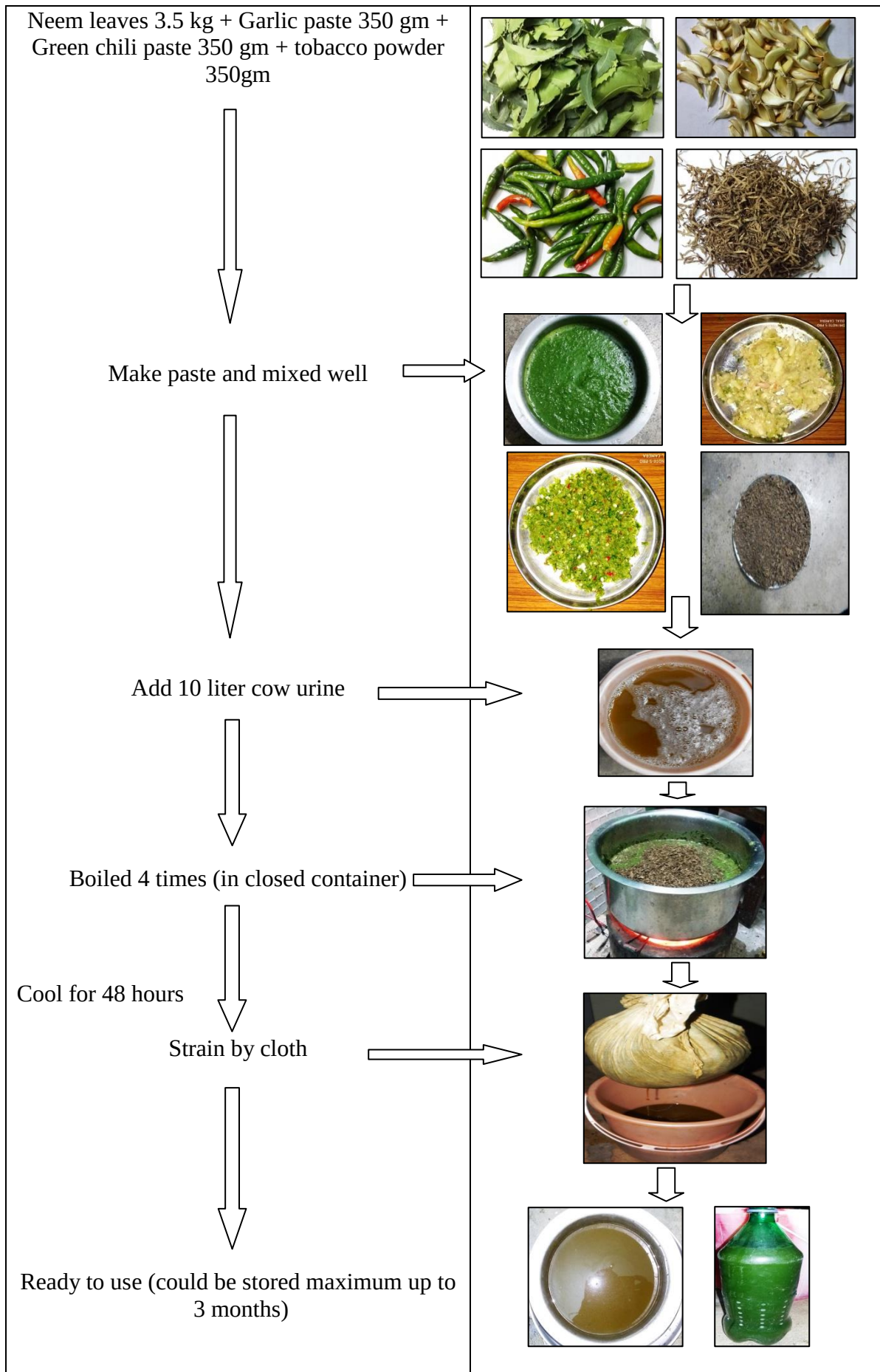
PoUT= post treatment population with untreated plot

### 3.7.3.2: Preparation of Bio-pesticides (Agniastra) as per Palekar, 2001

**Table 8: Components of indigenous Bio-pesticides (Agniastra)**

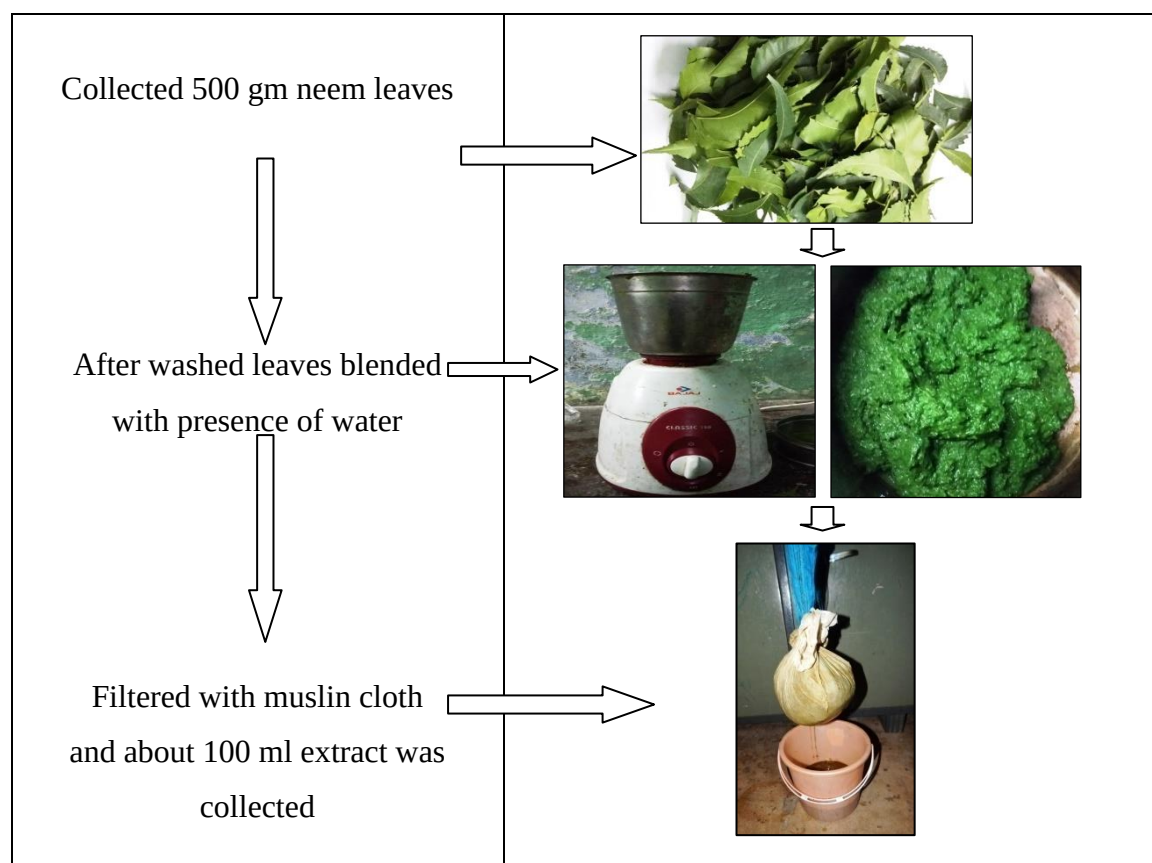
| Sl.No. | Composition         | Quantity |
|--------|---------------------|----------|
| 1.     | Neem leaves paste : | 3.5 kg   |
| 2.     | Garlic paste :      | 350 gm   |
| 3.     | Green chili :       | 350 gm   |
| 4.     | Tobacco powder :    | 350 gm   |
| 5.     | Cow urine :         | 10 lit   |

Pesticides was prepared by making the paste of the Neem leaves 3.5 kg, garlic 350 g, green chili 350g, tobacco powder 350g mixed with 10 liter of cow urine. All the ingredients were mixed in a bowl and covered with the lid. It was boiled for 45 minute to 1 hour and was kept in room for 48 hours. The mixture was strained by cloth, poured in the bottle which can be kept in bottle for 3 month in cool and dry place. The procedure is presented schematically:



### 3.7.3.3: Preparation of Neem (*Azadirachta indica*) leaf extracts as per Zobayer and Hasan, 2013

About 500gm of fresh leaves of neem were collected from neem trees and washed thoroughly in water. The leaves were blended with the presence of water and this mixture was then filtered with the help of muslin cloth and the filtrate leaf extract was used for the experiment. About 100ml of neem extract was collected from 500 gm of leaves.



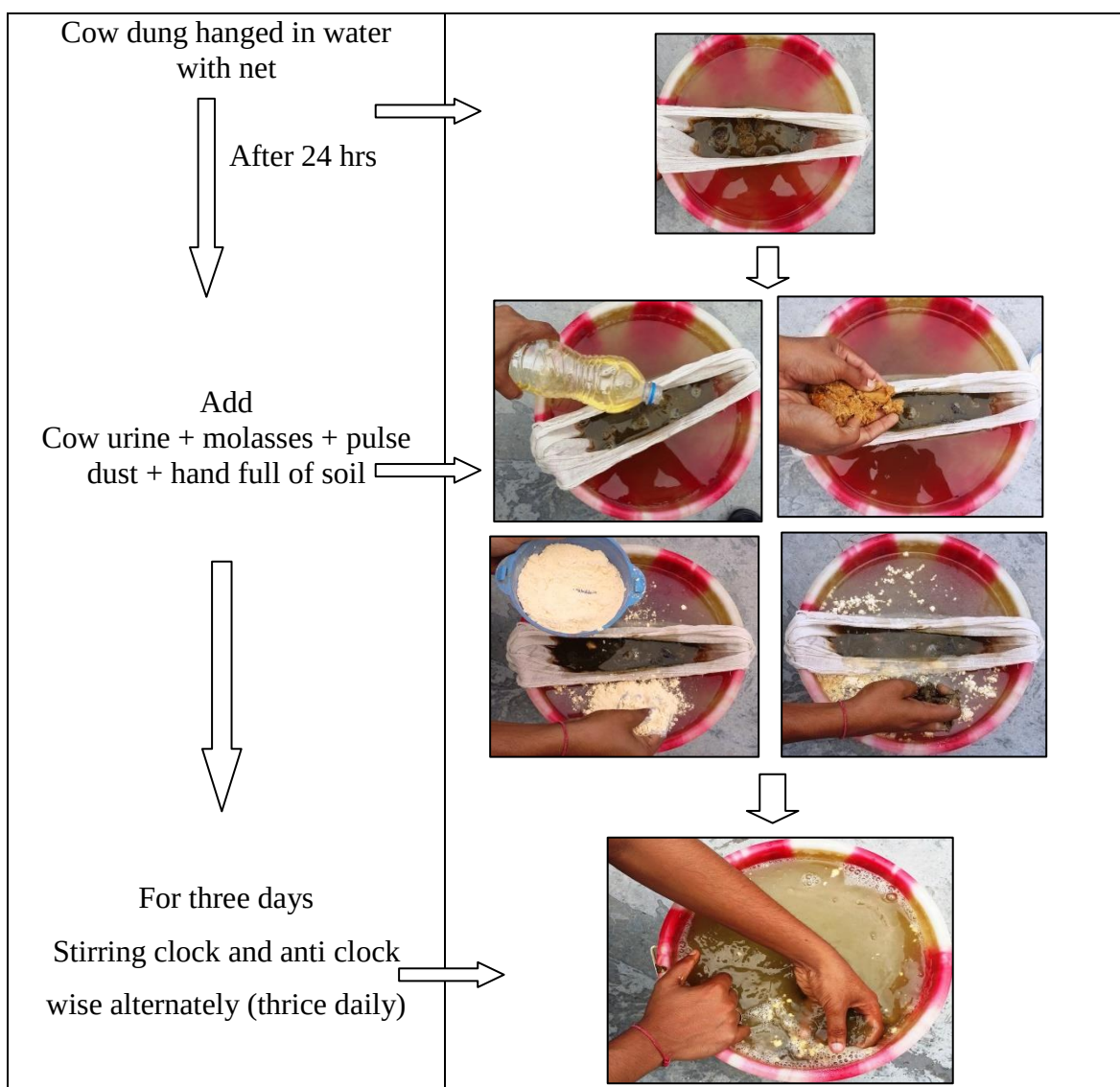
### 3.7.3.4: Preparation of indigenous microbial culture (Jiwamrita) as per Palekar, 2001

**Table 9: Components of Jiwamrita**

| Sl.No. | Composition       | Quantity                    |
|--------|-------------------|-----------------------------|
| 1.     | Fresh cow dung    | : 10 kg                     |
| 2.     | Cow urine         | : 10 lit                    |
| 3.     | Molasses          | : 2 kg                      |
| 4.     | Pulse dust (Gram) | : 2 kg                      |
| 5.     | Soil              | : One hand full (from bund) |
| 6.     | Water             | : 200 lit                   |

## Method of preparation

Fresh cow dung was hanged in muslin cloths in 200 lit of water. After one day or 24 hours cow dung was mixed with water by shaking through muslin cloths as much as possible and then cow urine + molasses + pulse dust + handful of bund soil were added in the cow dung mixed water. For next three days, the same is stirred thrice in clock and anti-clockwise alternately by a wooden or bamboo stick daily. The indigenous material was prepared after three days and was ready to use. The preparation procedure is represented in simpler way as:



## Application procedure

Application was done by spreading diluted microbial culture according to its requirement entirely in the plots at late afternoon hours simply with plastic mug available.

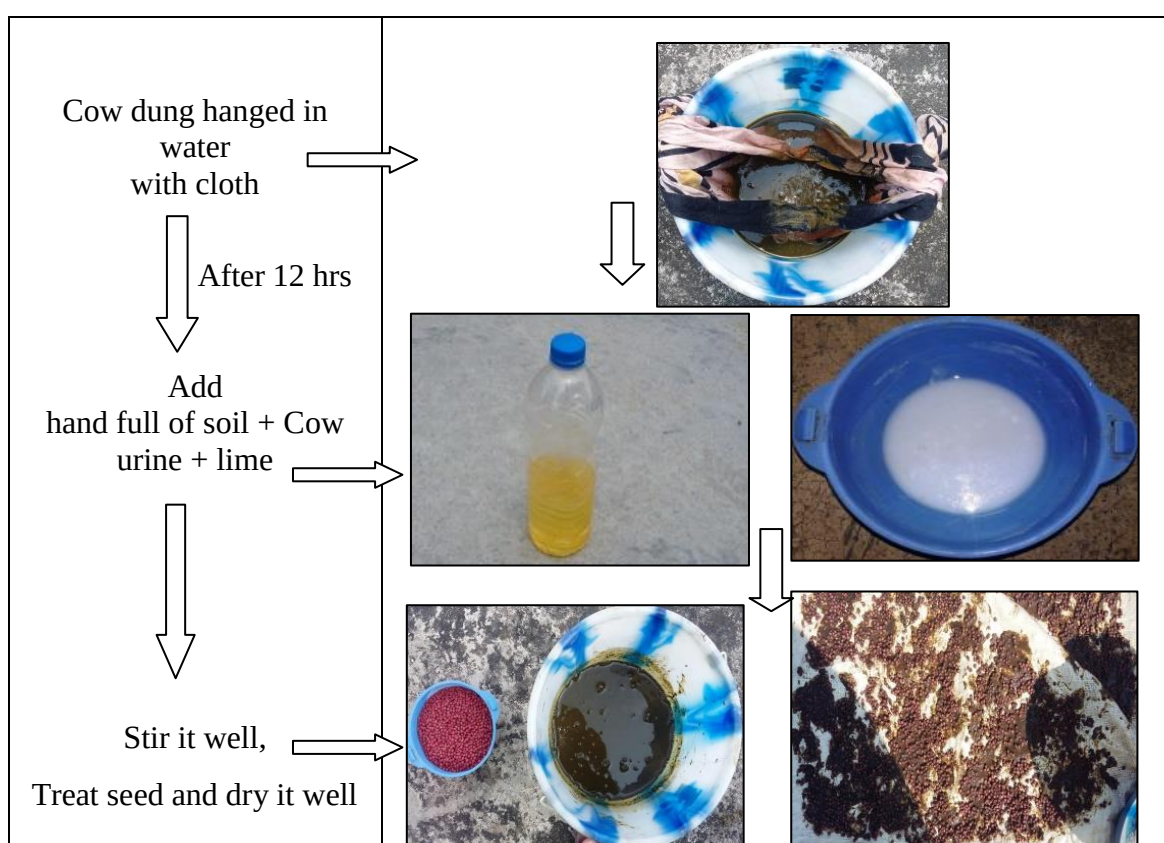
### 3.7.3.5: Preparation of indigenous microbial culture (Bijamrita) as per Palekar, 2001

**Table 10: Components of Bijamrita for 100 kg of seed treatment**

| Sl.No. | Composition      | Quantity                                 |
|--------|------------------|------------------------------------------|
| 1.     | Fresh cow dung : | 5 kg                                     |
| 2.     | Cow urine :      | 5 lit                                    |
| 3.     | Lime :           | 50 gm                                    |
| 4.     | Soil :           | One hand full (from surface of boundary) |
| 5.     | Water :          | 20 lit                                   |

#### Method of preparation

Take 5 kg of deshi cow dung in a cloth and after bound it, hang this bundle of cow dung in 20 litre water for a night (12 hours). Take 1 litre water and add 50 gm lime in it, let it stable for a night. Then next morning, squeeze this bundle of cow dung in that water thrice continuously, so that all essence of cow dung will accumulate in that water. Then add a handful of soil in that water solution and stir it well. Then add 5 litre of deshi cow urine and lime water and stir it well. After that seed is treated with it, dry it well and use for sowing.



**Statistical analysis:** Two way ANOVA was performed for each of the parameters and separation of the means was done. Statistical software SAS (Version 9.2) was used for data analysis with transformed value.

**Plate 2: Field view of different pest management modules against insect-pests of okra**





## CHAPTER-IV

## RESULT AND DISSCUSION

### 4.1. Seasonal incidence of insect pests of okra and their predators

The results obtained from experiments conducted to study the incidence of pests and predators of okra with influence of weather parameters in two season (post-kharif and pre-kharif) and it was observed that the crop was infested by the number of sucking pests namely aphid (*Aphis gossypii* Glover), jassid (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabaci* Gennadius) and mite (*Tetranychus urticae* Koch); foliage feeders like semilooper (*Anomis flava* Fabricius), leaf folder (*Sylepta derogata* Fabricius) and flea beetle and internal feeder namely fruit borer (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.). The important predators include coccinellid beetles and spiders.

**Plate 3: Sucking pest and internal feeder of okra**

| Sucking pest                                                  |                                                                                      |                                                                                       |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Aphid</b><br>( <i>Aphis gossypii</i> Glover)               |  |  |
| <b>Jassid</b><br>( <i>Amrasca biguttula biguttula</i> Ishida) |  |  |

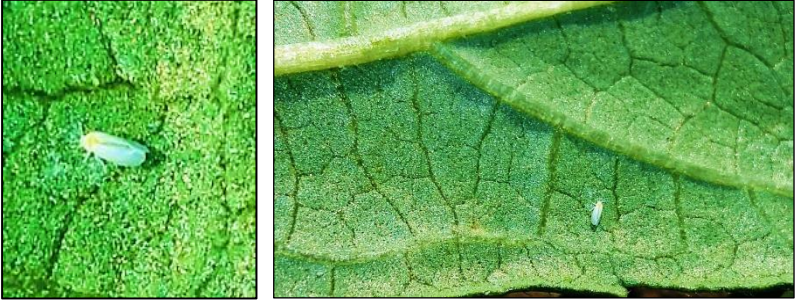
|                                                                        |                                                                                      |
|------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p><b>Whitefly</b><br/>(<i>Bemisia tabaci</i><br/>Gennadius)</p>       |    |
| <p><b>Mite</b><br/>(<i>Tetranychus urticae</i><br/>Koch)</p>           |    |
| <p><b>Internal feeder</b></p>                                          |                                                                                      |
| <p><b>Fruit borer</b><br/>(<i>Earias vittella</i> Fabricius)</p>       |  |
| <p><b>Fruit borer</b><br/><i>Helicoverpa armigera</i><br/>(Hubner)</p> |  |

**Plate 4: Foliage feeder of okra**

| Foliage feeder                                             |                                                                                      |                                                                                       |
|------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <p>Semilooper<br/>(<i>Anomis flava</i> Fabricius)</p>      |    |    |
|                                                            |                                                                                      |                                                                                       |
| <p>Flea beetles</p>                                        |   |   |
|                                                            |  |  |
|                                                            |                                                                                      |                                                                                       |
|                                                            |                                                                                      |                                                                                       |
| <p>Leaf folder<br/>(<i>Sylepta derogata</i> Fabricius)</p> |  |  |
|                                                            |                                                                                      |                                                                                       |

**Plate 5: Predators (Coccinellids and Spider) of okra**

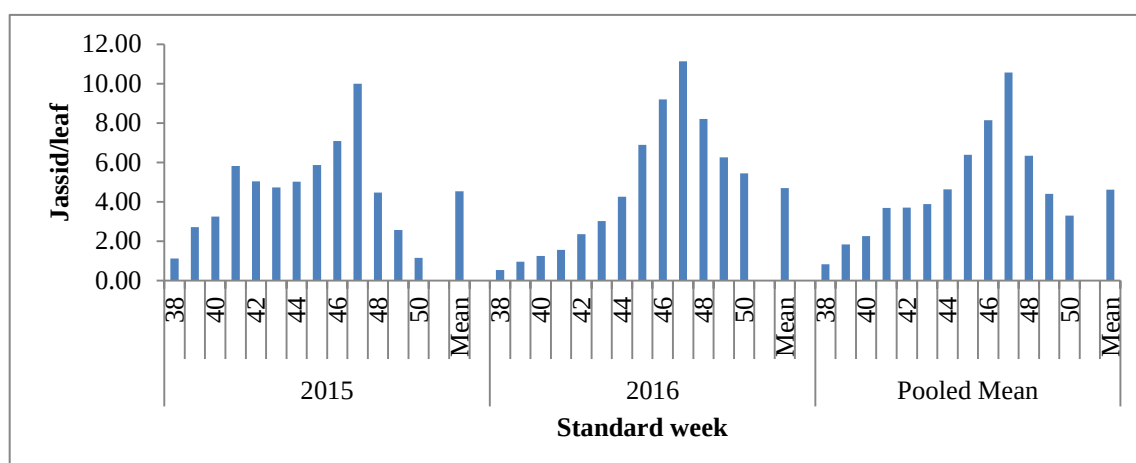
| Predators          |                                                                                    |                                                                                     |                                                                                      |
|--------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Coccinellid beetle |   |   |   |
| Spider             |  |  |  |

#### **4.1.1. Incidence of insect pests of okra and their predators during post-kharif**

##### **4.1.1.1. Fluctuation of jassid (*Amrasca biguttula biguttula* Ishida) population:**

In post-kharif season, average mean population of jassid was 4.53/leaf in 2015, 4.7/leaf in 2016 and 4.61/leaf in pooled mean (Fig. 3). The incidence of jassid was witnessed almost throughout the cropping period from 38<sup>th</sup> SW to 50<sup>th</sup> SW. The population was come to sight in 38<sup>th</sup> SW in 2015, in 2016 and pooled mean of two years with (1.12/leaf), (0.53/leaf) and 0.83/leaf respectively. With the advancement of crop growth the jassid population increased and reached 10.00/leaf, 11.13/leaf and 10.57/leaf on 47<sup>th</sup> SW in 2015, 2016 and pooled mean of two years respectively. Thereafter, the population declined in the succeeding weeks towards the end of crop period *i.e.* on 50<sup>th</sup> SW, 1.15/leaf in 2016; 5.45/leaf in 2017, 3.30/leaf in pooled mean of two years data.

**Fig. 3: Fluctuation of jassid population during post-kharif season**



The correlation analysis of jassid infestation during post-kharif, indicates that all the environmental parameters of all weeks had negatively non-significant effect except evening RH of current week had significant negative effect on jassid infestation during 2015 (Table 11). During 2016, maximum and minimum temperature of all the week were found to have significant negative relation and morning RH of 2-lag week found to have significant and positive relation with jassid population. The pooled mean data reveals that maximum and minimum temperature of all the weeks had negatively significant influence on jassid infestation.

**Table 11: Correlation between jassid population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |            | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum    | Morning             | Evening |                     |
| 2015        | Current | 0.132          | -0.275     | -0.472              | -0.503* | -0.454              |
|             | 1-lag   | -0.109         | -0.167     | -0.069              | -0.348  | -0.275              |
|             | 2-lag   | -0.012         | -0.223     | -0.239              | -0.572  | -0.166              |
| 2016        | Current | -0.723*        | -0.654*    | 0.203               | -0.037  | 0.481               |
|             | 1-lag   | -0.904****     | -0.887**** | 0.391               | 0.136   | 0.305               |
|             | 2-lag   | -0.952****     | -0.944**** | 0.586*              | 0.349   | 0.171               |
| Pooled Mean | Current | -0.671*        | -0.827**** | 0.197               | 0.047   | -0.531              |
|             | 1-lag   | -0.811****     | -0.792**** | 0.524               | 0.057   | -0.444              |
|             | 2-lag   | -0.726***      | -0.783**** | 0.311               | -0.160  | -0.348              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.2. Fluctuation of aphid (*Aphis gossypii* Glover) population

The activity of aphid on okra crop was observed almost throughout the cropping period from 40<sup>th</sup> SW to 50<sup>th</sup> SW. In post-kharif the population was initiated on 40<sup>th</sup> SW (2.98/leaf) in 2015, (3.13/leaf) in 2016 and (3.05/leaf) in pooled mean of two years

study. The population increased with the advancement of crop growth with a highest population observed 9.00/leaf during 43<sup>th</sup> SW in 2015; 44<sup>th</sup> SW during 2016 with 8.33/leaf and 8.50/leaf on 43<sup>th</sup> SW in pooled mean of two years. At the end of the cropping period *i.e.* on 50<sup>th</sup> SW, populations were 0.25/leaf in 2015; 4.80/leaf in 2016 and 2.53/leaf in pooled mean. The average mean population of aphid was 3.94/leaf in 2015, 5.20/leaf in the year 2016 and it was 4.57/leaf in their pooled mean (Fig. 4).

**Fig. 4: Fluctuation of aphid population during post-kharif season**

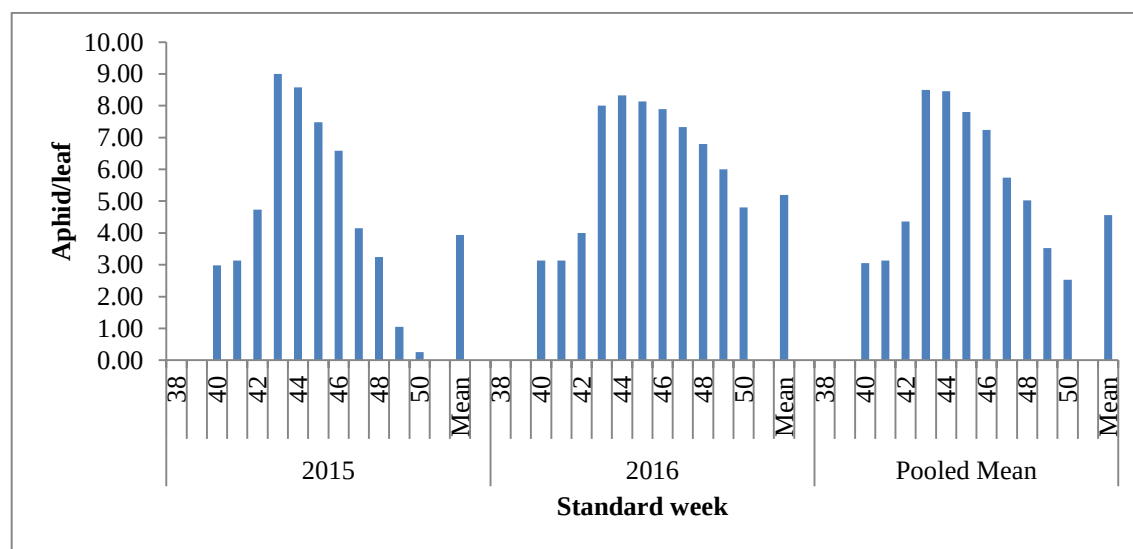


**Table 12: Correlation between aphid population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |             | Relative humidity % |             | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|-------------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening     |                     |
| 2015        | Current | 0.069          | -0.223      | -0.307              | -0.676**    | -0.416              |
|             | 1-lag   | 0.019          | -0.188      | -0.261              | -0.805***** | -0.475              |
|             | 2-lag   | -0.047         | -0.132      | -0.315              | -0.548*     | -0.045              |
| 2016        | Current | -0.903*****    | -0.896***** | 0.230               | 0.126       | 0.204               |
|             | 1-lag   | -0.906*****    | -0.857***** | 0.159               | 0.103       | 0.167               |
|             | 2-lag   | -0.865*****    | -0.858***** | 0.273               | 0.326       | 0.109               |
| Pooled Mean | Current | -0.575*        | -0.753***   | 0.150               | -0.171      | -0.537*             |
|             | 1-lag   | -0.591*        | -0.654*     | 0.084               | -0.413      | -0.634*             |
|             | 2-lag   | -0.576*        | -0.600*     | -0.039              | -0.205      | -0.149              |

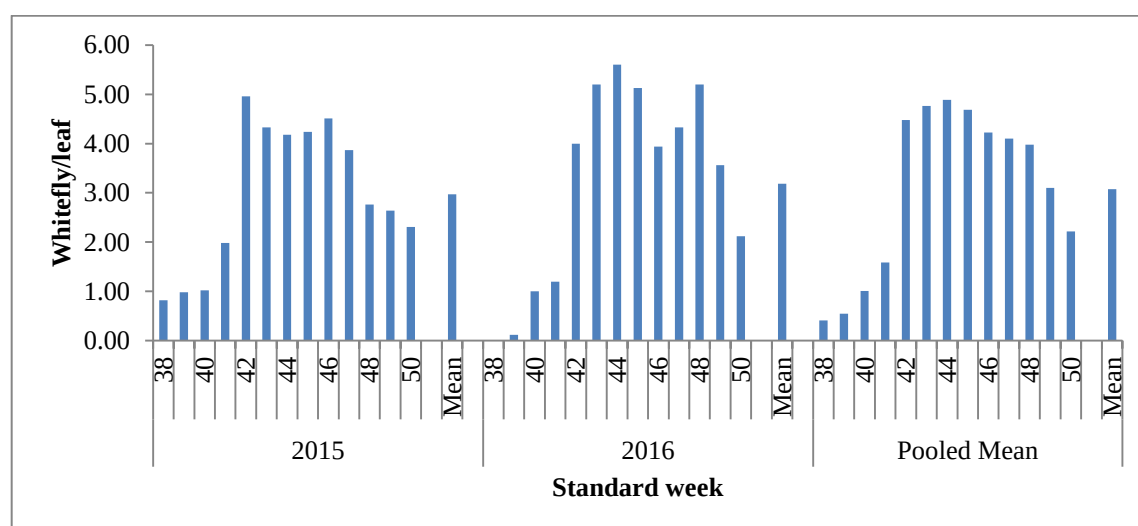
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\*\* Significant at 0.001%

The correlation analysis of aphid infestation during post-kharif, depicted that the evening RH in all weeks had significant negative effect on aphid infestation during 2015 (Table 12). During 2016, maximum and minimum temperature of all the week were found to have significant negative relation with aphid population. The pooled mean data revealed that maximum and minimum temperature of all the weeks and total rainfall of current and 1-lag week have significant negative effect on aphid population.

#### 4.1.1.3 Fluctuation of whitefly (*Bemisia tabaci* Gennadius) population:

In post-kharif season the activity of whitefly on okra crop was observed almost throughout the cropping period from 38<sup>th</sup> SW to 50<sup>th</sup> SW. The population was initiated on 38<sup>th</sup> SW (0.82/leaf) in 2015, (0.00/leaf) in 2016 and (0.41/leaf) in pooled mean of two years study. The population increased with the advancement of crop growth with a highest population observed on 42<sup>th</sup> SW with 4.96/leaf during in 2015; 44<sup>th</sup> SW with 5.60/leaf in 2016 and 4.89/leaf in pooled mean of two years. At the end of the cropping period *i.e.* on 50<sup>th</sup> SW, populations were 2.31/leaf in 2015; 2.12/leaf in 2016 and 2.22/leaf in pooled mean. The average mean population of whitefly was 2.97/leaf in 2015, 3.18/leaf in the year 2016 and it was 3.08/leaf in their pooled mean (Fig. 5).

**Fig. 5: Fluctuation of whitefly population during post-kharif season**



The correlation analysis of whitefly infestation during post-kharif, showed that the minimum temperature of current weeks had negatively significant effect on whitefly population and evening RH of 1 and 2-lag week had significant negative effect on whitefly infestation during 2015 (Table 13). The maximum and minimum temperature of all the week were found to have significant negative relation with whitefly population during 2016. The pooled mean data revealed that maximum and minimum temperature of all the weeks had negatively significant influence on whitefly infestation.

**Table 13: Correlation between whitefly population and the environmental factors during post-kharif season**

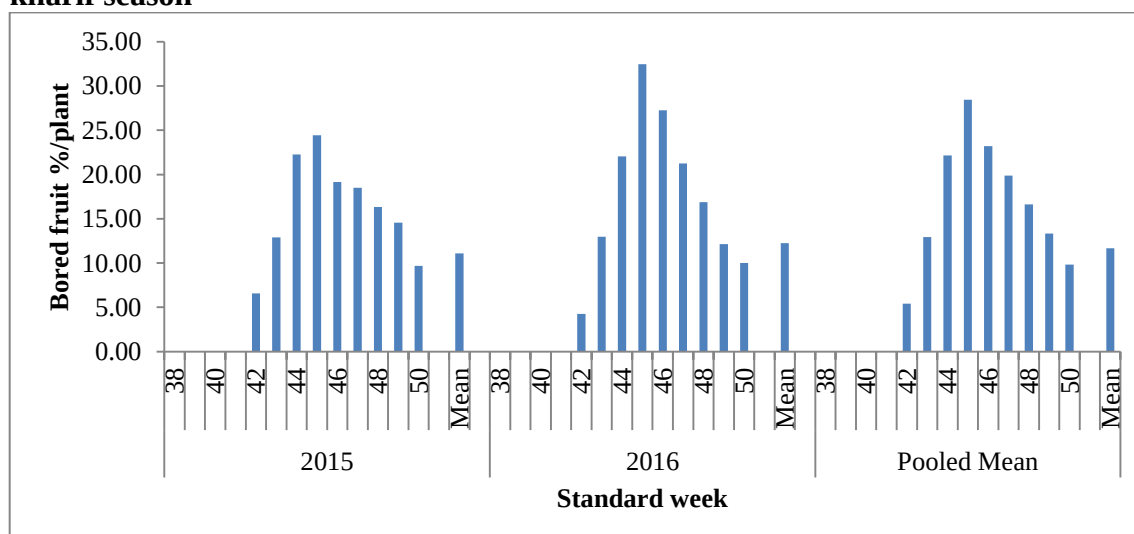
| Year        | Week    | Temperature °C |            | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum    | Morning             | Evening |                     |
| 2015        | Current | -0.337         | -0.547*    | 0.041               | -0.472  | -0.474              |
|             | 1-lag   | -0.412         | -0.517     | -0.094              | -0.594* | -0.444              |
|             | 2-lag   | -0.223         | -0.487     | -0.497              | -0.659* | -0.455              |
| 2016        | Current | -0.872****     | -0.868**** | 0.152               | 0.089   | 0.180               |
|             | 1-lag   | -0.922****     | -0.870**** | 0.207               | 0.156   | 0.271               |
|             | 2-lag   | -0.842****     | -0.816**** | 0.282               | 0.459   | 0.092               |
| Pooled Mean | Current | -0.701**       | -0.825**** | 0.167               | -0.267  | -0.530              |
|             | 1-lag   | -0.743***      | -0.764***  | 0.138               | -0.331  | -0.519              |
|             | 2-lag   | -0.623*        | -0.694**   | -0.107              | -0.155  | -0.407              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.4. Fluctuation of fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.) infestation:

With the initiation of fruit setting the infestation of fruit borer was noticed. The average fruit damage was recorded 11.10%, 12.25% and 11.68% in 2015, 2016 and pooled mean respectively during post-kharif season (Fig. 6). The infestation was recorded first on 42<sup>th</sup> SW in 2015 (6.56%/plant), in 2016 (4.24%/plant) and pooled mean of two years study with 5.41% damaged fruit. The highest per cent of damage was found 24.42% on 45<sup>th</sup> SW in 2015, 32.45% on 45<sup>th</sup> SW during 2016 and 28.43% on 45<sup>th</sup> SW in pooled mean of both the years. Thereafter the level of damage declined gradually and reached 9.67%, 10.01% and 9.84% respectively on 50<sup>th</sup> SW in both the years and pooled mean at the end of the crop growing period respectively.

**Fig. 6: Fluctuation of fruit borer complex (bored fruit %) population during post-kharif season**



Correlation study showed that during post-kharif season, the minimum and maximum temperature had negatively significant effect on fruit borer population in all weeks. Evening RH of 2-lag week had significant negative effect on fruit borer infestation during 2015 (Table 14). The maximum and minimum temperature of all the week were found to have significant negative relation with fruit borer population during 2016. The pooled mean data also explained that maximum and minimum temperature of all the weeks had negatively significant influence on fruit borer infestation.

**Table 14: Correlation between fruit borer complex (% bored fruit) and the environmental factors during post-kharif season**

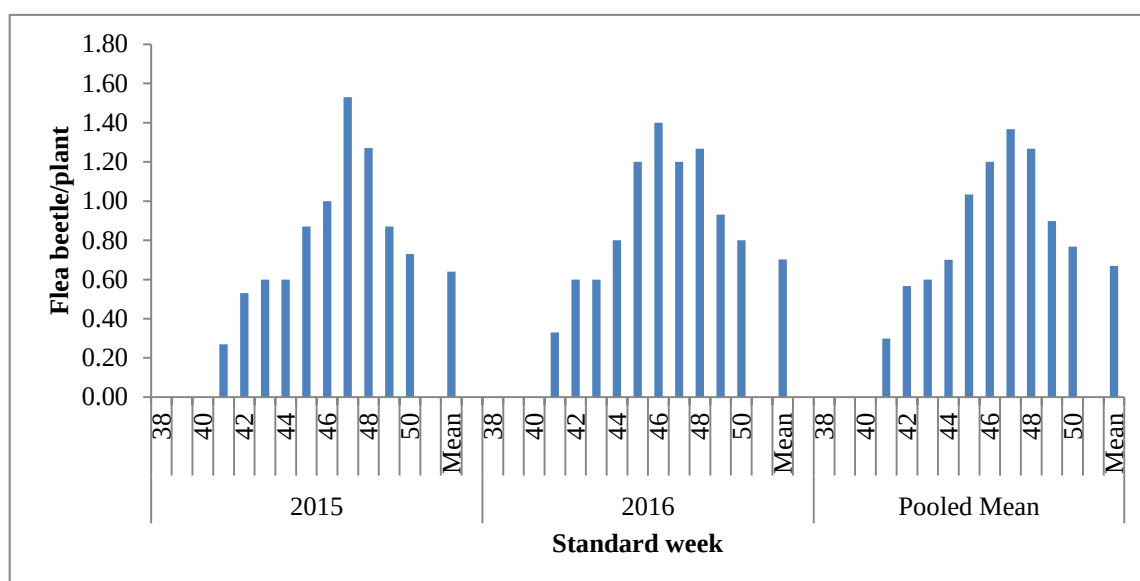
| Year        | Week    | Temperature °C |             | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening |                     |
| 2015        | Current | -0.608*        | -0.808****  | 0.322               | -0.178  | -0.449              |
|             | 1-lag   | -0.715*        | -0.778***   | 0.250               | -0.459  | -0.468              |
|             | 2-lag   | -0.624*        | -0.775***   | -0.149              | -0.622* | -0.456              |
| 2016        | Current | -0.830*****    | -0.804****  | 0.372               | 0.060   | 0.253               |
|             | 1-lag   | -0.918*****    | -0.914***** | 0.336               | 0.121   | 0.174               |
|             | 2-lag   | -0.899*****    | -0.899***** | 0.299               | 0.284   | 0.076               |
| Pooled Mean | Current | -0.825*****    | -0.906***** | 0.435               | -0.112  | -0.440              |
|             | 1-lag   | -0.883*****    | -0.878***** | 0.373               | -0.295  | -0.460              |
|             | 2-lag   | -0.807*****    | -0.847****  | 0.099               | -0.294  | -0.443              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.5. Fluctuation of flea beetle population:

The flea beetle population was first observed on 41<sup>rd</sup> SW when flea beetle population was 0.27/plant in 1<sup>st</sup> year, 0.33/plant in 2<sup>nd</sup> year and in pooled mean 0.30/plant. The population increased steadily and reached to the peak 1.53/plant in the 47<sup>th</sup> SW in 2015, during 2016 in 46<sup>th</sup> SW (1.40/plant) and 47 SW (1.37/plant) in the pooled mean of two years. The population started declining and reached to 0.73/plant, 0.80/plant and 0.77/plant in 50<sup>th</sup> SW in two years and pooled mean respectively. The mean population of flea beetle during post-kharif was 0.64/plant in 2015; 0.70/plant in 2016, and their pooled mean of two years was 0.67/plant (Fig. 7).

**Fig. 7: Fluctuation of flea beetle population during post-kharif season**



Correlation study showed that during post-kharif season the minimum and maximum temperature of all weeks had negatively significant effect on flea beetle population during 2015, 2016 and pooled mean of both years (Table 15).

**Table 15: Correlation between flea beetle population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |             | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening |                     |
| 2015        | Current | -0.674*        | -0.887***** | 0.253               | -0.035  | -0.458              |
|             | 1-lag   | -0.777***      | -0.844***** | 0.189               | -0.189  | -0.507              |
|             | 2-lag   | -0.695**       | -0.872***** | -0.065              | -0.469  | -0.515              |
| 2016        | Current | -0.820*****    | -0.771***   | 0.191               | -0.049  | 0.286               |
|             | 1-lag   | -0.958*****    | -0.947***** | 0.351               | 0.199   | 0.317               |
|             | 2-lag   | -0.961*****    | -0.950***** | 0.468               | 0.385   | 0.153               |
| Pooled Mean | Current | -0.886*****    | -0.940***** | 0.283               | -0.091  | -0.470              |
|             | 1-lag   | -0.935*****    | -0.946***** | 0.361               | -0.072  | -0.521              |
|             | 2-lag   | -0.875*****    | -0.930***** | 0.252               | -0.143  | -0.531              |

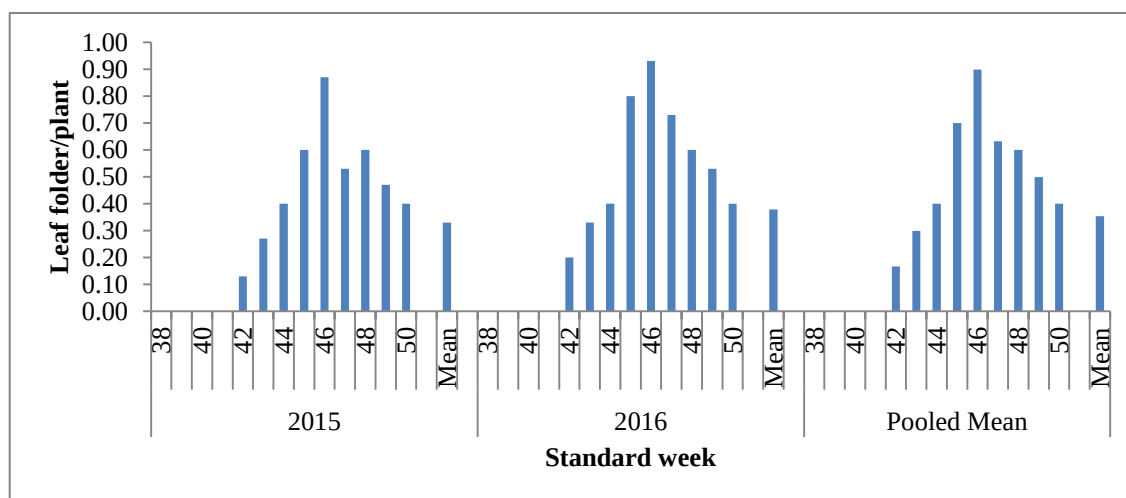
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.6. Fluctuation of leaf folder (*Sylepta derogata* Fabricius) population:

The population of leaf folder was recorded very minimum during post-kharif season which did not cause any considerable damage and very negligible number of leaf folder was noticed mainly during vegetative stage of crop growth (Fig. 8). The highest mean population was recorded 0.38/plant in 2016 and 0.33/plant in 2015. In pooled mean of two years study, the population was 0.35/plant. The population appeared in 42<sup>th</sup> SW of 0.13/plant, 0.20/plant and 0.17/leaf during 2015, 2016 and pooled of both years

respectively. The peak population was observed in 46<sup>th</sup> SW with 0.87/plant in 2015, 0.93/plant in 2016 and in pooled over mean of two years it was 0.90/plant.

**Fig. 8: Fluctuation of leaf folder population during post-kharif season**



The correlation analysis showed that maximum and minimum temperature of all the weeks had significantly negative effect on leaf folder population during 2015, 2016 and pooled mean of both years (Table 16).

**Table 16: Correlation between leaf folder population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |             | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening |                     |
| 2015        | Current | -0.694**       | -0.809***** | 0.381               | 0.101   | -0.416              |
|             | 1-lag   | -0.755***      | -0.864***** | 0.339               | -0.337  | -0.444              |
|             | 2-lag   | -0.747***      | -0.816***** | 0.079               | -0.460  | -0.423              |
| 2016        | Current | -0.763***      | -0.712**    | 0.285               | -0.006  | 0.318               |
|             | 1-lag   | -0.915*****    | -0.908***** | 0.418               | 0.166   | 0.216               |
|             | 2-lag   | -0.929*****    | -0.945***** | 0.491               | 0.338   | 0.158               |
| Pooled Mean | Current | -0.853*****    | -0.886***** | 0.432               | 0.019   | -0.420              |
|             | 1-lag   | -0.907*****    | -0.913***** | 0.481               | -0.153  | -0.442              |
|             | 2-lag   | -0.872*****    | -0.904***** | 0.327               | -0.181  | -0.428              |

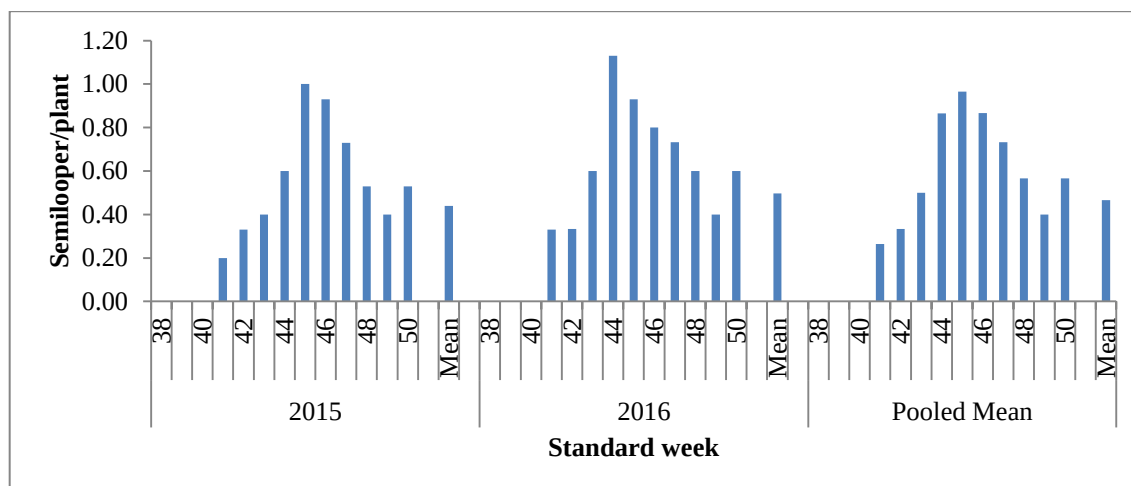
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\*\* Significant at 0.001%

#### 4.1.1.7. Fluctuation of semilooper (*Anomis flava* Fabricius) population

The mean population of semilooper during post-kharif was 0.44/plant in 2015; 0.50/plant in 2016 and their pooled mean of two years was 0.47/plant (Fig. 9). The semilooper population was first observed on 41<sup>st</sup> SW (0.20/plant) in 1<sup>st</sup> year, (0.33/plant) in 2<sup>nd</sup> year and (0.27/plant) in pooled mean. The population increased steadily and reached to the peak 1.00/plant in the 45<sup>th</sup> SW in 2015, during 2016 in 44<sup>th</sup> SW (1.13/plant) and the pooled mean of two years followed the same trend as that of 2016

and the maximum population 0.97/plant was recorded in 45<sup>th</sup> SW. The population started declining and reached to 0.53/plant, 0.60/plant and 0.57/plant in 50<sup>th</sup> SW in two years and pooled over mean respectively.

**Fig. 9: Fluctuation of semilooper population during post-kharif season**



Correlation study showed that during post-kharif season the minimum and maximum temperature of all weeks and evening RH of 2-lag week had negatively significant effect on semilooper population during 2015 (Table 17). The minimum and maximum temperature of all week were found to have significant negative relation with semilooper population during 2016. The pooled mean data revealed that minimum and maximum temperature of all the weeks had negatively significant influence on semilooper infestation.

**Table 17: Correlation between semilooper population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |             | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening |                     |
| 2015        | Current | -0.606*        | -0.776***   | 0.287               | -0.131  | -0.445              |
|             | 1-lag   | -0.657*        | -0.759***   | 0.195               | -0.432  | -0.489              |
|             | 2-lag   | -0.572*        | -0.732***   | -0.102              | -0.672* | -0.490              |
| 2016        | Current | -0.893*****    | -0.874***** | 0.439               | 0.132   | 0.206               |
|             | 1-lag   | -0.871*****    | -0.883***** | 0.200               | 0.106   | 0.107               |
|             | 2-lag   | -0.819*****    | -0.789***** | 0.071               | 0.195   | -0.053              |
| Pooled Mean | Current | -0.854*****    | -0.898***** | 0.487               | -0.060  | -0.452              |
|             | 1-lag   | -0.822*****    | -0.862***** | 0.287               | -0.303  | -0.515              |
|             | 2-lag   | -0.738***      | -0.787***   | -0.002              | -0.388  | -0.500              |

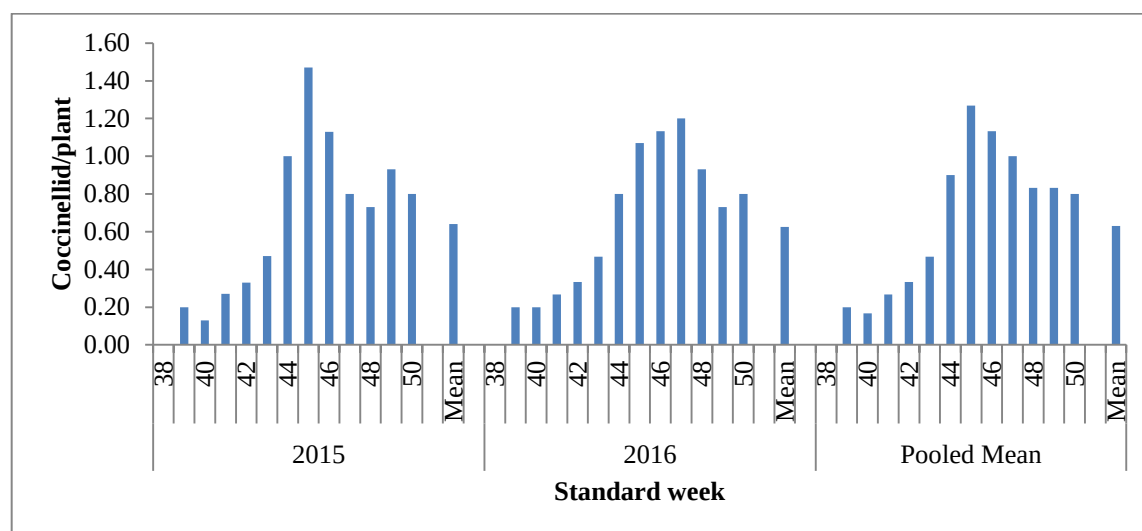
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.8. Fluctuation of coccinellid population

During post-kharif season average coccinellid population was recorded 0.64/plant in 2015, 0.63/plant in 2016 and 0.63/plant in mean of both the years (Fig. 10). The

coccinellid population was commenced in the field during 39<sup>th</sup> SW (0.20/plant) in 2015, in 2016 (0.20/plant) and pooled mean of two year (0.20/plant). The peak population was recorded on 45<sup>th</sup> SW in 2015 (1.47/plant), 46<sup>th</sup> SW in 2016 (1.13/plant) and 45<sup>th</sup> SW of pooled mean with population density of 1.27/plant. At the end of the crop 0.80/plant of coccinellid population was observed in 2015, 2016 and pooled mean of two years.

**Fig. 10: Fluctuation of coccinellids population during post-kharif season**



Correlation study showed that during post-kharif season the minimum and maximum temperature in all weeks and evening RH of 2-lag week had negatively significant effect on coccinellid population during 2015 (Table 18). The minimum and maximum temperature of all the week were found to have significant negative relation with coccinellid population during 2016. The pooled mean data revealed that minimum and maximum temperature of all the weeks and total rainfall of current week had negatively significant influence on coccinellid population.

**Table 18: Correlation between coccinellids population and the environmental factors during post-kharif season**

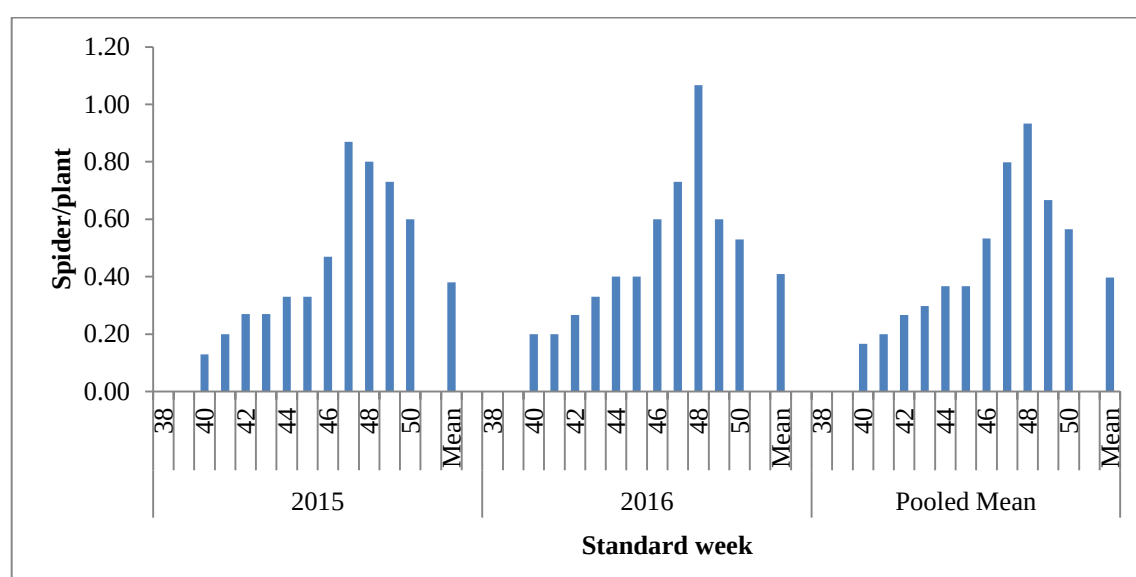
| Year        | Week    | Temperature °C |            | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum    | Morning             | Evening |                     |
| 2015        | Current | -0.623*        | -0.819**** | 0.287               | -0.081  | -0.521              |
|             | 1-lag   | -0.736***      | -0.791***  | 0.360               | -0.367  | -0.397              |
|             | 2-lag   | -0.638*        | -0.783***  | -0.060              | -0.626* | -0.423              |
| 2016        | Current | -0.795***      | -0.720***  | 0.311               | 0.024   | 0.399               |
|             | 1-lag   | -0.910****     | -0.925**** | 0.355               | 0.095   | 0.233               |
|             | 2-lag   | -0.945****     | -0.932**** | 0.428               | 0.282   | 0.100               |
| Pooled Mean | Current | -0.854****     | -0.927**** | 0.397               | -0.032  | -0.549*             |
|             | 1-lag   | -0.918****     | -0.929**** | 0.447               | -0.208  | -0.423              |
|             | 2-lag   | -0.855****     | -0.888**** | 0.178               | -0.308  | -0.413              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.1.9. Fluctuation of spider population

In post-kharif the mean population of spider was 0.38/plant in 2015, 0.41/plant in 2016 and 0.40/plant in pooled mean. Spider populations were first come into noticed in 40<sup>th</sup> SW in 2015 (0.13/plant) (Fig. 11). In 2016 and pooled mean of two years, spider population was 0.20/plant and 0.17/plant observed in 40<sup>th</sup> SW. The peak population was observed on 47<sup>th</sup> SW in 2015 (0.87/plant), on 48<sup>th</sup> SW in 2016 (1.07/plant) and on 48<sup>th</sup> SW in pooled mean of two years (0.93/plant). After that the population decreased and at end of the crop *i.e.* on 50<sup>th</sup> SW reached 0.60/plant, 0.53/plant and 0.57/plant in 2015, 2016 and pooled mean of two years respectively.

**Fig. 11: Fluctuation of spider population during post-kharif season**



Correlation study showed that during post-kharif season the minimum and maximum temperature in all week and total rainfall of 1-lag week had negatively significant effect on spider population during 2015. The minimum and maximum temperature of all week was found to have significant negative relation while morning RH of 2-lag week and total rainfall of 1-lag week had significant positive correlation on spider population during 2016. The pooled mean data revealed that minimum and maximum temperature of all the weeks and total rainfall of 1-lag week had negatively significant influence on spider population (Table 19).

**Table 19: Correlation between spider population and the environmental factors during post-kharif season**

| Year        | Week    | Temperature °C |             | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-------------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum     | Morning             | Evening |                     |
| 2015        | Current | -0.752***      | -0.922***** | 0.259               | 0.156   | -0.466              |
|             | 1-lag   | -0.818*****    | -0.889***** | 0.191               | -0.022  | -0.538*             |
|             | 2-lag   | -0.825*****    | -0.936***** | 0.126               | -0.205  | -0.369              |
| 2016        | Current | -0.634*        | -0.619*     | -0.014              | -0.167  | 0.323               |
|             | 1-lag   | -0.822*****    | -0.749***   | 0.197               | 0.054   | 0.599*              |
|             | 2-lag   | -0.916*****    | -0.902***** | 0.639*              | 0.405   | 0.207               |
| Pooled Mean | Current | -0.834*****    | -0.883***** | 0.117               | -0.055  | -0.481              |
|             | 1-lag   | -0.879*****    | -0.905***** | 0.211               | -0.085  | -0.558*             |
|             | 2-lag   | -0.934*****    | -0.928***** | 0.465               | 0.106   | -0.341              |

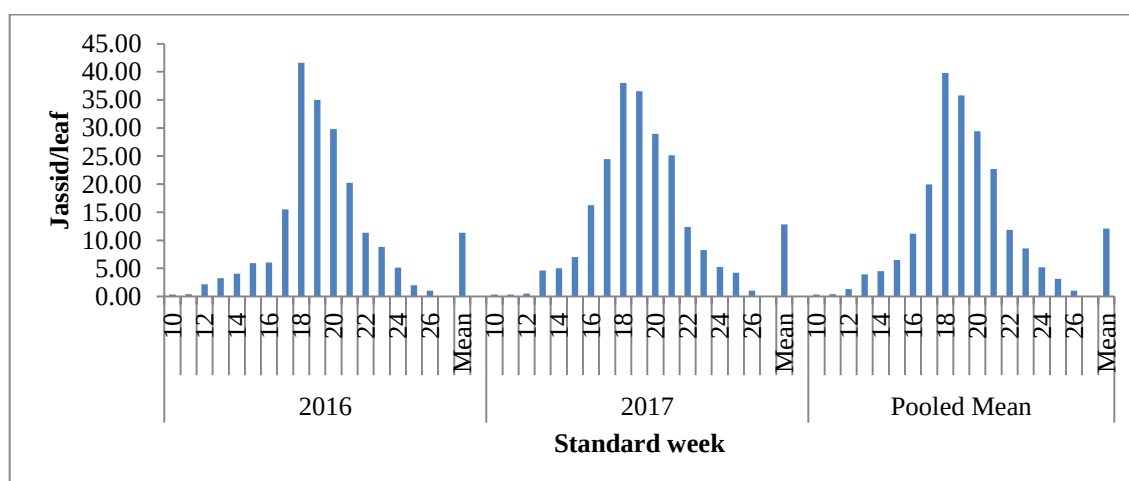
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\*\* Significant at 0.001%

#### 4.1.2 Seasonal incidence of insect pests of okra and their predators in pre-kharif season

##### 4.1.2.1. Fluctuation of jassid (*Amrasca biguttula biguttula* Ishida) population:

The activity of jassids on okra crop was observed almost throughout the cropping period. During pre-kharif season the population was initiated on 10<sup>th</sup> SW in both years with 0.33/leaf in 2016, 0.33/leaf in 2017 and 0.33/leaf in their pooled mean respectively. The population increased with the advancement of crop growth stage with a highest population count of 41.62/leaf during 18<sup>th</sup> SW in 2016; 38.00/leaf on 18<sup>th</sup> SW in 2017 and their average was 39.81/leaf on 18<sup>th</sup> SW. Thereafter, the population started declining gradually in the rest of the succeeding weeks till end of cropping period. At the end of the crop period *i.e.* on 26<sup>th</sup> SW, the population was 1.03/leaf in 2016; 1.05/leaf in 2017 and their average was 1.04/leaf. The overall mean population of jassid was 11.34/leaf in 2016, 12.84/leaf in 2017 and their pooled mean was 12.09/leaf (Fig. 12).

**Fig. 12: Fluctuation of jassid population during pre-kharif season**



The correlation analysis showed that maximum and minimum temperature of all week had non-significantly positive effect while morning RH and total rainfall of current week had significant positive influence on jassid population during 2016. In 2017, the maximum and minimum temperature of all the weeks were found to be non-significant positive influence and morning RH of 2-lag week had significant negative influence on jassid population. The pooled mean reflected that all environmental parameters of all weeks had non-significant positive influence except morning RH of 2-lag week had negative non-significant effect of on jassid population (Table 20).

**Table 20: Correlation between jassid population and the environmental factors during pre-kharif season**

| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | 0.040          | 0.204   | 0.536*              | 0.373   | 0.575*              |
|             | 1-lag   | 0.219          | 0.277   | 0.285               | 0.163   | 0.383               |
|             | 2-lag   | 0.404          | 0.199   | 0.018               | -0.122  | 0.176               |
| 2017        | Current | 0.288          | 0.394   | 0.063               | 0.473   | 0.185               |
|             | 1-lag   | 0.325          | 0.377   | -0.472              | 0.342   | 0.122               |
|             | 2-lag   | 0.155          | 0.339   | -0.477*             | 0.318   | 0.305               |
| Pooled Mean | Current | 0.263          | 0.346   | 0.404               | 0.457   | 0.299               |
|             | 1-lag   | 0.330          | 0.346   | 0.098               | 0.325   | 0.215               |
|             | 2-lag   | 0.349          | 0.305   | -0.143              | 0.182   | 0.401               |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.2 Fluctuation of aphid (*Aphis gosypii* Glover) population:

The mean population of aphid during pre-kharif was 1.08/leaf in 2016; 0.96/leaf in 2017 and their pooled mean of both years was 1.02/leaf (Fig. 13). The incidence was commenced on 11<sup>th</sup> SW (0.35/leaf) in 1<sup>st</sup> year, 11<sup>th</sup> SW (0.62/leaf) in 2<sup>nd</sup> year and in pooled mean (0.49/leaf) again on 11<sup>th</sup> SW. In 2016 the population decreased steadily after its increase and after that again aphid population increased steadily reaching to the peak 2.42/leaf in the 23<sup>th</sup> SW. During 2017, the population increased steadily after its initiation and reached to the peak 1.80/leaf in 14<sup>th</sup> SW. The pooled mean of both years followed the same trend as that of 2016 and the maximum population of 1.77/leaf was recorded in 14<sup>th</sup> SW. The population started declining and reached to 0.96/leaf, 0.33/leaf and 0.64/leaf respectively in 26<sup>th</sup> SW in both years and pooled mean of both years.

**Fig. 13: Fluctuation of aphid population during pre-kharif season**

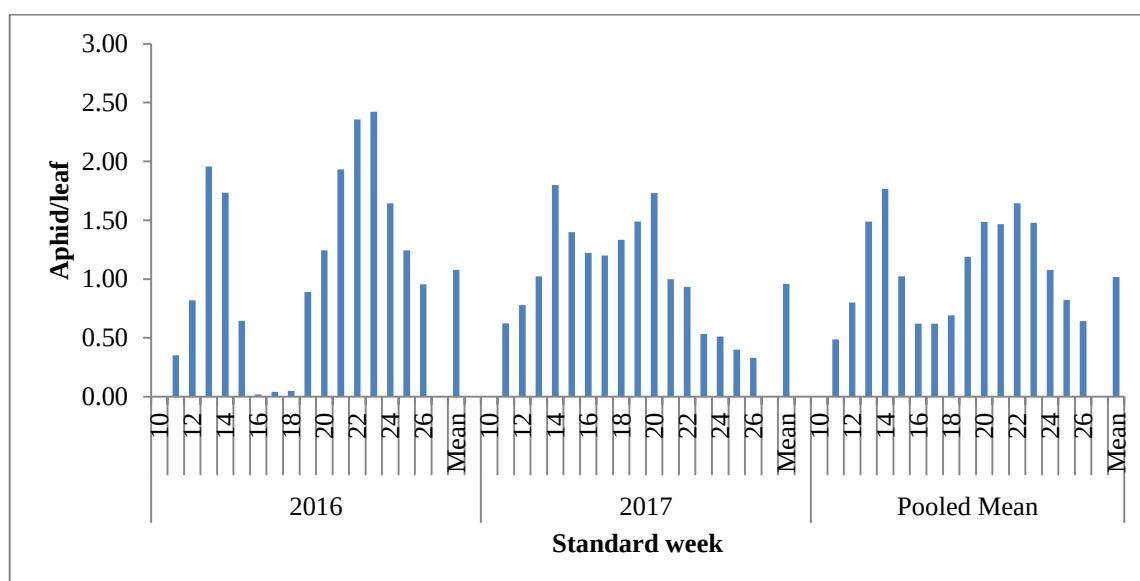


**Table 21: Correlation between aphid population and the environmental factors during pre-kharif season**

| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | -0.146         | 0.373   | 0.456               | 0.482*  | 0.241               |
|             | 1-lag   | -0.190         | 0.369   | 0.516*              | 0.465   | 0.260               |
|             | 2-lag   | 0.073          | 0.423   | 0.371               | 0.246   | 0.301               |
| 2017        | Current | -0.095         | 0.087   | -0.016              | 0.167   | -0.191              |
|             | 1-lag   | -0.150         | 0.044   | -0.475*             | 0.153   | -0.153              |
|             | 2-lag   | -0.268         | -0.061  | -0.524*             | -0.031  | 0.083               |
| Pooled Mean | Current | 0.148          | 0.470   | 0.351               | 0.483*  | 0.004               |
|             | 1-lag   | -0.009         | 0.394   | 0.339               | 0.481*  | 0.168               |
|             | 2-lag   | 0.165          | 0.262   | 0.047               | 0.185   | 0.479*              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

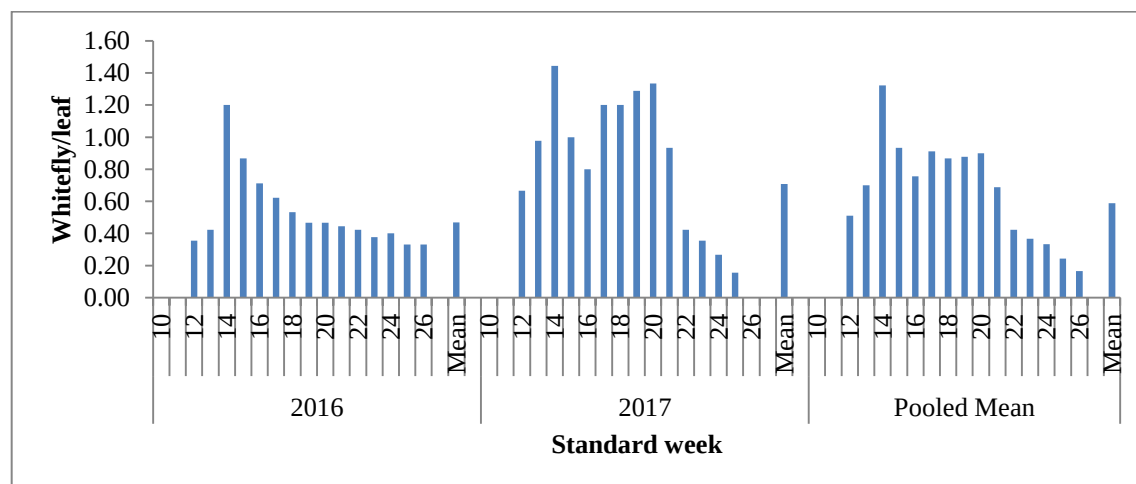
The correlation analysis showed that morning RH of 1-lag week and evening RH of current week had significant positive influence on aphid population during 2016. In 2017, morning RH of 1-lag and 2-lag week had significant negative influence on aphid population. The pooled mean reflected that evening RH of current and 1-lag week and total rainfall of 2-lag week had significant positive influence on aphid population (Table 21).

#### 4.1.2.3. Fluctuation of whitefly (*Bemisia tabaci* Gennadius) population:

The whitefly incidence was commenced on 12<sup>th</sup> SW (0.36/leaf) in 1<sup>st</sup> year, 12<sup>th</sup> SW (0.67/leaf) in 2<sup>nd</sup> year and 12<sup>th</sup> SW (0.51/leaf) in pooled mean. The population increased steadily and reached to the peak 1.20/leaf in the 14<sup>th</sup> SW in 2016, during 2017

in 14<sup>th</sup> SW (1.44/leaf). The pooled mean of both years followed the same trend as that of 2016 and the maximum population of 1.32/leaf was recorded in 14<sup>th</sup> SW. The population started declining and reached to 0.33/leaf, 0.00/leaf and 0.17/leaf in 26<sup>th</sup> SW during 2016, 2017 and pooled mean of both years respectively. The mean population of whitefly during pre-kharif, was 0.47/leaf in 2016; 0.71/leaf in 2017 and their pooled mean was 0.59/leaf (Fig. 14).

**Fig. 14: Fluctuation of whitefly population during pre-kharif season**



The correlation analysis showed that maximum and minimum temperature of all week had non-significantly negative effect on whitefly population while morning RH, evening RH and total rainfall of current and 1-lag week had non-significant positive influence on whitefly population during 2016. In 2017, only morning RH of 2-lag week had significant negative influence on whitefly population. The pooled mean reflected that all the environmental parameters of all weeks had non-significant influence on whitefly population.

**Table 22: Correlation between whitefly population and the environmental factors during pre-kharif season**

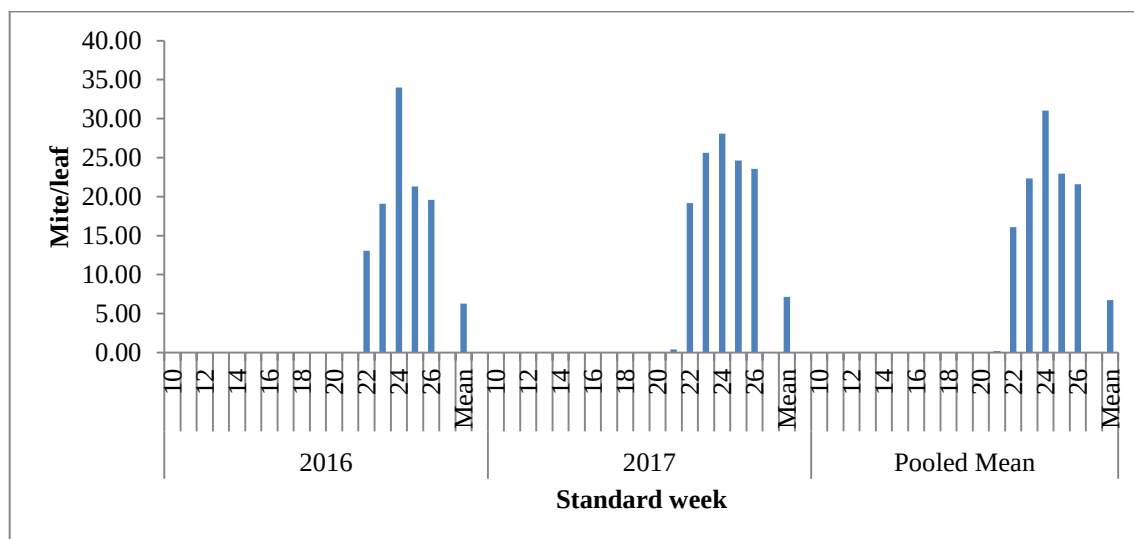
| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | -0.009         | -0.065  | 0.094               | 0.105   | 0.127               |
|             | 1-lag   | -0.040         | -0.003  | 0.019               | 0.009   | 0.047               |
|             | 2-lag   | -0.140         | -0.182  | -0.037              | -0.045  | -0.049              |
| 2017        | Current | -0.094         | 0.087   | 0.014               | 0.221   | -0.166              |
|             | 1-lag   | -0.195         | 0.008   | -0.456              | 0.106   | -0.225              |
|             | 2-lag   | -0.260         | -0.141  | -0.485*             | -0.081  | 0.032               |
| Pooled Mean | Current | -0.042         | 0.055   | 0.071               | 0.225   | -0.078              |
|             | 1-lag   | -0.063         | 0.044   | -0.189              | 0.106   | -0.156              |
|             | 2-lag   | -0.143         | -0.100  | -0.391              | -0.104  | -0.004              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.4. Fluctuation of mite (*Tetranychus urticae* Koch) population:

The mite incidence was 13.04/leaf on 22<sup>th</sup> SW in 1<sup>st</sup> year, 0.42/leaf on 21<sup>st</sup> SW in 2<sup>nd</sup> year and 0.21/leaf on 21<sup>st</sup> SW in pooled mean. The population increased steadily and reached to the peak 34.00/leaf in the 24<sup>th</sup> SW in 2016, during 2017 in 24<sup>th</sup> SW (28.07/leaf). The pooled mean of both years followed the same trend as that of 2016 and the maximum population of 31.03/leaf was recorded in 24<sup>th</sup> SW. The population started declining and reached to 19.58/leaf, 23.58/leaf and 21.58/leaf in 26<sup>th</sup> SW in two years and pooled mean of both years respectively. The mean population of mite during pre-kharif was 6.30/leaf in 2016; 7.15/leaf in 2017 and their pooled mean of both years was 6.72/leaf (Fig. 15).

**Fig. 15: Fluctuation of mite population during pre-kharif season**



The correlation analysis of mite infestation during pre-kharif, depicted that the minimum temperature of all weeks, morning and evening RH of 1-lag and 2-lag week had significant positive effect on mite infestation during 2016 (Table 23). During 2017, maximum and minimum temperatures of all week and evening RH of 1-lag, 2-lag week were found to have significant positive relation with mite population. The pooled mean data reflected that maximum temperature of 2-lag week, minimum temperature of all weeks, evening RH of all the week and total rainfall of 2-lag week had positively significant influence on mite infestation.

**Table 23: Correlation between mite population and the environmental factors during pre-kharif season**

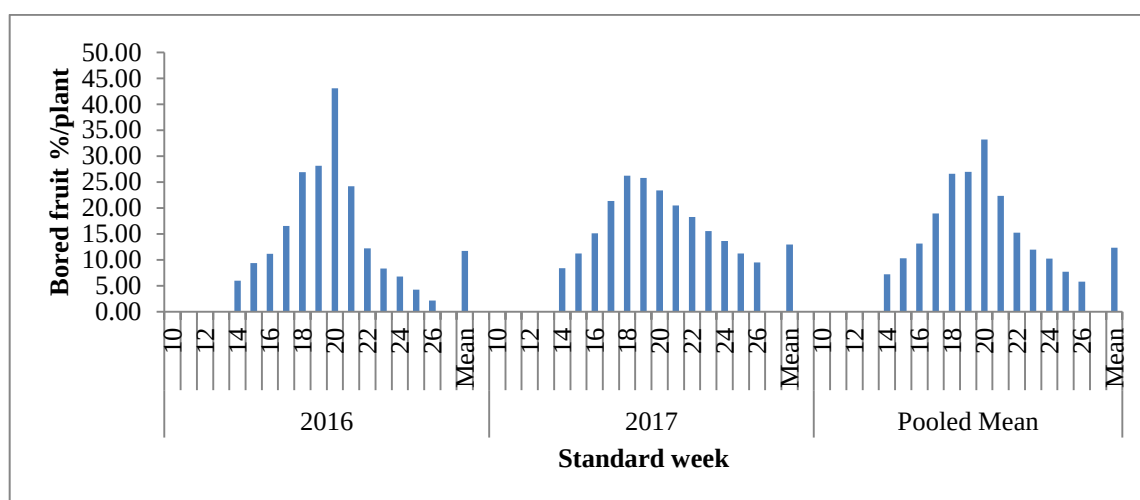
| Year        | Week    | Temperature °C |           | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-----------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum   | Morning             | Evening |                     |
| 2016        | Current | 0.100          | 0.704***  | 0.417               | 0.433   | 0.226               |
|             | 1-lag   | -0.017         | 0.781**** | 0.537*              | 0.539*  | 0.352               |
|             | 2-lag   | 0.026          | 0.717**** | 0.533*              | 0.520*  | 0.278               |
| 2017        | Current | 0.552*         | 0.685**** | -0.120              | 0.408   | 0.342               |
|             | 1-lag   | 0.586*         | 0.689**** | 0.234               | 0.534*  | 0.420               |
|             | 2-lag   | 0.721****      | 0.723**** | -0.046              | 0.508*  | 0.452               |
| Pooled Mean | Current | 0.438          | 0.730**** | 0.277               | 0.487*  | 0.388               |
|             | 1-lag   | 0.420          | 0.755**** | 0.598*              | 0.587*  | 0.460               |
|             | 2-lag   | 0.534*         | 0.753**** | 0.518*              | 0.565*  | 0.489*              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.5. Fluctuation of fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.) infestation:

The higher mean per cent of fruit damage due to fruit borer was recorded in 2017 (12.95%) as compared to 2016 with 11.71%. The pooled mean data of both years revealed that 12.33% of fruits were damaged by borer (Fig. 16). Initiation of fruit borer infestation was recorded on 14<sup>th</sup> SW in both years with the level of 6.00% and 8.39% in 2016 and 2017 respectively. The pooled mean data showed 7.20% damage at initial harvest on 14<sup>th</sup> SW. The highest percent of damage was recorded on 20<sup>th</sup> SW (43.07%) in 2016, 18<sup>th</sup> SW (26.25%) in 2017 and the pooled mean it was 33.22% on 20<sup>th</sup> SW. Thereafter the damage level declined and reached 2.15%, 9.48% and 5.82% on 26<sup>th</sup> SW during 2016, 2017 and pooled mean respectively.

**Fig. 16: Fluctuation of fruit borer complex (bored fruit %) population during pre-kharif season**



The correlation analysis during pre-kharif, showed that morning RH of current week and total rainfall of current and 1-lag week had positive significant effect on fruit borer infestation during 2016 (Table 24). During 2017, maximum and minimum temperature, evening RH and total rainfall of all week were found to have significant positive relation. The pooled mean data revealed that maximum temperature of current week, minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer damage.

**Table 24: Correlation between fruit borer complex (bored fruit %) population and the environmental factors during pre-kharif season**

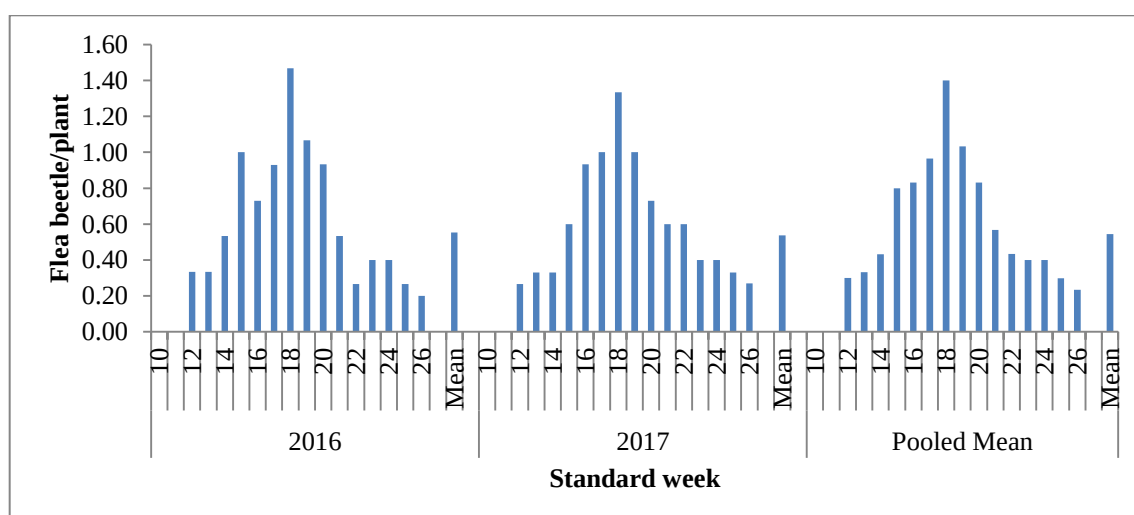
| Year        | Week    | Temperature °C |            | Relative humidity % |          | Total rainfall (mm) |
|-------------|---------|----------------|------------|---------------------|----------|---------------------|
|             |         | Maximum        | Minimum    | Morning             | Evening  |                     |
| 2016        | Current | 0.176          | 0.289      | 0.492*              | 0.312    | 0.498*              |
|             | 1-lag   | 0.107          | 0.340      | 0.456               | 0.328    | 0.570*              |
|             | 2-lag   | 0.240          | 0.263      | 0.243               | 0.113    | 0.344               |
| 2017        | Current | 0.655***       | 0.790***** | 0.023               | 0.683*** | 0.510*              |
|             | 1-lag   | 0.758*****     | 0.769***** | -0.190              | 0.592*   | 0.477*              |
|             | 2-lag   | 0.636*         | 0.796***** | -0.403              | 0.670*** | 0.604**             |
| Pooled Mean | Current | 0.493*         | 0.586*     | 0.411               | 0.545*   | 0.462               |
|             | 1-lag   | 0.442          | 0.634**    | 0.342               | 0.564*   | 0.382               |
|             | 2-lag   | 0.419          | 0.573*     | 0.062               | 0.454    | 0.543*              |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\*\* Significant at 0.001%

#### 4.1.2.6. Fluctuation of flea beetle populations:

The population of flea beetle was first observed on 12<sup>th</sup> SW with 0.33/plant in 2016 and 0.27/plant in 2017. Pooled mean it was also in 12<sup>th</sup> SW (0.30/plant). The peak population was recorded on 18<sup>th</sup> SW in 2016 with the population of 1.47/leaf, in 2017 on 18<sup>nd</sup> SW (1.33/plant) and their pooled mean of both years it was in 18<sup>th</sup> SW (1.40/leaf). Thereafter the population started to decline and maintained with 0.20/plant in 2016, 0.27/plant in 2017 and 0.24/plant in pooled mean up to 26<sup>th</sup> SW. The average population of flea beetle on okra crop was observed 0.55/plant in 2016; 0.54/plant in 2017 and 0.54/plant in pooled mean (Fig. 17).

**Fig. 17: Fluctuation of flea beetle population during pre-kharif season**



The correlation analysis of flea beetle infestation during pre-kharif, indicated that all weather parameters did not show any significant effect on flea beetle population during 2016 (Table 25). During 2017, only morning RH of 2-lag week was found to have significant negative relation with flea beetle population. The pooled mean data also revealed non-significant influence of environmental factors on flea beetle population.

**Table 25: Correlation between flea beetle population and the environmental factors during pre-kharif season**

| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | 0.091          | -0.017  | 0.267               | 0.147   | 0.445               |
|             | 1-lag   | 0.157          | 0.131   | 0.139               | 0.070   | 0.265               |
|             | 2-lag   | 0.224          | 0.023   | -0.134              | -0.183  | -0.031              |
| 2017        | Current | 0.293          | 0.388   | -0.113              | 0.415   | 0.139               |
|             | 1-lag   | 0.256          | 0.352   | -0.439              | 0.336   | 0.118               |
|             | 2-lag   | 0.160          | 0.368   | -0.540*             | 0.301   | 0.244               |
| Pooled Mean | Current | 0.280          | 0.258   | 0.149               | 0.299   | 0.197               |
|             | 1-lag   | 0.220          | 0.291   | -0.031              | 0.266   | 0.081               |
|             | 2-lag   | 0.209          | 0.243   | -0.292              | 0.124   | 0.196               |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.7. Fluctuation of leaf folder (*Sylepta derogata* Fabricius) population:

Leaf folder population was very negligible during study period. The mean population of leaf folder recorded was the population size of 0.34/plant in pre-kharif 2016 and it was 0.33/plant in 2017. Pooled mean of both year data showed that the population was 0.34/plant. During 2016 the population was commenced in 15<sup>th</sup> SW (0.40/plant) and 2017 (0.40/plant). The pooled mean data showed that the leaf folder population appeared in 15<sup>th</sup> SW (0.40/plant). The peak population was noticed in 18<sup>th</sup>

SW in 2016, 2017 and pooled mean with population of 0.87/plant, 0.73/plant and 0.80/plant respectively.

**Fig. 18: Fluctuation of leaf folder population during pre-kharif season**

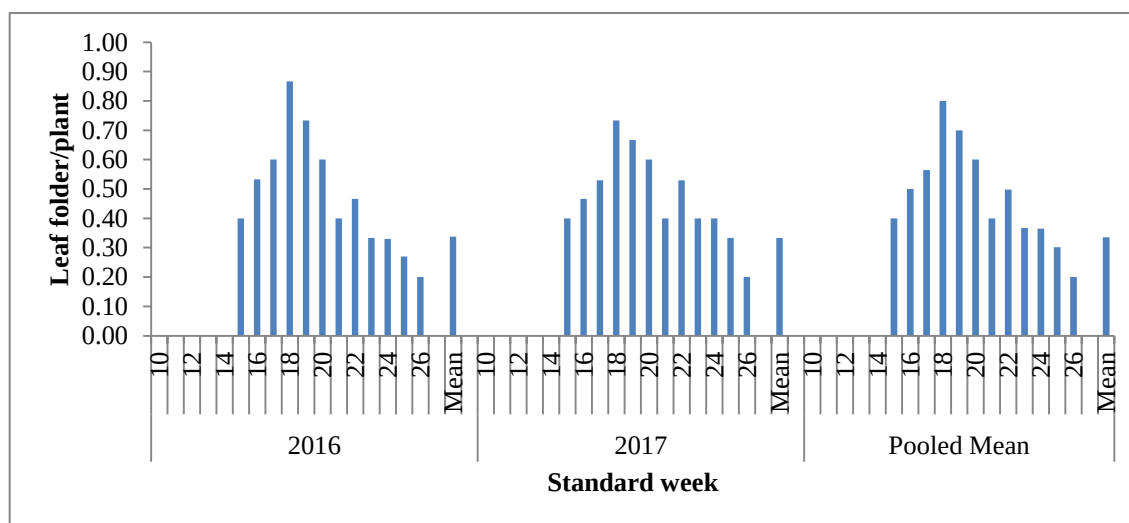


**Table 26: Correlation between leaf folder population and the environmental factors during pre-kharif season**

| Year        | Week    | Temperature °C |           | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-----------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum   | Morning             | Evening |                     |
| 2016        | Current | 0.307          | 0.425     | 0.425               | 0.250   | 0.531*              |
|             | 1-lag   | 0.180          | 0.456     | 0.376               | 0.279   | 0.441               |
|             | 2-lag   | 0.332          | 0.326     | 0.170               | 0.069   | 0.226               |
| 2017        | Current | 0.606**        | 0.580*    | -0.070              | 0.447   | 0.291               |
|             | 1-lag   | 0.504*         | 0.624**   | -0.324              | 0.549*  | 0.262               |
|             | 2-lag   | 0.475*         | 0.688**** | -0.535*             | 0.560*  | 0.459               |
| Pooled Mean | Current | 0.570*         | 0.541*    | 0.321               | 0.428   | 0.414               |
|             | 1-lag   | 0.429          | 0.584*    | 0.284               | 0.506*  | 0.362               |
|             | 2-lag   | 0.515*         | 0.595*    | -0.002              | 0.407   | 0.473               |

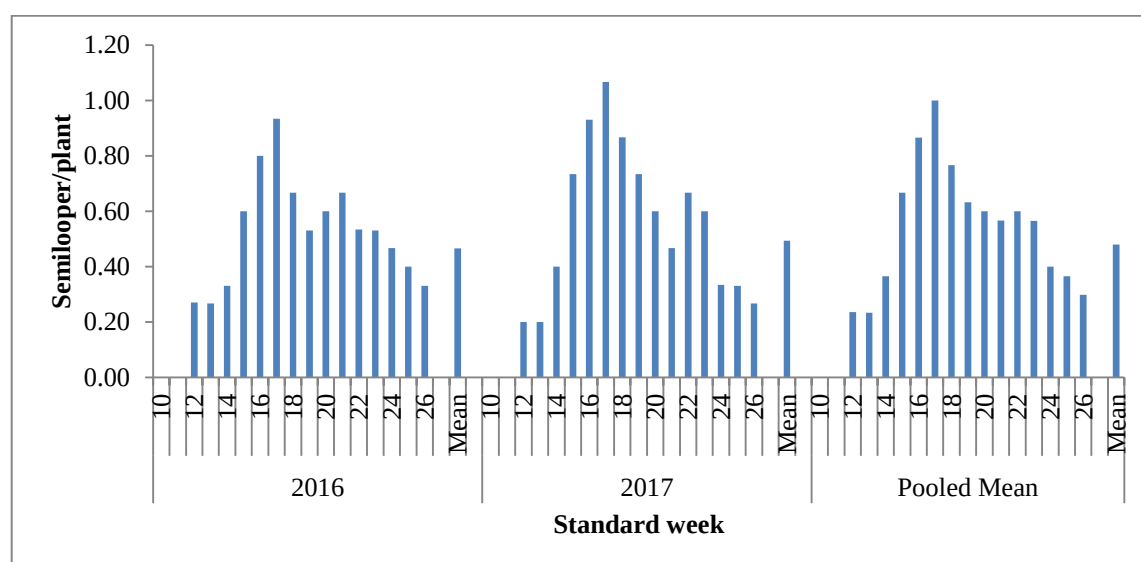
\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

The correlation analysis of leaf folder infestation indicated that only total rainfall of current week had positive significant effect on leaf folder population during 2016 (Table 26). During 2017, maximum and minimum temperatures of all the weeks, evening RH of 1-lag, 2-lag week were found to have significant positive relation while morning RH of 2-lag week had significant negative effect on leaf folder population. The pooled mean data revealed that maximum temperature of current and 2-lag week, minimum temperature of all the week and evening RH of 1-lag week had positively significant influence on leaf folder population.

#### 4.1.2.8. Fluctuation of semilooper (*Anomis flava* Fabricius) population:

During pre-kharif season very negligible populations of semilooper were observed in both years. The highest mean population of semilooper was recorded in pre kharif 2017 with the population size of 0.49/plant and it was 0.47/plant in 2016. Pooled mean of both years data showed that the population was 0.48/plant. The population was commenced in 12<sup>th</sup> SW (0.27/plant) during 2016 and also 12<sup>th</sup> SW (0.20/plant) in 2017 and pooled mean of both years with 0.24/plant. Throughout the season the population of semilooper was fluctuated. The peak population was witnessed in 17<sup>th</sup> SW in 2016 and 2017 with (0.93/plant) and (1.07/plant) respectively in both years and 17<sup>th</sup> SW (1.00/plant) in pooled mean data of both years (Fig. 19).

**Fig. 19: Fluctuation of semilooper population during pre-kharif season**



The correlation analysis of semilooper infestation depicted that none of the environmental factor posed significant effect on semilooper population during 2016 (Table 27). During 2017, morning RH of 2-lag week were found to have significant negative relation on semilooper population. The pooled mean data reflected that maximum and minimum temperature of current week had positively significant influence on semilooper population.

**Table 27: Correlation between semilooper population and the environmental factors during pre-kharif season**

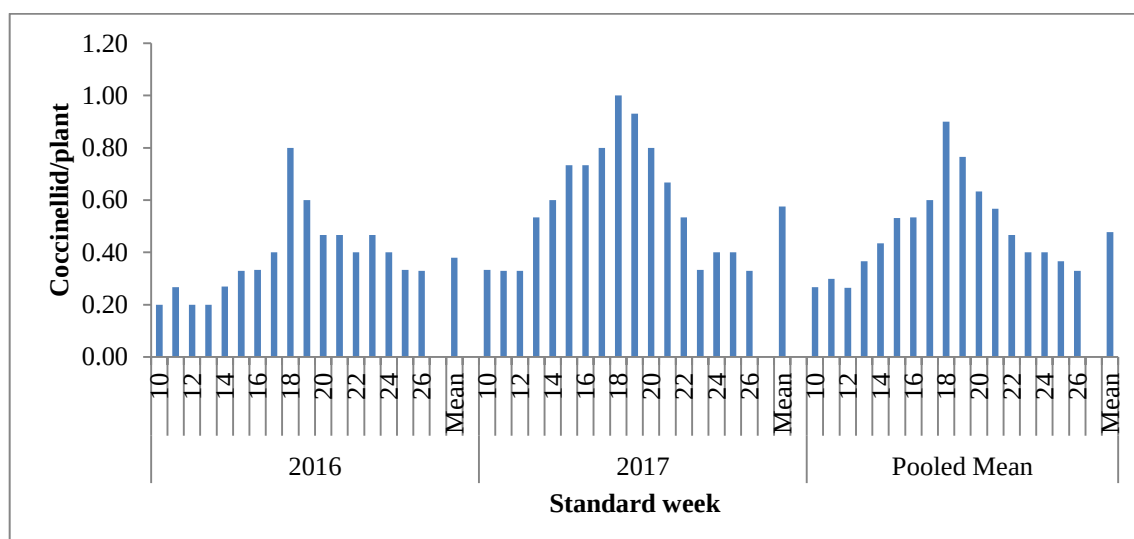
| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | 0.378          | 0.362   | 0.214               | 0.130   | 0.319               |
|             | 1-lag   | 0.244          | 0.357   | 0.250               | 0.139   | 0.300               |
|             | 2-lag   | -0.007         | 0.242   | 0.278               | 0.192   | 0.303               |
| 2017        | Current | 0.405          | 0.446   | -0.122              | 0.353   | 0.057               |
|             | 1-lag   | 0.300          | 0.426   | -0.469              | 0.371   | 0.107               |
|             | 2-lag   | 0.237          | 0.427   | -0.655***           | 0.299   | 0.298               |
| Pooled Mean | Current | 0.521*         | 0.476*  | 0.120               | 0.360   | 0.228               |
|             | 1-lag   | 0.407          | 0.460   | 0.007               | 0.320   | 0.182               |
|             | 2-lag   | 0.245          | 0.405   | -0.127              | 0.259   | 0.320               |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.9. Fluctuation of coccinellids population:

Coccinellids population were observed at very low densities during the early stages of the crop growth but the coccinellids population were present from starting to last in entire crop growth stages. Coccinellids population followed their prey in attaining their peak densities. In pre-kharif season, the average coccinellid population was recorded 0.38/plant in 2016, 0.58/plant in 2017 and 0.48/plant in pooled mean of the both years studied (Fig. 20). In 2016 the coccinellid population appeared in the field during 10<sup>th</sup> SW with a population of 0.20/plant, in 2017 10<sup>th</sup> SW (0.33/plant) and also observed on 10<sup>th</sup> SW with 0.27/plant in pooled mean. The peak population was recorded on 18<sup>th</sup> SW (0.80/plant) in 2016, (1.00/plant) in 2017 and pooled mean coccinellids population of both years was 0.90/plant. The population was recorded least on 26<sup>th</sup> SW and it was 0.33/plant in 2016, 0.33/plant in 2017 and 0.33/plant in pooled mean.

**Fig. 20: Fluctuation of coccinellids population during pre-kharif season**



The correlation analysis of coccinellid population indicated that minimum temperature of current and 1-lag week, morning RH, evening RH and total rainfall of current week were found to have significant positive relation on coccinellid population during 2016. The environmental parameters did not show significant effect on coccinellid population during 2017 and pooled mean of both years (Table 28).

**Table 28: Correlation between coccinellids population and the environmental factors during pre-kharif season**

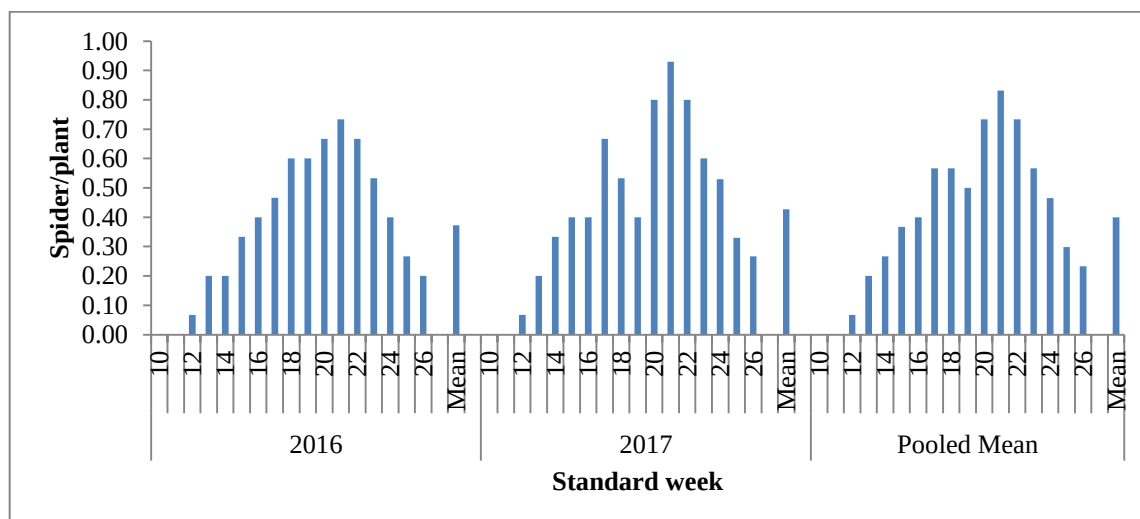
| Year        | Week    | Temperature °C |         | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|---------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum | Morning             | Evening |                     |
| 2016        | Current | 0.065          | 0.473*  | 0.656***            | 0.492*  | 0.636**             |
|             | 1-lag   | 0.267          | 0.507*  | 0.360               | 0.259   | 0.366               |
|             | 2-lag   | 0.449          | 0.383   | 0.093               | -0.001  | 0.215               |
| 2017        | Current | 0.078          | 0.140   | -0.037              | 0.243   | 0.030               |
|             | 1-lag   | 0.005          | 0.148   | -0.465              | 0.217   | -0.018              |
|             | 2-lag   | -0.112         | 0.105   | -0.452              | 0.124   | 0.021               |
| Pooled Mean | Current | 0.227          | 0.272   | 0.289               | 0.361   | 0.262               |
|             | 1-lag   | 0.234          | 0.304   | 0.036               | 0.323   | 0.172               |
|             | 2-lag   | 0.320          | 0.261   | -0.265              | 0.128   | 0.241               |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### 4.1.2.10. Fluctuation of Spider population:

The mean population of spider was recorded 0.37/plant in pre-kharif 2016, 0.43/plant in 2017 and 0.40/plant in pooled mean (Fig. 21). Spider population was first observed during 12<sup>th</sup> SW in 2016 and 2017 with 0.07/plant population. The peak population was recorded on 21<sup>st</sup> SW at the level of 0.73/plant in 2016, 0.93/plant in 2017 and in pooled mean 0.83/plant on 21<sup>st</sup> SW. The population declined till the end of the crop on 26<sup>th</sup> SW (0.20/plant) in 2016, 0.27/plant in 2017 and 0.23/plant in pooled mean.

**Fig. 21: Fluctuation of spider population during pre-kharif season**



The correlation analysis depicted that minimum temperature, morning RH and total rainfall of current and 1-lag week had positive significant effect on spider population during 2016. During 2017, minimum temperatures of all weeks, maximum temperature, evening RH of current and 1-lag week and total rainfall of 2-lag week were found to have significant positive relation while morning RH of 2-lag week had significant negative effect. The pooled mean data reflected that maximum temperature and evening RH of current and 1-lag week, minimum temperature of all the weeks and total rainfall of 2-lag week had positively significant influence on spider population (Table 29).

**Table 29: Correlation between spider population and the environmental factors during pre-kharif season**

| Year        | Week    | Temperature °C |           | Relative humidity % |         | Total rainfall (mm) |
|-------------|---------|----------------|-----------|---------------------|---------|---------------------|
|             |         | Maximum        | Minimum   | Morning             | Evening |                     |
| 2016        | Current | 0.191          | 0.522*    | 0.575*              | 0.443   | 0.532*              |
|             | 1-lag   | 0.155          | 0.493*    | 0.505*              | 0.372   | 0.481*              |
|             | 2-lag   | 0.277          | 0.430     | 0.365               | 0.187   | 0.426               |
| 2017        | Current | 0.630**        | 0.724**** | -0.008              | 0.603** | 0.304               |
|             | 1-lag   | 0.589*         | 0.725**** | -0.283              | 0.567*  | 0.281               |
|             | 2-lag   | 0.471          | 0.623**   | -0.644**            | 0.462   | 0.490*              |
| Pooled Mean | Current | 0.567*         | 0.696**** | 0.411               | 0.607** | 0.392               |
|             | 1-lag   | 0.508*         | 0.673**** | 0.358               | 0.561*  | 0.401               |
|             | 2-lag   | 0.447          | 0.604**   | 0.180               | 0.453   | 0.644**             |

\*Significant at 0.05%, \*\* Significant at 0.01%, \*\*\* Significant at 0.005%, \*\*\*\* Significant at 0.001%

#### **Jassid (*Amrasca biguttula biguttula* Ishida)**

The mean Jassid population under the present investigation was highest in pre-kharif (12.09/leaf) over post-kharif (4.61/leaf) crops. Incidence of jassid was commenced on 38<sup>th</sup> SW (3<sup>rd</sup> week of September) with a population of 0.83/leaf in post-kharif, whereas in pre-kharif the pest was commenced on 10<sup>th</sup> SW (2<sup>nd</sup> week of March) with the population of 0.33/leaf. Populations were attended at peak levels *i.e.* 10.57/leaf on 47<sup>th</sup> SW (4<sup>th</sup> week of November) in post-kharif, 39.81/leaf in 18<sup>th</sup> SW (1<sup>st</sup> week of May) in pre-kharif season. The present study was confirmed by Srinivasa (1993) who reported that the population appeared in okra crop on 36<sup>th</sup> SW *i.e.* after 2 weeks of sowing in post-kharif crop and while it was on after 3 weeks of sowing in pre-kharif (10<sup>th</sup> SW). Kumari *et al.* (2012) studied the effects of climatic factors on the incidence of jassid (*A. biguttula biguttula*) on okra in Uttar Pradesh, India, during the summer and rainy seasons and observed jassid population initially on the second week of April (mean density of 4.8 per

3 leaves) and its peak population on the fourth week of May (mean density of 22.3 per 3 leaves). Gogoi and Dutta (2000) also noticed maximum jassid population (37.53nymphs/leaf and 30.00nymphs/leaf) in last week of May and middle of April in Assam though the population was much higher than the present study which might be due to climatic differences in two regions. Ghosh and Senapati (2003) found that the jassid population (4.63/leaf) was highest in April-May and lowest (0.50/leaf) in mid-July that also supported the present findings. Boopathi *et al.* (2011) reported the peak level of jassid on okra crop in Mizoram during 12<sup>th</sup> week after sowing partially confirmed the present study in case of pre-kharif and post-kharif crop. Kadam (2003) observed jassid population was associated from early vegetative to late flowering cum fruiting stage of crop. Jayasimha *et al.* (2012) revealed that the seasonal incidence of jassid recorded from March-2007 to March-2008 and the highest incidence of 16.44 jassid/leaf was observed during March second fortnight, while the lowest of 0.25 jassid/leaf was observed during December second fortnight which was not similar to present study.

Under present investigation significantly negative correlation with maximum and minimum temperature of all weeks while total rainfall of all weeks had non-significant negative effect on jassid population was observed during post-kharif, which was supported by Chauhan (2014) who observed leafhopper population throughout the cropping season having negative correlation with maximum temperature and positive with morning relative humidity. Verma *et al.* (2010) observed that of jassid population on okra had negative effect of rainfall to jassid population build up. During pre-kharif season maximum and minimum temperature, evening RH and total rainfall of all weeks and morning RH (current and 1-lag week) had non-significant positive effect while morning RH of 2-lag week had negative effect on jassid population build up. The present results were in conformity with the observations made by Jayasimha *et al.* (2012) where relative humidity had non-significant and negative impact. Mahmood *et al.* (2002) found negative and non-significant relation to relative humidity and rainfall. Verma *et al.* (2010) observed that jassid population was positively correlated with maximum and minimum temperature, and negatively correlated with relative humidity and rainfall this finding is in conformity with the present result.

#### **Aphid (*Aphis gossypii* Glover)**

The pooled mean of both years followed the same trend as that of 2016 and 2017 and the maximum population of 8.50/leaf was recorded in 43<sup>th</sup> SW (4<sup>th</sup> week of October) during post-kharif. Singh *et al.*, (2013) also opined that aphid population was

commenced from 4<sup>th</sup> week after sowing i.e., 2<sup>nd</sup> week of September with an average population of 1.42 aphids/leaf which increased gradually and reached the peak of 25.87 aphids per leaf during 2<sup>nd</sup> week of October at Chitrakoot (M. P.) that slightly differ from the present findings because of regional difference.

However, during pre-kharif aphid population first observed on 11<sup>th</sup> SW with 0.49/ leaf and reach to peak at 14 SW (1<sup>st</sup> week of April) with 1.77/leaf. The present investigation revealed that, higher aphid population observed in post-kharif (4.57/leaf) comparison to pre-kharif (1.02/leaf). Although the aphid population was very low level in both seasons but a definite trend of increase in population level with the advancement of the season is seen.

In present findings correlation analysis between aphid and weather parameters showed that maximum temperature, minimum temperature of all weeks and total rainfall of current, 1-lag week had significant negative correlation with aphid population in post-kharif season. The present study was supported by Singh (2013) who also reported that aphid population showed negative relation with minimum temperature, rainfall and maximum and minimum RH. Shukla (2014) observed that the population of aphid had negative correlation to both maximum and minimum temperature. Whereas, evening RH of current, 1-lag week and rainfall of 2-lag week had positive correlation with aphid population in pre-kharif crop. The present work was satisfactorily supported by Ghosh *et al.* (2004) who reported that aphid population showed significant positive correlation with relative humidity and weekly rainfall on okra crop. Shukla (2014) also found positive correlation of rainfall and relative humidity with aphid population.

#### **Whitefly (*Bemisia tabaci* Gennadius)**

Very low whitefly population was observed throughout the year. The average mean population was 3.08/leaf and 0.59/leaf in post-kharif and pre-kharif season. The whitefly population was initiated on 38<sup>th</sup> SW (0.41/leaf) i.e. 3<sup>rd</sup> week of September in post-kharif and on 12<sup>th</sup> SW (0.51/leaf) i.e. during 3<sup>rd</sup> week March during pre-kharif. The maximum population was found on 44<sup>th</sup> SW (4.89/leaf) in post-kharif season. The present study satisfactorily supported by Harinkhere (2014) where whitefly population started increasing from 37<sup>th</sup> SW (16th September 2011) and reached at its peak (25.46 whitefly/30 leaves) during 44<sup>th</sup> SW. The peak activity of whitefly occurred during second week of October to last week of October with 2.7 nos./plant (Netam, 2003). In pre-kharif seasons relatively higher population of whitefly was observed on 14<sup>th</sup> SW (1<sup>st</sup> week of April with 1.44/leaf) in early stages. Which was partially supported by Netam *et*

*al.*, (2007) who reported the activity of whiteflies on okra crop started after two weeks of sowing *i.e.*, from first week of April (9.16 whiteflies/3 leaves) and increased gradually upto last week of April (14.91 whiteflies/3 leaves) and there after population started declining at Raipur (C.G.). Anitha, (2007) reported that the activity of whiteflies on okra sown during fourth week of March 2006, started from first week of April 2006 with 9.16 whiteflies per 3 leaves (2nd week of sowing). There was a gradual increase in whitefly population up to last week of April (14.91 whiteflies/3 leaves) and there after population started declining. However, population was low throughout the year.

In the present study minimum and maximum temperature of all weeks had significant negative influence on whitefly population during post kharif season which was conformity with the observations made by Singh *et al.* (2013) who reported that temperature (maximum and minimum) and relative humidity (morning and evening) had significantly negative impact with whitefly population. During pre-kharif season maximum temperature and total rainfall had non-significant negative effect while minimum temperature of current and 1-lag week, morning RH of current week and evening RH of current, 1-lag week had non-significant positive correlation on whitefly population. The results of above lines conformed from the result of Nath *et al.* (2011), as it was reported that the whitefly population had non-significant positive correlation with minimum temperature and relative humidity.

#### **Mite (*Tetranychus urticae* Koch)**

There was no mite population observed in post-kharif season. However, the average mean population of mite was 6.72/leaf observed in pre-kharif. The maximum population was found on 24<sup>th</sup> SW (2<sup>nd</sup> week of June with 31.03/leaf) in pre-kharif season. The present finding more or less similar to work of Gulati (2004) reported that in summer crop mites appeared in the month of April, showed an increasing trend in May and then attained a peak in the month of June. Geroh and Gulati (2007) observed two peaks activity of *T. urticae* during first fortnight of June and first fortnight of August.

The correlation study showed that maximum temperature of 2-lag week, minimum temperature of all weeks, morning RH of 1-lag, 2-lag week, evening RH of all weeks and total rainfall of 2<sup>nd</sup> lag week had significant positive correlation with mite population. The present study supported by Geroh and Gulati (2007) who, observed among the abiotic factors, spider mite population showed significant positive correlation with maximum and minimum temperature.

### **Fruit borer complex (*Earias vittella* Fab. and *Helicoverpa armigera* Hubner)**

In present study revealed that there was no incidence of fruit borer at early crop growth stage. The fruit borer infestation was started from 42<sup>th</sup> SW (3<sup>rd</sup> week of October) (5.41%) *e.i.* 5 week after sowing in post-kharif and 14<sup>th</sup> SW (1<sup>st</sup> week of April) (7.20%) in pre-kharif. The maximum percentage of fruit borer damage (bored fruit %) was recorded in pre-kharif (12.33%) as compare to post-kharif (11.68%). These observation are in above line was more or less similar with the observations recorded by Acharya (2002) and Dangi (2004) who reported the incidence of okra shoot and fruit borer was commenced from 6<sup>th</sup> week after sowing. Pal *et al.* (2013) where no incidence of shoot and fruit borer was observed at early growth stages of the crop, however, the population was observed from 14<sup>th</sup> standard week *i.e.* 2<sup>nd</sup> week of April. Naresh *et al.* (2003) from Mohanpur (West Bengal) found that the damage caused by *E. vittella* on okra shoots and fruits was initiated on 3<sup>rd</sup> and 6<sup>th</sup> week old crop respectively. Shivashankara (2012) revealed that the incidence commenced from 5<sup>th</sup> WAS and increased at fruit maturity stage. The incidence was as high as 80 larvae per 25 plants with a minimum of two larvae per plant. The mean number of larvae ranged from 0.08 to 3.20 larvae per plant. The mean incidence peak (3.20 larvae/plant) was during 14<sup>th</sup> WAS. The present observations are partially confirms with the observations of Netam (2003) who reported that the peak activity of *Earias vittella* occurred during the second week of November with 1.08 larvae/ plant.

The correlation study showed that minimum and maximum temperature of all week were significant negative influence on fruit borer (bored fruit %) during post-kharif season. The results of this present study are satisfactorily supported by the findings of Chauhan (2014) who observed fruit damage by *Earias* spp. and minimum temperature had significantly negatively correlation. Mandal *et al.* (2006a) reported that maximum temperature had negative effect on larval population buildup and the fruit damage at Samastipur, Bihar. During pre-kharif season the minimum temperature of all weeks, maximum temperature of current week, evening RH of current and 1-lag week had significant positive correlation with bored fruit % while total rainfall of 2-lag week also showed significant positive effect. This result during pre-kharif also supports the findings of the Selvaraj *et al.* (2010) who also noticed significant positive correlation between *E. vitella* population and maximum temperature. In the same way Mohanasundaram and Sharma (2011b) and Aziz *et al.* (2011) who also reported significant positive effect of minimum temperature on the fruit damage.

## **Flea Beetle**

The average mean population of flea beetle was 0.67 and 0.54 per plant in post-kharif and pre-kharif season. The flea beetle population is higher in post-kharif season comparison to pre-kharif season. The population was noticed on 41<sup>th</sup> SW (0.30/plant) *i.e.* 2<sup>nd</sup> week of October in post-kharif. In pre-kharif flea beetle infestation was initiated on 12<sup>th</sup> SW (0.30/plant) *i.e.* 3<sup>rd</sup> week of March. The maximum population was found during 47<sup>th</sup> SW (1.37/plant) *e.i.* 11 week after sowing in post-kharif. In pre-kharif seasons peak population of flea beetle was observed on 18<sup>th</sup> SW (1.40/plant) in mid fruiting stages. The last population count in post-kharif and pre-kharif was on 50<sup>th</sup> SW, 26<sup>th</sup> SW (0.77/plant and 0.54/plant respectively). The result of the present study of post-kharif season was supported by the result of Shivashankara (2012) who revealed that the flea beetle was found during the vegetative and flowering stage of the crop, adults fed on leaves and caused irregular holes. The incidence was maximum (2.12/plant) during 11<sup>th</sup> WAS and minimum (0.12/plant) during 4<sup>th</sup> and 16<sup>th</sup> WAS.

## **Leaf folder (*Sylepta derogata* Fabricius)**

In post-kharif leaf folder population was initiated on 42<sup>th</sup> SW (0.17/plant) which was 3<sup>rd</sup> week of October and in pre-kharif the population was observed on 15<sup>th</sup> SW (0.40/plant) which was 2<sup>nd</sup> week of April. The peak population of leaf folder was observed on 46<sup>th</sup> SW (0.90/plant) *i.e.* in mid fruiting stage during post-kharif. In pre-kharif, the peak population was recorded on 18<sup>th</sup> SW (0.80/plant) which was mid-fruiting stages. The average leaf folder population was 0.35/plant and 0.34/plant in post-kharif and pre-kharif seasons respectively. At the end of the crop periods the population was 0.40/plant, 0.20/plant in post-kharif and pre-kharif season respectively.

## **Semilooper (*Anomis flava* Fab.)**

The magnitude of semilooper infestation was negligible under the present investigation. The average mean population of semilooper was 0.47 and 0.48 per plant in post-kharif and pre-kharif. The population was commenced on 41<sup>th</sup> SW (0.27/plant) *i.e.* 2<sup>nd</sup> week of October in post-kharif. In pre-kharif semilooper infestation was initiated on 12<sup>th</sup> SW (0.24/plant) *i.e.* 2<sup>nd</sup> week March. The maximum population was found during mid-fruiting stage on 45<sup>th</sup> SW (0.97/plant) during post-kharif. In pre-kharif seasons peak population of semilooper was observed on 17<sup>th</sup> SW (1.00/plant) in early fruiting stages. The last population count in post-kharif and pre-kharif was made on 50<sup>th</sup> SW and 26<sup>th</sup> SW (0.57/plant and 0.30/plant respectively).

## Coccinellid

Several coccinellid species were observed under present investigation during post-kharif and pre-kharif season. The coccinellid population commenced in the field during 39<sup>th</sup> SW (last week of September) with 0.20/plant in post-kharif, while in pre-kharif start from 10<sup>th</sup> SW (1<sup>st</sup> week of March) with 0.27 coccinellid/plant. The coccinellid populations reached to peak at 45<sup>th</sup> SW in post-kharif (1.27/plant) and 18<sup>th</sup> SW in pre-kharif (0.90/plant). Nonita *et al.* (2006) concluded that coccinellid appeared during the first week of May in the field and continued their activities until the end of July. In the present investigation the activity of coccinellid population were more or less with jassid and aphid population and this study was supported by earlier worker Singh *et al.* (2013) who revealed that on okra, aphidophagous predators like coccinellid were more or less with aphid and jassid population.

The correlation analysis depicted that coccinellid beetles were found significantly negative correlation with maximum and minimum temperature of all weeks and rainfall of current week in post-kharif. The coccinellid beetles had non-significantly positive effect with maximum and minimum temperature, total rainfall and evening RH of all weeks in pre-kharif season. The result of above lines was supported by the observation of Meena and Kanwat (2010) who found that minimum temperature and relative humidity had negative correlation while maximum temperature showed non-significant positive and rainfall showed non-significant negative correlation with coccinellids population.

## Spider

The spider population was initiated from 40<sup>th</sup> SW (1<sup>st</sup> week of October) *e.i.* 3<sup>rd</sup> week after sowing in post-kharif and 12<sup>th</sup> SW (3<sup>rd</sup> week of March) in pre-kharif season. The spider populations attained peak at 48<sup>th</sup> SW (1<sup>st</sup> week of December) with 0.93/plant during post-kharif season while during pre-kharif, population became peak at 21<sup>st</sup> SW (4<sup>th</sup> week of May) with 0.83/plant spider population. The present work was partially supported by Hegde *et al.* (2004) who reported the peak activity (0.25spiders/plant) was observed during 2<sup>nd</sup> week of May (10<sup>th</sup> week after germination).

The correlation analysis indicated that spider was found significantly negative correlation with maximum temperature and minimum temperature of all weeks while total rainfall of 1-lag week during post-kharif season. The correlation between spider and maximum temperature of current, 1-lag week and minimum temperature of all weeks were found significantly positive effect while evening RH of current and 1-lag week and total rainfall of 2-lag week also had significant positive relation with spider population

during pre-kharif season. The results are in conformity with Hegde *et al.* (2004) where, the maximum temperature and minimum temperature exerted highly significant positive association with population fluctuation of spiders. In the present study of pre-kharif season evening RH of current and 1-lag week and total rainfall of 2-lag week had significant positive effect with spider population. The trend of these results is similar to the finding of Sahito (2013) who observed positive correlation between spider population and morning humidity and evening humidity on cotton and okra crop respectively.

## **4.2. Screening of available genotypes/cultivars of okra for resistance/susceptibility to different pests based on physical and chemical characters**

This study was conducted to screen out 14 (fourteen) cultivars of okra for their resistance or susceptibility against the pest of okra during post-kharif, 2015 and pre-kharif, 2016. The result of the experiment is presented in the following sub-sections.

### **4.2.1. Post kharif season, 2015**

#### **4.2.1.1. Jassid, (*Amrasca biguttula biguttula* Ishida)**

The data presented in the table 30 revealed that the infestation was first observed one week after sowing *i.e.* in third week of September (38<sup>th</sup> SW) and attained peak at 47<sup>th</sup> SW. In 47<sup>th</sup> SW, the cultivar Kaveri was found significantly superior over other varieties as it contains lowest jassid population (1.20/leaf) followed by Chameli-015 (1.33/leaf). The maximum population was recorded in Bhindi No.10 (9.00/leaf) followed by Tanvi (6.00/leaf). The rest of the cultivars namely Parbhani Kranti (2.10/leaf), Arka Anamika (2.15/ leaf), Miss-717 (2.45/leaf), Basanti (2.50/leaf), Aparupa DG (2.60/leaf), Subarna (3.00/leaf), JKOH-7315 (3.20/leaf), Tiger Green (3.55/leaf) and PAN-2127 (4.00/leaf) had middle level of infestation.

#### **4.2.1.2. Aphid, (*Aphis gossypii* Glover)**

The incidence of aphid was observed in all the cultivars in 40<sup>th</sup> SW and reached its peak in 43<sup>th</sup> SW. In peak period of infestation, the population was minimum in Kaveri (2.24/leaf) followed by 2.40/leaf in both Chameli-015 and JKOH-7315. The maximum population was observed in Bhindi No.10 (5.80/leaf). The pest population observed in cultivars Meena-117 (5.12/leaf) and PAN-2127 (5.00/leaf) was at par with each other. The rest of the cultivars recorded medium level of population ranging from 2.76 to 4.96/leaf.

#### **4.2.1.3. Whitefly (*Bemisia tabaci* Gennadius)**

The data of table 32 indicated that whitefly population reached its peak at 42<sup>th</sup> SW and cultivar Kaveri was least preferred by whitefly as it contained the lowest population of 2.27/leaf, followed by Chameli-015 (2.35/leaf) and Parbhani Kranti (2.44/leaf). Bhendi No.10 was found to be the highly susceptible/preferred cultivar having highest population (4.66/leaf) followed by Meena-117 (4.22/leaf) and Tanvi (4.13/leaf). The rest of the cultivars recorded medium white fly population ranging from 2.62 to 4.03/leaf.

**Table 30: Screening of different cultivars of okra against jassid in post-kharif season (2015)**

| Cultivars       | Mean jassid population/ leaf* |                  |                   |                  |                  |                  |                   |                  |                 |                 |                  |                  |                  |                 |
|-----------------|-------------------------------|------------------|-------------------|------------------|------------------|------------------|-------------------|------------------|-----------------|-----------------|------------------|------------------|------------------|-----------------|
|                 | 38SW                          | 39SW             | 40SW              | 41SW             | 42SW             | 43SW             | 44SW              | 45SW             | 46SW            | 47SW**          | 48SW             | 49SW             | 50SW             | Mean            |
| Arka Anamika    | 0.28g<br>(0.88)               | 0.52f<br>(1.01)  | 0.65de<br>(1.07)  | 0.73fg<br>(1.11) | 0.62ij<br>(1.06) | 0.78gh<br>(1.13) | 0.90cde<br>(1.18) | 1.83fg<br>(1.53) | 2.00g<br>(1.58) | 2.15h<br>(1.63) | 1.64fg<br>(1.46) | 0.98fg<br>(1.22) | 0.83de<br>(1.15) | 1.07h<br>(1.25) |
| Subarna         | 0.20h<br>(0.84)               | 0.38g<br>(0.94)  | 0.32h<br>(0.91)   | 0.56i<br>(1.03)  | 0.60ij<br>(1.05) | 0.68ij<br>(1.09) | 1.02cd<br>(1.23)  | 1.71gh<br>(1.49) | 2.21f<br>(1.65) | 3.00f<br>(1.87) | 1.60fg<br>(1.45) | 0.90gh<br>(1.18) | 0.76e<br>(1.12)  | 1.07h<br>(1.25) |
| Aparupa DG      | 0.45d<br>(0.97)               | 0.60e<br>(1.05)  | 0.76c<br>(1.12)   | 0.98d<br>(1.22)  | 0.90ef<br>(1.18) | 1.00f<br>(1.22)  | 1.20c<br>(1.30)   | 2.28d<br>(1.67)  | 2.43e<br>(1.71) | 2.60g<br>(1.76) | 2.10e<br>(1.61)  | 1.50c<br>(1.41)  | 0.98c<br>(1.22)  | 1.37d<br>(1.37) |
| Tiger Green     | 0.41e<br>(0.95)               | 0.50f<br>(1.00)  | 0.60ef<br>(1.05)  | 0.66h<br>(1.08)  | 0.68h<br>(1.09)  | 1.10e<br>(1.26)  | 1.00cde<br>(1.22) | 2.08e<br>(1.61)  | 2.24f<br>(1.66) | 3.55e<br>(2.01) | 2.10e<br>(1.61)  | 1.28d<br>(1.33)  | 0.88d<br>(1.17)  | 1.31e<br>(1.35) |
| JKOH-7315       | 0.26g<br>(0.87)               | 0.33h<br>(0.91)  | 0.40gh<br>(0.95)  | 0.34j<br>(0.92)  | 0.64hi<br>(1.07) | 0.70hi<br>(1.10) | 0.86cde<br>(1.17) | 1.33i<br>(1.35)  | 2.22f<br>(1.65) | 3.20f<br>(1.92) | 1.18i<br>(1.30)  | 0.93g<br>(1.20)  | 0.50g<br>(1.00)  | 0.99i<br>(1.22) |
| Parbhani Kranti | 0.36f<br>(0.93)               | 0.48f<br>(0.99)  | 0.53f<br>(1.01)   | 0.68gh<br>(1.09) | 0.96e<br>(1.21)  | 0.82g<br>(1.15)  | 0.95cde<br>(1.17) | 1.64h<br>(1.46)  | 1.76h<br>(1.50) | 2.10h<br>(1.61) | 1.40h<br>(1.38)  | 0.96g<br>(1.21)  | 0.63f<br>(1.06)  | 1.02i<br>(1.23) |
| Basanti         | 0.40e<br>(0.95)               | 0.64de<br>(1.07) | 0.69cde<br>(1.09) | 0.86e<br>(1.17)  | 0.78g<br>(1.13)  | 0.98f<br>(1.22)  | 1.00cde<br>(1.22) | 2.00ef<br>(1.58) | 2.22f<br>(1.65) | 2.50g<br>(1.73) | 1.71f<br>(1.49)  | 1.10e<br>(1.26)  | 0.76e<br>(1.12)  | 1.20f<br>(1.31) |
| Miss-717        | 0.60b<br>(1.05)               | 0.67d<br>(1.08)  | 0.73cd<br>(1.11)  | 0.78f<br>(1.13)  | 0.88f<br>(1.17)  | 0.78gh<br>(1.13) | 0.94cde<br>(1.20) | 1.82gh<br>(1.52) | 2.16f<br>(1.63) | 2.45g<br>(1.72) | 1.54g<br>(1.43)  | 1.08ef<br>(1.26) | 0.81de<br>(1.14) | 1.17g<br>(1.29) |
| Meena-117       | 0.76a<br>(1.12)               | 0.97b<br>(1.21)  | 0.98b<br>(1.22)   | 1.23c<br>(1.31)  | 2.27b<br>(1.66)  | 2.20c<br>(1.64)  | 2.28b<br>(1.67)   | 3.80b<br>(2.07)  | 4.37b<br>(2.21) | 4.45c<br>(2.22) | 3.20c<br>(1.92)  | 2.92b<br>(1.85)  | 1.20b<br>(1.30)  | 2.36b<br>(1.69) |
| Bhindi No.10    | 0.80a<br>(1.14)               | 1.27a<br>(1.33)  | 1.20a<br>(1.30)   | 1.90a<br>(1.55)  | 2.64a<br>(1.77)  | 3.76a<br>(2.06)  | 4.18a<br>(2.16)   | 6.85a<br>(2.71)  | 8.42a<br>(2.99) | 9.00a<br>(3.08) | 7.73a<br>(2.87)  | 5.68a<br>(2.49)  | 4.26a<br>(2.18)  | 4.44a<br>(2.22) |
| PAN-2127        | 0.54c<br>(1.02)               | 0.83c<br>(1.15)  | 1.02b<br>(1.23)   | 1.48b<br>(1.41)  | 2.03c<br>(1.59)  | 2.38b<br>(1.70)  | 2.47b<br>(1.72)   | 3.64bc<br>(2.03) | 3.94c<br>(2.11) | 4.00d<br>(2.12) | 2.87d<br>(1.84)  | 1.20de<br>(1.30) | 0.76e<br>(1.12)  | 2.09c<br>(1.61) |
| Tanvi           | 0.57bc<br>(1.03)              | 0.87c<br>(1.17)  | 0.91b<br>(1.19)   | 0.93d<br>(1.20)  | 1.20d<br>(1.30)  | 1.84d<br>(1.53)  | 1.98b<br>(1.57)   | 3.52c<br>(2.00)  | 3.76d<br>(2.06) | 6.00b<br>(2.55) | 3.92b<br>(2.10)  | 1.25d<br>(1.32)  | 0.64f<br>(1.07)  | 2.11c<br>(1.61) |
| Kaveri          | 0.25g<br>(0.87)               | 0.30h<br>(0.89)  | 0.43g<br>(0.96)   | 0.30j<br>(0.89)  | 0.58j<br>(1.04)  | 0.60k<br>(1.05)  | 0.62e<br>(1.06)   | 0.95j<br>(1.20)  | 1.00j<br>(1.22) | 1.20i<br>(1.30) | 1.06j<br>(1.25)  | 0.78i<br>(1.13)  | 0.48gh<br>(0.99) | 0.66k<br>(1.08) |
| Chameli-015     | 0.28g<br>(0.88)               | 0.30h<br>(0.89)  | 0.40gh<br>(0.95)  | 0.60i<br>(1.05)  | 0.58j<br>(1.04)  | 0.62jk<br>(1.06) | 0.70de<br>(1.10)  | 1.00j<br>(1.22)  | 1.13i<br>(1.28) | 1.33i<br>(1.35) | 1.08ij<br>(1.26) | 0.80hi<br>(1.14) | 0.42h<br>(0.96)  | 0.71j<br>(1.10) |
| <b>F Value</b>  | 252.94                        | 256.14           | 47.85             | 494.53           | 756.91           | 639.66           | 27.23             | 375.22           | 1973.90         | 634.48          | 813.67           | 579.52           | 630.11           | 3274.05         |
| <b>Pr&gt;F</b>  | <.0001                        | <.0001           | <.0001            | <.0001           | <.0001           | <.0001           | <.0001            | <.0001           | <.0001          | <.0001          | <.0001           | <.0001           | <.0001           | <.0001          |
| <b>LSD</b>      | 0.0176                        | 0.0236           | 0.0507            | 0.0234           | 0.0265           | 0.035            | 0.1743            | 0.0609           | 0.0293          | 0.0542          | 0.0443           | 0.0442           | 0.0348           | 0.0152          |

\*Mean of three replications, \*\*Peak population of jassid

Figure in parenthesis indicates square root transformed value

**Table 31: Screening of different cultivars of okra against aphid in post-kharif (2015)**

| Cultivars       | Mean aphid population/ leaf* |                 |                  |                 |                  |                  |                  |                  |                  |                  |                  |                   |                  |                  |
|-----------------|------------------------------|-----------------|------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|------------------|------------------|
|                 | 38SW                         | 39SW            | 40SW             | 41SW            | 42SW             | 43SW**           | 44SW             | 45SW             | 46SW             | 47SW             | 48SW             | 49SW              | 50SW             | Mean             |
| Arka Anamika    | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 0.67g<br>(1.08)  | 0.84h<br>(1.16) | 2.56e<br>(1.75)  | 3.63f<br>(2.03)  | 3.47f<br>(1.99)  | 3.28g<br>(1.94)  | 3.09g<br>(1.89)  | 2.27f<br>(1.66)  | 1.37g<br>(1.37)  | 0.50i<br>(1.00)   | 0.42d<br>(0.96)  | 1.70g<br>(1.48)  |
| Subarna         | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 0.86f<br>(1.17)  | 1.27g<br>(1.33) | 2.40e<br>(1.70)  | 3.10g<br>(1.90)  | 2.90g<br>(1.84)  | 2.72h<br>(1.79)  | 2.61h<br>(1.76)  | 2.32f<br>(1.68)  | 1.18h<br>(1.30)  | 0.70gh<br>(1.10)  | 0.48cd<br>(0.99) | 1.58g<br>(1.44)  |
| Aparupa DG      | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.82cd<br>(1.52) | 2.00e<br>(1.58) | 3.53c<br>(2.01)  | 4.28d<br>(2.19)  | 4.12d<br>(2.15)  | 3.91e<br>(2.10)  | 3.76de<br>(2.06) | 3.38d<br>(1.97)  | 2.66cd<br>(1.78) | 2.06cd<br>(1.60)  | 1.37b<br>(1.37)  | 2.53de<br>(1.74) |
| Tiger Green     | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.67d<br>(1.47)  | 1.83f<br>(1.53) | 2.44e<br>(1.71)  | 4.00e<br>(2.12)  | 3.84e<br>(2.08)  | 3.68f<br>(2.04)  | 3.47f<br>(1.99)  | 2.34f<br>(1.69)  | 2.10e<br>(1.61)  | 1.43e<br>(1.39)   | 1.28b<br>(1.33)  | 2.16f<br>(1.63)  |
| JKOH-7315       | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 0.72g<br>(1.10)  | 0.94h<br>(1.20) | 1.69g<br>(1.48)  | 2.40h<br>(1.70)  | 2.26h<br>(1.66)  | 2.08i<br>(1.61)  | 1.86j<br>(1.54)  | 1.50h<br>(1.41)  | 1.12hi<br>(1.27) | 0.88fg<br>(1.17)  | 0.67cd<br>(1.08) | 1.24h<br>(1.32)  |
| Parbhani Kranti | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.18e<br>(1.30)  | 1.36g<br>(1.36) | 2.03f<br>(1.59)  | 3.12g<br>(1.90)  | 2.94g<br>(1.85)  | 2.78h<br>(1.81)  | 2.36i<br>(1.69)  | 1.78g<br>(1.51)  | 1.59f<br>(1.45)  | 1.00f<br>(1.22)   | 0.83c<br>(1.15)  | 1.61g<br>(1.45)  |
| Basanti         | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.64d<br>(1.46)  | 2.23d<br>(1.65) | 2.76d<br>(1.81)  | 4.58c<br>(2.25)  | 4.37c<br>(2.21)  | 3.80ef<br>(2.07) | 3.48f<br>(1.99)  | 2.66e<br>(1.78)  | 2.44d<br>(1.71)  | 1.88d<br>(1.54)   | 1.71b<br>(1.48)  | 2.43e<br>(1.71)  |
| Miss-717        | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.72cd<br>(1.49) | 2.46c<br>(1.72) | 2.91d<br>(1.85)  | 3.92e<br>(2.10)  | 3.84e<br>(2.08)  | 3.76f<br>(2.06)  | 3.66e<br>(2.04)  | 2.78e<br>(1.81)  | 2.60cd<br>(1.76) | 1.58e<br>(1.44)   | 1.47b<br>(1.40)  | 2.36e<br>(1.69)  |
| Meena-117       | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 2.95a<br>(1.86)  | 3.32a<br>(1.95) | 3.86b<br>(2.09)  | 5.12b<br>(2.37)  | 5.00b<br>(2.35)  | 4.87b<br>(2.32)  | 4.65b<br>(2.27)  | 3.67b<br>(2.04)  | 3.50a<br>(2.00)  | 2.98a<br>(1.87)   | 2.72a<br>(1.79)  | 3.28b<br>(1.94)  |
| Bhindi No.10    | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 3.00a<br>(1.87)  | 3.24a<br>(1.93) | 4.96a<br>(2.34)  | 5.80a<br>(2.51)  | 5.54a<br>(2.46)  | 5.28a<br>(2.40)  | 5.16a<br>(2.38)  | 4.68a<br>(2.28)  | 3.72a<br>(2.05)  | 2.83a<br>(1.82)   | 2.61a<br>(1.76)  | 3.60a<br>(2.03)  |
| PAN-2127        | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 2.72b<br>(1.79)  | 2.88b<br>(1.84) | 3.68bc<br>(2.04) | 5.00b<br>(2.35)  | 4.87b<br>(2.32)  | 4.62c<br>(2.26)  | 4.36c<br>(2.20)  | 3.50c<br>(2.00)  | 3.06b<br>(1.89)  | 2.48b<br>(1.73)   | 2.36a<br>(1.69)  | 3.04c<br>(1.88)  |
| Tanvi           | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 1.87c<br>(1.54)  | 2.20d<br>(1.64) | 3.58c<br>(2.02)  | 4.45cd<br>(2.22) | 4.22cd<br>(2.17) | 4.06d<br>(2.14)  | 3.87d<br>(2.09)  | 3.43cd<br>(1.98) | 2.70c<br>(1.79)  | 2.22bc<br>(1.65)  | 1.72b<br>(1.46)  | 2.64d<br>(1.77)  |
| Kaveri          | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 0.66g<br>(1.08)  | 0.92h<br>(1.19) | 1.50h<br>(1.41)  | 2.24h<br>(1.66)  | 2.02i<br>(1.59)  | 1.88j<br>(1.54)  | 1.67k<br>(1.47)  | 1.22i<br>(1.31)  | 1.06hi<br>(1.25) | 0.81fgh<br>(1.14) | 0.51cd<br>(1.00) | 1.11h<br>(1.27)  |
| Chameli-015     | 0.00a<br>(0.71)              | 0.00a<br>(0.71) | 0.63g<br>(1.06)  | 0.84h<br>(1.16) | 1.62gh<br>(1.46) | 2.40h<br>(1.70)  | 2.20h<br>(1.64)  | 1.92j<br>(1.56)  | 1.84j<br>(1.53)  | 1.40h<br>(1.38)  | 1.00i<br>(1.22)  | 0.62hi<br>(1.06)  | 0.50cd<br>(1.00) | 1.15h<br>(1.29)  |
| <b>F Value</b>  | -                            | -               | 200.42           | 286.22          | 195.83           | 196.83           | 371.23           | 523.97           | 340.93           | 622.27           | 171.04           | 85.62             | 23.19            | 189.29           |
| <b>Pr&gt;F</b>  | -                            | -               | <.0001           | <.0001          | <.0001           | <.0001           | <.0001           | <.0001           | <.0001           | <.0001           | <.0001           | <.0001            | <.0001           | <.0001           |
| <b>LSD</b>      | -                            | -               | 0.06             | 0.0493          | 0.0563           | 0.0557           | 0.0416           | 0.0353           | 0.045            | 0.0331           | 0.0645           | 0.0933            | 0.1789           | 0.0521           |

\*Mean of three replication, \*\*Peak population of aphid

Figure in parenthesis indicates square root transformed value

**Table 32: Screening of different cultivars of okra against whitefly in post-kharif, (2015)**

| Cultivars       | Mean whitefly population/ leaf* |                  |                   |                  |                  |                  |                  |                  |                   |                  |                  |                 |                  |                    |
|-----------------|---------------------------------|------------------|-------------------|------------------|------------------|------------------|------------------|------------------|-------------------|------------------|------------------|-----------------|------------------|--------------------|
|                 | 38SW                            | 39SW             | 40SW              | 41SW             | 42SW**           | 43SW             | 44SW             | 45SW             | 46SW              | 47SW             | 48SW             | 49SW            | 50SW             | Mean               |
| Arka Anamika    | 0.00a<br>(0.71)                 | 0.23gh<br>(0.85) | 0.45d<br>(0.97)   | 1.06de<br>(1.25) | 3.18f<br>(1.92)  | 2.60e<br>(1.76)  | 1.83ef<br>(1.53) | 2.52de<br>(1.74) | 2.76cde<br>(1.81) | 2.12e<br>(1.62)  | 1.56d<br>(1.44)  | 1.34g<br>(1.36) | 1.03cd<br>(1.24) | 1.59efg<br>(1.45)  |
| Subarna         | 0.00a<br>(0.71)                 | 0.83b<br>(1.15)  | 0.96abc<br>(1.21) | 1.00de<br>(1.22) | 2.98g<br>(1.87)  | 2.25f<br>(1.66)  | 1.64g<br>(1.46)  | 2.12f<br>(1.62)  | 2.35f<br>(1.69)   | 1.86f<br>(1.54)  | 1.34e<br>(1.36)  | 1.16h<br>(1.29) | 0.92ef<br>(1.19) | 1.49fgh<br>(1.41)  |
| Aparupa DG      | 0.00a<br>(0.71)                 | 0.70c<br>(1.10)  | 1.40a<br>(1.38)   | 1.60b<br>(1.45)  | 3.68c<br>(2.04)  | 2.84d<br>(1.83)  | 2.51b<br>(1.73)  | 2.56de<br>(1.75) | 2.68e<br>(1.78)   | 2.68b<br>(1.78)  | 1.65cd<br>(1.47) | 1.97d<br>(1.57) | 1.21ab<br>(1.31) | 1.96bc<br>(1.57)   |
| Tiger Green     | 0.00a<br>(0.71)                 | 0.29f<br>(0.89)  | 1.02abc<br>(1.23) | 1.72b<br>(1.49)  | 3.46de<br>(1.99) | 3.02cd<br>(1.88) | 2.08d<br>(1.60)  | 2.47e<br>(1.72)  | 2.83cd<br>(1.82)  | 2.26de<br>(1.66) | 1.21ef<br>(1.31) | 1.10i<br>(1.26) | 0.90fg<br>(1.18) | 1.72cdef<br>(1.49) |
| JKOH-7315       | 0.00a<br>(0.71)                 | 0.97a<br>(1.21)  | 1.06abc<br>(1.25) | 1.63b<br>(1.46)  | 3.54d<br>(2.01)  | 3.12c<br>(1.90)  | 1.98de<br>(1.57) | 2.56de<br>(1.75) | 2.78cde<br>(1.81) | 2.28d<br>(1.67)  | 1.84b<br>(1.53)  | 1.56e<br>(1.43) | 1.12bc<br>(1.27) | 1.88bcd<br>(1.54)  |
| Parbhani Kranti | 0.00a<br>(0.71)                 | 0.22h<br>(0.85)  | 0.64cd<br>(1.07)  | 1.38c<br>(1.37)  | 2.44h<br>(1.71)  | 2.16fg<br>(1.63) | 1.56g<br>(1.44)  | 1.88g<br>(1.54)  | 1.98g<br>(1.57)   | 1.69g<br>(1.48)  | 1.35e<br>(1.36)  | 1.44f<br>(1.39) | 1.00de<br>(1.22) | 1.36gh<br>(1.37)   |
| Basanti         | 0.00a<br>(0.71)                 | 0.30f<br>(0.89)  | 0.70bcd<br>(1.10) | 0.96e<br>(1.21)  | 3.38e<br>(1.97)  | 2.97cd<br>(1.86) | 1.70fg<br>(1.48) | 2.70cd<br>(1.79) | 2.90c<br>(1.84)   | 2.48c<br>(1.73)  | 1.85b<br>(1.53)  | 1.28g<br>(1.33) | 0.62i<br>(1.06)  | 1.68def<br>(1.48)  |
| Miss-717        | 0.00a<br>(0.71)                 | 0.40e<br>(0.95)  | 0.48d<br>(0.99)   | 0.50f<br>(1.00)  | 3.17f<br>(1.92)  | 2.92d<br>(1.85)  | 1.63g<br>(1.46)  | 2.52de<br>(1.74) | 2.73de<br>(1.80)  | 2.31d<br>(1.68)  | 1.76bc<br>(1.50) | 1.54e<br>(1.43) | 0.32j<br>(0.91)  | 1.56fg<br>(1.44)   |
| Meena-117       | 0.00a<br>(0.71)                 | 0.28fg<br>(0.88) | 0.50d<br>(0.95)   | 1.02de<br>(1.23) | 4.22b<br>(2.17)  | 3.64b<br>(2.03)  | 2.01d<br>(1.58)  | 2.90b<br>(1.84)  | 3.17b<br>(1.92)   | 2.72b<br>(1.79)  | 1.64cd<br>(1.46) | 1.98d<br>(1.57) | 0.63i<br>(1.06)  | 1.90bcd<br>(1.55)  |
| Bhindi No.10    | 0.00a<br>(0.71)                 | 0.98a<br>(1.22)  | 1.14ab<br>(1.28)  | 2.60a<br>(1.76)  | 4.66a<br>(2.27)  | 4.58a<br>(2.25)  | 2.76a<br>(1.81)  | 3.14a<br>(1.91)  | 4.10a<br>(2.14)   | 3.06a<br>(1.89)  | 2.62a<br>(1.77)  | 2.60b<br>(1.76) | 1.04cd<br>(1.24) | 2.56a<br>(1.75)    |
| PAN-2127        | 0.00a<br>(0.71)                 | 0.50d<br>(1.00)  | 0.93abc<br>(1.19) | 1.72b<br>(1.49)  | 3.10fg<br>(1.90) | 2.96cd<br>(1.86) | 2.36bc<br>(1.69) | 2.66cd<br>(1.78) | 2.71de<br>(1.79)  | 2.23de<br>(1.65) | 1.80bc<br>(1.52) | 2.12c<br>(1.62) | 1.18ab<br>(1.30) | 1.87cde<br>(1.54)  |
| Tanvi           | 0.00a<br>(0.71)                 | 0.70c<br>(1.10)  | 1.15ab<br>(1.28)  | 1.38c<br>(1.37)  | 4.13b<br>(2.15)  | 3.72b<br>(2.05)  | 2.28c<br>(1.67)  | 2.84bc<br>(1.83) | 3.17b<br>(1.92)   | 2.63bc<br>(1.77) | 1.90b<br>(1.55)  | 2.81a<br>(1.82) | 1.24a<br>(1.32)  | 2.15b<br>(1.63)    |
| Kaveri          | 0.00a<br>(0.71)                 | 0.50d<br>(1.00)  | 0.76bcd<br>(1.12) | 1.10de<br>(1.26) | 2.27i<br>(1.66)  | 2.06g<br>(1.60)  | 1.32h<br>(1.35)  | 1.74g<br>(1.50)  | 1.98g<br>(1.57)   | 1.65g<br>(1.47)  | 1.18f<br>(1.30)  | 1.56e<br>(1.44) | 0.78h<br>(1.13)  | 1.30h<br>(1.34)    |
| Chameli-015     | 0.00a<br>(0.71)                 | 0.80b<br>(1.14)  | 0.93abc<br>(1.20) | 1.14d<br>(1.28)  | 2.35hi<br>(1.69) | 2.10fg<br>(1.61) | 1.41h<br>(1.38)  | 1.80g<br>(1.52)  | 2.06g<br>(1.60)   | 1.71g<br>(1.49)  | 1.23ef<br>(1.32) | 1.60e<br>(1.45) | 0.81gh<br>(1.14) | 1.38gh<br>(1.37)   |
| <b>F Value</b>  | -                               | 153.74           | 3.59              | 74.92            | 250.40           | 103.34           | 56.59            | 43.94            | 123.88            | 65.02            | 37.75            | 404.34          | 72.33            | 13.99              |
| <b>Pr&gt;F</b>  | -                               | <.0001           | 0.0027            | <.0001           | <.0001           | <.0001           | <.0001           | <.0001           | <.0001            | <.0001           | <.0001           | <.0001          | <.0001           | <.0001             |
| <b>LSD</b>      | -                               | 0.0315           | 0.1987            | 0.0607           | 0.0333           | 0.0532           | 0.0525           | 0.0549           | 0.04              | 0.0465           | 0.0598           | 0.0241          | 0.0395           | 0.0873             |

\*Mean of three replication, \*\*Peak population of whitefly

Figure in parenthesis indicates square root transformed value

#### 4.2.1.4. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hubner) during 2015:

The incidence of fruit borer in the fourteen okra cultivars was assessed as % bored fruit per plant. The data presented in Table 33 and Fig.22 clearly revealed that the infestation level varied significantly among the cultivars. The cultivar Aparupa DG was found significantly superior over other cultivars against fruit borer attack as it witnessed minimum damage of fruit (13.32% bored fruit/plant) followed by Chameli-015 (13.38% bored fruit/plant) and Kaveri (13.60% bored fruit/per plant). The most susceptible cultivar was Meena-117 having highest bored fruit% per plant (19.24% bored fruit/plant) followed by Tiger Green (18.78% bored fruit/plant), Bhindi No.10 (18.74% bored fruit/plant) and Tanvi (18.40% bored fruit/plant).

**Fig. 22: Pest population at peak in cultivars of okra during post-kharif season**

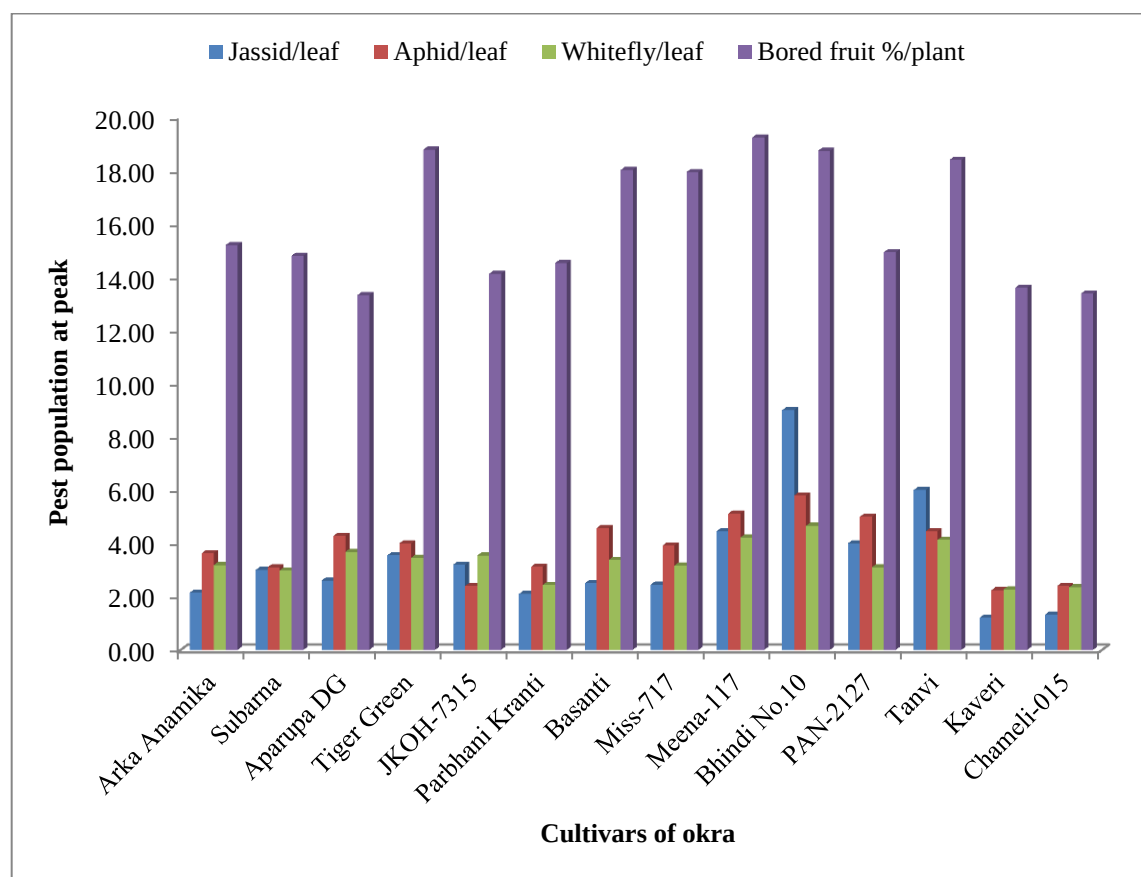


**Table 33: Screening of different cultivars of okra against fruit borer complex (no. basis) in post-kharif, (2015)**

| Cultivars       | Mean bored fruit % (no. basis) / plant* |                 |                 |                 |                 |                  |                    |                    |                   |                  |                   |                   |                 |                  |
|-----------------|-----------------------------------------|-----------------|-----------------|-----------------|-----------------|------------------|--------------------|--------------------|-------------------|------------------|-------------------|-------------------|-----------------|------------------|
|                 | 38SW                                    | 39SW            | 40SW            | 41SW            | 42SW            | 43SW             | 44SW               | 45SW**             | 46SW              | 47SW             | 48SW              | 49SW              | 50SW            | Mean             |
| Arka Anamika    | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 3.20d<br>(1.92) | 6.20gh<br>(2.59) | 11.24def<br>(3.43) | 15.20b<br>(3.96)   | 12.78cd<br>(3.64) | 10.22b<br>(3.27) | 8.16ef<br>(2.94)  | 5.36d<br>(2.42)   | 4.08c<br>(2.14) | 5.88cd<br>(2.53) |
| Subarna         | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 2.82e<br>(1.82) | 6.56fg<br>(2.66) | 11.56de<br>(3.47)  | 14.80bc<br>(3.91)  | 12.18cd<br>(3.56) | 9.76b<br>(3.20)  | 7.16fg<br>(2.77)  | 5.08d<br>(2.36)   | 3.27c<br>(1.94) | 5.63cd<br>(2.48) |
| Aparupa DG      | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 2.04f<br>(1.59) | 6.07h<br>(2.56)  | 10.37f<br>(3.30)   | 13.32d<br>(3.72)   | 12.52cd<br>(3.60) | 10.20b<br>(3.27) | 6.88g<br>(2.72)   | 4.00e<br>(2.12)   | 3.24c<br>(1.93) | 5.28d<br>(2.40)  |
| Tiger Green     | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 5.84c<br>(2.52) | 12.28a<br>(3.57) | 15.63bc<br>(4.02)  | 18.78a<br>(4.39)   | 17.46ab<br>(4.23) | 14.56a<br>(3.88) | 13.20a<br>(3.70)  | 11.30a<br>(3.43)  | 7.56a<br>(2.84) | 8.97a<br>(3.08)  |
| JKOH-7315       | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 2.03f<br>(1.59) | 7.06e<br>(2.75)  | 10.64ef<br>(3.34)  | 14.12bcd<br>(3.82) | 11.37d<br>(3.45)  | 9.18b<br>(3.11)  | 8.54de<br>(3.01)  | 5.36d<br>(2.42)   | 3.30c<br>(1.94) | 5.51d<br>(2.45)  |
| Parbhani Kranti | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 1.21g<br>(1.31) | 6.18h<br>(2.58)  | 11.92d<br>(3.52)   | 14.52bcd<br>(3.88) | 13.70c<br>(3.77)  | 10.74b<br>(3.35) | 9.58cd<br>(3.17)  | 5.27d<br>(2.40)   | 3.64c<br>(2.03) | 5.90cd<br>(2.53) |
| Basanti         | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 5.80c<br>(2.51) | 11.63b<br>(3.48) | 15.36bc<br>(3.98)  | 18.02a<br>(4.30)   | 16.78ab<br>(4.16) | 13.20a<br>(3.70) | 12.32ab<br>(3.58) | 10.37ab<br>(3.30) | 7.28a<br>(2.79) | 8.52ab<br>(3.00) |
| Miss-717        | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 6.62b<br>(2.67) | 11.36b<br>(3.44) | 15.18bc<br>(3.96)  | 17.94a<br>(4.29)   | 16.65ab<br>(4.14) | 13.08a<br>(3.68) | 12.10ab<br>(3.55) | 9.97b<br>(3.24)   | 7.34a<br>(2.80) | 8.48ab<br>(2.99) |
| Meena-117       | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 6.57b<br>(2.66) | 12.48a<br>(3.60) | 17.67a<br>(4.26)   | 19.24a<br>(4.44)   | 18.54a<br>(4.36)  | 14.54a<br>(3.86) | 12.96ab<br>(3.67) | 10.21b<br>(3.27)  | 7.78a<br>(2.88) | 9.23a<br>(3.12)  |
| Bhindi No.10    | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 7.80a<br>(2.88) | 11.20b<br>(3.42) | 15.82b<br>(4.04)   | 18.74a<br>(4.38)   | 17.10ab<br>(4.19) | 13.36a<br>(3.72) | 11.72b<br>(3.50)  | 9.80b<br>(3.21)   | 8.34a<br>(2.97) | 8.76ab<br>(3.04) |
| PAN-2127        | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 3.25d<br>(1.94) | 8.50d<br>(3.00)  | 12.28d<br>(3.57)   | 14.93b<br>(3.93)   | 13.38c<br>(3.72)  | 10.72b<br>(3.35) | 8.67de<br>(3.03)  | 7.63c<br>(2.85)   | 5.40b<br>(2.43) | 6.52c<br>(2.65)  |
| Tanvi           | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 6.63b<br>(2.67) | 9.80c<br>(3.21)  | 14.37c<br>(3.86)   | 18.40a<br>(4.35)   | 15.67b<br>(4.02)  | 13.10a<br>(3.69) | 10.31c<br>(3.29)  | 7.20c<br>(2.77)   | 5.56b<br>(2.46) | 7.77b<br>(2.88)  |
| Kaveri          | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 2.68f<br>(1.78) | 6.74ef<br>(2.69) | 10.56ef<br>(3.32)  | 13.60cd<br>(3.75)  | 11.98cd<br>(3.53) | 9.87b<br>(3.22)  | 6.70g<br>(2.67)   | 5.60d<br>(2.47)   | 3.36c<br>(1.96) | 5.47d<br>(2.43)  |
| Chameli-015     | 0.00a<br>(0.71)                         | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 0.00a<br>(0.71) | 1.21g<br>(1.31) | 6.10h<br>(2.57)  | 10.16f<br>(3.26)   | 13.38d<br>(3.72)   | 11.28d<br>(3.43)  | 9.27b<br>(3.12)  | 6.40g<br>(2.63)   | 5.20d<br>(2.39)   | 3.56c<br>(2.01) | 5.12d<br>(2.37)  |
| <b>F Value</b>  | -                                       | -               | -               | -               | 1349.53         | 270.61           | 31.87              | 22.67              | 16.19             | 7.43             | 39.35             | 72.38             | 28.30           | 22.76            |
| <b>Pr&gt;F</b>  | -                                       | -               | -               | -               | <.0001          | <.0001           | <.0001             | <.0001             | <.0001            | <.0001           | <.0001            | <.0001            | <.0001          | <.0001           |
| <b>LSD</b>      | -                                       | -               | -               | -               | 0.0434          | 0.0747           | 0.174              | 0.1711             | 0.2357            | 0.299            | 0.1802            | 0.1529            | 0.2263          | 0.1761           |

\*Mean of three replication, \*\*Peak population of fruit borer  
Figure in parenthesis indicates square root transformed value

#### **4.2.1.5. Physico-morphic constituents in different okra cultivars during post-kharif season, 2015**

The data on physico-morphic constituents in different okra cultivars were presented in table 34 and 35.

##### **4.2.1.5.1. Plant and leaf parameters**

The plant height (79.69cm), number of leaves (21.73/plant) and branches (1.94/plant) per plant, leaf thickness (1.69mm) and area of leaf (157.97cm<sup>2</sup>) were observed significantly more in Bhindi No.10 and lowest corresponding values of them were found in Kaveri (48.67 cm, 14.21/plant, 0.93/plant, 1.18 mm and 137.70 cm<sup>2</sup>) and Chameli-015 (48.47 cm, 14.51/plant, 1.07/plant, 1.29mm and 137.26 cm<sup>2</sup>). The maximum trichome density of both leaf surfaces was recorded in Chameli-015 (11.40/cm<sup>2</sup> and 17.47/cm<sup>2</sup> in upper and lower surface). The density was minimum in Bhindi No 10 (6.00/cm<sup>2</sup> and 9.53/cm<sup>2</sup>).

##### **4.2.1.5.2. Fruit parameters**

Among the cultivars, the highest number of flowers (10.55/plant) and fruits (10.40/plant) were found in JKOH 7315. The fruit length was maximum (16.25cm) in Tiger Green and minimum (11.53cm) in Kaveri. The fruit breadth of different okra cultivars varied from 1.58cm (Kaveri) to 2.03cm (Bhindi No.10). The highest number of seeds per fruit was found in Miss-717 (68.93/fruit) and lowest in Kaveri (39.80/fruit). The highest and lowest trichome density in fruit was recorded 167.87/cm<sup>2</sup> and 96.07/cm<sup>2</sup> in Chameli-015 and Meena-117 respectively (Table 35).

#### **4.2.1.6. Correlation of pest's incidence with physico-morphic constituents of okra cultivars**

The correlation studies between sucking pests (jassid, aphid and white fly) and physico-morphic characters revealed that plant height, number of leaves and branch per plant, thickness and area of leaf had significant positive influence on pest population fluctuation except aphid population with plant height and whitefly with number of branch/plant while trichome density of leaf (upper and lower surface) showed significant negative correlation.

The correlation between fruit borer damage and physico-morphic characters of fruit revealed that number of seeds/fruits had significant positive effect while trichome density of fruit had significant negative effect and rest of the parameters showed non-significant positive effect.

**Table 34: Physico-morphic character of plant at 60 days in different okra cultivar during post-kharif, 2015**

| Sl. No.            | Cultivars       | Physico-morphic character |                     |                     |                            |                            |                     |                              |
|--------------------|-----------------|---------------------------|---------------------|---------------------|----------------------------|----------------------------|---------------------|------------------------------|
|                    |                 | Plant height (cm)         | No. of leaves/plant | No. of branch/plant | Trichome U/cm <sup>2</sup> | Trichome L/cm <sup>2</sup> | Leaf thickness (mm) | Leaf area (cm <sup>2</sup> ) |
| 1.                 | Arka Anamika    | 48.87bc                   | 15.80ghi            | 1.01efg             | 9.27c                      | 13.60c                     | 1.40cd              | 146.67abc                    |
| 2.                 | Subarna         | 57.98bc                   | 19.64bcd            | 1.84ab              | 7.73d                      | 12.27d                     | 1.41bcd             | 147.67abc                    |
| 3.                 | Aparupa DG      | 47.93c                    | 15.18hi             | 0.87g               | 10.00bc                    | 15.13b                     | 1.17d               | 136.34c                      |
| 4.                 | Tiger Green     | 62.67b                    | 20.13abc            | 1.51bc              | 7.80d                      | 12.20d                     | 1.48abc             | 152.91ab                     |
| 5.                 | JKOH-7315       | 53.80bc                   | 17.33efg            | 1.07defg            | 9.74c                      | 15.11b                     | 1.52abc             | 148.83abc                    |
| 6.                 | Parbhani Kranti | 52.00bc                   | 17.80def            | 1.14defg            | 9.80c                      | 14.53bc                    | 1.32cd              | 145.40abc                    |
| 7.                 | Basanti         | 53.80bc                   | 16.47fgh            | 1.51bc              | 9.07c                      | 14.07bc                    | 1.43abcd            | 153.00ab                     |
| 8.                 | Miss-717        | 51.60bc                   | 17.67efg            | 1.28cde             | 6.97de                     | 14.60bc                    | 1.38cd              | 141.90bc                     |
| 9.                 | Meena-117       | 58.60bc                   | 21.48ab             | 1.27cdef            | 6.67de                     | 10.00e                     | 1.68ab              | 154.77ab                     |
| 10.                | Bhindi No.10    | 79.69a                    | 21.73a              | 1.94a               | 6.00e                      | 9.53e                      | 1.69a               | 157.97a                      |
| 11.                | PAN-2127        | 45.73c                    | 18.73cde            | 1.41cd              | 10.07bc                    | 14.20bc                    | 1.53abc             | 149.70abc                    |
| 12.                | Tanvi           | 54.00bc                   | 20.60abc            | 1.54bc              | 7.47d                      | 12.27d                     | 1.49abc             | 153.07ab                     |
| 13.                | Kaveri          | 48.67c                    | 14.21i              | 0.93fg              | 11.20ab                    | 17.00a                     | 1.18d               | 137.70c                      |
| 14.                | Chameli-015     | 48.47c                    | 14.51i              | 1.07defg            | 11.40a                     | 17.47a                     | 1.29cd              | 137.26c                      |
| F Value            |                 | 3.27                      | 14.44               | 7.54                | 15.16                      | 32.16                      | 2.79                | 1.87                         |
| Pr>F               |                 | 0.0049                    | <.0001              | <.0001              | <.0001                     | <.0001                     | 0.0125              | 0.0849                       |
| LSD                |                 | 13.883                    | 1.930               | 0.3478              | 1.2662                     | 1.1761                     | 0.2731              | 14.701                       |
| <b>Correlation</b> |                 |                           |                     |                     |                            |                            |                     |                              |
| <b>Jassid</b>      |                 | 0.797**                   | 0.805**             | 0.702**             | -0.721**                   | -0.801**                   | 0.769**             | 0.752**                      |
| <b>Aphid</b>       |                 | 0.495                     | 0.653*              | 0.534*              | -0.663**                   | -0.752**                   | 0.644*              | 0.661**                      |
| <b>Whitefly</b>    |                 | 0.653*                    | 0.710**             | 0.478               | -0.808**                   | -0.762**                   | 0.724**             | 0.708**                      |

\* Significant at 0.05%, \*\*Significant at 0.01%.

**Table 35: Physico-morphic character of fruit in different okra cultivar during post-kharif, 2015**

| Sl. No.                             | Cultivars       | Physico-morphic character of fruit |                    |                    |                             |                    |                     |
|-------------------------------------|-----------------|------------------------------------|--------------------|--------------------|-----------------------------|--------------------|---------------------|
|                                     |                 | Fruit length (cm)                  | Fruit breadth (cm) | No. of seeds/fruit | Trichome (cm <sup>2</sup> ) | No. of fruit/plant | No. of flower/Plant |
| 1.                                  | Arka Anamika    | 14.85ab                            | 1.85bc             | 41.80de            | 117.33cd                    | 6.20cde            | 6.76de              |
| 2.                                  | Subarna         | 16.17a                             | 2.03a              | 56.93bc            | 114.20de                    | 8.90b              | 9.90ab              |
| 3.                                  | Aparupa DG      | 11.83cd                            | 1.63de             | 54.87c             | 139.80b                     | 5.60e              | 5.93e               |
| 4.                                  | Tiger Green     | 16.25a                             | 1.83bc             | 59.13b             | 100.60gh                    | 9.38ab             | 10.00ab             |
| 5.                                  | JKOH-7315       | 15.57a                             | 1.97ab             | 57.40bc            | 103.40fg                    | 10.40a             | 10.55a              |
| 6.                                  | Parbhani Kranti | 13.13cd                            | 1.89abc            | 56.33bc            | 100.73gh                    | 5.95cde            | 6.00e               |
| 7.                                  | Basanti         | 12.80cd                            | 1.78cd             | 55.67bc            | 118.07cd                    | 8.90b              | 9.96ab              |
| 8.                                  | Miss-717        | 12.80cd                            | 1.86bc             | 68.93a             | 122.60c                     | 6.93c              | 7.99cd              |
| 9.                                  | Meena-117       | 14.97ab                            | 1.89abc            | 55.60bc            | 96.07h                      | 6.10cde            | 6.44de              |
| 10.                                 | Bhindi No.10    | 13.00cd                            | 2.03a              | 65.53a             | 97.40gh                     | 9.07b              | 9.62ab              |
| 11.                                 | PAN-2127        | 12.87cd                            | 1.76cd             | 44.27d             | 109.13ef                    | 5.87de             | 6.35e               |
| 12.                                 | Tanvi           | 13.33bc                            | 1.97ab             | 65.33a             | 104.47fg                    | 6.16cde            | 8.85bc              |
| 13.                                 | Kaveri          | 11.53d                             | 1.58e              | 39.80e             | 144.80b                     | 6.61cde            | 6.87de              |
| 14.                                 | Chameli-015     | 11.93cd                            | 1.66de             | 58.27bc            | 167.87a                     | 6.67cd             | 7.07de              |
| F Value                             |                 | 7.43                               | 7.43               | 42.71              | 71.61                       | 19.53              | 9.40                |
| Pr>F                                |                 | <.0001                             | <.0001             | <.0001             | <.0001                      | <.0001             | <.0001              |
| LSD                                 |                 | 1.7115                             | 0.1538             | 3.8327             | 7.1804                      | 1.0623             | 1.6302              |
| Fruit borer complex (bored fruit %) |                 | 0.299                              | 0.495              | 0.530*             | -0.625*                     | 0.228              | 0.398               |

\* Significant at 0.05%, \*\*Significant at 0.01%.

#### **4.2.1.7. Bio-chemical constituents of okra leaf and fruit in different okra cultivars during post-kharif season, 2015**

The data depicted in table 36 revealed that the chlorophyll content of leaf was highest in Bhindi No. 10 (value of SPAD 53.39) closely followed by Meena-117 (value of SPAD 49.54). The lowest value was found in Kaveri (value of SPAD 35.95) that non-significantly followed by Chameli-015 (value of SPAD 36.07). The moisture, protein, nitrogen and phosphorous content of leaf (80.78%, 51.33mg/g, 3.36% and 0.23%) and fruit (89.02%, 53.81mg/g, 4.20% and 0.45%) were recorded highest in cultivar Bhindi No.10 which was closely followed by Meena-117 (80.63%, 51.33mg/g, 2.95% and 0.23% in leaf and 88.21%, 49.94mg/g, 3.73% and 0.40% in fruit). The cultivars Bhindi No.10 was also contained minimum amount of lipid, OD-phenol, phenol, potassium and zinc in leaf (0.98%, 0.40mg/g, 4.94mg/g, 1.54% and 42.50 mg/kg) and fruit (1.09%, 0.51mg/g, 9.01mg/g, 1.54% and 64.68 mg/kg) which was followed by Meena-117 (1.03%, 0.45mg/g, 4.96mg/g, 1.38% and 43.97mg/kg in leaf and 1.18%, 0.50mg/g, 7.83mg/g, 1.78% and 64.67mg/kg in fruit). The cultivar Kaveri accounted significantly maximum concentrations of lipid, OD-phenol, phenol, potassium and zinc (1.84%, 0.62mg/gm, 8.37mg/g, 2.08% and 67.90mg/kg in leaf and 2.00%, 0.93mg/gm, 14.98mg/g, 2.60% and 80.99mg/kg in fruit) which was closely followed by Chameli-015 (1.82%, 0.58mg/gm, 8.49mg/g, 2.03% and 67.07mg/kg in leaf and 2.13%, 0.97mg/gm, 15.23mg/g, 2.64% and 82.07mg/kg in fruit).

#### **4.2.1.8. Correlation of pest's incidence with bio-chemical constituents of okra cultivars**

Correlation of incidence of different pests with the bio-chemical constituents of the okra leaves and fruits was done and presented in Table 36 and 37.

The results revealed that among the various bio-chemical concentration of leaf and fruit, moisture, nitrogen, phosphorus and protein posed significant positive influence on jassid, aphid, whitefly and fruit borer population fluctuation while, lipid, OD phenol, phenol, potassium and zinc had significantly negative effect (Table 36 and 37). The chlorophyll content in leaf had significantly positive effect on sucking pest of okra.

**Table 36: Bio-chemical character of leaf at 60 days in different okra cultivars during post-kharif, 2015**

| Sl. No.     | Cultivars       | Biochemical characters |          |            |                   |                |                 |            |              |             |              |
|-------------|-----------------|------------------------|----------|------------|-------------------|----------------|-----------------|------------|--------------|-------------|--------------|
|             |                 | Chlorophyll            | Lipid %  | Moisture % | OD phenol (mg/gm) | Phenol (mg/gm) | Protein (mg/gm) | Nitrogen % | Phosphorus % | Potassium % | Zinc (mg/kg) |
| 1.          | Arka Anamika    | 40.42ef                | 0.99g    | 76.70abcd  | 0.52bcd           | 7.11ab         | 40.75def        | 2.75bc     | 0.19de       | 1.86ab      | 51.53de      |
| 2.          | Subarna         | 43.95cde               | 1.27de   | 77.51abc   | 0.53bcd           | 5.78ab         | 43.50cde        | 2.31cd     | 0.21bcde     | 1.83ab      | 49.60ef      |
| 3.          | Aparupa DG      | 38.33fg                | 1.60c    | 73.09cd    | 0.62a             | 7.84ab         | 33.67g          | 2.10d      | 0.19ef       | 1.99a       | 67.00a       |
| 4.          | Tiger Green     | 46.09bc                | 1.08fg   | 78.77ab    | 0.47cde           | 5.21b          | 49.67ab         | 2.80bc     | 0.24a        | 1.67bc      | 48.17efg     |
| 5.          | JKOH-7315       | 43.51cde               | 1.11efg  | 76.54abcd  | 0.49bcd           | 6.02ab         | 45.83abcd       | 2.65bc     | 0.22abcd     | 1.51cde     | 53.53bcde    |
| 6.          | Parbhani Kranti | 40.19ef                | 1.64c    | 76.41abcd  | 0.56ab            | 7.59ab         | 37.50fg         | 2.86ab     | 0.19de       | 1.95a       | 57.23bcd     |
| 7.          | Basanti         | 41.99def               | 1.39d    | 75.86abcd  | 0.55abc           | 6.88ab         | 37.75efg        | 2.88ab     | 0.20cde      | 1.66bcd     | 57.70bc      |
| 8.          | Miss-717        | 42.74cde               | 1.65bc   | 76.64abcd  | 0.55ab            | 7.08ab         | 44.58bcd        | 2.71bc     | 0.20de       | 1.61bcde    | 52.43cde     |
| 9.          | Meena-117       | 49.54ab                | 1.03g    | 80.63a     | 0.45de            | 4.96b          | 51.33a          | 2.95ab     | 0.23abc      | 1.38e       | 43.97fg      |
| 10.         | Bhindi No.10    | 53.39a                 | 0.98g    | 80.78a     | 0.40e             | 4.94b          | 51.33a          | 3.36a      | 0.23ab       | 1.54cde     | 42.50g       |
| 11.         | PAN-2127        | 43.25cde               | 1.24def  | 76.32abcd  | 0.52bcd           | 5.89ab         | 45.17bcd        | 2.95ab     | 0.22abcd     | 1.40de      | 58.27b       |
| 12.         | Tanvi           | 45.43cd                | 1.00g    | 77.12abcd  | 0.50bcd           | 6.20ab         | 46.83abc        | 2.82bc     | 0.23ab       | 1.55cde     | 42.87g       |
| 13.         | Kaveri          | 35.95g                 | 1.84a    | 74.44bcd   | 0.62a             | 8.37a          | 23.08h          | 1.80d      | 0.16f        | 2.08a       | 67.90a       |
| 14.         | Chameli-015     | 36.07g                 | 1.82ab   | 71.87d     | 0.58ab            | 8.49a          | 22.50h          | 1.85d      | 0.16f        | 2.03a       | 67.07a       |
| F Value     |                 | 12.44                  | 28.48    | 1.66       | 4.35              | 1.25           | 20.82           | 6.10       | 6.26         | 6.77        | 19.82        |
| Pr>F        |                 | <.0001                 | <.0001   | 0.1327     | 0.0007            | 0.3043         | <.0001          | <.0001     | <.0001       | <.0001      | <.0001       |
| LSD         |                 | 3.9765                 | 0.1753   | 5.589      | 0.0841            | 3.131          | 5.919           | 0.5293     | 0.0287       | 0.265       | 5.707        |
| Correlation |                 |                        |          |            |                   |                |                 |            |              |             |              |
| Jassid      |                 | 0.881**                | -0.685** | 0.753**    | -0.816**          | -0.745**       | 0.702**         | 0.701**    | 0.737**      | -0.629*     | -0.736**     |
| Aphid       |                 | 0.732**                | -0.555*  | 0.634*     | -0.587*           | -0.623*        | 0.654*          | 0.744**    | 0.644*       | -0.650*     | -0.550*      |
| Whitefly    |                 | 0.840**                | -0.759** | 0.731**    | -0.748**          | -0.734**       | 0.760**         | 0.657*     | 0.764**      | -0.691**    | -0.728**     |

\* Significant at 0.05%, \*\*Significant at 0.01%.

**Table 37: Bio-chemical character of fruit in different okra cultivars during post-kharif, 2015**

| Sl. No.                             | Cultivars       | Biochemical characters |            |                   |                |                 |            |              |             |              |
|-------------------------------------|-----------------|------------------------|------------|-------------------|----------------|-----------------|------------|--------------|-------------|--------------|
|                                     |                 | Lipid %                | Moisture % | OD phenol (mg/gm) | Phenol (mg/gm) | Protein (mg/gm) | Nitrogen % | Phosphorus % | Potassium % | Zinc (mg/kg) |
| 1.                                  | Arka Anamika    | 1.53cd                 | 85.52cd    | 0.74def           | 9.61ef         | 39.58efg        | 2.85d      | 0.36c        | 2.43bc      | 72.67bcd     |
| 2.                                  | Subarna         | 1.25fg                 | 86.13cd    | 0.65fg            | 9.24efg        | 40.56ef         | 2.88d      | 0.36c        | 2.27cd      | 70.43e       |
| 3.                                  | Aparupa DG      | 1.81b                  | 83.77ef    | 0.87bc            | 13.42b         | 34.50h          | 2.41e      | 0.31e        | 2.67a       | 80.34a       |
| 4.                                  | Tiger Green     | 1.20fg                 | 87.69ab    | 0.53i             | 9.14efg        | 49.22b          | 3.67b      | 0.41b        | 1.68gh      | 63.57f       |
| 5.                                  | JKOH-7315       | 1.65bc                 | 86.39bc    | 0.71efg           | 9.81ef         | 42.75de         | 3.45bc     | 0.33d        | 1.94ef      | 73.97b       |
| 6.                                  | Parbhani Kranti | 1.52cd                 | 84.93de    | 0.81cd            | 11.88c         | 36.72gh         | 3.58bc     | 0.34d        | 2.24cd      | 71.31de      |
| 7.                                  | Basanti         | 1.34ef                 | 83.03f     | 0.77de            | 10.14de        | 38.67fg         | 3.35c      | 0.34d        | 2.09de      | 73.16bc      |
| 8.                                  | Miss-717        | 1.75b                  | 85.50cd    | 0.72ef            | 11.37c         | 37.86fgh        | 2.86d      | 0.33d        | 2.00e       | 71.64cde     |
| 9.                                  | Meena-117       | 1.18fg                 | 88.21a     | 0.50i             | 7.83h          | 49.94b          | 3.73b      | 0.40b        | 1.78fg      | 64.67f       |
| 10.                                 | Bhindi No.10    | 1.09g                  | 89.02a     | 0.51i             | 9.01fg         | 53.81a          | 4.20a      | 0.45a        | 1.54h       | 64.68f       |
| 11.                                 | PAN-2127        | 1.46de                 | 86.67bc    | 0.63gh            | 10.95cd        | 45.22cd         | 3.61bc     | 0.40b        | 1.97ef      | 71.27de      |
| 12.                                 | Tanvi           | 1.19fg                 | 87.78ab    | 0.56hi            | 8.50gh         | 47.00bc         | 3.57bc     | 0.41b        | 1.68gh      | 64.70f       |
| 13.                                 | Kaveri          | 2.00a                  | 82.45f     | 0.93ab            | 14.98a         | 27.53i          | 2.41e      | 0.29f        | 2.60ab      | 80.99a       |
| 14.                                 | Chameli-015     | 2.13a                  | 80.92g     | 0.97a             | 15.23a         | 26.72i          | 1.64f      | 0.28f        | 2.64ab      | 82.07a       |
| F Value                             |                 | 31.61                  | 23.13      | 27.57             | 39.50          | 44.67           | 46.70      | 57.26        | 25.31       | 95.13        |
| Pr>F                                |                 | <.0001                 | <.0001     | <.0001            | <.0001         | <.0001          | <.0001     | <.0001       | <.0001      | <.0001       |
| LSD                                 |                 | 0.1674                 | 1.4212     | 0.0848            | 1.0791         | 3.4774          | 0.2893     | 0.0196       | 0.2179      | 1.8344       |
| Correlation                         |                 |                        |            |                   |                |                 |            |              |             |              |
| Fruit borer complex (Bored fruit %) |                 | -0.754**               | 0.662**    | -0.797**          | -0.736**       | 0.752**         | 0.677**    | 0.726**      | -0.838**    | -0.845**     |

\* Significant at 0.05%, \*\*Significant at 0.01%.

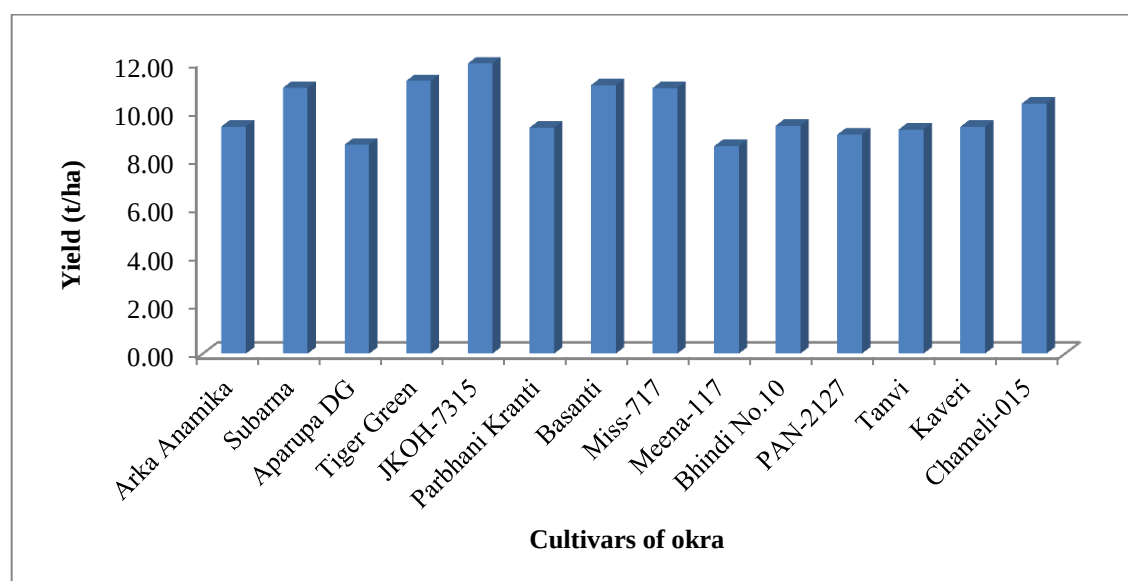
#### 4.2.1.9. Yield of different okra cultivars during post-kharif season, 2015

Fruits were harvested at 3-4 days interval and weighed. The cumulative yield data of all pickings of different cultivars were analyzed and expressed in t/ha (Table 38 and Fig. 23). The okra yield varied from 8.56 to 11.96 t/ha. The significantly highest yield was recorded in cultivar JKOH-7315 (11.96t/ha) followed by Tiger Green (11.24 t/ha) while the lowest yield was recorded in Meena-117(8.56 t/ha).

**Table 38: Yield of different cultivars of okra during post-kharif season 2015**

| Sl. No.        | Post-kharif season |              |
|----------------|--------------------|--------------|
|                | Cultivars          | Yield (t/ha) |
| 1.             | Arka Anamika       | 9.36d        |
| 2.             | Subarna            | 10.96b       |
| 3.             | Aparupa DG         | 8.61e        |
| 4.             | Tiger Green        | 11.24b       |
| 5.             | JKOH-7315          | 11.96a       |
| 6.             | Parbhani Kranti    | 9.31d        |
| 7.             | Basanti            | 11.07b       |
| 8.             | Miss-717           | 10.95b       |
| 9.             | Meena-117          | 8.56e        |
| 10.            | Bhindi No.10       | 9.40d        |
| 11.            | PAN-2127           | 9.03de       |
| 12.            | Tanvi              | 9.24d        |
| 13.            | Kaveri             | 9.35d        |
| 14.            | Chameli-015        | 10.31c       |
| <b>F Value</b> |                    | 36.95        |
| <b>Pr&gt;F</b> |                    | <.0001       |
| <b>LSD</b>     |                    | 0.5242       |

**Fig. 23: Yield of different cultivars of okra during post-kharif season, 2015**



#### **4.2.2. Pre-kharif season, 2016**

##### **4.2.2.1. Jassid, (*Amrasca biguttula biguttula* Ishida)**

During pre-kharif 2016, jassid infestation was first observed in 10<sup>th</sup> SW (2<sup>nd</sup> week of March) *i.e.* one week after sowing. Initially the mean jassid population ranged from 0.29 to 0.49 per leaf among cultivars. The infestation was started to decrease from 12<sup>th</sup> SW and again increased gradually and reached peak in first week of May (18<sup>th</sup> SW). The infestation was found maximum 54.27/leaf in Meena-117 followed by 48.09/leaf in Bhindi No.10, 42.78/leaf in PAN-2127 and 42.00/leaf in Tiger Green. The minimum infestation 15.00/leaf was observed in Chameli-015 followed by Kaveri (16.93/leaf). The population of jassids ranged between 18.00 to 28.44/leaf in peak period of activity during 18<sup>th</sup> SW in rest of cultivars.

##### **4.2.2.2. Aphid, (*Aphis gossypii* Glover)**

The aphid population was first observed in 11<sup>th</sup> SW (Table 40). The population was started to increase from 20<sup>th</sup> SW and reached peak in 23<sup>th</sup> SW. At peak the highest population was recorded in Bhindi No.10 (2.38/leaf) followed by Tiger Green (2.02/leaf) and Meena-117 (2.00/leaf). The least population was recorded in Subarna (0.84/leaf), which was closely followed by Chameli-015 (0.91/leaf) and Kaveri (0.96/leaf) while the rest of the cultivars harboured medium population level ranging between 1.03 -1.99/leaf.

##### **4.2.2.3. Whitefly (*Bemisia tabaci* Gennadius)**

The whitefly population was first noticed during 12<sup>th</sup> SW that increased gradually and reached peak in 14<sup>th</sup> SW (Table 41). At peak, whitefly population was highest in Bhendi No.10 (1.00/leaf) followed by Meena-117, PAN-2127 and Tanvi having same population of 0.84/leaf each. The least population was recorded 0.53/leaf in three cultivars like Parbhani Kranti, Chameli-015 and Kaveri. The rest of the cultivars recorded medium level population ranging from 0.55/leaf to 0.83/leaf.

**Table 39: Screening of different cultivars of okra against jassid in pre-kharif, (2016)**

| Cultivars       | Mean jassid population/ leaf* |                   |                  |                  |                 |                  |                   |                    |                  |                  |                   |                  |                  |                  |                 |                  |                  |                  |
|-----------------|-------------------------------|-------------------|------------------|------------------|-----------------|------------------|-------------------|--------------------|------------------|------------------|-------------------|------------------|------------------|------------------|-----------------|------------------|------------------|------------------|
|                 | 10SW                          | 11SW              | 12SW             | 13SW             | 14SW            | 15SW             | 16SW              | 17SW               | 18SW**           | 19SW             | 20SW              | 21SW             | 22SW             | 23SW             | 24SW            | 25SW             | 26SW             | Mean             |
| Arka Anamika    | 0.49a<br>(0.99)               | 0.56a<br>(1.03)   | 0.42bc<br>(0.96) | 3.58d<br>(2.02)  | 5.13c<br>(2.37) | 5.11e<br>(2.37)  | 10.40c<br>(3.32)  | 20.78b<br>(4.61)   | 21.96i<br>(4.74) | 15.31g<br>(3.98) | 12.76g<br>(3.64)  | 1.47g<br>(1.38)  | 1.07gh<br>(1.25) | 3.49a<br>(1.99)  | 3.07a<br>(1.89) | 1.00d<br>(1.22)  | 1.00b<br>(1.22)  | 6.33h<br>(2.61)  |
| Subarna         | 0.29b<br>(0.89)               | 0.36c<br>(0.92)   | 0.20f<br>(0.84)  | 4.78ab<br>(2.30) | 5.87c<br>(2.41) | 5.93c<br>(2.54)  | 5.60h<br>(2.47)   | 13.47f<br>(3.74)   | 22.00i<br>(4.74) | 9.96i<br>(3.22)  | 8.22j<br>(2.95)   | 1.98d<br>(1.57)  | 1.76c<br>(1.50)  | 2.89c<br>(1.84)  | 2.53b<br>(1.74) | 1.73b<br>(1.49)  | 1.07b<br>(1.25)  | 5.21i<br>(2.38)  |
| Aparupa DG      | 0.38b<br>(0.94)               | 0.49ab<br>(0.99)  | 0.25ef<br>(0.87) | 3.47d<br>(1.99)  | 4.69d<br>(2.21) | 4.93ef<br>(2.31) | 9.24de<br>(3.12)  | 11.09g<br>(3.40)   | 27.27f<br>(5.27) | 22.91d<br>(4.84) | 19.33d<br>(4.45)  | 0.64j<br>(1.07)  | 0.56i<br>(1.03)  | 2.87c<br>(1.83)  | 2.56b<br>(1.75) | 0.98d<br>(1.22)  | 0.98b<br>(1.22)  | 6.63g<br>(2.67)  |
| Tiger Green     | 0.38b<br>(0.94)               | 0.47abc<br>(0.98) | 0.32de<br>(0.90) | 4.91a<br>(2.33)  | 6.78a<br>(2.68) | 6.89a<br>(2.75)  | 8.29f<br>(2.96)   | 17.76cde<br>(4.27) | 42.00d<br>(6.52) | 13.71h<br>(3.77) | 11.42hi<br>(3.45) | 3.98a<br>(2.12)  | 3.49b<br>(1.99)  | 3.53a<br>(2.01)  | 2.91a<br>(1.84) | 1.98a<br>(1.57)  | 1.24a<br>(1.32)  | 7.65d<br>(2.86)  |
| JKOH-7315       | 0.33b<br>(0.91)               | 0.47abc<br>(0.98) | 0.33d<br>(0.91)  | 1.11i<br>(1.27)  | 1.58h<br>(1.44) | 2.09i<br>(1.60)  | 8.40ef<br>(2.98)  | 17.62de<br>(4.26)  | 18.00j<br>(4.30) | 13.93h<br>(3.80) | 11.80h<br>(3.51)  | 2.22c<br>(1.65)  | 1.73c<br>(1.50)  | 3.33b<br>(1.96)  | 2.93a<br>(1.65) | 1.91a<br>(1.55)  | 1.29a<br>(1.34)  | 5.24i<br>(2.40)  |
| Parbhani Kranti | 0.36b<br>(0.92)               | 0.56a<br>(1.03)   | 0.52a<br>(1.00)  | 4.56bc<br>(2.25) | 6.87a<br>(2.70) | 7.42a<br>(2.80)  | 8.29f<br>(2.97)   | 23.00a<br>(4.84)   | 28.27e<br>(5.36) | 23.60d<br>(4.91) | 10.96i<br>(3.38)  | 1.60f<br>(1.45)  | 1.22ef<br>(1.31) | 1.36g<br>(1.36)  | 1.04f<br>(1.24) | 0.73fg<br>(1.11) | 0.53de<br>(1.02) | 7.11f<br>(2.76)  |
| Basanti         | 0.36b<br>(0.92)               | 0.42bc<br>(0.96)  | 0.20f<br>(0.84)  | 3.07f<br>(1.89)  | 3.36f<br>(1.98) | 4.00g<br>(2.15)  | 11.76b<br>(3.56)  | 18.22cde<br>(4.33) | 26.33g<br>(5.18) | 21.07e<br>(4.64) | 17.96e<br>(4.30)  | 3.58b<br>(2.02)  | 3.56ab<br>(2.01) | 2.13e<br>(1.62)  | 1.78d<br>(1.51) | 0.78f<br>(1.13)  | 0.78c<br>(1.13)  | 7.02f<br>(2.75)  |
| Miss-717        | 0.33b<br>(0.91)               | 0.44abc<br>(0.97) | 0.43b<br>(0.96)  | 2.80g<br>(1.82)  | 3.93e<br>(2.09) | 4.73f<br>(2.29)  | 9.24de<br>(3.12)  | 19.24bc<br>(4.44)  | 24.82h<br>(5.03) | 19.47f<br>(4.47) | 17.20f<br>(4.21)  | 1.22h<br>(1.31)  | 1.11fg<br>(1.27) | 1.33gh<br>(1.35) | 0.98f<br>(1.22) | 0.76f<br>(1.12)  | 0.53d<br>(1.02)  | 6.39h<br>(2.62)  |
| Meena-117       | 0.36b<br>(0.92)               | 0.44abc<br>(0.97) | 0.52a<br>(1.00)  | 4.47c<br>(2.22)  | 6.13b<br>(2.58) | 6.71b<br>(2.68)  | 11.31a<br>(3.96)  | 23.31a<br>(4.88)   | 54.27a<br>(7.40) | 41.82a<br>(6.50) | 33.22a<br>(5.81)  | 3.89a<br>(2.09)  | 3.76a<br>(2.06)  | 1.33gh<br>(1.35) | 0.98f<br>(1.22) | 0.98d<br>(1.22)  | 0.51de<br>(1.01) | 11.41a<br>(3.48) |
| Bhindi No.10    | 0.38b<br>(0.93)               | 0.42bc<br>(0.96)  | 0.25ef<br>(0.87) | 3.53d<br>(2.01)  | 4.58d<br>(2.26) | 4.98ef<br>(2.32) | 3.98i<br>(2.09)   | 18.53cd<br>(4.36)  | 48.09b<br>(6.97) | 38.84b<br>(6.27) | 33.84a<br>(5.86)  | 0.96i<br>(1.21)  | 1.16fg<br>(1.27) | 1.27h<br>(1.33)  | 0.96f<br>(1.21) | 0.96d<br>(1.21)  | 0.53de<br>(1.02) | 9.60b<br>(3.18)  |
| PAN-2127        | 0.31b<br>(0.90)               | 0.40bc<br>(0.95)  | 0.35cd<br>(0.92) | 3.56d<br>(2.01)  | 4.71d<br>(2.28) | 4.98ef<br>(2.34) | 9.27cd<br>(3.26)  | 19.16c<br>(4.43)   | 42.78c<br>(6.58) | 35.82c<br>(6.02) | 31.04b<br>(5.62)  | 1.04i<br>(1.24)  | 0.91h<br>(1.19)  | 1.09i<br>(1.26)  | 0.80g<br>(1.14) | 0.64g<br>(1.07)  | 0.44e<br>(0.97)  | 9.25c<br>(3.13)  |
| Tanvi           | 0.36b<br>(0.92)               | 0.44abc<br>(0.97) | 0.35cd<br>(0.92) | 3.36de<br>(1.96) | 4.78d<br>(2.30) | 5.58d<br>(2.47)  | 10.04cd<br>(3.25) | 19.00cd<br>(4.39)  | 28.44e<br>(5.36) | 24.00d<br>(4.95) | 21.22c<br>(4.66)  | 1.80e<br>(1.52)  | 1.38df<br>(1.37) | 2.22e<br>(1.65)  | 0.80d<br>(1.50) | 1.27c<br>(1.33)  | 0.84c<br>(1.16)  | 7.40e<br>(2.82)  |
| Kaveri          | 0.31b<br>(0.90)               | 0.42bc<br>(0.96)  | 0.23f<br>(0.86)  | 1.56h<br>(1.43)  | 1.89g<br>(1.55) | 2.20h<br>(1.70)  | 4.58i<br>(2.23)   | 16.82e<br>(4.16)   | 16.93k<br>(4.18) | 12.31i<br>(3.58) | 10.96i<br>(3.38)  | 1.71ef<br>(1.49) | 1.36e<br>(1.36)  | 2.64d<br>(1.77)  | 2.07c<br>(1.60) | 0.80ef<br>(1.14) | 0.60d<br>(1.05)  | 4.55j<br>(2.25)  |
| Chameli-015     | 0.31b<br>(0.90)               | 0.51ab<br>(1.01)  | 0.48ab<br>(0.99) | 3.09ef<br>(1.89) | 4.62d<br>(2.26) | 4.80ef<br>(2.30) | 6.58g<br>(2.68)   | 12.76f<br>(3.64)   | 15.00l<br>(3.94) | 8.24j<br>(3.22)  | 6.89k<br>(2.72)   | 1.64f<br>(1.46)  | 1.53d<br>(1.43)  | 1.71f<br>(1.48)  | 1.20e<br>(1.30) | 0.89de<br>(1.18) | 0.60d<br>(1.05)  | 4.17k<br>(2.16)  |
| <b>F Value</b>  | 2.30                          | 1.64              | 19.04            | 167.22           | 286.28          | 195.4            | 96.78             | 52.32              | 5508.93          | 622.14           | 1138.90           | 556.99           | 224.56           | 649.27           | 261.84          | 117.78           | 57.78            | 147.51           |
| <b>Pr&gt;F</b>  | 0.0345                        | 0.1378            | <.0001           | <.0001           | <.0001          | <.0001           | <.0001            | <.0001             | <.0001           | <.0001           | <.0001            | <.0001           | <.0001           | <.0001           | <.0001          | <.0001           | <.0001           | <.0001           |
| <b>LSD</b>      | 0.0502                        | 0.0678            | 0.0391           | 0.681            | 0.0633          | 0.0716           | 0.1486            | 0.1704             | 0.0421           | 0.1296           | 0.0894            | 0.0404           | 0.063            | 0.0311           | 0.0499          | 0.045            | 0.0475           | 0.0279           |

\*Mean of three replications, \*\*Peak population of jassid

Figure in parenthesis indicates square root transformed value

**Table 40: Screening of different cultivars of okra against aphid in pre-kharif, (2016)**

| Cultivars       | Mean aphid population/ leaf* |                  |                  |                  |                  |                 |                  |                   |                 |                   |                  |                  |                 |                  |                  |                  |                  |                 |
|-----------------|------------------------------|------------------|------------------|------------------|------------------|-----------------|------------------|-------------------|-----------------|-------------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|-----------------|
|                 | 10SW                         | 11SW             | 12SW             | 13SW             | 14SW             | 15SW            | 16SW             | 17SW              | 18SW            | 19SW              | 20SW             | 21SW             | 22SW            | 23SW**           | 24SW             | 25SW             | 26SW             | Mean            |
| Arka Anamika    | 0.00a<br>(0.71)              | 0.16f<br>(0.81)  | 0.67g<br>(1.08)  | 0.56e<br>(1.03)  | 0.27ef<br>(0.86) | 0.20c<br>(0.84) | 0.13c<br>(0.79)  | 0.20cd<br>(0.84)  | 0.22c<br>(0.85) | 0.24efg<br>(0.86) | 0.49f<br>(0.99)  | 0.76ef<br>(1.12) | 1.42d<br>(1.39) | 1.71c<br>(1.49)  | 1.49c<br>(1.41)  | 0.56f<br>(1.03)  | 0.49de<br>(0.99) | 0.56h<br>(1.03) |
| Subarna         | 0.00a<br>(0.71)              | 0.16f<br>(0.81)  | 0.44h<br>(0.97)  | 0.44f<br>(0.96)  | 0.40b<br>(0.95)  | 0.33b<br>(0.91) | 0.08c<br>(0.76)  | 0.13de<br>(0.79)  | 0.13d<br>(0.79) | 0.20g<br>(0.84)   | 0.20h<br>(0.84)  | 0.31j<br>(0.90)  | 0.73g<br>(1.11) | 0.84h<br>(1.16)  | 0.58g<br>(1.04)  | 0.56f<br>(1.03)  | 0.31g<br>(0.90)  | 0.34l<br>(0.92) |
| Aparupa DG      | 0.00a<br>(0.71)              | 0.33d<br>(0.91)  | 0.91cd<br>(1.19) | 0.64cd<br>(1.08) | 0.38bc<br>(0.94) | 0.33b<br>(0.91) | 0.09c<br>(0.77)  | 0.13de<br>(0.79)  | 0.22c<br>(0.85) | 0.28e<br>(0.88)   | 0.49f<br>(0.99)  | 0.91cd<br>(1.19) | 1.38d<br>(1.37) | 1.69c<br>(1.48)  | 1.40c<br>(1.38)  | 0.89bc<br>(1.18) | 0.84b<br>(1.16)  | 0.64f<br>(1.07) |
| Tiger Green     | 0.00a<br>(0.71)              | 0.51ab<br>(1.01) | 0.82de<br>(1.15) | 0.69c<br>(1.09)  | 0.20f<br>(0.84)  | 0.13d<br>(0.79) | 0.07c<br>(0.75)  | 0.09e<br>(0.77)   | 0.21c<br>(0.84) | 0.43d<br>(0.96)   | 0.60de<br>(1.05) | 0.98c<br>(1.22)  | 1.62c<br>(1.46) | 2.02b<br>(1.59)  | 1.87a<br>(1.54)  | 0.80cd<br>(1.14) | 0.71c<br>(1.10)  | 0.69d<br>(1.09) |
| JKOH-7315       | 0.00a<br>(0.71)              | 0.33de<br>(0.91) | 0.87de<br>(1.17) | 0.71c<br>(1.11)  | 0.24ef<br>(0.86) | 0.20c<br>(0.84) | 0.13c<br>(0.79)  | 0.22bcd<br>(0.85) | 0.22c<br>(0.85) | 0.45d<br>(0.97)   | 0.64d<br>(1.07)  | 1.00c<br>(1.22)  | 1.47d<br>(1.39) | 1.96b<br>(1.57)  | 1.07e<br>(1.25)  | 0.96b<br>(1.21)  | 0.82b<br>(1.15)  | 0.66e<br>(1.08) |
| Parbhani Kranti | 0.00a<br>(0.71)              | 0.24e<br>(0.86)  | 0.62g<br>(1.06)  | 0.40f<br>(0.95)  | 0.33cd<br>(0.91) | 0.13d<br>(0.79) | 0.08c<br>(0.76)  | 0.20cd<br>(0.84)  | 0.24c<br>(0.86) | 0.26ef<br>(0.87)  | 0.33g<br>(0.91)  | 0.49i<br>(0.99)  | 0.82g<br>(1.15) | 1.38d<br>(1.37)  | 0.67fg<br>(1.08) | 0.56f<br>(1.03)  | 0.42ef<br>(0.96) | 0.42k<br>(0.96) |
| Basanti         | 0.00a<br>(0.71)              | 0.16f<br>(0.81)  | 0.78ef<br>(1.13) | 0.64cd<br>(1.08) | 0.20f<br>(0.85)  | 0.20c<br>(0.84) | 0.13c<br>(0.79)  | 0.16cde<br>(0.81) | 0.26c<br>(0.87) | 0.44d<br>(0.97)   | 0.64d<br>(1.07)  | 0.93c<br>(1.20)  | 1.22e<br>(1.31) | 1.24e<br>(1.32)  | 1.04e<br>(1.24)  | 0.64ef<br>(1.07) | 0.56d<br>(1.03)  | 0.53i<br>(1.02) |
| Miss-717        | 0.00a<br>(0.71)              | 0.16f<br>(0.81)  | 1.62b<br>(1.46)  | 1.51b<br>(1.43)  | 0.29de<br>(0.89) | 0.26c<br>(0.87) | 0.20b<br>(0.84)  | 0.22bcd<br>(0.85) | 0.24c<br>(0.86) | 0.60b<br>(1.05)   | 0.87c<br>(1.17)  | 1.62b<br>(1.46)  | 1.62c<br>(1.46) | 1.73c<br>(1.49)  | 1.62b<br>(1.46)  | 0.96b<br>(1.21)  | 0.40f<br>(0.95)  | 0.81b<br>(1.15) |
| Meena-117       | 0.00a<br>(0.71)              | 0.44bc<br>(0.97) | 0.67g<br>(1.08)  | 0.40g<br>(0.87)  | 0.20f<br>(0.84)  | 0.20c<br>(0.84) | 0.13c<br>(0.79)  | 0.23bc<br>(0.85)  | 0.33b<br>(0.91) | 0.96a<br>(1.21)   | 1.00b<br>(1.22)  | 1.60b<br>(1.45)  | 1.78b<br>(1.51) | 2.00b<br>(1.58)  | 1.22d<br>(1.31)  | 1.20a<br>(1.30)  | 1.00a<br>(1.22)  | 0.79c<br>(1.13) |
| Bhindi No.10    | 0.00a<br>(0.71)              | 0.53a<br>(1.02)  | 1.96a<br>(1.57)  | 1.78a<br>(1.51)  | 0.58a<br>(1.04)  | 0.56a<br>(1.03) | 0.33a<br>(0.91)  | 0.45a<br>(0.97)   | 0.60a<br>(1.05) | 1.00a<br>(1.22)   | 1.20a<br>(1.30)  | 1.96a<br>(1.57)  | 2.36a<br>(1.69) | 2.38a<br>(1.70)  | 1.69b<br>(1.48)  | 1.18a<br>(1.30)  | 1.04a<br>(1.24)  | 1.14a<br>(1.28) |
| PAN-2127        | 0.00a<br>(0.71)              | 0.33de<br>(0.91) | 1.09c<br>(1.26)  | 0.69cd<br>(1.08) | 0.24ef<br>(0.86) | 0.22c<br>(0.85) | 0.20b<br>(0.84)  | 0.33b<br>(0.91)   | 0.53a<br>(1.01) | 0.53c<br>(1.01)   | 0.56ef<br>(1.03) | 0.82de<br>(1.15) | 1.02f<br>(1.23) | 1.20ef<br>(1.30) | 0.76f<br>(1.12)  | 0.78d<br>(1.13)  | 0.71c<br>(1.10)  | 0.58g<br>(1.04) |
| Tanvi           | 0.00a<br>(0.71)              | 0.40cd<br>(0.95) | 0.71fg<br>(1.10) | 0.60de<br>(1.05) | 0.38bc<br>(0.93) | 0.33b<br>(0.91) | 0.26ab<br>(0.87) | 0.32b<br>(0.91)   | 0.33b<br>(0.91) | 0.44d<br>(0.97)   | 0.49f<br>(0.99)  | 0.60gh<br>(1.05) | 0.82g<br>(1.15) | 1.11f<br>(1.27)  | 0.71f<br>(1.10)  | 0.67e<br>(1.08)  | 0.56d<br>(1.03)  | 0.51j<br>(1.01) |
| Kaveri          | 0.00a<br>(0.71)              | 0.13f<br>(0.80)  | 0.29i<br>(0.89)  | 0.23g<br>(0.85)  | 0.20f<br>(0.84)  | 0.20c<br>(0.84) | 0.07c<br>(0.75)  | 0.13de<br>(0.79)  | 0.24c<br>(0.86) | 0.26e<br>(0.87)   | 0.33g<br>(0.91)  | 0.53hi<br>(1.02) | 0.76g<br>(1.12) | 0.96g<br>(1.21)  | 0.60g<br>(1.05)  | 0.33g<br>(0.91)  | 0.31g<br>(0.90)  | 0.33l<br>(0.91) |
| Chameli-015     | 0.00a<br>(0.71)              | 0.11f<br>(0.78)  | 0.24i<br>(0.86)  | 0.13h<br>(0.80)  | 0.13g<br>(0.79)  | 0.09d<br>(0.77) | 0.06c<br>(0.75)  | 0.07e<br>(0.75)   | 0.13d<br>(0.79) | 0.21fg<br>(0.84)  | 0.24h<br>(0.86)  | 0.69fg<br>(1.09) | 0.80g<br>(1.14) | 0.91gh<br>(1.19) | 0.73f<br>(1.11)  | 0.33g<br>(0.91)  | 0.29g<br>(0.89)  | 0.30m<br>(0.90) |
| F Value         | -                            | 26.25            | 169.59           | 193.18           | 27.57            | 23.85           | 9.48             | 8.30              | 31.96           | 129.48            | 106.84           | 188.97           | 109.17          | 178.81           | 147.47           | 55.83            | 84.76            | 1021.31         |
| Pr>F            | -                            | <.0001           | <.0001           | <.0001           | <.0001           | <.0001          | <.0001           | <.0001            | <.0001          | <.0001            | <.0001           | <.0001           | <.0001          | <.0001           | <.0001           | <.0001           | <.0001           | <.0001          |
| LSD             | -                            | 0.0455           | 0.042            | 0.0415           | 0.0358           | 0.0398          | 0.046            | 0.0612            | 0.0379          | 0.0319            | 0.0375           | 0.0402           | 0.0488          | 0.0371           | 0.0419           | 0.0478           | 0.0378           | 0.0095          |

\*Mean of three replication, \*\*Peak population of aphid

Figure in parenthesis indicates square root transformed value

**Table 41: Screening of different cultivars of okra against whitefly in pre-kharif, (2016)**

| Cultivars       | Mean whitefly population/ leaf* |                  |                   |                    |                   |                    |                    |                  |                    |                   |                    |                  |                   |                   |                    |                   |                   |                   |
|-----------------|---------------------------------|------------------|-------------------|--------------------|-------------------|--------------------|--------------------|------------------|--------------------|-------------------|--------------------|------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------------------|
|                 | 10SW                            | 11SW             | 12SW              | 13SW               | 14SW<br>**        | 15SW               | 16SW               | 17SW             | 18SW               | 19SW              | 20SW               | 21SW             | 22SW              | 23SW              | 24SW               | 25SW              | 26SW              | Mean              |
| Arka Anamika    | 0.00a<br>(0.71)                 | 0.00a<br>(0.71)  | 0.31abc<br>(0.90) | 0.36abcd<br>(0.92) | 0.62cde<br>(1.06) | 0.53bcd<br>(1.02)  | 0.47bcd<br>(0.98)  | 0.38bc<br>(0.94) | 0.33cde<br>(0.91)  | 0.31de<br>(0.90)  | 0.29de<br>(0.89)   | 0.27c<br>(0.88)  | 0.24cde<br>(0.86) | 0.20de<br>(0.84)  | 0.20de<br>(0.84)   | 0.22bcd<br>(0.85) | 0.20bc<br>(0.84)  | 0.29def<br>(0.89) |
| Subarna         | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.24c<br>(0.86)   | 0.29 d<br>(0.89)   | 0.64cd<br>(1.07)  | 0.51bcde<br>(1.01) | 0.40cde<br>(0.95)  | 0.36bc<br>(0.92) | 0.31de<br>(0.90)   | 0.31de<br>(0.90)  | 0.29de<br>(0.89)   | 0.27c<br>(0.88)  | 0.27cde<br>(0.88) | 0.24bcd<br>(0.86) | 0.24bcde<br>(0.86) | 0.22bcd<br>(0.85) | 0.20bc<br>(0.84)  | 0.28ef<br>(0.88)  |
| Aparupa DG      | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.33ab<br>(0.91)  | 0.38abc<br>(0.94)  | 0.60de<br>(1.05)  | 0.58b<br>(1.04)    | 0.49bc<br>(0.99)   | 0.44ab<br>(0.97) | 0.42abc<br>(0.96)  | 0.44ab<br>(0.97)  | 0.40ab<br>(0.95)   | 0.38ab<br>(0.94) | 0.29cde<br>(0.89) | 0.29bc<br>(0.89)  | 0.27bcd<br>(0.88)  | 0.20cd<br>(0.84)  | 0.20bc<br>(0.84)  | 0.34c<br>(0.91)   |
| Tiger Green     | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.27abc<br>(0.88) | 0.31cd<br>(0.90)   | 0.69cd<br>(1.09)  | 0.53bcd<br>(1.02)  | 0.44bcde<br>(0.97) | 0.40bc<br>(0.95) | 0.36bcde<br>(0.92) | 0.36cde<br>(0.92) | 0.33bcde<br>(0.91) | 0.31bc<br>(0.90) | 0.31bc<br>(0.90)  | 0.29bc<br>(0.89)  | 0.27bcd<br>(0.88)  | 0.27bc<br>(0.88)  | 0.24abc<br>(0.86) | 0.32cde<br>(0.90) |
| JKOH-7315       | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.29abc<br>(0.89) | 0.33bcd<br>(0.91)  | 0.67cd<br>(1.08)  | 0.56bc<br>(1.03)   | 0.47bcd<br>(0.98)  | 0.44ab<br>(0.97) | 0.40abcd<br>(0.95) | 0.38bcd<br>(0.94) | 0.36bcd<br>(0.92)  | 0.33c<br>(0.88)  | 0.31bc<br>(0.90)  | 0.31de<br>(0.84)  | 0.29bc<br>(0.89)   | 0.29b<br>(0.89)   | 0.27abc<br>(0.88) | 0.33cd<br>(0.91)  |
| Parbhani Kranti | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.27bc<br>(0.87)  | 0.31cd<br>(0.90)   | 0.53e<br>(1.02)   | 0.40e<br>(0.95)    | 0.40cde<br>(0.95)  | 0.38bc<br>(0.94) | 0.40ab<br>(0.97)   | 0.36cde<br>(0.92) | 0.36bcd<br>(0.92)  | 0.27bc<br>(0.90) | 0.20e<br>(0.84)   | 0.20b<br>(0.84)   | 0.20de<br>(0.84)   | 0.20cd<br>(0.84)  | 0.20bc<br>(0.84)  | 0.27ef<br>(0.89)  |
| Basanti         | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.31abc<br>(0.90) | 0.36abcd<br>(0.92) | 0.60de<br>(1.05)  | 0.58b<br>(1.04)    | 0.49bc<br>(0.99)   | 0.42ab<br>(0.96) | 0.38bcde<br>(0.94) | 0.36cde<br>(0.92) | 0.33cde<br>(0.91)  | 0.29bc<br>(0.89) | 0.29bcd<br>(0.89) | 0.29bc<br>(0.89)  | 0.20de<br>(0.84)   | 0.20cd<br>(0.84)  | 0.20bc<br>(0.84)  | 0.31cde<br>(0.90) |
| Miss-717        | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.31abc<br>(0.90) | 0.36abcd<br>(0.92) | 0.71c<br>(1.10)   | 0.56bc<br>(1.03)   | 0.44bcd<br>(0.97)  | 0.38bc<br>(0.94) | 0.33cde<br>(0.91)  | 0.33cde<br>(0.91) | 0.29de<br>(0.89)   | 0.27c<br>(0.88)  | 0.27cde<br>(0.88) | 0.24bcd<br>(0.86) | 0.22cde<br>(0.85)  | 0.20cd<br>(0.84)  | 0.18c<br>(0.82)   | 0.30def<br>(0.89) |
| Meena-117       | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.31abc<br>(0.90) | 0.40ab<br>(0.95)   | 0.84b<br>(1.16)   | 0.51bcde<br>(1.01) | 0.47bcd<br>(0.98)  | 0.44ab<br>(0.97) | 0.38bcde<br>(0.94) | 0.36cde<br>(0.92) | 0.36bcd<br>(0.92)  | 0.33bc<br>(0.91) | 0.31bc<br>(0.90)  | 0.27bc<br>(0.88)  | 0.24bcde<br>(0.86) | 0.24bcd<br>(0.86) | 0.22abc<br>(0.85) | 0.33bc<br>(0.91)  |
| Bhindi No.10    | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.36a<br>(0.92)   | 0.42a<br>(0.96)    | 1.00a<br>(1.22)   | 0.73a<br>(1.11)    | 0.60a<br>(1.05)    | 0.51a<br>(1.00)  | 0.49a<br>(0.99)    | 0.49a<br>(0.99)   | 0.47a<br>(0.98)    | 0.44a<br>(0.97)  | 0.42a<br>(0.96)   | 0.38a<br>(0.94)   | 0.38a<br>(0.94)    | 0.38a<br>(0.94)   | 0.31a<br>(0.90)   | 0.43a<br>(0.97)   |
| PAN-2127        | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.31abc<br>(0.90) | 0.38abc<br>(0.94)  | 0.84b<br>(1.16)   | 0.60ab<br>(1.05)   | 0.49bc<br>(0.99)   | 0.44ab<br>(0.97) | 0.42abc<br>(0.96)  | 0.40bcd<br>(0.95) | 0.31de<br>(0.90)   | 0.29bc<br>(0.89) | 0.29bcd<br>(0.89) | 0.29bc<br>(0.89)  | 0.22cde<br>(0.85)  | 0.20cd<br>(0.84)  | 0.20bc<br>(0.84)  | 0.33c<br>(0.91)   |
| Tanvi           | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.31abc<br>(0.90) | 0.36abcd<br>(0.92) | 0.84b<br>(1.16)   | 0.60ab<br>(1.05)   | 0.51ab<br>(1.01)   | 0.44ab<br>(0.97) | 0.42abc<br>(0.96)  | 0.42abc<br>(0.96) | 0.40abc<br>(0.95)  | 0.38ab<br>(0.94) | 0.36ab<br>(0.92)  | 0.31b<br>(0.90)   | 0.31ab<br>(0.90)   | 0.29b<br>(0.89)   | 0.29ab<br>(0.89)  | 0.37b<br>(0.93)   |
| Kaveri          | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.27bc<br>(0.88)  | 0.31cd<br>(0.90)   | 0.53e<br>(1.02)   | 0.44cde<br>(0.97)  | 0.36e<br>(0.92)    | 0.29c<br>(0.89)  | 0.29e<br>(0.89)    | 0.27e<br>(0.88)   | 0.27e<br>(0.88)    | 0.24c<br>(0.86)  | 0.22de<br>(0.85)  | 0.18e<br>(0.82)   | 0.18e<br>(0.82)    | 0.18d<br>(0.82)   | 0.20bc<br>(0.84)  | 0.25g<br>(0.86)   |
| Chameli-015     | 0.00 a<br>(0.71)                | 0.00 a<br>(0.71) | 0.27bc<br>(0.88)  | 0.29d<br>(0.89)    | 0.53e<br>(1.02)   | 0.42de<br>(0.96)   | 0.38de<br>(0.94)   | 0.36bc<br>(0.92) | 0.33cde<br>(0.91)  | 0.31de<br>(0.90)  | 0.29de<br>(0.89)   | 0.24c<br>(0.86)  | 0.22de<br>(0.85)  | 0.24cd<br>(0.86)  | 0.24bcde<br>(0.86) | 0.22bcd<br>(0.85) | 0.22abc<br>(0.85) | 0.27fg<br>(0.88)  |
| <b>F Value</b>  | -                               | -                | 1.11              | 2.23               | 17.67             | 3.60               | 3.64               | 2.16             | 3.04               | 3.59              | 4.87               | 2.53             | 4.89              | 5.71              | 3.46               | 4.13              | 1.10              | 17.43             |
| <b>Pr&gt;F</b>  | -                               | -                | 0.3912            | 0.0399             | <.0001            | 0.0026             | 0.0025             | 0.0461           | 0.0077             | 0.0027            | 0.0003             | 0.0212           | 0.0003            | <.0001            | 0.0034             | 0.0010            | 0.3980            | <.0001            |
| <b>LSD</b>      | -                               | -                | 0.045             | 0.0414             | 0.0439            | 0.0641             | 0.0488             | 0.0589           | 0.0518             | 0.0489            | 0.0389             | 0.0563           | 0.0396            | 0.0353            | 0.0451             | 0.042             | 0.0593            | 0.0179            |

\*Mean of three replication, \*\*Peak population of whitefly

Figure in parenthesis indicates square root transformed value

#### 4.2.2.4. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hubner) during 2016:

Data presented in table 42 revealed that initiation of fruit borer infestation was found in 16<sup>th</sup> SW. Initially it was ranged from 4.65% to 9.13% bored fruit/plant. There after the infestation increased gradually and reached peak in last week of May (22<sup>th</sup> SW). The minimum damage was recorded in Chameli-015 (33.94% bored fruit/plant) followed by Kaveri (34.06% bored fruit/plant) and Aparupa DG (34.37% bored fruit/plant). The maximum damage was obtained from Meena-117 (47.13% bored fruit/plant) followed by Bhindi No.10 (46.95% bored fruit/plant), Tiger Green (46.04% bored fruit/plant) and PAN-2127 (45.68% bored fruit/plant). Cultivars like Subarna (35.79% bored fruit/plant), Arka Anamika (37.39% bored fruit/plant), JKOH-7315 (37.41% bored fruit/plant), Parbhani Kranti (39.13% bored fruit/plant), Tanvi (39.89% bored fruit/plant), Basanti (43.85% bored fruit/plant) and Miss-717 (44.46% bored fruit/plant) were found moderately susceptible.

**Fig. 24: Pest population at peak in different cultivars of okra during pre-kharif season**

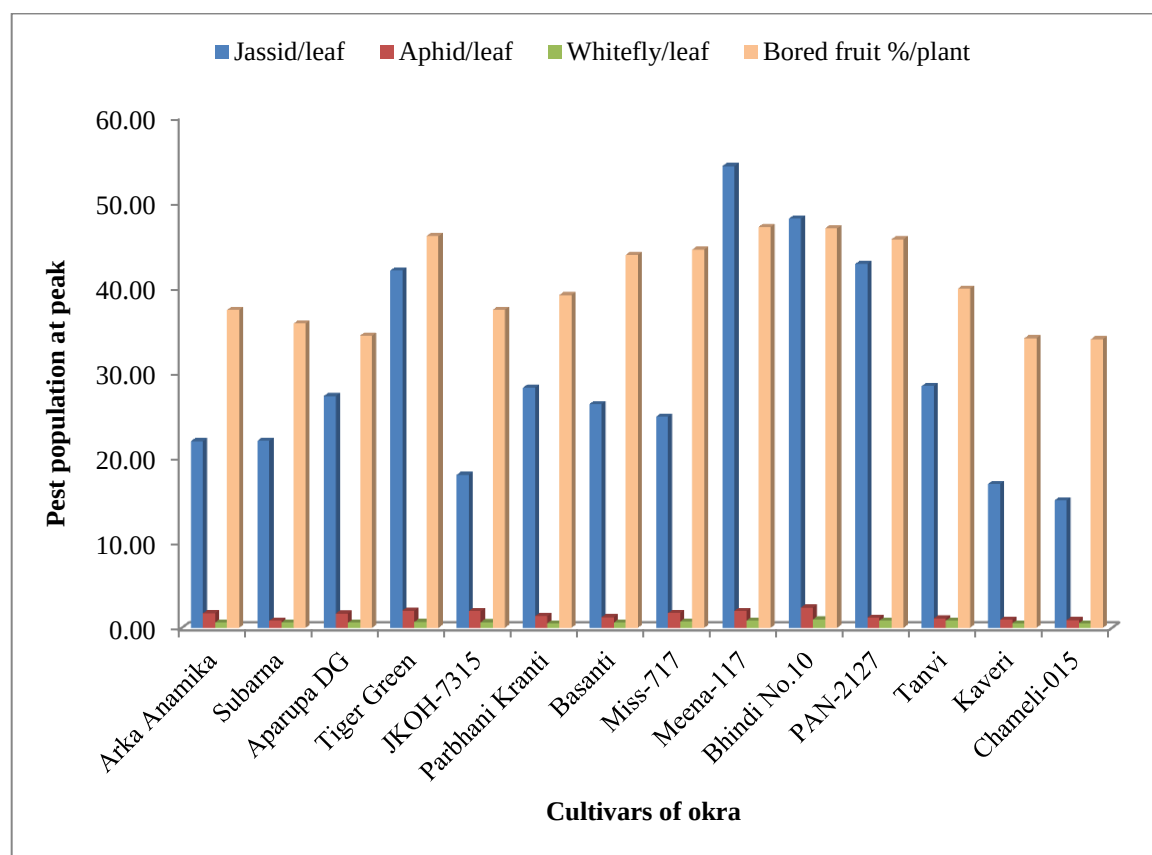


**Table 42: Screening of different cultivars of okra against fruit borer complex (no. basis) in pre-kharif, (2016)**

| Cultivars       | Mean bored fruit % (no. basis) / plant* |                  |                  |                  |                  |                  |                    |                    |                    |                     |                    |                    |                   |                   |                   |                  |                    |                   |
|-----------------|-----------------------------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|--------------------|---------------------|--------------------|--------------------|-------------------|-------------------|-------------------|------------------|--------------------|-------------------|
|                 | 10SW                                    | 11SW             | 12SW             | 13SW             | 14SW             | 15SW             | 16SW               | 17SW               | 18SW               | 19SW                | 20SW               | 21SW               | 22SW**            | 23SW              | 24SW              | 25SW             | 26SW               | Mean              |
| Arka Anamika    | 0.00a<br>(0.71)                         | 0.00a<br>(0.71)  | 0.00a<br>(0.71)  | 0.00a<br>(0.71)  | 0.00a<br>(0.71)  | 0.00a<br>(0.71)  | 7.18bcd<br>(2.77)  | 7.94bcde<br>(2.90) | 10.31cde<br>(3.27) | 11.64ef<br>(3.46)   | 21.69ef<br>(4.71)  | 34.68ab<br>(5.93)  | 37.39cd<br>(6.16) | 21.78b<br>(4.71)  | 10.31a<br>(3.28)  | 8.83ab<br>(3.05) | 6.26bcde<br>(2.59) | 10.47cd<br>(3.31) |
| Subarna         | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 6.28de<br>(2.60)   | 10.90b<br>(3.38)   | 12.50bcd<br>(3.60) | 13.08cde<br>(3.68)  | 27.35scd<br>(5.28) | 29.85cde<br>(5.51) | 35.79de<br>(6.02) | 22.44b<br>(4.79)  | 5.83 cd<br>(2.50) | 4.91cd<br>(2.32) | 4.93de<br>(2.33)   | 10.23de<br>(3.27) |
| Aparupa DG      | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 8.72ab<br>(3.03)   | 9.26bcd<br>(3.12)  | 10.53cde<br>(3.31) | 12.40def<br>(3.59)  | 18.52fg<br>(4.35)  | 22.62g<br>(4.80)   | 34.37e<br>(5.90)  | 21.19b<br>(4.66)  | 10.78a<br>(3.35)  | 5.97cd<br>(2.53) | 5.31de<br>(2.39)   | 9.39f<br>(3.14)   |
| Tiger Green     | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 7.49abcd<br>(2.82) | 9.90bc<br>(3.22)   | 10.62cde<br>(3.31) | 11.10ef<br>(3.40)   | 28.57bc<br>(5.38)  | 34.13ab<br>(5.88)  | 46.04ab<br>(6.82) | 21.40b<br>(4.67)  | 10.08a<br>(3.25)  | 8.24ab<br>(2.96) | 7.17abcd<br>(2.77) | 11.45b<br>(3.46)  |
| JKOH-7315       | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 5.47ef<br>(2.44)   | 7.37cde<br>(2.75)  | 8.09e<br>(2.92)    | 9.79f<br>(3.20)     | 18.59fg<br>(4.37)  | 32.90bcd<br>(5.78) | 37.41cd<br>(6.16) | 28.08a<br>(5.35)  | 5.76cd<br>(2.50)  | 5.17cd<br>(2.37) | 4.36e<br>(2.18)    | 9.59ef<br>(3.18)  |
| Parbhani Kranti | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 6.62cde<br>(2.66)  | 7.07de<br>(2.72)   | 10.67cde<br>(3.34) | 12.50def<br>(3.59)  | 33.77a<br>(5.85)   | 33.93bc<br>(5.86)  | 39.13c<br>(6.29)  | 13.52d<br>(3.72)  | 7.17bcd<br>(2.76) | 6.85bc<br>(2.70) | 5.96cde<br>(2.52)  | 10.42cd<br>(3.30) |
| Basanti         | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 9.13a<br>(3.10)    | 10.07b<br>(3.24)   | 10.71cde<br>(3.33) | 12.07def<br>(3.52)  | 25.12cde<br>(5.04) | 34.36ab<br>(5.90)  | 43.85b<br>(6.66)  | 14.05d<br>(3.81)  | 10.40a<br>(3.30)  | 9.64a<br>(3.18)  | 9.11a<br>(3.08)    | 11.09bc<br>(3.40) |
| Miss-717        | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 8.40ab<br>(2.97)   | 9.56bcd<br>(3.17)  | 14.07b<br>(3.82)   | 16.74b<br>(4.15)    | 25.13cde<br>(5.06) | 26.91ef<br>(5.23)  | 44.46ab<br>(6.70) | 15.95cd<br>(4.05) | 9.52ab<br>(3.16)  | 9.41a<br>(3.15)  | 8.19abc<br>(2.94)  | 11.08bc<br>(3.40) |
| Meena-117       | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 8.19abc<br>(2.95)  | 17.83a<br>(4.27)   | 18.21a<br>(4.32)   | 20.50a<br>(4.58)    | 29.07abc<br>(5.44) | 38.49a<br>(6.24)   | 47.13a<br>(6.90)  | 15.18d<br>(3.96)  | 10.60a<br>(3.33)  | 9.39a<br>(3.12)  | 8.89ab<br>(3.06)   | 13.15a<br>(3.69)  |
| Bhindi No.10    | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 4.65f<br>(2.27)    | 10.77b<br>(3.35)   | 13.22bc<br>(3.70)  | 15.90bc<br>(4.05)   | 29.03abc<br>(5.43) | 31.95bcd<br>(5.70) | 46.95a<br>(6.89)  | 21.16b<br>(4.65)  | 8.04abc<br>(2.92) | 6.87bc<br>(2.70) | 5.63de<br>(2.45)   | 11.42b<br>(3.45)  |
| PAN-2127        | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 6.05def<br>(2.54)  | 11.02b<br>(3.39)   | 12.70bcd<br>(3.63) | 15.07bcd<br>(3.94)  | 26.20bcd<br>(5.17) | 29.31de<br>(5.45)  | 45.68ab<br>(6.79) | 23.29b<br>(4.87)  | 6.61cd<br>(2.64)  | 6.00cd<br>(2.54) | 5.60cde<br>(2.46)  | 11.03bc<br>(3.40) |
| Tanvi           | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 5.46ef<br>(2.44)   | 10.67b<br>(3.34)   | 11.41bcd<br>(3.45) | 13.75bcde<br>(3.77) | 30.00ab<br>(5.52)  | 35.28fg<br>(4.99)  | 39.89c<br>(6.35)  | 21.44b<br>(4.68)  | 6.09cd<br>(2.57)  | 5.27cd<br>(2.40) | 4.81de<br>(2.30)   | 10.83de<br>(3.27) |
| Kaveri          | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 5.15ef<br>(2.37)   | 8.66bce<br>(3.02)  | 9.55de<br>(3.17)   | 11.66ef<br>(3.49)   | 16.92g<br>(4.17)   | 27.17ef<br>(5.26)  | 34.06e<br>(5.88)  | 19.45bc<br>(4.46) | 5.43d<br>(2.43)   | 4.54d<br>(2.24)  | 4.25e<br>(2.17)    | 8.64g<br>(3.02)   |
| Chameli-015     | 0.00 a<br>(0.71)                        | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 0.00 a<br>(0.71) | 5.57ef<br>(2.46)   | 6.01e<br>(2.55)    | 9.59de<br>(3.18)   | 11.73ef<br>(3.49)   | 23.58de<br>(4.91)  | 25.96efg<br>(5.14) | 33.94e<br>(5.87)  | 13.45d<br>(3.73)  | 5.32d<br>(2.41)   | 4.84cd<br>(2.31) | 4.10e<br>(2.14)    | 8.48g<br>(3.00)   |
| <b>F Value</b>  | -                                       | -                | -                | -                | -                | -                | 6.60               | 5.91               | 4.44               | 6.05                | 11.21              | 10.39              | 29.87             | 10.61             | 6.16              | 6.09             | 3.68               | 28.01             |
| <b>Pr&gt;F</b>  | -                                       | -                | -                | -                | -                | -                | <.0001             | <.0001             | 0.0006             | <.0001              | <.0001             | <.0001             | <.0001            | <.0001            | <.0001            | <.0001           | 0.0023             | <.0001            |
| <b>LSD</b>      | -                                       | -                | -                | -                | -                | -                | 0.3022             | 0.4954             | 0.4759             | 0.4275              | 0.4299             | 0.3768             | 0.2111            | 0.4428            | 0.442             | 0.4053           | 0.486              | 0.101             |

\*Mean of three replication, \*\*Peak population of fruit borer  
Figure in parenthesis indicates square root transformed value

#### **4.2.2.5. Physico-morphic constituents in different okra cultivars during pre-kharif season, 2016**

The data on physico-morphic constituents of different okra cultivars were presented in table 43 & 44.

##### **4.2.2.5.1. Plant and leaf parameters**

The plant height, number of leaves and branches per plant, thickness and area of leaf were significantly more in Bhindi No.10 (80.27cm, 22.93/plant, 2.00/plant, 1.75mm and 159.20cm<sup>2</sup>) and lowest in Aparupa DG (49.27cm, 16.00/plant, 0.93/plant, 1.30mm and 139.40cm<sup>2</sup>) and Kaveri (50.00cm, 14.80/plant, 1.00/plant, 1.40mm and 139.10cm<sup>2</sup>). The trichome density of both upper and lower leaf surface was highest in Chameli-015 (11.00 and 17.07/cm<sup>2</sup>) and lowest in Meena-117 (5.00 and 8.60/cm<sup>2</sup>) followed by Bhindi No.10 (5.73 and 9.20/cm<sup>2</sup>).

##### **4.2.2.5.2. Fruit parameter**

Among the cultivars, the number of flowers (11.18/plant) and fruits (10.81/plant) were highest in JKOH 7315. The fruit was longest in cultivar Tiger Green (16.91cm) and shortest in Kaveri (12.00cm). The fruit breadth of different okra cultivars varied from 1.60cm (Kaveri) to 2.30cm (Bhindi No.10). The number of seeds/fruit was highest in cultivar Miss-717(70.47/fruit) and lowest in Kaveri (42.00/fruit). The trichome density in fruit was maximum (163.20/cm<sup>2</sup>) in Chameli-015 and minimum (92.67/cm<sup>2</sup>) value was recorded in Meena-117 (Table 44).

#### **4.2.2.6. Correlation of pest's incidence with physico-morphic constituents of okra cultivars**

The correlation analysis revealed that plant height, number of leaves and branch per plant, thickness and area of leaf had significant positive influence and trichome density of leaf surface (upper and lower) had significant negative impact on population fluctuation of sucking pests except number of leaves and branch per plant, leaf thickness, area of leaf and trichome density of leaf surface (lower) on aphid population and number of branch per plant on jassid population had non-significant effect.

The correlation between fruit borer damage and physico-morphic characters of fruit revealed that only trichome density had significant negative effect and rest of the parameters showed non-significant positive effect.

**Plate 6: Size of fruit in different cultivars of okra**

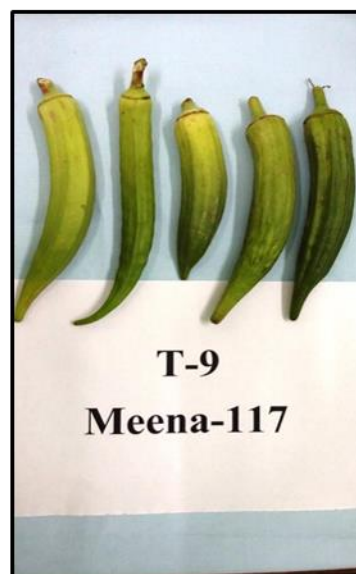




**Table 43: Physico-morphic character of plant at 60 days in different okra cultivar during pre-kharif, 2016**

| Sl. No.            | Cultivars       | Physico-morphic characters |                     |                     |                            |                            |                     |                              |
|--------------------|-----------------|----------------------------|---------------------|---------------------|----------------------------|----------------------------|---------------------|------------------------------|
|                    |                 | Plant height (cm)          | No. of leaves/plant | No. of branch/plant | Trichome U/cm <sup>2</sup> | Trichome L/cm <sup>2</sup> | Leaf thickness (mm) | Leaf area (cm <sup>2</sup> ) |
| 1.                 | Arka Anamika    | 50.07c                     | 17.27efg            | 1.13cde             | 9.00b                      | 13.60c                     | 1.46cde             | 149.30bcde                   |
| 2.                 | Subarna         | 58.47bc                    | 20.47abcd           | 2.00a               | 7.07c                      | 11.67d                     | 1.58abcd            | 150.33abcde                  |
| 3.                 | Aparupa DG      | 49.27c                     | 16.00fg             | 0.93e               | 9.20b                      | 15.13bc                    | 1.30e               | 139.40de                     |
| 4.                 | Tiger Green     | 64.13b                     | 22.60ab             | 1.53bc              | 7.27c                      | 11.40d                     | 1.61abc             | 155.93ab                     |
| 5.                 | JKOH-7315       | 55.00bc                    | 18.40def            | 1.13cde             | 9.20b                      | 15.33b                     | 1.52bcde            | 149.63bcde                   |
| 6.                 | Parbhani Kranti | 52.00bc                    | 19.67cde            | 1.27bcde            | 9.07b                      | 14.13bc                    | 1.36de              | 147.83bcde                   |
| 7.                 | Basanti         | 55.53bc                    | 17.87def            | 1.60ab              | 9.00c                      | 13.60d                     | 1.53abcd            | 154.73abcd                   |
| 8.                 | Miss-717        | 52.60bc                    | 19.73cde            | 1.40bcd             | 7.00c                      | 13.67c                     | 1.44cde             | 146.83bcde                   |
| 9.                 | Meena-117       | 60.27bc                    | 22.80a              | 1.33bcde            | 5.00d                      | 8.60e                      | 1.70ab              | 156.23ab                     |
| 10.                | Bhindi No.10    | 80.27a                     | 22.93a              | 2.00a               | 5.73d                      | 9.20e                      | 1.75a               | 159.20a                      |
| 11.                | PAN-2127        | 47.00c                     | 20.07bcd            | 1.47bc              | 8.80b                      | 13.87bc                    | 1.55abcd            | 152.50abcde                  |
| 12.                | Tanvi           | 54.00bc                    | 21.40abc            | 1.60ab              | 7.13b                      | 11.67c                     | 1.55abcd            | 155.13abc                    |
| 13.                | Kaveri          | 50.00c                     | 14.80g              | 1.00de              | 10.20a                     | 17.00a                     | 1.40cde             | 139.10e                      |
| 14.                | Chameli-015     | 51.20bc                    | 16.87fg             | 1.20bcde            | 11.00a                     | 17.07a                     | 1.43cde             | 141.07cde                    |
| F Value            |                 | 3.33                       | 7.69                | 4.46                | 28.83                      | 19.92                      | 2.61                | 2.27                         |
| Pr>F               |                 | 0.0044                     | <.0001              | 0.0006              | <.0001                     | <.0001                     | 0.0181              | 0.0363                       |
| LSD                |                 | 13.482                     | 2.7118              | 0.4524              | 0.9169                     | 1.6609                     | 0.2249              | 15.576                       |
| <b>Correlation</b> |                 |                            |                     |                     |                            |                            |                     |                              |
| <b>Jassid</b>      |                 | 0.552*                     | 0.787**             | 0.416               | -0.757**                   | -0.818**                   | 0.691**             | 0.722**                      |
| <b>Aphid</b>       |                 | 0.577*                     | 0.459               | 0.023               | -0.532*                    | -0.510                     | 0.379               | 0.449                        |
| <b>Whitefly</b>    |                 | 0.607*                     | 0.770**             | 0.578*              | -0.779**                   | -0.773**                   | 0.756**             | 0.753**                      |

\* Significant at 0.05%, \*\*Significant at 0.01%.

**Table 44: Physico-morphic character of fruit in different okra cultivar during pre-kharif, 2016**

| Sl. No.                                    | Cultivars       | Physico-morphic character of fruit |                    |                    |                             |                    |                     |
|--------------------------------------------|-----------------|------------------------------------|--------------------|--------------------|-----------------------------|--------------------|---------------------|
|                                            |                 | Fruit length (cm)                  | Fruit breadth (cm) | No. of seeds/fruit | Trichome (cm <sup>2</sup> ) | No. of fruit/plant | No. of flower/Plant |
| 1.                                         | Arka Anamika    | 15.63ab                            | 1.94bcd            | 43.47h             | 114.67cd                    | 6.53def            | 7.13ef              |
| 2.                                         | Subarna         | 16.87a                             | 2.11ab             | 59.47de            | 109.33de                    | 9.57b              | 10.86ab             |
| 3.                                         | Aparupa DG      | 12.50de                            | 1.74de             | 56.33f             | 132.13b                     | 6.07f              | 7.56de              |
| 4.                                         | Tiger Green     | 16.91a                             | 1.88cd             | 61.67d             | 95.80gh                     | 10.04b             | 11.08a              |
| 5.                                         | JKOH-7315       | 16.70a                             | 2.05bc             | 59.13e             | 98.47fgh                    | 10.81a             | 11.18a              |
| 6.                                         | Parbhani Kranti | 13.47cde                           | 1.94bcd            | 58.00ef            | 98.53fgh                    | 6.45def            | 6.73f               |
| 7.                                         | Basanti         | 13.83cd                            | 1.81de             | 57.73ef            | 115.47cd                    | 9.80b              | 10.81ab             |
| 8.                                         | Miss-717        | 13.40cde                           | 1.90bcd            | 70.47a             | 119.73c                     | 7.67c              | 7.78d               |
| 9.                                         | Meena-117       | 15.70ab                            | 1.93bcd            | 57.47ef            | 92.67h                      | 6.24ef             | 6.66f               |
| 10.                                        | Bhindi No.10    | 13.53cde                           | 2.30a              | 66.53bc            | 92.80h                      | 9.67b              | 10.53b              |
| 11.                                        | PAN-2127        | 13.40cde                           | 1.80de             | 46.00g             | 104.80ef                    | 6.43def            | 7.35de              |
| 12.                                        | Tanvi           | 14.73bc                            | 2.06bc             | 68.87ab            | 100.73fg                    | 6.82de             | 9.37c               |
| 13.                                        | Kaveri          | 12.00e                             | 1.60e              | 42.00h             | 132.80b                     | 6.94d              | 7.27e               |
| 14.                                        | Chameli-015     | 13.00cde                           | 1.77de             | 65.00c             | 163.20a                     | 7.07cd             | 7.29de              |
| F Value                                    |                 | 7.69                               | 5.57               | 109.89             | 74.65                       | 52.88              | 116.26              |
| Pr>F                                       |                 | <.0001                             | 0.0001             | <.0001             | <.0001                      | <.0001             | <.0001              |
| LSD                                        |                 | 1.7501                             | 0.2166             | 2.4642             | 6.6596                      | 0.6801             | 0.4915              |
| <b>Fruit borer complex (Bored fruit %)</b> |                 | 0.194                              | 0.349              | 0.265              | -0.664**                    | 0.209              | 0.192               |

\* Significant at 0.05%, \*\*Significant at 0.01%.

#### **4.2.2.7. Bio-chemical constituents of okra leaf and fruit in different okra cultivars during pre-kharif season, 2016**

The data depicted in table 45 revealed that the chlorophyll content in leaf was found highest in Bhindi No. 10 (value of SPAD 55.67) and lowest in Kaveri (value of SPAD 37.43). The highest content of moisture, protein, nitrogen and phosphorous in leaf (82.15%, 53.83mg/g, 3.70% and 0.25%) and fruit (90.12%, 55.06mg/g, 4.15% and 0.53%) were recorded in Bhindi No.10 which was closely followed by Meena-117 (81.12%, 52.17 mg/g, 3.25% and 0.24% in leaf and 89.28%, 52.67mg/g, 3.94% and 0.52% in fruit). The lowest value of moisture, protein, nitrogen and phosphorous in leaf (77.18%, 23.33mg/g, 1.90 % and 0.18%) and fruit (82.07%, 28.06mg/g, 1.92% and 0.36%) was estimated in Chameli-015 and was closely followed by Kaveri (77.31%, 25.58mg/g, 1.84% and 0.17% in leaf and 84.84%, 29.89mg/g, 2.70% and 0.35% in fruit). The concentration of lipid, OD-phenol, phenol, potassium and zinc in leaf and fruit were recorded lowest in Bhindi No.10 (1.01%, 0.44mg/g, 5.78 mg/g, 1.67% and 44.37mg/kg in leaf and 1.12%, 0.71mg/g, 10.77mg/g, 1.72% and 65.71mg/kg in fruit) followed by Meena-117 (1.09%, 0.48mg/g, 5.63 mg/g, 1.43% and 45.50 mg/kg in leaf, 1.24%, 0.74mg/g, 10.88mg/g, 1.79% and 64.79mg/kg in fruit). The leaf and fruit of Kaveri had significantly higher level of lipid, OD-phenol, phenol, potassium and zinc (1.93%, 0.64mg/g, 8.87mg/g, 2.19 % and 69.13mg/kg in leaf, 2.09%, 1.18mg/g, 16.76mg/g, 2.78% and 82.68mg/kg in fruit) followed by Chameli-015 (1.91%, 0.61mg/g, 9.22mg/g, 2.12% and 68.40mg/kg in leaf 2.19%, 1.11mg/g, 17.04mg/g, 2.66% and 82.93mg/kg in fruit).

#### **4.2.2.8. Correlation of pest's incidence with bio-chemical constituents of okra cultivars**

Correlation of incidence of different pests with the bio-chemical constituents of the okra leaves and fruits was done and presented in table 45 & 46.

The results revealed that moisture, nitrogen, phosphorus and protein in leaf and fruit showed significant positive correlation with jassid, aphid, whitefly and fruit borer population fluctuation while, lipid, OD phenol, phenol, potassium and zinc showed significantly negative effect except potassium and zinc on aphid population (Table 45 & 46). The chlorophyll content in leaf had positive and significant effect on sucking pest of okra.

**Table 45: Bio-chemical character of leaf at 60 days in different okra cultivar during pre-kharif, 2016**

| Sl. No.     | Cultivars       | Biochemical characters |          |            |                   |                |                 |            |              |             |              |
|-------------|-----------------|------------------------|----------|------------|-------------------|----------------|-----------------|------------|--------------|-------------|--------------|
|             |                 | Chlorophyll            | Lipid %  | Moisture % | OD phenol (mg/gm) | Phenol (mg/gm) | Protein (mg/gm) | Nitrogen % | Phosphorus % | Potassium % | Zinc (mg/kg) |
| 1.          | Arka Anamika    | 41.29def               | 1.04de   | 77.70de    | 0.54bc            | 7.57ab         | 42.42ef         | 2.80de     | 0.21ghi      | 1.88bcde    | 52.90cd      |
| 2.          | Subarna         | 45.65c                 | 1.30c    | 78.89cde   | 0.57ab            | 6.62ab         | 44.33de         | 2.39ef     | 0.22efg      | 1.93bcd     | 51.40cd      |
| 3.          | Aparupa DG      | 39.38ef                | 1.63b    | 77.36de    | 0.63a             | 8.25ab         | 35.33h          | 2.19fg     | 0.20i        | 2.06ab      | 69.90a       |
| 4.          | Tiger Green     | 46.89bc                | 1.11de   | 80.38abc   | 0.48cd            | 5.63b          | 51.33ab         | 2.89cd     | 0.27a        | 1.76cdef    | 50.23d       |
| 5.          | JKOH-7315       | 44.33cd                | 1.13d    | 79.14bcde  | 0.53bc            | 6.85ab         | 46.67cd         | 2.69de     | 0.23def      | 1.59fg      | 54.47c       |
| 6.          | Parbhani Kranti | 41.19def               | 1.73b    | 77.38de    | 0.58ab            | 8.00ab         | 39.17g          | 2.95cd     | 0.20hi       | 2.00abc     | 59.23b       |
| 7.          | Basanti         | 43.53cde               | 1.39c    | 77.74de    | 0.57ab            | 7.71ab         | 39.42fg         | 3.01cd     | 0.21ghi      | 1.75def     | 59.57b       |
| 8.          | Miss-717        | 43.87cd                | 1.71b    | 77.95de    | 0.57ab            | 7.49ab         | 45.42cde        | 2.89cd     | 0.21fgh      | 1.68efg     | 53.80cd      |
| 9.          | Meena-117       | 50.26b                 | 1.09de   | 81.12ab    | 0.48cd            | 5.63b          | 52.17a          | 3.25bc     | 0.24cd       | 1.43g       | 45.50e       |
| 10.         | Bhindi No.10    | 55.67a                 | 1.01e    | 82.15a     | 0.44d             | 5.78b          | 53.83a          | 3.70a      | 0.25ab       | 1.67efg     | 44.37e       |
| 11.         | PAN-2127        | 44.94cd                | 1.33c    | 79.41bcd   | 0.54bc            | 6.72ab         | 47.67c          | 3.11bcd    | 0.23cde      | 1.45g       | 59.97b       |
| 12.         | Tanvi           | 46.24bc                | 1.03de   | 80.09abc   | 0.51bcd           | 6.62ab         | 48.50bc         | 3.44ab     | 0.25bc       | 1.60fg      | 44.00e       |
| 13.         | Kaveri          | 37.43f                 | 1.93a    | 77.31e     | 0.64a             | 8.87ab         | 25.58i          | 1.84g      | 0.17j        | 2.19a       | 69.13a       |
| 14.         | Chameli-015     | 37.71f                 | 1.91a    | 77.18e     | 0.61a             | 9.22a          | 23.33i          | 1.90g      | 0.18j        | 2.12a       | 68.40a       |
| F Value     |                 | 10.90                  | 77.32    | 4.98       | 5.15              | 1.04           | 70.22           | 13.95      | 31.78        | 7.97        | 51.28        |
| Pr>F        |                 | <0.001                 | <.0001   | 0.0002     | 0.0002            | 0.4440         | <.0001          | <.0001     | <.0001       | <.0001      | <.0001       |
| LSD         |                 | 4.3089                 | 0.1116   | 2.0818     | 0.0726            | 3.2631         | 3.216           | 0.4251     | 0.015        | 0.2482      | 3.594        |
| Correlation |                 |                        |          |            |                   |                |                 |            |              |             |              |
| Jassid      |                 | 0.783**                | -0.548*  | 0.789**    | -0.754**          | -0.784**       | 0.746**         | 0.739**    | 0.732**      | -0.661**    | -0.567*      |
| Aphid       |                 | 0.598*                 | -0.528*  | 0.558*     | -0.665**          | -0.578*        | 0.637*          | 0.533*     | 0.558*       | -0.464      | -0.473       |
| Whitefly    |                 | 0.889**                | -0.698** | 0.899**    | -0.820**          | -0.796**       | 0.808**         | 0.813**    | 0.774**      | -0.797**    | -0.746**     |

\* Significant at 0.05%, \*\*Significant at 0.01%.

**Table 46: Bio-chemical character of fruit in different okra cultivars during pre-kharif, 2016**

| Sl. No.                             | Cultivars       | Biochemical characters |            |                   |                |                 |            |              |             |              |
|-------------------------------------|-----------------|------------------------|------------|-------------------|----------------|-----------------|------------|--------------|-------------|--------------|
|                                     |                 | Lipid %                | Moisture % | OD phenol (mg/gm) | Phenol (mg/gm) | Protein (mg/gm) | Nitrogen % | Phosphorus % | Potassium % | Zinc (mg/kg) |
| 1.                                  | Arka Anamika    | 1.61cde                | 87.73bcd   | 0.95cd            | 12.18e         | 42.83ef         | 3.07e      | 0.39g        | 2.51c       | 74.49bc      |
| 2.                                  | Subarna         | 1.30gh                 | 87.73bcd   | 0.89d             | 11.48f         | 42.25efg        | 3.00ef     | 0.41fg       | 2.41c       | 70.72d       |
| 3.                                  | Aparupa DG      | 1.96b                  | 85.10ef    | 1.09ab            | 15.92b         | 36.56h          | 2.66g      | 0.36h        | 2.75ab      | 81.06a       |
| 4.                                  | Tiger Green     | 1.31gh                 | 89.27abc   | 0.71e             | 11.02fg        | 51.06bc         | 4.05ab     | 0.51bc       | 1.76f       | 67.80e       |
| 5.                                  | JKOH-7315       | 1.73cd                 | 87.59bcd   | 0.95d             | 11.17fg        | 44.28ef         | 3.48d      | 0.43de       | 2.08e       | 74.47bc      |
| 6.                                  | Parbhani Kranti | 1.60de                 | 86.06def   | 1.05bc            | 14.04c         | 38.64gh         | 3.60d      | 0.41ef       | 2.26d       | 72.31cd      |
| 7.                                  | Basanti         | 1.46efg                | 86.85def   | 0.96cd            | 13.18d         | 42.00fg         | 3.48d      | 0.42def      | 2.24d       | 75.32b       |
| 8.                                  | Miss-717        | 1.78c                  | 87.76abcd  | 0.97cd            | 11.46f         | 38.83gh         | 2.96efg    | 0.43d        | 2.06e       | 72.40cd      |
| 9.                                  | Meena-117       | 1.24hi                 | 89.28abc   | 0.74e             | 10.88fg        | 52.67ab         | 3.94abc    | 0.52ab       | 1.79f       | 64.79f       |
| 10.                                 | Bhindi No.10    | 1.12i                  | 90.12a     | 0.71e             | 10.77g         | 55.06a          | 4.15a      | 0.53a        | 1.72f       | 65.71ef      |
| 11.                                 | PAN-2127        | 1.52ef                 | 87.34cde   | 0.88d             | 12.43e         | 46.06de         | 3.71cd     | 0.50c        | 2.06e       | 72.34cd      |
| 12.                                 | Tanvi           | 1.40fgh                | 89.92ab    | 0.75e             | 12.20e         | 48.64cd         | 3.78bcd    | 0.50c        | 1.71f       | 66.30ef      |
| 13.                                 | Kaveri          | 2.09ab                 | 84.84f     | 1.18a             | 16.76a         | 29.89i          | 2.70fg     | 0.35h        | 2.78a       | 82.68a       |
| 14.                                 | Chameli-015     | 2.19a                  | 82.07g     | 1.11ab            | 17.04a         | 28.06i          | 1.92h      | 0.36h        | 2.66ab      | 82.93a       |
| F Value                             |                 | 28.25                  | 7.22       | 18.92             | 92.14          | 35.34           | 32.94      | 103.92       | 108.23      | 55.03        |
| Pr>F                                |                 | <.0001                 | <.0001     | <.0001            | <.0001         | <.0001          | <.0001     | <.0001       | <.0001      | <.0001       |
| LSD                                 |                 | 0.1772                 | 2.3869     | 0.1022            | 0.667          | 3.8814          | 0.320      | 0.018        | 0.106       | 2.346        |
| Correlation                         |                 |                        |            |                   |                |                 |            |              |             |              |
| Fruit borer complex (Bored fruit %) |                 | -0.723**               | 0.707**    | -0.761**          | -0.709**       | 0.778**         | 0.796**    | 0.863**      | -0.836**    | -0.760**     |

\* Significant at the 0.05%, \*\*Significant at the 0.01%.

#### 4.2.2.9. Yield of different okra cultivars during pre-kharif season, 2016

Fruits were harvested at 2-3 days interval and weighed. The cumulative yield data of all pickings of different cultivars were analyzed and expressed in t/ha (Table 47 & Fig. 25). The yield was significantly highest 12.20 t/ha in cultivar JKOH-7315 followed by 11.84 t/ha in Tiger Green and 11.56 t/ha in Basanti. Whereas, cultivar Aparupa DG (9.17 t/ha) yielded the lowest.

**Table 47: Yield of different cultivars of okra during pre-kharif season, 2016.**

| Sl. No.        | Pre-kharif season |              |
|----------------|-------------------|--------------|
|                | Cultivars         | Yield (t/ha) |
| 1.             | Arka Anamika      | 10.37c       |
| 2.             | Subarna           | 11.53ab      |
| 3.             | Aparupa DG        | 9.17d        |
| 4.             | Tiger Green       | 11.84a       |
| 5.             | JKOH-7315         | 12.20a       |
| 6.             | Parbhani Kranti   | 10.30c       |
| 7.             | Basanti           | 11.56ab      |
| 8.             | Miss-717          | 11.44ab      |
| 9.             | Meena-117         | 9.18d        |
| 10.            | Bhindi No.10      | 10.46c       |
| 11.            | PAN-2127          | 9.23d        |
| 12.            | Tanvi             | 10.09c       |
| 13.            | Kaveri            | 10.34c       |
| 14.            | Chameli-015       | 10.74bc      |
| <b>F Value</b> |                   | 11.80        |
| <b>Pr&gt;F</b> |                   | <.0001       |
| <b>LSD</b>     |                   | 0.8483       |

**Fig. 25: Yield of different cultivars of okra during pre-kharif season (2016)**

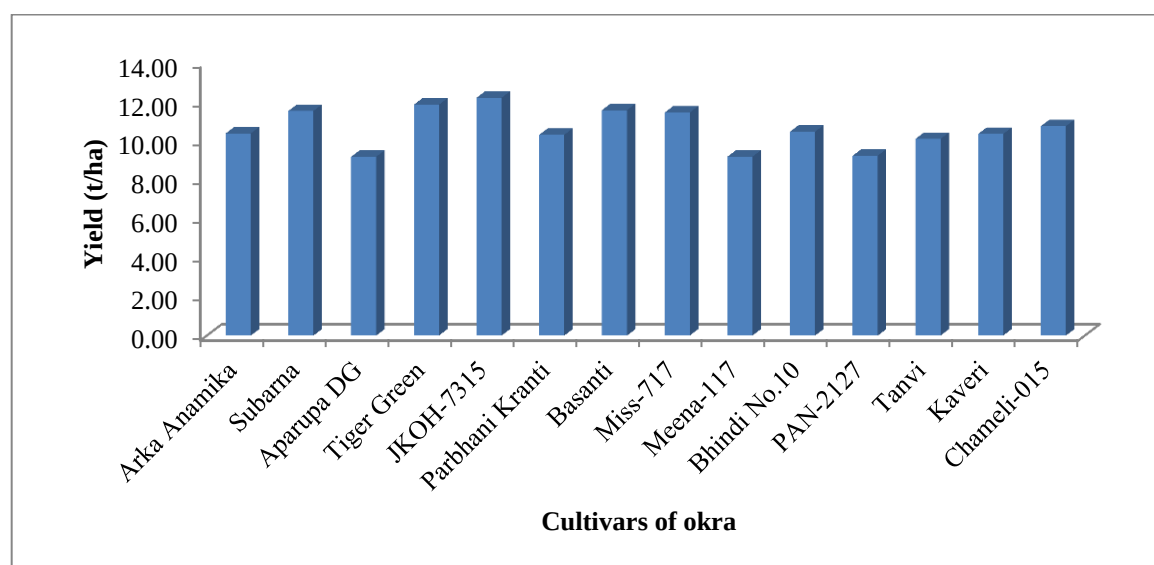


**Table 48: Categorization of different cultivars of okra during post-kharif season (2015)**

| <b>Cultivars</b> | <b>Jassid/leaf</b> | <b>Aphid/leaf</b> | <b>Whitefly/leaf</b> | <b>Bored fruit %</b> | <b>Grade</b> |
|------------------|--------------------|-------------------|----------------------|----------------------|--------------|
| Arka Anamika     |                    |                   |                      |                      |              |
| Subarna          |                    |                   |                      |                      |              |
| Aparupa DG       |                    |                   |                      |                      |              |
| Tiger Green      |                    |                   |                      |                      |              |
| JKOH-7315        |                    |                   |                      |                      |              |
| Parbhani Kranti  |                    |                   |                      |                      |              |
| Basanti          |                    |                   |                      |                      |              |
| Miss-717         |                    |                   |                      |                      |              |
| Meena-117        |                    |                   |                      |                      |              |
| Bhindi No.10     |                    |                   |                      |                      |              |
| PAN-2127         |                    |                   |                      |                      |              |
| Tanvi            |                    |                   |                      |                      |              |
| Kaveri           |                    |                   |                      |                      |              |
| Chameli-015      |                    |                   |                      |                      |              |

| <b>Pests</b>        |                         |                               |                           |
|---------------------|-------------------------|-------------------------------|---------------------------|
|                     | <b>Less susceptible</b> | <b>Moderately susceptible</b> | <b>Highly susceptible</b> |
| Jassid/leaf         | Below <1.35             | Between 1.35 to 5.44          | Above >5.44               |
| Aphid/leaf          | Below <2.76             | Between 2.76 to 4.96          | Above >4.96               |
| White fly/leaf      | Below <2.62             | Between 2.62 to 4.03          | Above >4.03               |
| Bored fruit %/plant | Below <13.78            | Between 13.78 to 18.36        | Above >18.36              |

**Table 49: Categorization of different cultivars of okra during pre-kharif season (2016)**

| Cultivars       | Jassid/leaf | Aphid/leaf | Whitefly/leaf | Bored fruit % | Grade |
|-----------------|-------------|------------|---------------|---------------|-------|
| Arka Anamika    |             |            |               |               |       |
| Subarna         |             |            |               |               |       |
| Aparupa DG      |             |            |               |               |       |
| Tiger Green     |             |            |               |               |       |
| JKOH-7315       |             |            |               |               |       |
| Parbhani Kranti |             |            |               |               |       |
| Basanti         |             |            |               |               |       |
| Miss-717        |             |            |               |               |       |
| Meena-117       |             |            |               |               |       |
| Bhindi No.10    |             |            |               |               |       |
| PAN-2127        |             |            |               |               |       |
| Tanvi           |             |            |               |               |       |
| Kaveri          |             |            |               |               |       |
| Chameli-015     |             |            |               |               |       |

| Pests               |                  |                        |                    |
|---------------------|------------------|------------------------|--------------------|
|                     | Less susceptible | Moderately Susceptible | Highly Susceptible |
| Jassid/leaf         | Below < 17.50    | Between 17.50 to 41.95 | Above > 41.95      |
| Aphid/leaf          | Below < 1.03     | Between 1.03 to 1.99   | Above > 1.99       |
| White fly/leaf      | Below < 0.55     | Between 0.55 to 0.83   | Above > 0.83       |
| Bored fruit %/plant | Below < 35.35    | Between 35.35 to 45.52 | Above > 45.52      |

### **Jassid**

From the overall observations, it is found that out of 14 okra cultivars studied so far Bhendi No.10 and Tanvi were considered as highly susceptible; Arka Anamika, Subarna, Aparupa DG, Tiger Green, JKOH-7315, Parbhani Kranti, Basanti, Miss-717 Meena-117 and PAN-2127 were moderately susceptible while Kaveri and Chameli-015 were found less susceptible during post-kharif season. However, Tiger Green, Meena-117, Bhindi No.10 and PAN-2127 were considered as highly susceptible; Arka Anamika, Subarna, Aparupa DG, JKOH-7315, Parbhani Kranti, Basanti, Miss-717 and Tanvi were moderately susceptible while Kaveri and Chameli-015 were found less susceptible during pre-kharif season to jassid population build up in this present experiment. In general, the experiment of varietal screening differed from worker to worker as all the varieties of a particular crop considered by a worker for his experiment are not exactly same with the varieties taken by another scientist for his experiment. Only some varieties may be same. The present finding can partially be compared with those of Gadekar (2015) who revealed that Arka Abhay, A-4, Pusa Sawani, Arka Anamika, Parbhani Kranti and Hissar Naveen emerged as moderately susceptible to the attack of jassid. Similar finding also observed from Patni and Pareek (2000), Bairwa and Kanwat (2001), Bhat *et al* (2007), who reported Arka Abhay, Arka Anamika, Pusa Sawani and Parbhani Kranti as moderately susceptible in their different experiments that supported the present findings.

### **Aphid**

From the overall observations, it is found that out of 14 okra cultivars studied so far Meena-117, Bhendi No.10 and PAN-2127 were considered as highly susceptible; Arka Anamika, Subarna, Aparupa DG, Tiger Green, Parbhani Kranti, Basanti, Miss-717 and Tanvi were moderately susceptible while JKOH-7315, Kaveri and Chameli-015 were found less susceptible during post-kharif season. However, Tiger Green, Meena-117 and Bhindi No.10 were considered as highly susceptible; Arka Anamika, Aparupa DG, JKOH-7315, Parbhani Kranti, Basanti, Miss-717, PAN-2127 and Tanvi were moderately susceptible while Subarna, Kaveri and Chameli-015 were found less susceptible during pre-kharif season to aphid population build up in this present experiment. Similar results were reported by Sharma *et al.*, (2001) who reported that both Arka Anamika and Parbhani Kranti showed moderate resistance against aphids. The present findings also satisfactorily conformed by Ghosh *et al.*, (1999) who tested six okra varieties viz. Parbhani Kranti, Arka Anamika, LBH-55, H-7, Amtala hybrid and

Kamdheni at Pundibari (West Bengal) for resistance against aphids. They also found that both Arka Anamika and Parbhani Kranti showed moderate resistance against aphids.

### **Whitefly**

From the overall observations, it is found that out of 14 okra cultivars studied so far Meena-117, Bhendi No.10 and Tanvi were registered as highly susceptible; Arka Anamika, Subarna, Aparupa DG, Tiger Green, JKOH-7315, Basanti, Miss-717 and PAN-2127 were moderately susceptible while Parbhani Kranti, Kaveri and Chameli-015 were found less susceptible during post-kharif season. However, Meena-117, Bhendi No.10 PAN-2127 and Tanvi were considered as highly susceptible; Arka Anamika, Subarna, Aparupa DG, Tiger Green, JKOH-7315, Basanti, and Miss-717 were moderately susceptible while Parbhani Kranti, Kaveri and Chameli-015 were found less susceptible during pre-kharif season to whitefly population build up in this present experiment.

Many worker have conducted a trial to determine the resistant or susceptibility of different cultivars against whitefly, among them Bairwa and Kanwat (2001) revealed that Hissar Unnat, Varsha Uphar and Pusa Sawni as least susceptible to whitefly, while varieties namely A-4, Arka Abhay, Arka Anamika, Parbhani Kranti, Hissar Naveen and Kashi Mohini rated as moderately susceptible which supports the present finding. The findings of present experiment was confirmed by Patni and Pareek (2000), and Bhat *et al* (2007), who reported Arka Abhay, Arka Anamika, Pusa Sawani and Parbhani Kranti as moderately susceptible. Gadekar (2015) also reported that out of ten varieties of okra, the varieties A-4, Arka Abhay, Arka Anamika, Parbhani Kranti, Hissar Naveen, and Kashi Mohini emerged as moderately susceptible against whitefly on okra crop which was at par with the present findings.

### **Fruit borer complex**

From the overall observations, it is found that out of 14 okra cultivars studied so far Tiger Green, Meena-117, Bhendi No.10 and Tanvi were depicted as highly susceptible; Arka Anamika, Subarna, Aparupa DG, JKOH-7315, Basanti, Miss-717 and PAN-2127 were moderately susceptible while Parbhani Kranti, Kaveri and Chameli-015 were found less susceptible during post-kharif season. However, Tiger Green, Meena-117, Bhendi No.10 and PAN-2127 were found as highly susceptible; Arka Anamika, Subarna, Parbhani Kranti, JKOH-7315, Basanti, Miss-717 and Tanvi were moderately susceptible while Aparupa DG, Kaveri and Chameli-015 were found less susceptible during pre-kharif season to fruit borer complex population build up in this present experiment. The present findings are in agreement with Ghosh *et al.*, (1999) who

revealed that six okra varieties viz. Parbhani Kranti, Arka Anamika, LBH-55, H-7, Amtala hybrid and Kamdhenu showed low to moderate level damage to fruit tested at Pundibari (West Bengal).

The present study revealed that among the physico-morphic character of okra leaf and fruit, trichome (upper surface of leaf/cm<sup>2</sup>), trichome (lower surface of leaf/cm<sup>2</sup>) in leaf and trichome/cm<sup>2</sup> in fruit had significantly negative correlation and would impart tolerance against insect pests of okra. A number of works have been made by various workers about the influence of trichomes against insect pests of okra. The observations were documented by Iqbal *et al.* (2011) who reported a significant negative correlation between trichome density of leaf lamina and jassid incidence in okra from Pakistan that also supported the present findings. Halder *et al.*, (2016) opined that genotype SB-6 had relatively lower number of trichomes on leaf lamina (10.11), mid-rib (7.17) and vein (8.05) and showed highly susceptible to jassids (17.57 jassids/leaf) as compared to tolerant genotype VROB-181 (5.43 jassids/leaf) which had 11.85, 9.17 and 9.95 trichomes per cm<sup>2</sup>, respectively and confirmed the present findings firmly.

However, the plant height (cm), no. of leaves/plant, no. of branch/plant, leaf thickness (mm), leaf area (cm<sup>2</sup>), fruit length (cm), fruit breadth (cm), no. of seed/fruit, no. of fruit/plant and no. of flower/plant had positive interaction with the entire insect pests incidence. The present findings are in agreement with the findings of Shinde *et al.* (2014) who reported that cotton accessions taller in height (166.5 - 168 cm) harbored more jassid infestation and higher number of total leaves (31.9) per plant was also showed higher population. Leaf length, plant height, angle between mid-ribs and total leaves showed a strong positive relation with jassid population (Halder *et al.*, 2016) and these results are at par with present findings. Halder *et al.*, (2016) observed that susceptible cultivar SB-10 possessed higher mid-rib thickness (1.75 mm) and leaf length (25.65 cm) as compared to tolerant genotype VROB-181 (1.58 mm and 22.43 cm, respectively). Shinde *et al.* (2014) also documented that cotton genotypes which had lower mid-rib thickness were found less susceptible to jassid infestation while the genotypes with higher midrib thickness showed high infestation of jassid. The above findings of Shinde *et al.* (2014) are in conformity with present results.

The present study revealed that among the bio-chemical content of okra leaves and fruit, lipid, potassium, zinc, OD phenol, phenol had significantly negative correlation with insect pest population indicating that more amount of lipid, potassium, zinc, OD phenol and phenols would impart tolerance against insect pests of okra. However, the

chlorophyll, moisture, nitrogen, phosphorus, protein had positive and significant interaction with the entire insect pests incidence. The present findings are in agreement with the findings of Roseleen and Ramaraju (2011b) who reported that okra variety Mahyco-10 had highest content of leaf chlorophyll as susceptible check. The findings of Halder *et al.* (2016) confirmed the present experiment by stating that total phenol content was highest in okra variety, VROB-181 and this variety had lowest incidence of jassids than those of susceptible genotypes, viz. SB-6 (42.61 mg/100 g) and SB-10 (48.35 mg/100 g) and there by establishing the significant negative correlation ( $r = -0.577$ ) with the jassid incidence and total phenol content. Phenolics in a fairly large concentration could have direct toxicity to the insect. These findings are in close conformity with those of Hooda *et al.* (1997) who reported that resistance of okra leaf-hopper was correlated with higher concentration of total phenol in leaves.

Mineral contents like Ca, Mn and Zn showed negative correlation but their contribution towards fruit infestation was very nominal as reported by Aziz *et al.*, (2012). Iqbal *et al.* (2011) observed that positive correlation between nitrogen, phosphorus and copper content of okra leaves and jassid population whereas, calcium and magnesium had negative impact. This results are in partial agreement with the present findings where nitrogen and phosphorus showed positive correlation with jassid population. Roseleen and Ramaraju (2012) reported that susceptible cultivar of okra hybrid Mahyco 10 had high amount of proteins (78.5 mg/g) and carbohydrates compared to resistant wild type Kasturi bhendi, which recorded high levels of total phenols (6.23 mg/g) and tannin (3.40 mg/g). Similar result also observed by Aziz. *et al.* (2012) Crude protein showed the positive and significant impact (69%) on the jassid population fluctuation on okra. High amount of crude protein can be used as marker traits to select for resistance against *Earias* spp. Similarly Aziz *et al.* (2012) supported our present findings where protein content in okra plants had significant positive correlation with jassid population.

In the present study maximum yield was recorded during pre-kharif season compare to post-kharif season and the highest yield was recorded from okra variety, JKOH-7315 with 11.24 t/ha & 12.20t/ha in two season respectively and this variety was found superior over other varieties in terms of yield. This might be due to higher yield potentiality of this variety and difference of climatic conditions of these two seasons. The variety JKOH-7315 was moderately susceptible to all insect pests of okra. This variety can be recommended for cultivation in farmers field in terai region of West

Bengal. While Parbhani Kranti (9.31 & 10.30t/ha), Arka Anamika (9.36 & 10.37t/ha), Kaveri (9.35 & 10.34t/ha) and Chameli-015 (10.31 & 10.74t/ha) produced medium yield with medium to highly susceptible to insect pests. Analogous observations were made by Shukla *et al.* (1998) described that okra varieties Ankur 35 and Parbhani Kranti registered higher fruit yields at Jabalpur (Madhya Pradesh) which was not similar with the present study. This could be because of the difference in weather parameters, time of sowing, soil fertility etc. Arka Anamika recorded highest yield as compare to Parbhani Kranti, Harbhajan and P-8 at Hamirpur Himachal Pradesh, (Anonymous, 2004). In the present study also Arka Anamika gave higher yield than Parbhani Kranti.

From overall observation from pest population and yield data, it is found that JKOH-7315 is moderately susceptible to all the insect pests of okra and produced maximum yield. The other varieties like Tiger Green, Basanti, Subarna and Miss 717 are also moderately susceptible to all the pests and yielded at par with JKOH -7315. Therefore farmers can select any of the said varieties for better economic return.

For finding the best pest module strategy against insect pests of okra, the highly susceptible okra variety should be considered for getting good performance. In the present experiment, Bhendi No.10 and Meena-117 were found highly susceptible to all the pests of okra and medium yielder. Therefore, okra variety Bhendi No.10 has been considered for conducting the study of pest module strategy which is the main moto of this thesis.

### **4.3. Formulation of pest management modules for major insect-pest of okra**

#### **4.3.1. Post-kharif season**

##### **4.3.1.1. Jassid (*Amrasca biguttula biguttula* Ishida)**

The jassid population varied significantly among the plots where seed treatment was adopted at one day before spray of insecticides. Maximum population was observed in untreated plot (M-15) and other plots like M-1, M-2, M-7 where no seed treatment was done ranged between (6.31 to 6.32/leaf), (6.76 to 6.80/leaf) and (6.54 to 6.56/leaf) in 2016, 2017 and pooled mean of both years respectively. The significant lowest population was observed from imidacloprid 17.8SL treated plot M-14 (5.98, 6.02, 6.00/leaf) followed by M-4 (6.00, 6.00 and 6.00/leaf), M-3 (6.10, 6.22 and 6.16/leaf) and M-11 (6.11, 6.21 and 6.16/leaf) during 2016, 2017 and pooled mean of both years respectively. The moderate population was observed from bijamrita treated plots (M-5, M-6, M-8, M-9, M-10, M-12 and M-13) ranged between (6.21 to 6.23/leaf), (6.52 to 6.57/leaf) and (6.37 to 6.39/leaf) during 2016, 2017 and pooled mean of both years respectively (Table 50, 52 and 54).

The different protection modules showed less jassid population in comparison to untreated one. During first spray minimum jassid population was observed in M-14 containing 1.14 jassid/leaf in both years and their pooled mean and which was followed by M-11 with population of 1.42, 1.21 and 1.31/leaf and M-4 having population of 1.51, 1.47 and 1.49/leaf during 2016, 2017 and pooled of both years respectively. They were significantly differed from each other.

In 2<sup>nd</sup> spray, M-14 was found most effective as it had minimum population (0.69, 0.53 and 0.61/leaf) of jassid which was followed by M-11 with population of 0.89, 0.62 and 0.76/leaf and M-4 with 1.09, 0.82 and 0.96/leaf during 2016, 2017 and pooled mean of both years respectively.

In both the spray, the overall efficacy revealed that module M-14 (82.81%, 85.95% and 84.38%) was found most effective in reducing the population of jassid followed by M-11 (79.44%, 84.92% and 82.18%), M-4 (77.64%, 81.87% and 79.75%). Minimum reduction was observed on M-10 at 31.88% during 2016, 40.47% in 2017 and 36.17% in pooled mean of both years respectively.

Reduction percentage of jassid population on okra varied significantly among different date of observation after spraying insecticides. In overall efficacy during 1<sup>st</sup>

spray, the maximum reduction per cent was recorded after 3 days of spraying (84.32%, 84.82% and 84.57%) which was followed by 1 day after spraying (75.79%, 75.66% and 75.73%), 7 days after spraying (67.88%, 66.72% and 67.30%) and minimum reduction per cent was observed after 14 days of spraying (44.46%, 45.51% and 44.98%) in 2016, 2017 and pooled mean of both years respectively. The similar trend was observed in the 2<sup>nd</sup> spray where 3 days after spraying gave maximum mortality per cent ( 78.93%, 76.99% and 77.96%) followed by 1 day (65.66%, 65.30% and 65.48%), 7 days (60.58%, 59.04% and 59.81%) and minimum mortality was recorded 14 days after spraying (35.03%, 39.07% and 37.05%) during 2016, 2017 and pooled mean of both years respectively.

**Table 50: Efficacy of pesticide modules on jassid population (no./leaf) during post-kharif season in 2016**

| Treat.      | DBS          | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |             |             |
|-------------|--------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|
|             |              | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        |
| <b>M-1</b>  | 6.32a(2.61)  | 1.02(1.23)            | 0.42(0.96)  | 1.60(1.45)  | 4.02(2.13)  | 1.77k(1.44) | 1.20(1.30)            | 0.80(1.14)  | 1.53(1.43)  | 2.87(1.83)  | 1.60h(1.43) |
| <b>M-2</b>  | 6.32a(2.61)  | 1.53(1.43)            | 0.91(1.19)  | 2.09(1.61)  | 4.76(2.29)  | 2.32i(1.63) | 1.00(1.22)            | 0.56(1.03)  | 1.56(1.43)  | 2.80(1.82)  | 1.48i(1.38) |
| <b>M-3</b>  | 6.10d(2.57)  | 1.24(1.32)            | 0.75(1.12)  | 1.78(1.51)  | 4.53(2.24)  | 2.08j(1.55) | 1.38(1.37)            | 0.93(1.20)  | 1.82(1.52)  | 3.31(1.95)  | 1.86g(1.51) |
| <b>M-4</b>  | 6.00e(2.55)  | 0.80(1.14)            | 0.29(0.89)  | 1.36(1.36)  | 3.60(2.02)  | 1.51m(1.35) | 0.76(1.12)            | 0.40(0.95)  | 1.11(1.27)  | 2.09(1.61)  | 1.09j(1.24) |
| <b>M-5</b>  | 6.22bc(2.59) | 2.18(1.64)            | 1.56(1.43)  | 2.93(1.85)  | 5.71(2.49)  | 3.09e(1.85) | 2.20(1.64)            | 1.62(1.46)  | 2.80(1.82)  | 4.33(2.20)  | 2.74e(1.78) |
| <b>M-6</b>  | 6.21bc(2.59) | 2.33(1.68)            | 1.80(1.52)  | 3.00(1.87)  | 6.00(2.55)  | 3.28d(1.90) | 2.51(1.74)            | 1.93(1.56)  | 3.04(1.88)  | 4.82(2.31)  | 3.08d(1.87) |
| <b>M-7</b>  | 6.31a(2.61)  | 2.93(1.85)            | 2.24(1.66)  | 3.62(2.03)  | 6.53(2.65)  | 3.83c(2.05) | 3.18(1.92)            | 2.51(1.74)  | 4.02(2.13)  | 5.80(2.51)  | 3.88c(2.07) |
| <b>M-8</b>  | 6.23bc(2.59) | 2.02(1.59)            | 1.38(1.37)  | 2.53(1.74)  | 5.62(2.47)  | 2.89g(1.79) | 2.07(1.60)            | 1.53(1.43)  | 2.53(1.74)  | 4.18(2.16)  | 2.58f(1.73) |
| <b>M-9</b>  | 6.23b(2.59)  | 0.95(1.21)            | 0.31(0.90)  | 1.44(1.39)  | 4.00(2.12)  | 1.68l(1.41) | 1.22(1.31)            | 0.80(1.14)  | 1.47(1.40)  | 2.80(1.82)  | 1.57h(1.42) |
| <b>M-10</b> | 6.22bc(2.59) | 3.38(1.97)            | 2.84(1.83)  | 3.93(2.11)  | 7.22(2.78)  | 4.34b(2.17) | 3.56(2.01)            | 2.91(1.85)  | 4.51(2.24)  | 6.60(2.66)  | 4.39b(2.19) |
| <b>M-11</b> | 6.11d(2.57)  | 0.73(1.11)            | 0.00(0.71)  | 1.36(1.36)  | 3.58(2.02)  | 1.42n(1.30) | 0.60(1.05)            | 0.00(0.71)  | 1.02(1.23)  | 1.96(1.57)  | 0.89k(1.14) |
| <b>M-12</b> | 6.23bc(2.59) | 2.02(1.59)            | 1.54(1.43)  | 2.87(1.83)  | 5.67(2.48)  | 3.02f(1.83) | 1.31(1.35)            | 0.80(1.14)  | 2.00(1.58)  | 3.47(1.99)  | 1.89g(1.51) |
| <b>M-13</b> | 6.21c(2.59)  | 1.78(1.51)            | 1.18(1.30)  | 2.38(1.70)  | 4.73(2.29)  | 2.52h(1.70) | 3.73(2.06)            | 1.67(1.47)  | 1.24(1.32)  | 3.75(2.06)  | 2.60f(1.73) |
| <b>M-14</b> | 5.98e(2.55)  | 0.53(1.02)            | 0.00(0.71)  | 1.00(1.22)  | 3.02(1.88)  | 1.14o(1.21) | 0.42(0.96)            | 0.00(0.71)  | 0.76(1.12)  | 1.60(1.45)  | 0.69k(1.06) |
| <b>M-15</b> | 6.31a(2.61)  | 7.02(2.74)            | 7.02(2.74)  | 7.20(2.77)  | 9.02(3.09)  | 7.57a(2.84) | 9.02(3.09)            | 9.16(3.11)  | 9.20(3.11)  | 9.82(3.21)  | 9.30a(3.13) |
| <b>Mean</b> |              | 2.03c(1.53)           | 1.48d(1.32) | 2.61b(1.72) | 5.20a(2.37) |             | 2.28c(1.58)           | 1.71d(1.37) | 2.57b(1.68) | 4.01a(2.08) |             |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14      | 42           |
| <b>MS</b>      | 0.00   | 9.22                  | 2.06    | 0.03         | 3.91                  | 3.18    | 0.05         |
| <b>F Value</b> | 48.17  | 31106.1               | 6962.96 | 90.04        | 17809.6               | 14490.8 | 207.67       |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastara + Agniastara], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastara + Agniastara], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastara + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 51: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during post-kharif season in 2016**

| Treat.      | 1 <sup>st</sup> spray |               |               |               |                | 2 <sup>nd</sup> spray |               |               |               |               | Overall reduction |
|-------------|-----------------------|---------------|---------------|---------------|----------------|-----------------------|---------------|---------------|---------------|---------------|-------------------|
|             | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean           | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          |                   |
| <b>M-1</b>  | 85.47(67.60)          | 94.00(75.83)  | 77.82(61.90)  | 55.50(48.16)  | 78.20e(63.37)  | 70.16(56.89)          | 80.40(63.73)  | 62.61(52.31)  | 34.53(35.99)  | 61.93e(52.23) | 70.87d(57.33)     |
| <b>M-2</b>  | 78.21(62.18)          | 87.05(68.92)  | 71.05(57.45)  | 47.42(43.52)  | 70.94g(58.02)  | 78.97(62.71)          | 88.48(70.17)  | 67.92(55.50)  | 45.92(42.66)  | 70.32c(57.76) | 71.56d(57.77)     |
| <b>M-3</b>  | 81.70(64.68)          | 88.91(70.55)  | 74.49(59.66)  | 48.06(43.89)  | 73.29f(59.70)  | 69.60(56.54)          | 79.70(63.23)  | 60.57(51.11)  | 32.91(35.01)  | 60.70f(51.47) | 65.15e(53.82)     |
| <b>M-4</b>  | 88.02(69.75)          | 95.67(78.01)  | 80.20(63.58)  | 58.05(49.63)  | 80.48c(65.24)  | 78.98(62.72)          | 89.04(70.67)  | 69.72(56.62)  | 46.63(43.06)  | 71.09c(58.27) | 77.64c(61.78)     |
| <b>M-5</b>  | 68.53(55.88)          | 77.52(61.70)  | 58.65(49.98)  | 35.76(36.72)  | 60.11k(51.07)  | 61.48(51.64)          | 72.00(58.05)  | 51.91(46.10)  | 30.30(33.40)  | 53.92h(47.30) | 55.22h(48.00)     |
| <b>M-6</b>  | 66.22(54.47)          | 73.94(59.31)  | 57.64(49.39)  | 32.40(34.69)  | 57.55l(49.47)  | 58.13(49.68)          | 68.22(55.69)  | 50.21(45.12)  | 26.16(30.76)  | 50.68i(45.31) | 50.09i(45.05)     |
| <b>M-7</b>  | 58.28(49.77)          | 68.05(55.59)  | 49.72(44.84)  | 27.59(31.69)  | 50.91m(45.47)  | 51.35(45.77)          | 62.11(52.01)  | 39.61(39.00)  | 18.43(25.40)  | 42.87k(40.54) | 40.95j(39.79)     |
| <b>M-8</b>  | 70.85(57.32)          | 80.16(63.55)  | 64.39(53.37)  | 36.91(37.41)  | 63.08 i(52.91) | 63.25(52.68)          | 73.11(58.77)  | 55.80(48.33)  | 31.74(34.29)  | 55.98g(48.52) | 56.94g(48.99)     |
| <b>M-9</b>  | 86.25(68.24)          | 95.51(77.79)  | 79.70(63.22)  | 55.10(47.93)  | 79.14d(64.29)  | 69.44(56.44)          | 80.28(63.65)  | 64.04(53.15)  | 35.71(36.69)  | 62.37e(52.48) | 71.13d(57.50)     |
| <b>M-10</b> | 51.24(45.71)          | 58.94(50.15)  | 44.61(41.90)  | 18.84(25.72)  | 43.41n(40.87)  | 50.77(45.44)          | 60.26(50.92)  | 38.73(38.49)  | 16.06(23.62)  | 41.46l(39.62) | 31.88k(34.37)     |
| <b>M-11</b> | 89.22(70.84)          | 100.00(90.00) | 80.56(63.84)  | 59.06(50.22)  | 82.21b(68.73)  | 83.23(65.82)          | 100.00(90.00) | 71.98(58.04)  | 49.77(44.87)  | 76.25b(64.68) | 79.44b(63.04)     |
| <b>M-12</b> | 70.85(57.32)          | 77.75(61.86)  | 59.69(50.59)  | 36.42(37.12)  | 61.18j(51.72)  | 76.86(61.25)          | 86.08(68.11)  | 65.38(53.96)  | 43.79(41.43)  | 68.03d(56.19) | 64.27e(53.29)     |
| <b>M-13</b> | 74.26(59.52)          | 82.95(65.61)  | 66.42(54.59)  | 46.66(43.08)  | 67.57h(55.70)  | 21.04(27.23)          | 65.27(53.89)  | 74.21(59.48)  | 27.10(31.34)  | 46.90j(42.99) | 61.15f(51.45)     |
| <b>M-14</b> | 91.99(73.56)          | 100.00(90.00) | 85.34(67.50)  | 64.66(53.52)  | 85.50a(71.14)  | 86.02(68.06)          | 100.00(90.00) | 75.47(60.32)  | 51.39(45.79)  | 78.22a(66.04) | 82.81a(65.51)     |
| <b>M-15</b> | -                     | -             | -             | -             | -              | -                     | -             | -             | -             | -             | -                 |
| <b>Mean</b> | 75.79b(61.20)         | 84.32a(69.20) | 67.88c(55.84) | 44.46d(41.66) |                | 65.66b(54.49)         | 78.93a(64.92) | 60.58c(51.25) | 35.03d(36.02) |               |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|---------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |                   |
| <b>DF</b>      | 3                     | 13      | 39           | 3                     | 13      | 39           | 13                |
| <b>MS</b>      | 5642.91               | 959.08  | 18.23        | 5999.7                | 823.18  | 86.9         | 236.28            |
| <b>F Value</b> | 19007.1               | 3230.48 | 61.4         | 8158.98               | 1119.44 | 118.18       | 1505.42           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 52: Efficacy of pesticide modules on jassid population (no./leaf) during post-kharif season in 2017**

| Treat.      | DBS         | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |             |              |
|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|-------------|--------------|
|             |             | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean         |
| <b>M-1</b>  | 6.76a(2.69) | 1.22(1.31)            | 0.56(1.03)  | 2.13(1.62)  | 4.33(2.20)  | 2.06i(1.54) | 1.33(1.35)            | 0.93(1.20)  | 1.93(1.56)  | 2.69(1.79)  | 1.72g(1.47)  |
| <b>M-2</b>  | 6.77a(2.70) | 1.58(1.44)            | 0.98(1.22)  | 2.73(1.80)  | 4.91(2.33)  | 2.55h(1.70) | 0.93(1.20)            | 0.40(0.95)  | 1.42(1.39)  | 2.46(1.72)  | 1.30j(1.31)  |
| <b>M-3</b>  | 6.22c(2.59) | 1.24(1.32)            | 0.67(1.08)  | 1.96(1.57)  | 3.56(2.01)  | 1.86j(1.50) | 1.11(1.27)            | 0.82(1.15)  | 1.58(1.44)  | 2.49(1.73)  | 1.50i(1.40)  |
| <b>M-4</b>  | 6.00d(2.55) | 0.78(1.13)            | 0.36(0.92)  | 1.47(1.40)  | 3.27(1.94)  | 1.47k(1.35) | 0.56(1.03)            | 0.20(0.84)  | 0.93(1.20)  | 1.60(1.45)  | 0.82k(1.13)  |
| <b>M-5</b>  | 6.52b(2.65) | 2.13(1.62)            | 1.49(1.41)  | 3.13 (1.91) | 5.73(2.50)  | 3.12e(1.86) | 2.40(1.70)            | 1.82(1.52)  | 3.07(1.89)  | 4.38(2.21)  | 2.92d(1.83)  |
| <b>M-6</b>  | 6.57b(2.66) | 2.38(1.70)            | 1.80(1.52)  | 3.40(1.97)  | 6.00(2.55)  | 3.39d(1.93) | 2.60(1.76)            | 2.02(1.59)  | 3.60(2.02)  | 4.69(2.28)  | 3.23c(1.91)  |
| <b>M-7</b>  | 6.76a(2.69) | 2.78(1.81)            | 2.04(1.60)  | 3.91(2.10)  | 6.60(2.66)  | 3.83c(2.04) | 3.58(2.02)            | 2.91(1.85)  | 4.42(2.22)  | 5.86(2.52)  | 4.19b(2.15)  |
| <b>M-8</b>  | 6.54b(2.65) | 1.96(1.57)            | 1.42(1.39)  | 2.91(1.85)  | 5.76 (2.50) | 3.01f(1.83) | 2.20(1.64)            | 1.71(1.49)  | 2.93(1.85)  | 4.36(2.20)  | 2.80e(1.80)  |
| <b>M-9</b>  | 6.52b(2.65) | 1.11(1.27)            | 0.44(0.97)  | 1.98(1.57)  | 4.07 (2.14) | 1.90j(1.49) | 1.20(1.30)            | 0.80(1.14)  | 1.67(1.47)  | 2.52(1.74)  | 1.55 h(1.41) |
| <b>M-10</b> | 6.52b(2.65) | 2.91(1.85)            | 2.42(1.71)  | 4.00(2.12)  | 6.31(2.61)  | 3.91b(2.07) | 3.53(2.01)            | 2.93(1.85)  | 4.40(2.21)  | 5.71(2.49)  | 4.14b(2.14)  |
| <b>M-11</b> | 6.21c(2.59) | 0.60(1.05)            | 0.00(0.71)  | 1.20(1.30)  | 3.02(1.88)  | 1.21l(1.23) | 0.42(0.96)            | 0.00(0.71)  | 0.67(1.08)  | 1.38(1.37)  | 0.62l(1.03)  |
| <b>M-12</b> | 6.53b(2.65) | 2.04(1.60)            | 1.47(1.40)  | 3.11(1.90)  | 5.75(2.50)  | 3.09e(1.85) | 1.33(1.35)            | 0.76(1.12)  | 2.00(1.58)  | 3.42(1.98)  | 1.88f(1.51)  |
| <b>M-13</b> | 6.52b(2.65) | 1.73(1.49)            | 1.11(1.27)  | 2.76(1.80)  | 4.84(2.31)  | 2.61g(1.72) | 3.82(2.08)            | 2.38(1.70)  | 1.67(1.47)  | 3.75(2.06)  | 2.91 d(1.83) |
| <b>M-14</b> | 6.02d(2.55) | 0.51(1.01)            | 0.00(0.71)  | 1.13(1.28)  | 2.93(1.85)  | 1.14m(1.21) | 0.29(0.89)            | 0.00(0.71)  | 0.58(1.04)  | 1.24(1.32)  | 0.53m(0.99)  |
| <b>M-15</b> | 6.80a(2.70) | 7.02(2.74)            | 7.20(2.77)  | 8.02(2.92)  | 9.20(3.11)  | 7.86a(2.89) | 9.22(3.12)            | 9.33(3.14)  | 9.62(3.18)  | 10.00(3.24) | 9.54a(3.17)  |
| <b>Mean</b> |             | 2.00c(1.53)           | 1.46d(1.31) | 2.92b(1.81) | 5.09a(2.34) |             | 2.30c(1.58)           | 1.80d(1.40) | 2.70b(1.71) | 3.77a(2.01) |              |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14      | 42           |
| <b>MS</b>      | 0.01   | 8.88                  | 2.09    | 0.02         | 2.96                  | 3.71    | 0.04         |
| <b>F Value</b> | 344.81 | 40818.5               | 9618.13 | 108.33       | 13050.1               | 16331.7 | 166.63       |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastara + Agniastara], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastara + Agniastara], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastara + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 53: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during post-kharif season in 2017**

| Treat. | 1 <sup>st</sup> spray |               |               |               |               | 2 <sup>nd</sup> spray |               |               |               |               | Overall reduction |
|--------|-----------------------|---------------|---------------|---------------|---------------|-----------------------|---------------|---------------|---------------|---------------|-------------------|
|        | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          |                   |
| M-1    | 82.49(65.26)          | 92.23(73.82)  | 73.24(58.85)  | 52.60(46.49)  | 75.14d(61.11) | 69.30(56.35)          | 78.77(62.57)  | 57.34(49.22)  | 42.95(40.95)  | 62.09g(52.27) | 72.96e(58.67)     |
| M-2    | 77.45(61.65)          | 86.36(68.33)  | 65.78(54.20)  | 46.38(42.93)  | 68.99e(56.78) | 81.04(64.20)          | 91.97(73.54)  | 72.31(58.25)  | 53.98(47.29)  | 74.83d(60.82) | 75.32d(60.22)     |
| M-3    | 80.63(63.90)          | 89.88 (71.45) | 73.35(58.92)  | 57.75(49.46)  | 75.40d(60.93) | 68.82(56.06)          | 77.19(61.48)  | 57.57(49.36)  | 35.66(36.66)  | 59.81h(50.89) | 72.81e(58.58)     |
| M-4    | 87.45(69.26)          | 94.40(76.33)  | 79.28(62.92)  | 59.76(50.63)  | 80.22b(64.78) | 83.02(65.68)          | 93.96(75.78)  | 72.65(58.49)  | 54.91(47.82)  | 76.14c(61.94) | 81.87c(64.80)     |
| M-5    | 68.30(55.74)          | 78.42(62.32)  | 59.25(50.33)  | 34.97(36.25)  | 60.24h(51.16) | 58.25(49.75)          | 68.66(55.96)  | 48.86(44.35)  | 29.75(33.05)  | 51.38j(45.78) | 54.32h(47.48)     |
| M-6    | 64.94(53.69)          | 74.12(59.42)  | 56.12(48.51)  | 32.46(34.73)  | 56.91i(49.09) | 56.78(48.90)          | 66.77 (54.80) | 42.64(40.77)  | 28.10(32.01)  | 48.57k(44.12) | 51.44i(45.83)     |
| M-7    | 60.22(50.90)          | 71.44(57.70)  | 50.97(45.56)  | 27.84(31.85)  | 52.62j(46.50) | 45.92(42.66)          | 56.51(48.74)  | 35.94(36.83)  | 18.38(25.38)  | 39.19m(38.40) | 41.10j(39.87)     |
| M-8    | 71.06(57.46)          | 79.47(63.06)  | 62.29(52.11)  | 34.98(36.26)  | 61.95g(52.22) | 61.86(51.86)          | 70.68(57.22)  | 51.28(45.73)  | 30.38(33.45)  | 53.55i(47.07) | 54.73h(47.72)     |
| M-9    | 83.51(66.04)          | 93.57(75.31)  | 74.30(59.54)  | 53.92(47.25)  | 76.33c(62.04) | 70.57(57.14)          | 80.60(63.87)  | 60.82(51.25)  | 42.97(40.96)  | 63.74f(53.30) | 73.72e(59.16)     |
| M-10   | 56.79(48.90)          | 64.93(53.69)  | 48.03(43.87)  | 28.49(32.26)  | 49.56k(44.68) | 44.15(41.64)          | 54.16(47.39)  | 33.35(35.28)  | 16.75(24.16)  | 37.10n(37.12) | 40.47j(39.50)     |
| M-11   | 90.65(72.21)          | 100.00(90.00) | 83.63(66.14)  | 64.03(53.15)  | 84.58a(70.38) | 86.08(68.10)          | 100.00(90.00) | 78.92(62.67)  | 58.07(49.65)  | 80.77b(67.60) | 84.92b(67.15)     |
| M-12   | 69.67(56.58)          | 78.78(62.57)  | 59.61(50.54)  | 34.84(36.18)  | 60.73h(51.47) | 76.88(61.27)          | 87.05(68.91)  | 66.77(54.80)  | 45.27(42.29)  | 68.99e(56.81) | 64.34f(53.34)     |
| M-13   | 74.27(59.52)          | 83.91(66.36)  | 64.20(53.25)  | 45.11(42.19)  | 66.87f(55.33) | 21.30(27.48)          | 51.60(45.92)  | 66.97(54.92)  | 28.85(32.48)  | 42.18l(40.20) | 60.94g(51.32)     |
| M-14   | 91.79(73.35)          | 100.00(90.00) | 84.05(66.47)  | 64.00(53.13)  | 84.96a(70.74) | 90.17(71.75)          | 100.00(90.00) | 81.17(64.29)  | 60.94(51.33)  | 83.07a(69.34) | 85.95a(67.99)     |
| M-15   | -                     | -             | -             | -             | -             | -                     | -             | -             | -             | -             | -                 |
| Mean   | 75.66b(61.03)         | 84.82a(69.31) | 66.72c(55.09) | 45.51(d42.34) |               | 65.30b(54.49)         | 76.99a(64.01) | 59.04c(50.44) | 39.07d(38.39) |               |                   |

| Source  | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              | Overall reduction |
|---------|-----------------------|---------|--------------|-----------------------|---------|--------------|-------------------|
|         | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |                   |
| DF      | 3                     | 13      | 39           | 3                     | 13      | 39           | 13                |
| MS      | 5410.02               | 831.56  | 15.33        | 4732.07               | 1308.42 | 69.5         | 267.05            |
| F Value | 24630.1               | 3785.83 | 69.77        | 9851.19               | 2723.85 | 144.69       | 1217.88           |
| Pr>F    | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 54: Efficacy of pesticide modules on jassid population (no./leaf) during post-kharif season (pooled 2016 &2017)**

| Treat.      | DBS          | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |             |             |
|-------------|--------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|
|             |              | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        |
| <b>M-1</b>  | 6.54a(2.65)  | 1.12(1.27)            | 0.49(0.99)  | 1.87(1.54)  | 4.18(2.16)  | 1.91k(1.49) | 1.27(1.33)            | 0.87(1.17)  | 1.73(1.49)  | 2.78(1.81)  | 1.66i(1.45) |
| <b>M-2</b>  | 6.55a(2.65)  | 1.56(1.43)            | 0.94(1.20)  | 2.41(1.71)  | 4.83(2.31)  | 2.44i(1.66) | 0.97(1.21)            | 0.48(0.99)  | 1.49(1.41)  | 2.63(1.77)  | 1.39k(1.34) |
| <b>M-3</b>  | 6.16d(2.58)  | 1.24(1.32)            | 0.71(1.10)  | 1.87(1.54)  | 4.04(2.13)  | 1.97j(1.52) | 1.24(1.32)            | 0.88(1.17)  | 1.70(1.48)  | 2.90(1.84)  | 1.68i(1.46) |
| <b>M-4</b>  | 6.00e(2.55)  | 0.79(1.14)            | 0.32(0.91)  | 1.41(1.38)  | 3.43(1.98)  | 1.49m(1.35) | 0.66(1.07)            | 0.30(0.89)  | 1.02(1.23)  | 1.84(1.53)  | 0.96l(1.18) |
| <b>M-5</b>  | 6.37bc(2.62) | 2.16(1.63)            | 1.52(1.42)  | 3.03(1.88)  | 5.72(2.49)  | 3.11e(1.86) | 2.30(1.67)            | 1.72(1.49)  | 2.93(1.85)  | 4.36(2.20)  | 2.83e(1.81) |
| <b>M-6</b>  | 6.39b(2.62)  | 2.36(1.69)            | 1.80(1.52)  | 3.20(1.92)  | 6.00(2.55)  | 3.34d(1.92) | 2.56(1.75)            | 1.98(1.57)  | 3.32(1.96)  | 4.76(2.29)  | 3.15d(1.89) |
| <b>M-7</b>  | 6.54a(2.65)  | 2.85(1.83)            | 2.14(1.63)  | 3.77(2.07)  | 6.57(2.66)  | 3.83c(2.05) | 3.38(1.97)            | 2.71(1.79)  | 4.22(2.17)  | 5.83(2.52)  | 4.03c(2.11) |
| <b>M-8</b>  | 6.39b(2.62)  | 1.99(1.58)            | 1.40(1.38)  | 2.72(1.79)  | 5.69(2.49)  | 2.95g(1.81) | 2.13(1.62)            | 1.62(1.46)  | 2.73(1.80)  | 4.27(2.18)  | 2.69g(1.77) |
| <b>M-9</b>  | 6.38bc(2.62) | 1.03(1.24)            | 0.38(0.94)  | 1.71(1.49)  | 4.03(2.13)  | 1.79l(1.45) | 1.21(1.31)            | 0.80(1.14)  | 1.57(1.44)  | 2.66(1.78)  | 1.56j(1.42) |
| <b>M-10</b> | 6.37bc(2.62) | 3.14(1.91)            | 2.63(1.77)  | 3.97(2.11)  | 6.77(2.70)  | 4.13b(2.12) | 3.54(2.01)            | 2.92(1.85)  | 4.46(2.23)  | 6.16(2.58)  | 4.27b(2.17) |
| <b>M-11</b> | 6.16d(2.58)  | 0.67(1.08)            | 0.00(0.71)  | 1.28(1.33)  | 3.30(1.95)  | 1.31n(1.27) | 0.51(1.01)            | 0.00(0.71)  | 0.84(1.16)  | 1.67(1.47)  | 0.76m(1.09) |
| <b>M-12</b> | 6.38bc(2.62) | 2.03(1.59)            | 1.51(1.42)  | 2.99(1.87)  | 5.71(2.49)  | 3.06f(1.84) | 1.32(1.35)            | 0.78(1.13)  | 2.00(1.58)  | 3.44(1.99)  | 1.89h(1.51) |
| <b>M-13</b> | 6.37c(2.62)  | 1.76(1.50)            | 1.14(1.28)  | 2.57(1.75)  | 4.79(2.30)  | 2.56h(1.71) | 3.78(2.07)            | 2.02(1.59)  | 1.46(1.40)  | 3.75(2.06)  | 2.75f(1.78) |
| <b>M-14</b> | 6.00e(2.55)  | 0.52(1.01)            | 0.00(0.71)  | 1.07(1.25)  | 2.98(1.86)  | 1.14o(1.21) | 0.36(0.92)            | 0.00(0.71)  | 0.67(1.08)  | 1.42(1.39)  | 0.61n(1.02) |
| <b>M-15</b> | 6.56a(2.66)  | 7.02(2.74)            | 7.11(2.76)  | 7.61(2.85)  | 9.11(3.10)  | 7.71a(2.86) | 9.12(3.10)            | 9.24(3.12)  | 9.41(3.15)  | 9.91(3.23)  | 9.42a(3.15) |
| <b>Mean</b> |              | 2.02c(1.53)           | 1.47d(1.31) | 2.76b(1.77) | 5.14a(2.35) |             | 2.29c(1.58)           | 1.75d(1.39) | 2.64b(1.70) | 3.89a(2.04) |             |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14      | 42           |
| <b>MS</b>      | 0.00   | 9.05                  | 2.07    | 0.02         | 3.42                  | 3.43    | 0.04         |
| <b>F Value</b> | 230.90 | 45569.2               | 10423.3 | 119.95       | 24120.8               | 24193.3 | 287.76       |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 55: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during post-kharif season (pooled 2016 & 2017)**

| Treat.      | 1 <sup>st</sup> spray |               |               |               |               | 2 <sup>nd</sup> spray |               |               |               |               | Overall reduction |
|-------------|-----------------------|---------------|---------------|---------------|---------------|-----------------------|---------------|---------------|---------------|---------------|-------------------|
|             | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          |                   |
| <b>M-1</b>  | 83.98(66.41)          | 93.12(74.80)  | 75.53(60.35)  | 54.05(47.32)  | 76.67e(62.22) | 69.73(56.62)          | 79.59(63.15)  | 59.98(50.75)  | 38.74(38.49)  | 62.01g(52.25) | 71.91e(58.00)     |
| <b>M-2</b>  | 77.83(61.91)          | 86.71(68.62)  | 68.42(55.81)  | 46.90(43.22)  | 69.96g(57.39) | 80.01(63.44)          | 90.22(71.78)  | 70.12(56.86)  | 49.95(44.97)  | 72.57d(59.26) | 73.44d(58.98)     |
| <b>M-3</b>  | 81.16(64.29)          | 89.40(71.00)  | 73.92(59.29)  | 52.90(46.66)  | 74.35f(60.31) | 69.21(56.30)          | 78.45(62.35)  | 59.07(50.23)  | 34.29(35.84)  | 60.25h(51.18) | 68.98f(56.16)     |
| <b>M-4</b>  | 87.74(69.50)          | 95.04(77.14)  | 79.74(63.25)  | 58.90(50.13)  | 80.35c(65.01) | 81.00(64.17)          | 91.50(73.05)  | 71.19(57.54)  | 50.77(45.44)  | 73.61c(60.05) | 79.75c(63.26)     |
| <b>M-5</b>  | 68.42(55.81)          | 77.97(62.01)  | 58.95(50.16)  | 35.36(36.49)  | 60.17k(51.11) | 59.86(50.69)          | 70.33(57.00)  | 50.39(45.22)  | 30.03(33.23)  | 52.65j(46.53) | 54.77j(47.74)     |
| <b>M-6</b>  | 65.58(54.08)          | 74.03(59.36)  | 56.88(48.95)  | 32.43(34.71)  | 57.23l(49.28) | 57.46(49.29)          | 67.50(55.24)  | 46.43(42.95)  | 27.13(31.39)  | 49.63k(44.72) | 50.77k(45.44)     |
| <b>M-7</b>  | 59.25(50.33)          | 69.75(56.63)  | 50.35(45.20)  | 27.72(31.77)  | 51.77m(45.98) | 48.64(44.22)          | 59.31(50.37)  | 37.77(37.92)  | 18.41(25.40)  | 41.03m(39.48) | 41.03l(39.83)     |
| <b>M-8</b>  | 70.95(57.39)          | 79.81(63.30)  | 63.34(52.74)  | 35.95(36.84)  | 62.51i(52.57) | 62.56(52.27)          | 71.89(57.99)  | 53.54(47.03)  | 31.06(33.87)  | 54.76i(47.79) | 55.84i(48.35)     |
| <b>M-9</b>  | 84.88(67.12)          | 94.54(76.50)  | 77.00(61.34)  | 54.51(47.59)  | 77.73d(63.14) | 70.00(56.79)          | 80.44(63.76)  | 62.43(52.20)  | 39.34(38.84)  | 63.05f(52.90) | 72.42e(58.32)     |
| <b>M-10</b> | 54.01(47.30)          | 61.93(51.90)  | 46.32(42.89)  | 23.67(29.11)  | 46.48n(42.80) | 47.46(43.55)          | 57.21(49.15)  | 36.04(36.89)  | 16.40(23.89)  | 39.28n(38.37) | 36.17m(36.97)     |
| <b>M-11</b> | 89.94(71.52)          | 100.00(90.00) | 82.10(64.97)  | 61.55(51.68)  | 83.39b(69.54) | 84.65(66.94)          | 100.00(90.00) | 75.45(60.30)  | 53.92(47.25)  | 78.51b(66.12) | 82.18b(65.03)     |
| <b>M-12</b> | 70.26(56.95)          | 78.26(62.21)  | 59.65(50.56)  | 35.63(36.65)  | 60.95j(51.59) | 76.87(61.25)          | 86.56(68.50)  | 66.08(54.38)  | 44.53(41.86)  | 68.51e(56.50) | 64.31g(53.31)     |
| <b>M-13</b> | 74.27(59.52)          | 83.43(65.98)  | 65.31(53.92)  | 45.88(42.64)  | 67.22h(55.51) | 21.17(27.37)          | 58.43(49.86)  | 70.59(57.16)  | 27.97(31.92)  | 44.54l(41.58) | 61.05h(51.38)     |
| <b>M-14</b> | 91.89(73.45)          | 100.00(90.00) | 84.70(66.98)  | 64.33(53.33)  | 85.23a(70.94) | 88.09(69.83)          | 100.00(90.00) | 78.32(62.25)  | 56.17(48.54)  | 80.64a(67.66) | 84.38a(66.72)     |
| <b>M-15</b> | -                     | -             | -             | -             | -             | -                     | -             | -             | -             | -             | -                 |
| <b>Mean</b> | 75.73b(61.11)         | 84.57a(69.25) | 67.30c(55.46) | 44.98d(42.01) |               | 65.48b(54.48)         | 77.96a(64.44) | 59.81c(50.83) | 37.05d(37.21) |               |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|---------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |                   |
| <b>DF</b>      | 3                     | 13      | 39           | 3                     | 13      | 39           | 13                |
| <b>MS</b>      | 5515.96               | 886.19  | 15.81        | 5330.59               | 1047.54 | 76.21        | 247.62            |
| <b>F Value</b> | 28886.8               | 4640.92 | 82.81        | 14319.5               | 2814    | 204.73       | 3668.77           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 26: Efficacy of pesticide modules on jassid population after 1<sup>st</sup> spray during post-kharif**

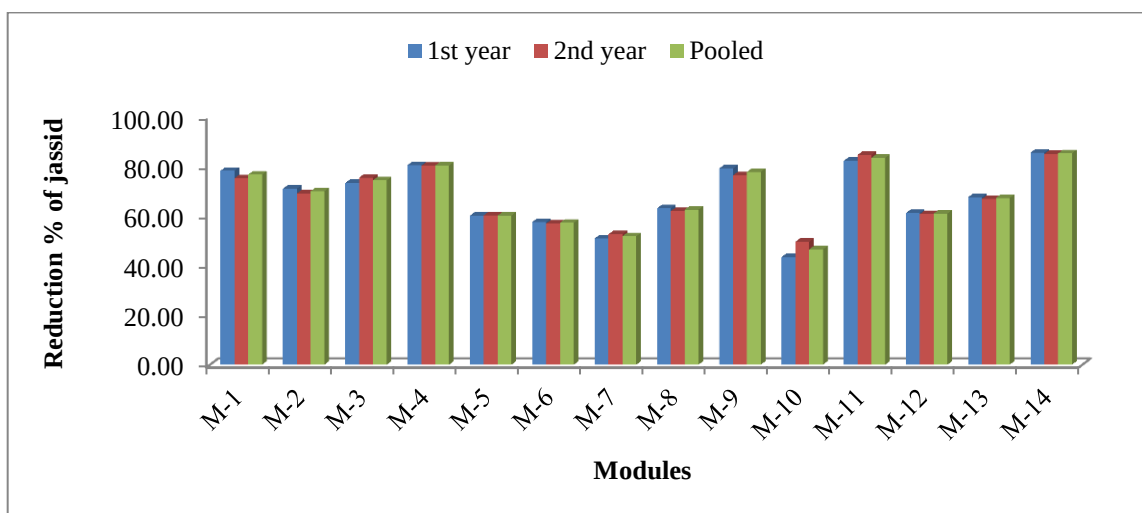


**Fig. 27: Efficacy of pesticide modules on jassid population after 2<sup>nd</sup> spray during post-kharif**

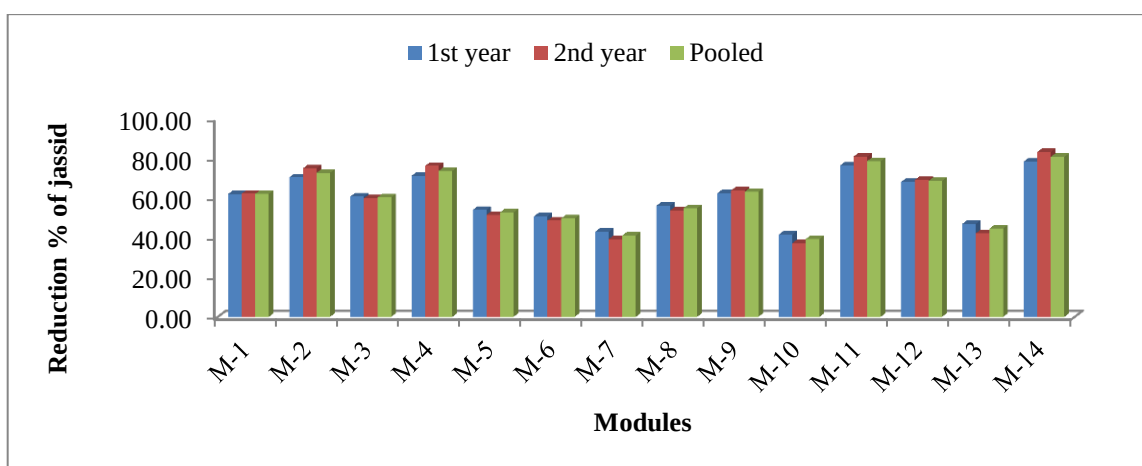
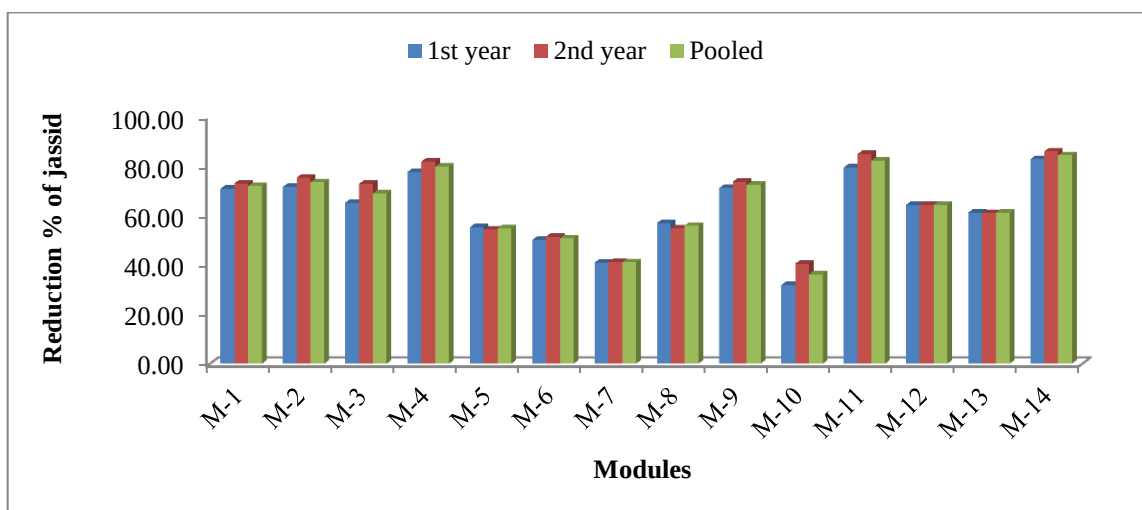


**Fig. 28: Overall efficacy of pesticide modules on jassid population during post-kharif**



#### 4.3.1.2. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.)

The fruit borer (bored fruit %) population varied significantly among the plots where seed treatment was adopted at one day before spray of insecticides. Maximum population was observed where no seed treatment was made, in untreated plot (M15) and other plots like M-1, M-2, M-7 ranged between (13.31 to 13.36%/plant), (14.22 to 14.29%/plant) and (13.78 to 13.80%/plant) in 2016, 2017 and in pooled mean of both years respectively. The significantly lowest population was observed from imidacloprid 17.8SL treated plots, M-14 (10.21, 11.38 and 10.79%/plant) followed by M-4 (10.22, 11.36 and 10.79%/plant) during 2016, 2017 and pooled mean of both years respectively. The moderately effective modules were bijamrita treated plots which were organic in nature (M-5, M-6, M-8, M-9, M-10, M-12 and M-13) ranged between (11.42 to 11.47%/plant), (12.27 to 12.50%/plant) and (11.86 to 11.98%/plant) during 2016, 2017 and pooled mean of both years respectively (Table 56, 58 and 60).

The results on efficacy of different modules on fruit borer population after first sprays are presented in table 56, 58 and 60. Minimum fruit damage was found on M-13 with 3.56%, 4.03% and 3.79% damaged fruit followed by M-14 with 3.62%, 4.47% and 4.05% damaged fruit and M-11 with 4.03%, 4.73% and 4.38% damaged fruit respectively during 2016, 2017 and pooled mean of both years respectively and they differed significantly among each other.

In 2<sup>nd</sup> spray, M-4 were found most effective as it possessed minimum damage fruit (2.03%, 2.65% and 2.34%) while maximum fruit damage was observed from M-10 with 8.28%, 9.41% and 8.84% damaged fruit compare to untreated plot M-15 (22.83%, 26.00% and 24.41% damaged fruit/plant) during 2016, 2017 and pooled mean of both years respectively.

The overall population reduction of the two sprays revealed that M-4 recorded the highest population reduction of 81.48%, 82.55% and 82.02% which was followed by M-2 with 79.29%, 79.60% and 79.44% mortality and M-9 with 78.32%, 79.21% and 78.77% reduction of population, while the lowest reduction was recorded from M-10 with 51.18%, 51.36% and 51.27% reduction of population during 2016, 2017 and pooled mean of both years respectively.

Reduction percentage of fruit borer population on okra varied significantly among different dates of observation after spraying. In overall efficacy during the 1<sup>st</sup>

spray, the highest percentage of reduction of fruit borer damage was noticed after 3day of spraying (70.17%, 71.53% and 70.85%) which was followed by 7 days of spraying (60.73%, 61.29% and 61.01%) and significantly minimum reduction was observed after 14 days of spraying (46.04%, 47.94% and 47.11%) in 2016, 2017 and pooled mean of both years respectively. The similar trend was observed in the 2<sup>nd</sup> spray where 3 days after spraying gave maximum mortality (67.20%, 65.82% and 66.51%) followed by 7 days after spraying (57.78%, 57.35% and 57.57%) and minimum mortality was recorded 14 days after spraying (45.96%, 45.84% and 45.90%) during 2016, 2017 and pooled mean of both the years respectively.

**Table 56: Efficacy of pesticide modules on fruit borer population (% bored fruit) during post-kharif season in 2016**

| Treat.      | DBS           | 1 <sup>st</sup> spray |              |              |               | 2 <sup>nd</sup> spray |              |              |               |
|-------------|---------------|-----------------------|--------------|--------------|---------------|-----------------------|--------------|--------------|---------------|
|             |               | 3DAS                  | 7DAS         | 14DAS        | Mean          | 3DAS                  | 7DAS         | 14DAS        | Mean          |
| <b>M-1</b>  | 13.36a (3.72) | 3.77 (2.07)           | 5.89 (2.53)  | 9.41 (3.15)  | 6.36i (2.58)  | 2.80 (1.82)           | 4.03 (2.13)  | 5.44 (2.44)  | 4.09g (2.13)  |
| <b>M-2</b>  | 13.31a (3.72) | 4.37 (2.21)           | 6.02 (2.55)  | 9.81 (3.21)  | 6.73g (2.66)  | 1.41 (1.38)           | 2.49 (1.73)  | 5.02 (2.35)  | 2.98m (1.82)  |
| <b>M-3</b>  | 10.97c (3.39) | 3.24 (1.93)           | 5.04 (2.35)  | 8.41 (2.98)  | 5.56j (2.42)  | 2.56 (1.75)           | 3.55 (2.01)  | 5.06 (2.36)  | 3.73i (2.04)  |
| <b>M-4</b>  | 10.22d (3.27) | 2.71 (1.79)           | 4.45 (2.22)  | 6.87 (2.71)  | 4.67l (2.24)  | 0.92 (1.19)           | 1.72 (1.49)  | 3.45 (1.99)  | 2.03n (1.56)  |
| <b>M-5</b>  | 11.42b (3.45) | 5.32 (2.41)           | 6.47 (2.64)  | 10.60 (3.33) | 7.46e (2.79)  | 4.88 (2.32)           | 5.81 (2.51)  | 8.30 (2.97)  | 6.33e (2.60)  |
| <b>M-6</b>  | 11.43b (3.45) | 6.00 (2.55)           | 8.05 (2.92)  | 10.81 (3.36) | 8.29d (2.95)  | 5.38 (2.43)           | 7.03 (2.74)  | 8.60 (3.02)  | 7.00d (2.73)  |
| <b>M-7</b>  | 13.35a (3.72) | 7.11 (2.76)           | 9.41 (3.15)  | 12.61 (3.62) | 9.71b (3.18)  | 6.47 (2.64)           | 8.81 (3.05)  | 11.42 (3.45) | 8.90b (3.05)  |
| <b>M-8</b>  | 11.43b (3.45) | 4.36 (2.21)           | 6.12 (2.57)  | 9.00 (3.08)  | 6.50h (2.62)  | 3.80 (2.07)           | 5.08 (2.36)  | 6.77 (2.70)  | 5.21f (2.38)  |
| <b>M-9</b>  | 11.47b (3.46) | 3.08 (1.89)           | 5.02 (2.35)  | 8.23 (2.95)  | 5.44k (2.40)  | 2.30 (1.67)           | 3.26 (1.94)  | 4.53 (2.24)  | 3.36k (1.95)  |
| <b>M-10</b> | 11.44b (3.45) | 6.19 (2.59)           | 8.05 (2.92)  | 11.22 (3.42) | 8.49c (2.98)  | 6.62 (2.67)           | 8.04 (2.92)  | 10.17 (3.27) | 8.28c (2.95)  |
| <b>M-11</b> | 11.00c (3.39) | 2.02 (1.59)           | 3.54 (2.01)  | 6.52 (2.65)  | 4.03m (2.08)  | 2.56 (1.75)           | 3.47 (1.99)  | 4.62 (2.26)  | 3.55j (2.00)  |
| <b>M-12</b> | 11.45b (3.46) | 5.17 (2.38)           | 6.40 (2.63)  | 10.47 (3.31) | 7.35f (2.77)  | 2.33 (1.68)           | 3.87 (2.09)  | 5.63 (2.48)  | 3.95h (2.08)  |
| <b>M-13</b> | 11.45b (3.46) | 1.46 (1.40)           | 3.02 (1.87)  | 6.21 (2.59)  | 3.56o (1.96)  | 3.80 (2.07)           | 3.41 (1.98)  | 4.97 (2.34)  | 4.06g (2.13)  |
| <b>M-14</b> | 10.21d (3.27) | 1.77 (1.51)           | 3.00 (1.87)  | 6.09 (2.57)  | 3.62n (1.98)  | 2.39 (1.70)           | 3.02 (1.87)  | 4.26 (2.18)  | 3.22l (1.92)  |
| <b>M-15</b> | 13.32a (3.72) | 15.39 (3.99)          | 16.67 (4.14) | 19.10 (4.43) | 17.05a (4.19) | 21.98 (4.74)          | 22.22 (4.77) | 24.27 (4.98) | 22.83a (4.83) |
| <b>Mean</b> |               | 4.80c (2.22)          | 6.48b (2.58) | 9.69a (3.16) |               | 4.68c (2.13)          | 5.72b (2.37) | 7.50a (2.73) |               |

| Source         | DBS     | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|---------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |         | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14      | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.07    | 10.13                 | 2.83    | 0.03         | 4.22                  | 5.65    | 0.03         |
| <b>F Value</b> | 1782.46 | 24712.9               | 6904.85 | 65.78        | 6399.87               | 8566.91 | 49.66        |
| <b>Pr&gt;F</b> | <.0001  | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 57: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during post-kharif season in 2016**

| Treat. | 1 <sup>st</sup> spray |         |        |         |        |         | 2 <sup>nd</sup> spray |         |        |         |        |         | Overall control |         |        |         |                |
|--------|-----------------------|---------|--------|---------|--------|---------|-----------------------|---------|--------|---------|--------|---------|-----------------|---------|--------|---------|----------------|
|        | 3DAS                  |         | 7DAS   |         | 14DAS  |         | Mean                  |         | 3DAS   |         | 7DAS   |         |                 | 14DAS   |        | Mean    |                |
| M-1    | 75.53                 | (60.35) | 64.74  | (53.57) | 50.85  | (45.48) | 63.70e                | (53.14) | 74.03  | (59.37) | 63.22  | (52.67) | 54.47           | (47.57) | 63.91d | (53.20) | 77.62cd(61.77) |
| M-2    | 71.58                 | (57.78) | 63.86  | (53.05) | 48.61  | (44.21) | 61.35f                | (51.68) | 87.43  | (69.24) | 78.16  | (62.14) | 59.69           | (50.59) | 75.09a | (60.66) | 79.29b(62.93)  |
| M-3    | 74.39                 | (59.61) | 63.25  | (52.68) | 46.52  | (43.00) | 61.39f                | (51.77) | 73.41  | (58.97) | 63.73  | (52.97) | 52.59           | (46.48) | 63.24d | (52.81) | 74.65f(59.77)  |
| M-4    | 77.06                 | (61.38) | 65.24  | (53.87) | 53.10  | (46.78) | 65.14d                | (54.01) | 88.38  | (70.07) | 78.43  | (62.33) | 60.47           | (51.05) | 75.76a | (61.15) | 81.48a(64.51)  |
| M-5    | 59.66                 | (50.57) | 54.75  | (47.73) | 35.25  | (36.42) | 49.89i                | (44.90) | 59.82  | (50.68) | 52.91  | (46.67) | 38.39           | (38.29) | 50.38g | (45.21) | 60.13h(50.84)  |
| M-6    | 54.55                 | (47.61) | 43.71  | (41.39) | 34.06  | (35.70) | 44.11j                | (41.57) | 56.60  | (48.80) | 44.07  | (41.59) | 37.36           | (37.68) | 46.01h | (42.69) | 58.71i(50.02)  |
| M-7    | 53.91                 | (47.24) | 43.66  | (41.36) | 34.13  | (35.74) | 43.90j                | (41.45) | 55.24  | (48.02) | 39.95  | (39.20) | 28.72           | (32.40) | 41.31i | (39.87) | 53.06j(46.76)  |
| M-8    | 66.95                 | (54.91) | 57.20  | (49.14) | 45.09  | (42.18) | 56.41g                | (48.74) | 63.21  | (52.67) | 51.51  | (45.86) | 40.83           | (39.72) | 51.85f | (46.08) | 67.51g(55.25)  |
| M-9    | 76.76                 | (61.18) | 65.00  | (53.73) | 49.88  | (44.93) | 63.88e                | (53.28) | 75.58  | (60.41) | 65.85  | (54.25) | 56.59           | (48.79) | 66.01c | (54.49) | 78.32c(62.25)  |
| M-10   | 53.16                 | (46.81) | 43.73  | (41.39) | 31.59  | (34.19) | 42.82k                | (40.80) | 48.57  | (44.18) | 38.41  | (38.30) | 28.62           | (32.33) | 38.53j | (38.27) | 51.18k(45.68)  |
| M-11   | 84.10                 | (66.50) | 74.27  | (59.52) | 58.64  | (49.98) | 72.34c                | (58.66) | 65.74  | (54.19) | 54.30  | (47.46) | 44.31           | (41.73) | 54.78e | (47.79) | 76.97de(61.32) |
| M-12   | 60.89                 | (51.29) | 55.33  | (48.06) | 36.25  | (37.01) | 50.82h                | (45.45) | 80.53  | (63.84) | 68.21  | (55.68) | 59.41           | (50.43) | 69.38b | (56.65) | 74.14f(59.44)  |
| M-13   | 88.95                 | (70.58) | 78.96  | (62.70) | 62.18  | (52.05) | 76.69a                | (61.78) | 46.57  | (43.03) | 52.78  | (46.60) | 37.02           | (37.48) | 45.46h | (42.37) | 76.19e(60.79)  |
| M-14   | 84.95                 | (67.17) | 76.53  | (61.02) | 58.39  | (49.83) | 73.29b                | (59.34) | 65.74  | (54.19) | 57.45  | (49.28) | 45.00           | (42.13) | 56.06e | (48.54) | 77.13de(61.43) |
| M-15   | -                     |         | -      |         | -      |         | -                     |         | -      |         | -      |         | -               |         | -      |         | -              |
| Mean   | 70.17a                | (57.36) | 60.73b | (51.37) | 46.04c | (42.68) |                       |         | 67.20a | (55.55) | 57.78b | (49.64) | 45.96c          | (42.62) |        |         |                |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 2                     | 13      | 26           | 2                     | 13     | 26           | 13                |
| <b>MS</b>      | 2288.58               | 427.65  | 5.38         | 1759.54               | 491.5  | 12.51        | 122.17            |
| <b>F Value</b> | 7262.12               | 1357.03 | 17.09        | 2315.84               | 646.89 | 16.46        | 847.07            |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 58: Efficacy of pesticide modules on fruit borer population (% bored fruit) during post-kharif season in 2017**

| Treat. | DBS     |        | 1 <sup>st</sup> spray |        |       |        |        |        | 2 <sup>nd</sup> spray |        |       |        |       |        |       |        |        |        |
|--------|---------|--------|-----------------------|--------|-------|--------|--------|--------|-----------------------|--------|-------|--------|-------|--------|-------|--------|--------|--------|
|        |         |        | 3DAS                  |        | 7DAS  |        | 14DAS  |        | Mean                  |        | 3DAS  |        | 7DAS  |        | 14DAS |        | Mean   |        |
| M-1    | 14.22a  | (3.84) | 4.27                  | (2.18) | 6.07  | (2.56) | 9.92   | (3.23) | 6.75g                 | (2.66) | 3.34  | (1.96) | 4.43  | (2.22) | 6.18  | (2.58) | 4.65f  | (2.25) |
| M-2    | 14.29a  | (3.85) | 5.00                  | (2.35) | 6.64  | (2.67) | 10.77  | (3.36) | 7.47f                 | (2.79) | 2.22  | (1.65) | 3.76  | (2.06) | 5.89  | (2.53) | 3.96hi | (2.08) |
| M-3    | 12.06c  | (3.54) | 3.96                  | (2.11) | 5.50  | (2.45) | 8.80   | (3.05) | 6.09h                 | (2.54) | 3.02  | (1.88) | 4.00  | (2.12) | 5.61  | (2.47) | 4.21g  | (2.16) |
| M-4    | 11.36d  | (3.44) | 3.21                  | (1.93) | 4.67  | (2.27) | 7.44   | (2.82) | 5.11j                 | (2.34) | 1.42  | (1.39) | 2.51  | (1.74) | 4.00  | (2.12) | 2.65k  | (1.75) |
| M-5    | 12.44b  | (3.60) | 5.41                  | (2.43) | 7.31  | (2.80) | 11.21  | (3.42) | 7.98d                 | (2.88) | 5.22  | (2.39) | 6.34  | (2.61) | 9.46  | (3.16) | 7.00d  | (2.72) |
| M-6    | 12.50b  | (3.61) | 5.53                  | (2.46) | 8.00  | (2.92) | 11.94  | (3.53) | 8.49c                 | (2.97) | 5.77  | (2.50) | 7.44  | (2.82) | 10.20 | (3.27) | 7.80c  | (2.86) |
| M-7    | 14.22a  | (3.84) | 6.43                  | (2.63) | 9.21  | (3.12) | 13.81  | (3.78) | 9.82b                 | (3.18) | 6.82  | (2.71) | 8.81  | (3.05) | 12.04 | (3.54) | 9.22b  | (3.10) |
| M-8    | 12.40b  | (3.59) | 4.82                  | (2.31) | 6.47  | (2.64) | 10.79  | (3.36) | 7.36f                 | (2.77) | 4.14  | (2.15) | 5.54  | (2.46) | 8.60  | (3.02) | 6.09e  | (2.54) |
| M-9    | 12.48b  | (3.60) | 3.35                  | (1.96) | 5.21  | (2.39) | 8.41   | (2.98) | 5.66i                 | (2.45) | 2.52  | (1.74) | 3.53  | (2.01) | 5.24  | (2.40) | 3.77j  | (2.05) |
| M-10   | 12.40b  | (3.59) | 6.52                  | (2.65) | 8.99  | (3.08) | 13.90  | (3.79) | 9.81b                 | (3.18) | 7.00  | (2.74) | 9.05  | (3.09) | 12.18 | (3.56) | 9.41b  | (3.13) |
| M-11   | 12.00c  | (3.54) | 2.68                  | (1.78) | 4.10  | (2.14) | 7.40   | (2.81) | 4.73k                 | (2.25) | 2.83  | (1.83) | 3.69  | (2.05) | 5.53  | (2.46) | 4.02h  | (2.11) |
| M-12   | 12.29bc | (3.58) | 5.22                  | (2.39) | 7.32  | (2.80) | 10.79  | (3.36) | 7.78e                 | (2.85) | 2.70  | (1.79) | 4.04  | (2.13) | 6.22  | (2.59) | 4.32g  | (2.17) |
| M-13   | 12.27bc | (3.57) | 1.59                  | (1.45) | 3.43  | (1.98) | 7.06   | (2.75) | 4.03m                 | (2.06) | 4.58  | (2.25) | 3.52  | (2.00) | 5.81  | (2.51) | 4.64f  | (2.26) |
| M-14   | 11.38d  | (3.45) | 2.51                  | (1.74) | 3.91  | (2.10) | 7.00   | (2.74) | 4.47l                 | (2.19) | 2.67  | (1.78) | 3.53  | (2.01) | 5.18  | (2.38) | 3.79ij | (2.06) |
| M-15   | 14.29a  | (3.85) | 17.73                 | (4.27) | 18.09 | (4.31) | 21.60  | (4.70) | 19.14a                | (4.43) | 24.24 | (4.97) | 24.87 | (5.04) | 28.88 | (5.42) | 26.00a | (5.14) |
| Mean   |         |        | 5.22c                 | (2.31) | 7.00b | (2.68) | 10.72a | (3.31) |                       |        | 5.23c | (2.25) | 6.34b | (2.49) | 8.74a | (2.93) |        |        |

| Source         | DBS    |  | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|--|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        |  | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     |  | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.06   |  | 11.55                 | 2.96    | 0.03         | 5.43                  | 6.11    | 0.03         |
| <b>F Value</b> | 123.96 |  | 13937.2               | 3571.71 | 33.04        | 5513.18               | 6208.39 | 29.68        |
| <b>Pr&gt;F</b> | <.0001 |  | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 59: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during post-kharif season in 2017**

| Treat.      | 1 <sup>st</sup> spray |                |                |                | 2 <sup>nd</sup> spray |                |                |                 | Overall reduction |
|-------------|-----------------------|----------------|----------------|----------------|-----------------------|----------------|----------------|-----------------|-------------------|
|             | 3DAS                  | 7DAS           | 14DAS          | Mean           | 3DAS                  | 7DAS           | 14DAS          | Mean            |                   |
| <b>M-1</b>  | 74.88 (59.93)         | 66.25 (54.49)  | 53.85 (47.21)  | 65.00d (53.88) | 70.03 (56.81)         | 61.19 (51.47)  | 53.40 (46.95)  | 61.54d (51.74)  | 78.50bc(62.38)    |
| <b>M-2</b>  | 70.78 (57.28)         | 63.26 (52.69)  | 50.12 (45.07)  | 61.39f (51.68) | 81.61 (64.60)         | 69.66 (56.58)  | 59.12 (50.26)  | 70.13a (57.15)  | 79.60b(63.16)     |
| <b>M-3</b>  | 72.58 (58.42)         | 63.95 (53.10)  | 51.71 (45.98)  | 62.74e (52.50) | 69.39 (56.41)         | 60.54 (51.08)  | 50.16 (45.09)  | 60.03e (50.86)  | 75.93ef(60.62)    |
| <b>M-4</b>  | 76.39 (60.94)         | 67.51 (55.25)  | 56.66 (48.83)  | 66.86c (55.01) | 83.00 (65.65)         | 70.67 (57.21)  | 59.75 (50.62)  | 71.14a (57.83)  | 82.55a(65.31)     |
| <b>M-5</b>  | 63.63 (52.92)         | 53.54 (47.03)  | 40.36 (39.44)  | 52.51h (46.46) | 58.51 (49.90)         | 50.91 (45.52)  | 36.92 (37.41)  | 48.78h (44.28)  | 62.37h(52.16)     |
| <b>M-6</b>  | 63.13 (52.61)         | 49.44 (44.68)  | 36.78 (37.33)  | 49.78i (44.87) | 56.93 (48.98)         | 45.90 (42.65)  | 36.05 (36.89)  | 46.29i (42.84)  | 59.61i(50.54)     |
| <b>M-7</b>  | 62.33 (52.14)         | 48.85 (44.34)  | 35.75 (36.72)  | 48.98i (44.40) | 55.99 (48.44)         | 44.60 (41.90)  | 34.74 (36.11)  | 45.11ij (42.15) | 58.08i(49.65)     |
| <b>M-8</b>  | 67.50 (55.25)         | 58.74 (50.03)  | 42.40 (40.63)  | 56.21g (48.64) | 65.81 (54.22)         | 55.36 (48.08)  | 40.40 (39.46)  | 53.86g (47.26)  | 65.67g(54.14)     |
| <b>M-9</b>  | 77.60 (61.76)         | 67.03 (54.96)  | 55.42 (48.11)  | 66.68c (54.94) | 73.28 (58.88)         | 63.52 (52.84)  | 53.37 (46.93)  | 63.39c (52.88)  | 79.21b(62.88)     |
| <b>M-10</b> | 56.03 (48.47)         | 42.69 (40.79)  | 25.79 (30.50)  | 41.50j (39.92) | 55.12 (47.94)         | 43.47 (41.25)  | 34.42 (35.92)  | 44.34j (41.70)  | 51.36j(45.78)     |
| <b>M-11</b> | 81.34 (64.42)         | 73.02 (58.71)  | 59.20 (50.30)  | 71.19b (57.81) | 65.91 (54.28)         | 56.72 (48.87)  | 44.08 (41.60)  | 55.57f (48.25)  | 77.18cde(61.47)   |
| <b>M-12</b> | 64.51 (53.44)         | 52.96 (46.70)  | 41.89 (40.33)  | 53.12h (46.82) | 77.68 (61.81)         | 67.48 (55.24)  | 56.82 (48.93)  | 67.33b (55.32)  | 74.93f(59.96)     |
| <b>M-13</b> | 89.15 (70.77)         | 77.92 (61.97)  | 61.94 (51.91)  | 76.34a (61.55) | 42.18 (40.50)         | 56.70 (48.85)  | 37.84 (37.96)  | 45.57i (42.44)  | 76.34def(60.90)   |
| <b>M-14</b> | 81.54 (64.57)         | 72.87 (58.61)  | 59.29 (50.35)  | 71.23b (57.84) | 66.04 (54.36)         | 56.18 (48.55)  | 44.71 (41.96)  | 55.64f (48.29)  | 77.49cd(61.68)    |
| <b>M-15</b> | -                     | -              | -              | -              | -                     | -              | -              | -               |                   |
| <b>Mean</b> | 71.53a (58.07)        | 61.29b (51.67) | 47.94c (43.76) |                | 65.82a (54.48)        | 57.35b (49.29) | 45.84c (42.58) |                 |                   |

| Source         | 1 <sup>st</sup> spray |        |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|--------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 2                     | 13     | 26           | 2                     | 13     | 26           | 13                |
| <b>MS</b>      | 2155.43               | 342.18 | 3.64         | 1496.4                | 288.89 | 13.99        | 113.34            |
| <b>F Value</b> | 3320.55               | 527.15 | 5.61         | 2437.96               | 470.67 | 22.79        | 330.92            |
| <b>Pr&gt;F</b> | <.0001                | <.0001 | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 60: Efficacy of pesticide modules on fruit borer population (% bored fruit) during post-kharif season (pooled 2016 & 2017)**

| Treat.      | DBS            | 1 <sup>st</sup> spray |              |               |               | 2 <sup>nd</sup> spray |              |              |               |
|-------------|----------------|-----------------------|--------------|---------------|---------------|-----------------------|--------------|--------------|---------------|
|             |                | 3DAS                  | 7DAS         | 14DAS         | Mean          | 3DAS                  | 7DAS         | 14DAS        | Mean          |
| <b>M-1</b>  | 13.79a (3.78)  | 4.02 (2.13)           | 5.98 (2.55)  | 9.66 (3.19)   | 6.56i (2.62)  | 3.07 (1.89)           | 4.23 (2.17)  | 5.81 (2.51)  | 4.37g (2.19)  |
| <b>M-2</b>  | 13.80a (3.78)  | 4.69 (2.28)           | 6.33 (2.61)  | 10.29 (3.28)  | 7.10g (2.73)  | 1.82 (1.52)           | 3.13 (1.90)  | 5.46 (2.44)  | 3.47l (1.96)  |
| <b>M-3</b>  | 11.52d (3.47)  | 3.60 (2.03)           | 5.27 (2.40)  | 8.61 (3.02)   | 5.83j (2.48)  | 2.79 (1.81)           | 3.77 (2.07)  | 5.34 (2.42)  | 3.97i (2.10)  |
| <b>M-4</b>  | 10.79e (3.36)  | 2.96 (1.86)           | 4.56 (2.25)  | 7.15 (2.77)   | 4.89l (2.29)  | 1.17 (1.29)           | 2.12 (1.62)  | 3.73 (2.06)  | 2.34m (1.66)  |
| <b>M-5</b>  | 11.93bc (3.53) | 5.37 (2.42)           | 6.89 (2.72)  | 10.91 (3.38)  | 7.72e (2.84)  | 5.05 (2.36)           | 6.07 (2.56)  | 8.88 (3.06)  | 6.67e (2.66)  |
| <b>M-6</b>  | 11.97bc (3.53) | 5.77 (2.50)           | 8.03 (2.92)  | 11.37 (3.45)  | 8.39d (2.96)  | 5.58 (2.47)           | 7.24 (2.78)  | 9.40 (3.15)  | 7.40d (2.80)  |
| <b>M-7</b>  | 13.78a (3.78)  | 6.77 (2.70)           | 9.31 (3.13)  | 13.21 (3.70)  | 9.76b (3.18)  | 6.65 (2.67)           | 8.81 (3.05)  | 11.73 (3.50) | 9.06b (3.07)  |
| <b>M-8</b>  | 11.92bc (3.52) | 4.59 (2.26)           | 6.30 (2.61)  | 9.90 (3.22)   | 6.93h (2.70)  | 3.97 (2.11)           | 5.31 (2.41)  | 7.68 (2.86)  | 5.65f (2.46)  |
| <b>M-9</b>  | 11.98b (3.53)  | 3.22 (1.93)           | 5.12 (2.37)  | 8.32 (2.97)   | 5.55k (2.42)  | 2.41 (1.71)           | 3.40 (1.97)  | 4.89 (2.32)  | 3.56k (2.00)  |
| <b>M-10</b> | 11.92bc (3.52) | 6.35 (2.62)           | 8.52 (3.00)  | 12.56 (3.61)  | 9.15c (3.08)  | 6.81 (2.70)           | 8.54 (3.01)  | 11.18 (3.42) | 8.84c (3.04)  |
| <b>M-11</b> | 11.50d (3.46)  | 2.35 (1.69)           | 3.82 (2.08)  | 6.96 (2.73)   | 4.38m (2.17)  | 2.70 (1.79)           | 3.58 (2.02)  | 5.07 (2.36)  | 3.78j (2.06)  |
| <b>M-12</b> | 11.87bc (3.52) | 5.20 (2.39)           | 6.86 (2.71)  | 10.63 (3.34)  | 7.56f (2.81)  | 2.52 (1.74)           | 3.96 (2.11)  | 5.93 (2.54)  | 4.13h (2.13)  |
| <b>M-13</b> | 11.86c (3.52)  | 1.53 (1.42)           | 3.22 (1.93)  | 6.63 (2.67)   | 3.79o (2.01)  | 4.19 (2.17)           | 3.46 (1.99)  | 5.39 (2.43)  | 4.35g (2.19)  |
| <b>M-14</b> | 10.79e (3.36)  | 2.14 (1.63)           | 3.45 (1.99)  | 6.55 (2.65)   | 4.05n (2.09)  | 2.53 (1.74)           | 3.27 (1.94)  | 4.72 (2.28)  | 3.51k (1.99)  |
| <b>M-15</b> | 13.80a (3.78)  | 16.56 (4.13)          | 17.38 (4.23) | 20.35 (4.57)  | 18.10a (4.31) | 23.11 (4.86)          | 23.55 (4.90) | 26.57 (5.20) | 24.41a (4.99) |
| <b>Mean</b> |                | 5.01c (2.26)          | 6.74b (2.63) | 10.21a (3.24) |               | 4.96c (2.19)          | 6.03b (2.43) | 8.12a (2.84) |               |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.07   | 10.86                 | 2.89    | 0.02         | 4.81                  | 5.87    | 0.03         |
| <b>F Value</b> | 544.31 | 31979.4               | 8511.63 | 66.57        | 10641.6               | 13007.1 | 61.68        |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 61: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during post-kharif season (pooled 2016 & 2017)**

| Treat. | 1 <sup>st</sup> spray |         |        |         |        |         | 2 <sup>nd</sup> spray |         |        |         |        |         | Overall reduction |         |        |         |               |
|--------|-----------------------|---------|--------|---------|--------|---------|-----------------------|---------|--------|---------|--------|---------|-------------------|---------|--------|---------|---------------|
|        | 3DAS                  |         | 7DAS   |         | 14DAS  |         | Mean                  |         | 3DAS   |         | 7DAS   |         |                   | 14DAS   |        | Mean    |               |
| M-1    | 75.21                 | (60.14) | 65.50  | (54.03) | 52.35  | (46.35) | 64.35e                | (53.50) | 72.03  | (58.07) | 62.20  | (52.06) | 53.94             | (47.26) | 62.72e | (52.47) | 78.06c(62.07) |
| M-2    | 71.18                 | (57.53) | 63.56  | (52.87) | 49.37  | (44.64) | 61.37f                | (51.68) | 84.52  | (66.83) | 73.91  | (59.29) | 59.41             | (50.42) | 72.61b | (58.85) | 79.44b(63.04) |
| M-3    | 73.48                 | (59.01) | 63.60  | (52.89) | 49.11  | (44.49) | 62.06f                | (52.13) | 71.40  | (57.67) | 62.13  | (52.02) | 51.37             | (45.79) | 61.63f | (51.83) | 75.29f(60.19) |
| M-4    | 76.73                 | (61.16) | 66.38  | (54.56) | 54.88  | (47.80) | 66.00d                | (54.51) | 85.69  | (67.77) | 74.55  | (59.71) | 60.11             | (50.83) | 73.45a | (59.44) | 82.02a(64.91) |
| M-5    | 61.65                 | (51.74) | 54.15  | (47.38) | 37.80  | (37.94) | 51.20h                | (45.68) | 59.17  | (50.29) | 51.91  | (46.10) | 37.66             | (37.85) | 49.58i | (44.75) | 61.25i(51.50) |
| M-6    | 58.84                 | (50.09) | 46.57  | (43.04) | 35.42  | (36.52) | 46.94i                | (43.22) | 56.76  | (48.89) | 44.99  | (42.12) | 36.71             | (37.28) | 46.15j | (42.77) | 59.16j(50.28) |
| M-7    | 58.12                 | (49.67) | 46.25  | (42.85) | 34.94  | (36.23) | 46.44i                | (42.92) | 55.62  | (48.23) | 42.28  | (40.56) | 31.73             | (34.28) | 43.21k | (41.02) | 55.57k(48.20) |
| M-8    | 67.22                 | (55.08) | 57.97  | (49.59) | 43.74  | (41.40) | 56.31g                | (48.69) | 64.51  | (53.44) | 53.43  | (46.97) | 40.62             | (39.59) | 52.85h | (46.67) | 66.59h(54.69) |
| M-9    | 77.18                 | (61.47) | 66.01  | (54.34) | 52.65  | (46.52) | 65.28d                | (54.11) | 74.43  | (59.63) | 64.69  | (53.54) | 54.98             | (47.86) | 64.70d | (53.68) | 78.77b(62.56) |
| M-10   | 54.59                 | (47.64) | 43.21  | (41.09) | 28.69  | (32.37) | 42.16j                | (40.37) | 51.84  | (46.06) | 40.94  | (39.78) | 31.52             | (34.15) | 41.43l | (40.00) | 51.27l(45.73) |
| M-11   | 82.72                 | (65.44) | 73.65  | (59.11) | 58.92  | (50.14) | 71.76c                | (58.23) | 65.83  | (54.23) | 55.51  | (48.16) | 44.20             | (41.67) | 55.18g | (48.02) | 77.08d(61.39) |
| M-12   | 62.70                 | (52.36) | 54.14  | (47.38) | 39.07  | (38.68) | 51.97h                | (46.14) | 79.11  | (62.80) | 67.85  | (55.46) | 58.12             | (49.67) | 68.36c | (55.98) | 74.54g(59.69) |
| M-13   | 89.05                 | (70.68) | 78.44  | (62.33) | 62.06  | (51.98) | 76.52a                | (61.66) | 44.37  | (41.76) | 54.74  | (47.72) | 37.43             | (37.72) | 45.51j | (42.40) | 76.27e(60.85) |
| M-14   | 83.25                 | (65.84) | 74.70  | (59.80) | 60.61  | (51.14) | 72.85b                | (58.93) | 65.89  | (54.27) | 56.82  | (48.92) | 44.85             | (42.05) | 55.85g | (48.41) | 77.31d(61.55) |
| M-15   | -                     |         | -      |         | -      |         | -                     |         | -      |         | -      |         | -                 |         | -      |         | -             |
| Mean   | 70.85a                | (57.70) | 61.01b | (51.52) | 47.11c | (43.30) |                       |         | 66.51a | (55.00) | 57.57b | (49.46) | 45.90c            | (42.60) |        |         |               |

| Source         | 1 <sup>st</sup> spray |        |              | 2 <sup>nd</sup> spray |         |              | Overall reduction |
|----------------|-----------------------|--------|--------------|-----------------------|---------|--------------|-------------------|
|                | Day                   | Module | Day x Module | Day                   | Module  | Day x Module |                   |
| <b>DF</b>      | 2                     | 13     | 26           | 2                     | 13      | 26           | 13                |
| <b>MS</b>      | 2192.42               | 383.89 | 2.2          | 1619.36               | 379.74  | 11.73        | 117.18            |
| <b>F Value</b> | 5337.76               | 934.64 | 5.35         | 5725.92               | 1342.75 | 41.47        | 1417.17           |
| <b>Pr&gt;F</b> | <.0001                | <.0001 | <.0001       | <.0001                | <.0001  | <.0001       | <.0001            |
| <b>LSD</b>     |                       |        |              |                       |         |              | 0.4826            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 29: Efficacy of pesticide modules on fruit borer population (bored fruit %) after 1<sup>st</sup> spray during post-kharif**

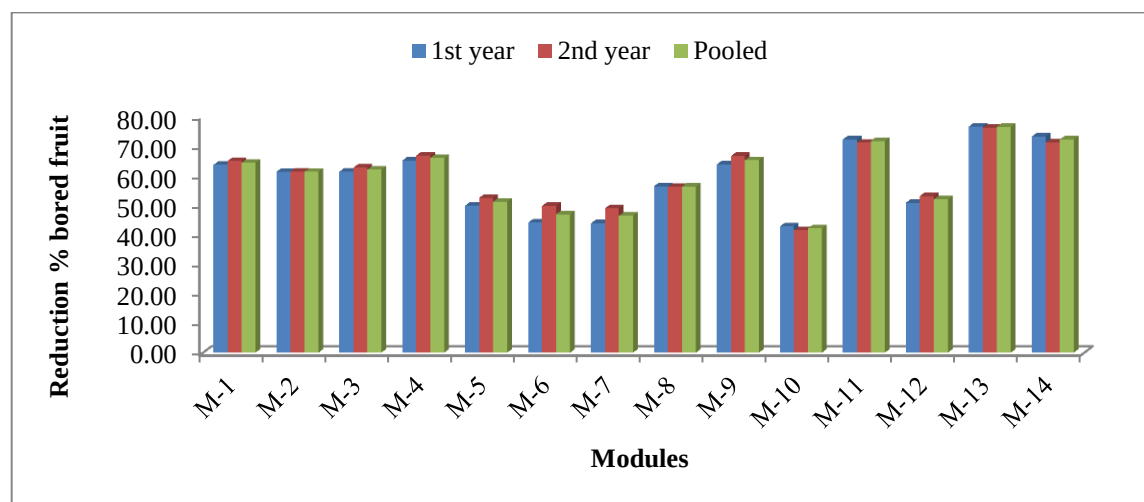


**Fig. 30: Efficacy of pesticide modules on fruit borer population (bored fruit %) after 2<sup>nd</sup> spray during post-kharif**

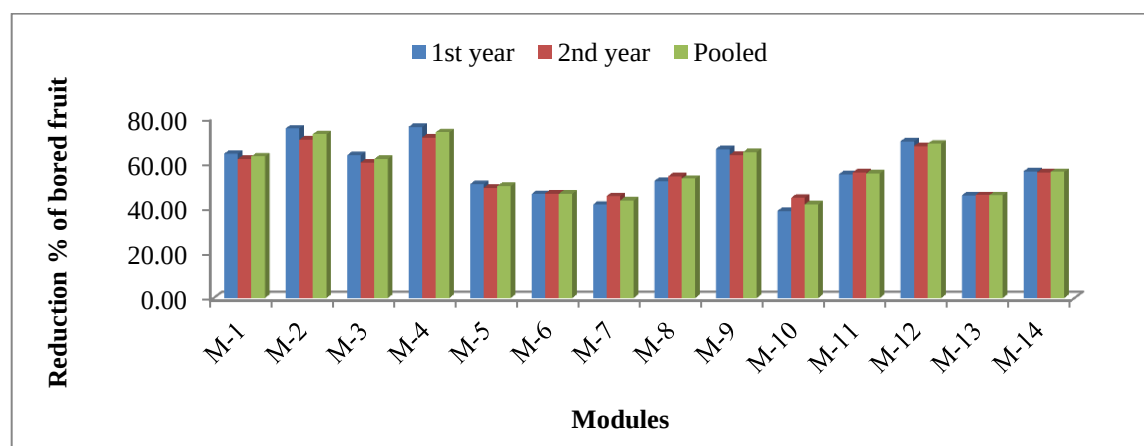
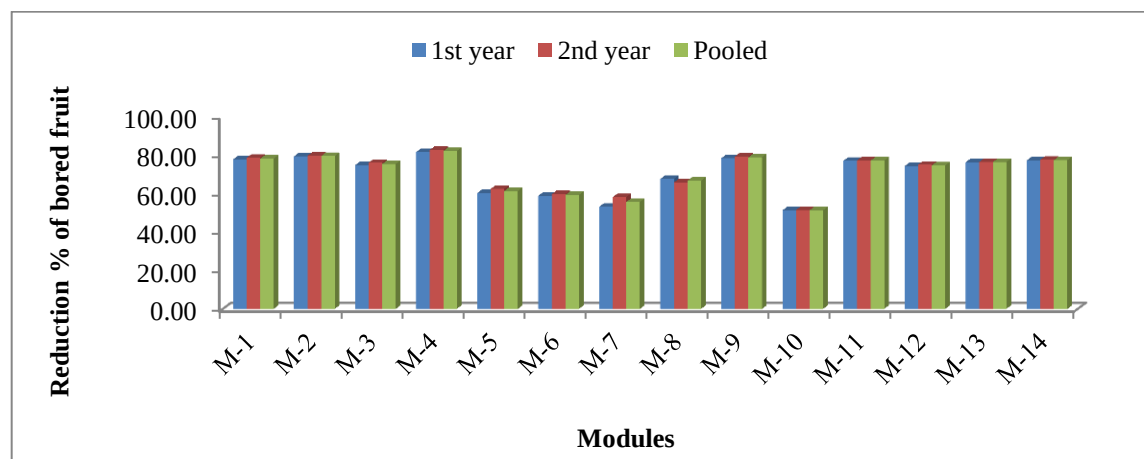


**Fig. 31: Overall efficacy of pesticide modules on fruit borer population (bored fruit %) during post-kharif**



#### 4.3.1.3. Coccinellid

The coccinellid populations on before insecticidal spray varied significantly among the plots where seed treatment was done. Maximum population was observed where no seed treatment was made in untreated plot (M15) and other plots like M1, M2 and M7 ranged between (1.00 to 1.00/plant), (0.80 to 0.87/plant) and (0.90 to 0.94/plant) in 2016, 2017 and in pooled mean of both years respectively. The significantly lowest population was observed from imidacloprid 17.8SL treated plot *i.e.*, M-14 with population of 0.62, 0.55 and 0.59/plant followed by M-4 (0.60, 0.55 and 0.58/plant) during 2016, 2017 and pooled mean of both year respectively. The next effective modules were bijamrita (organic in nature) treated plots like M-5, M-6, M-8, M-9, M-10, M-12 and M-13 range between (0.80 to 0.82/plant), (0.67 to 0.73/plant) and (0.75 to 0.77/plant) as compare to untreated plot (M-15) during 2016, 2017 and pooled mean of both years respectively (Table 62, 63 and 64).

The coccinellid population at 14 DAS revealed that M-14 recorded the maximum reduction of 52.86% with population of 0.35/plant, 47.94% with 0.33/plant and 50.40% with 0.34/plant during 2016, 2017 and pooled of both years and this module was found to be at par with M-11 having reduction of 51.61% with population of 0.40/plant, 46.39% with 0.40/plant and 49.00% with 0.40/plant during 2016, 2017 and pooled of both years respectively. The minimum reduction of 21.53% with 0.75/plant, 15.54% with 0.71/plant and 18.53% with 0.73/plant during 2016, 2017 and pooled of both years respectively, was recorded in M-10. After second spray, the similar trend of reduction % of coccinellids was found as that of 1<sup>st</sup> spray.

The overall mean of first and second spray indicated that the safest module was M-10 with reduction of 33.93%, 15.54% and 24.73% during 2016, 2017 and pooled of both years respectively and which was followed by M-7, M-6, M-5 and M-8 while M-14 and M-11 recorded the maximum reduction of coccinellid population of 74.72% and 73.78% during 2016, 68.45% and 66.96% during 2017, 71.58% and 70.37% in pooled mean of two years respectively.

**Table 62: Efficacy of pesticide modules on coccinellid population during post-kharif season in 2016**

| Treatment      | DBS           | 1 <sup>st</sup> spray |                   | 2 <sup>nd</sup> spray |                   | Overall Reduction % |
|----------------|---------------|-----------------------|-------------------|-----------------------|-------------------|---------------------|
|                |               | 14 DAS                | Reduction%        | 14 DAS                | Reduction%        |                     |
| <b>M-1</b>     | 1.00a (1.22)* | 0.67de (1.08)*        | 44.44bc (41.80)** | 0.49fg (0.99)*        | 36.83bc (37.35)** | 65.00c (53.74)**    |
| <b>M-2</b>     | 1.00a (1.22)  | 0.71cd (1.10)         | 40.83bcde (39.71) | 0.47g (0.98)          | 43.17ab (41.07)   | 66.43bc (54.59)     |
| <b>M-3</b>     | 0.69c (1.09)  | 0.47h (0.98)          | 43.14bcd (41.06)  | 0.35h (0.92)          | 35.56c (36.53)    | 63.50c (52.84)      |
| <b>M-4</b>     | 0.60d (1.05)  | 0.38i (0.94)          | 47.69ab (43.67)   | 0.25i (0.86)          | 44.11ab (41.61)   | 70.63ab (57.24)     |
| <b>M-5</b>     | 0.80b (1.14)  | 0.62ef (1.06)         | 35.07ef (36.29)   | 0.55e (1.03)          | 23.94d (29.29)    | 50.60de (45.34)     |
| <b>M-6</b>     | 0.82b (1.15)  | 0.67de (1.08)         | 31.83fg (34.33)   | 0.62d (1.06)          | 20.26de (26.62)   | 45.59ef (42.46)     |
| <b>M-7</b>     | 1.00a (1.22)  | 0.87b (1.17)          | 27.50g (31.63)    | 0.82b (1.15)          | 18.88de (25.67)   | 41.19f (39.92)      |
| <b>M-8</b>     | 0.82b (1.15)  | 0.62ef (1.06)         | 36.52def (37.14)  | 0.55e (1.02)          | 24.41d (29.61)    | 51.97d (46.13)      |
| <b>M-9</b>     | 0.82b (1.15)  | 0.53g (1.01)          | 46.08ab (42.75)   | 0.39h (0.94)          | 36.93bc (37.41)   | 66.01bc (54.34)     |
| <b>M-10</b>    | 0.80b (1.14)  | 0.75c (1.12)          | 21.53h (27.57)    | 0.74c (1.11)          | 15.85e (23.41)    | 33.93g (35.59)      |
| <b>M-11</b>    | 0.69c (1.09)  | 0.40i (0.95)          | 51.61a (45.92)    | 0.25i (0.87)          | 45.71a (42.52)    | 73.78a (59.26)      |
| <b>M-12</b>    | 0.80b (1.14)  | 0.62ef (1.06)         | 35.07ef (36.29)   | 0.49fg (0.99)         | 32.64c (34.84)    | 56.25d (48.59)      |
| <b>M-13</b>    | 0.80b (1.14)  | 0.58fg (1.04)         | 39.93cde (39.18)  | 0.53ef (1.01)         | 20.95de (27.09)   | 52.68d (46.54)      |
| <b>M-14</b>    | 0.62d (1.06)  | 0.35i (0.92)          | 52.86a (46.64)    | 0.22i (0.85)          | 46.19a (42.79)    | 74.72a (59.84)      |
| <b>M-15</b>    | 1.00a (1.22)  | 1.20a (1.30)          | -                 | 1.40a (1.38)          | -                 | -                   |
| <b>F Value</b> | 83.28         | 107.69                | 15.54             | 190.00                | 19.55             | 40.40               |
| <b>Pr&gt;F</b> | <.0001        | <.0001                | <.0001            | <.0001                | <.0001            | <.0001              |
| <b>LSD</b>     | 0.018         | 0.027                 | 3.9832            | 0.028                 | 4.5142            | 3.3866              |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 63: Efficacy of pesticide modules on coccinellid population during post-kharif season in 2017**

| Treatment      | DBS    |         | 1 <sup>st</sup> spray |         |                   | 2 <sup>nd</sup> spray |         |                    | Overall Reduction % |           |
|----------------|--------|---------|-----------------------|---------|-------------------|-----------------------|---------|--------------------|---------------------|-----------|
|                |        |         | 14 DAS                |         | Reduction %       | 14 DAS                |         | Reduction %        |                     |           |
| <b>M-1</b>     | 0.80ab | (1.14)* | 0.58def               | (1.04)* | 37.29bc (37.62)** | 0.42def               | (0.96)* | 38.76bcd (38.48)** | 53.96bc             | (47.28)** |
| <b>M-2</b>     | 0.80ab | (1.14)  | 0.60de                | (1.05)  | 34.75bcd (36.12)  | 0.40ef                | (0.95)  | 44.44abc (41.81)   | 56.50bc             | (48.73)   |
| <b>M-3</b>     | 0.65d  | (1.07)  | 0.47gh                | (0.98)  | 36.60bc (37.20)   | 0.35f                 | (0.92)  | 37.35cd (37.61)    | 52.45c              | (46.41)   |
| <b>M-4</b>     | 0.55e  | (1.03)  | 0.38i                 | (0.94)  | 40.72ab (39.63)   | 0.25g                 | (0.86)  | 45.66ab (42.51)    | 61.23ab             | (51.52)   |
| <b>M-5</b>     | 0.73bc | (1.11)  | 0.65cd                | (1.07)  | 22.93fg (28.54)   | 0.58c                 | (1.04)  | 25.71e (30.47)     | 31.27ef             | (33.96)   |
| <b>M-6</b>     | 0.67cd | (1.08)  | 0.62cde               | (1.06)  | 19.06gh (25.73)   | 0.58c                 | (1.04)  | 22.81efg (28.42)   | 25.12fg             | (30.00)   |
| <b>M-7</b>     | 0.87a  | (1.17)  | 0.82b                 | (1.15)  | 17.57gh (24.68)   | 0.80b                 | (1.14)  | 18.95fg (25.73)    | 19.74gh             | (26.15)   |
| <b>M-8</b>     | 0.69cd | (1.09)  | 0.58def               | (1.04)  | 27.25def (31.41)  | 0.51cd                | (1.00)  | 26.29e (30.85)     | 35.66de             | (36.65)   |
| <b>M-9</b>     | 0.71cd | (1.10)  | 0.51fg                | (1.00)  | 37.55bc (37.79)   | 0.37f                 | (0.93)  | 39.62bcd (38.92)   | 54.73bc             | (47.73)   |
| <b>M-10</b>    | 0.73bc | (1.11)  | 0.71c                 | (1.10)  | 15.54h (23.09)    | 0.71b                 | (1.10)  | 16.67g (24.09)     | 15.54h              | (23.09)   |
| <b>M-11</b>    | 0.65d  | (1.07)  | 0.40hi                | (0.95)  | 46.39a (42.92)    | 0.25g                 | (0.86)  | 48.46a (44.11)     | 66.96a              | (54.93)   |
| <b>M-12</b>    | 0.69cd | (1.09)  | 0.60de                | (1.05)  | 24.47efg (29.55)  | 0.47de                | (0.98)  | 35.30d (36.45)     | 41.29d              | (39.96)   |
| <b>M-13</b>    | 0.71cd | (1.10)  | 0.55ef                | (1.03)  | 32.17cde (34.52)  | 0.51cd                | (1.00)  | 23.05ef (28.58)    | 37.33de             | (37.62)   |
| <b>M-14</b>    | 0.55e  | (1.03)  | 0.33i                 | (0.91)  | 47.94a (43.82)    | 0.20g                 | (0.84)  | 49.49a (44.71)     | 68.45a              | (55.83)   |
| <b>M-15</b>    | 0.87a  | (1.17)  | 1.00a                 | (1.22)  | -                 | 1.20a                 | (1.30)  | -                  | -                   |           |
| <b>F Value</b> | 11.11  |         | 29.64                 |         | 15.05             | 55.73                 |         | 21.42              | 38.82               |           |
| <b>Pr&gt;F</b> | <.0001 |         | <.0001                |         | <.0001            | <.0001                |         | <.0001             | <.0001              |           |
| <b>LSD</b>     | 0.0381 |         | 0.043                 |         | 5.0051            | 0.0462                |         | 4.4184             | 4.9098              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 64: Efficacy of pesticide modules on coccinellid population during post-kharif season (pooled 2016 & 2017)**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.90b  | (1.18)* | 0.62d                 | (1.06)* | 40.87cde    | (39.72)** | 0.46gh                | (0.98)* | 37.80b      | (37.92)** | 59.48d              | (50.47)** |
| M-2       | 0.90b  | (1.18)  | 0.66d                 | (1.07)  | 37.79de     | (37.93)   | 0.44h                 | (0.97)  | 43.81a      | (41.44)   | 61.46cd             | (51.63)   |
| M-3       | 0.67d  | (1.08)  | 0.47g                 | (0.98)  | 39.87cde    | (39.15)   | 0.35i                 | (0.92)  | 36.46b      | (37.07)   | 57.98d              | (49.60)   |
| M-4       | 0.58e  | (1.04)  | 0.38hi                | (0.94)  | 44.20bc     | (41.67)   | 0.25j                 | (0.86)  | 44.89a      | (42.07)   | 65.93bc             | (54.30)   |
| M-5       | 0.77c  | (1.12)  | 0.64d                 | (1.07)  | 29.00gh     | (32.55)   | 0.57de                | (1.03)  | 24.82c      | (29.88)   | 40.93f              | (39.77)   |
| M-6       | 0.75c  | (1.12)  | 0.65d                 | (1.07)  | 25.45hi     | (30.29)   | 0.60d                 | (1.05)  | 21.53cd     | (27.53)   | 35.36g              | (36.46)   |
| M-7       | 0.93ab | (1.20)  | 0.85b                 | (1.16)  | 22.53ij     | (28.32)   | 0.81b                 | (1.15)  | 18.92de     | (25.72)   | 30.47h              | (33.46)   |
| M-8       | 0.76c  | (1.12)  | 0.60de                | (1.05)  | 31.89fg     | (34.33)   | 0.53ef                | (1.01)  | 25.35c      | (30.23)   | 43.82ef             | (41.44)   |
| M-9       | 0.77c  | (1.12)  | 0.52fg                | (1.01)  | 41.81cd     | (40.29)   | 0.38i                 | (0.94)  | 38.27b      | (38.20)   | 60.37d              | (50.99)   |
| M-10      | 0.77c  | (1.13)  | 0.73c                 | (1.11)  | 18.53j      | (25.43)   | 0.73c                 | (1.11)  | 16.26e      | (23.77)   | 24.73i              | (29.77)   |
| M-11      | 0.67d  | (1.08)  | 0.40h                 | (0.95)  | 49.00ab     | (44.43)   | 0.25j                 | (0.87)  | 47.09a      | (43.32)   | 70.37ab             | (57.06)   |
| M-12      | 0.75c  | (1.12)  | 0.61de                | (1.05)  | 29.77gh     | (33.07)   | 0.48fgh               | (0.99)  | 33.97b      | (35.65)   | 48.77e              | (44.29)   |
| M-13      | 0.76c  | (1.12)  | 0.57ef                | (1.03)  | 36.05ef     | (36.88)   | 0.52efg               | (1.01)  | 22.00cd     | (27.94)   | 45.01ef             | (42.13)   |
| M-14      | 0.59e  | (1.04)  | 0.34i                 | (0.92)  | 50.40a      | (45.23)   | 0.21j                 | (0.84)  | 47.84a      | (43.76)   | 71.58a              | (57.80)   |
| M-15      | 0.94a  | (1.20)  | 1.10a                 | (1.26)  | -           |           | 1.30a                 | (1.34)  | -           |           | -                   |           |
| F Value   | 61.37  |         | 88.48                 |         | 27.41       |           | 161.89                |         | 41.15       |           | 72.37               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0184 |         | 0.0272                |         | 3.3021      |           | 0.0288                |         | 3.1438      |           | 3.0083              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 32: Efficacy of pesticide modules on coccinelids population after 1<sup>st</sup> spray during post-kharif**

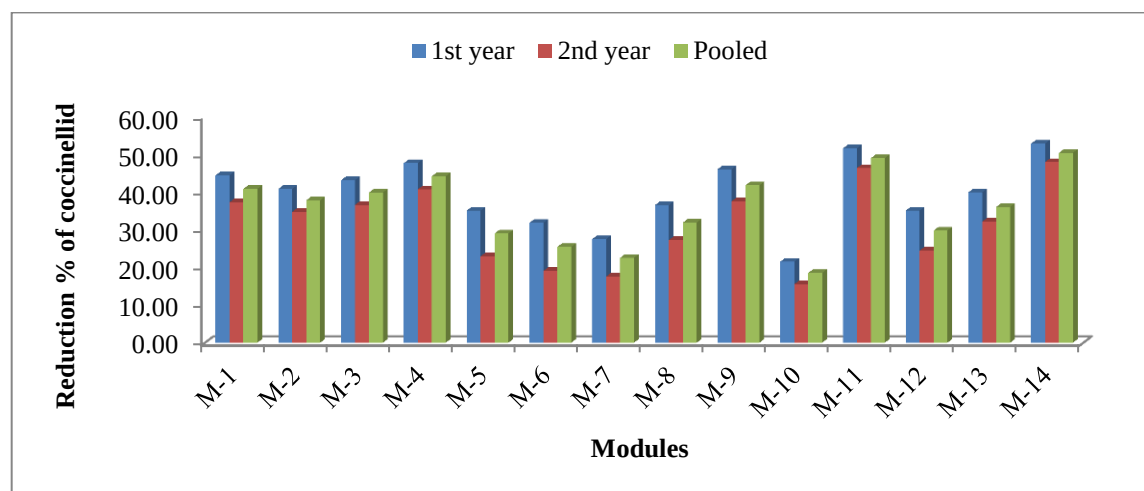


**Fig. 33: Efficacy of pesticide modules on coccinelids population after 2<sup>nd</sup> spray during post-kharif**

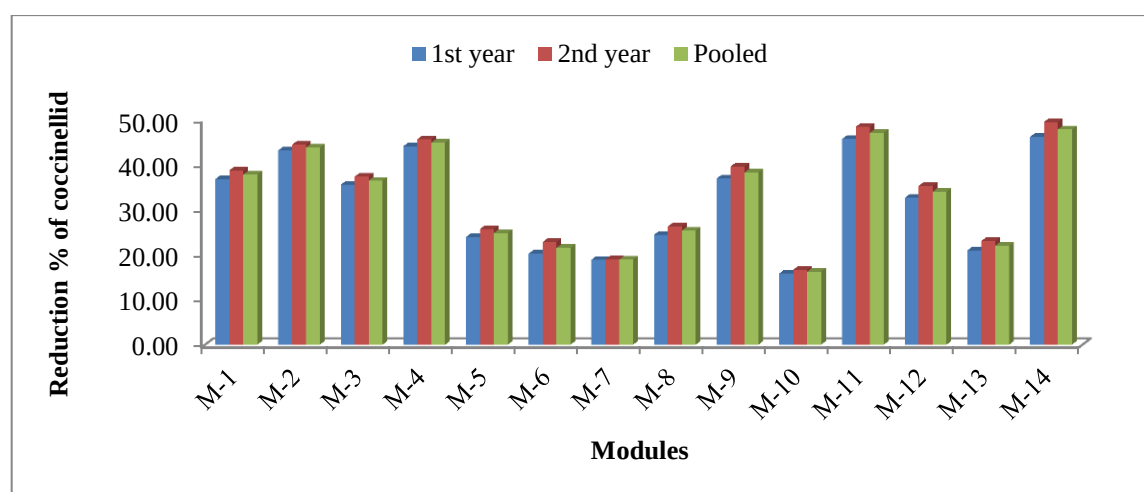
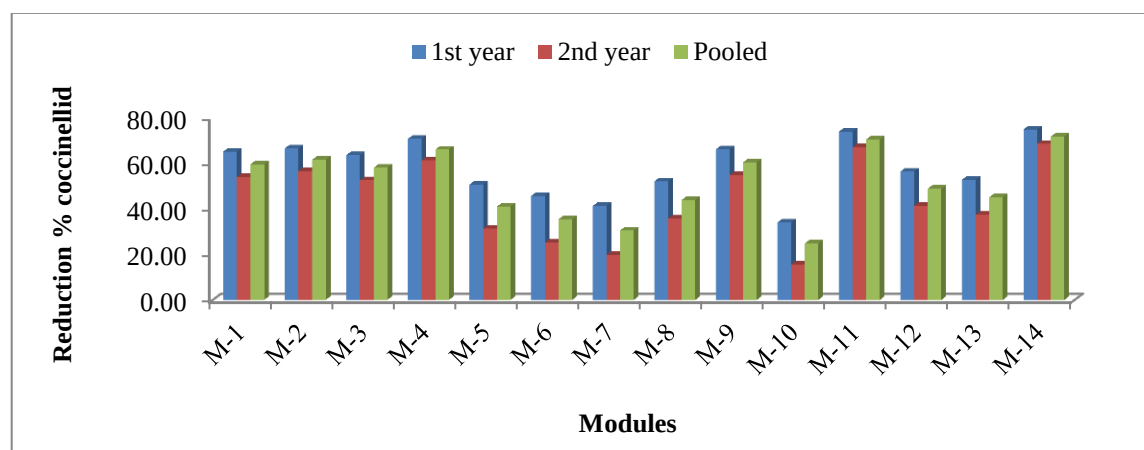


**Fig. 34: Overall efficacy of pesticide modules on coccinelids population during post-kharif**



#### 4.3.1.4. Spider

The spider population on before spray of insecticides varied significantly among the plots where seed treatment was adopted. Maximum population was observed where no seed treatment is adopted in untreated plot M-15 and other plots like M-1, M-2, M-7 ranged between (0.80 to 0.80/plant), (0.80 to 0.80/plant) and (0.80 to 0.80/plant) in 2016, 2017 and in pooled mean of both years respectively. The lowest population was observed from imidacloprid 17.8SL treated plot M-14 with the population of 0.60, 0.60 and 0.60/plant followed by M-4 (0.60, 0.58 and 0.59/plant) and M-3 (0.67, 0.67 and 0.67/plant) during 2016, 2017 and pooled mean of both years respectively. The next effective modules were bijamrita treated plots such as M-5, M-6, M-8, M-9, M-10, M-12 and M-13 ranged between (0.73 to 0.75/plant), (0.73 to 0.75/plant) and (0.73 to 0.75/plant) as compared to untreated plot M-15 during 2016, 2017 and pooled mean of both years respectively (Table 65, 66 and 67).

The spider population recorded at 14 DAS endorsed that M-14 was found to give the maximum reduction of 49.78% with population of 0.38/plant, 52.89% with 0.35/plant and 51.33% with 0.37/plant which were found to be at par with M-11 of 49.45% reduction with 0.42/plant, 48.20% with 0.45/plant and 48.83% with 0.44/plant during 2016, 2017 and pooled of both years, respectively. The minimum reduction of 17.44% with 0.78/plant, 17.44% with 0.75/plant and 17.44% with 0.77/plant during 2016, 2017 and pooled of both years respectively, was recorded on M-10. After second spray the similar trend was found as that 1<sup>st</sup> spray.

The overall mean of first and second spray reflected that the safest module was M-10 with population of 31.20%, 33.03% and 32.12% during 2016, 2017 and pooled of both years respectively and which was followed by M-7, M-6 while M-14 and M-11 recorded the maximum reduction of spider population of 75.19% and 73.13% during 2016, 80.37% and 76.19% during 2017, 77.78% and 74.66% in pooled mean of two years respectively.

**Table 65: Efficacy of pesticide modules on spider population during post-kharif season in 2016**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.80a  | (1.14)* | 0.60d                 | (1.05)* | 40.00cde    | (39.23)** | 0.47ef                | (0.98)* | 35.19cde    | (36.28)** | 61.11cd             | (51.45)** |
| M-2       | 0.80a  | (1.14)  | 0.62d                 | (1.06)  | 37.67def    | (37.84)   | 0.42f                 | (0.96)  | 43.48abc    | (41.25)   | 64.72bc             | (53.58)   |
| M-3       | 0.67c  | (1.08)  | 0.51e                 | (1.00)  | 39.10cde    | (38.69)   | 0.40f                 | (0.95)  | 34.90cde    | (36.12)   | 60.20cd             | (50.93)   |
| M-4       | 0.60d  | (1.05)  | 0.40f                 | (0.95)  | 46.67abc    | (43.09)   | 0.27g                 | (0.88)  | 43.75abc    | (41.41)   | 70.00ab             | (56.79)   |
| M-5       | 0.73b  | (1.11)  | 0.62d                 | (1.06)  | 31.69f      | (34.22)   | 0.55d                 | (1.03)  | 25.71fg     | (30.24)   | 49.47ef             | (44.69)   |
| M-6       | 0.75b  | (1.12)  | 0.71c                 | (1.10)  | 24.75g      | (29.65)   | 0.66c                 | (1.08)  | 22.34gh     | (28.10)   | 41.37fg             | (39.97)   |
| M-7       | 0.80a  | (1.14)  | 0.78b                 | (1.13)  | 22.33gh     | (28.15)   | 0.76b                 | (1.12)  | 18.95gh     | (25.73)   | 36.94gh             | (37.39)   |
| M-8       | 0.75b  | (1.12)  | 0.62d                 | (1.06)  | 33.83ef     | (35.57)   | 0.55d                 | (1.03)  | 26.05efg    | (30.69)   | 51.07e              | (45.61)   |
| M-9       | 0.73b  | (1.11)  | 0.53e                 | (1.01)  | 41.92bcd    | (40.35)   | 0.40f                 | (0.95)  | 37.11bcd    | (37.53)   | 63.47bc             | (52.81)   |
| M-10      | 0.75b  | (1.12)  | 0.78b                 | (1.13)  | 17.44h      | (24.56)   | 0.78b                 | (1.13)  | 16.67h      | (24.09)   | 31.20h              | (33.93)   |
| M-11      | 0.67c  | (1.08)  | 0.42f                 | (0.96)  | 49.45ab     | (44.68)   | 0.27g                 | (0.88)  | 46.54ab     | (43.01)   | 73.13a              | (58.78)   |
| M-12      | 0.75b  | (1.12)  | 0.62d                 | (1.06)  | 33.61ef     | (35.36)   | 0.51de                | (1.01)  | 31.61def    | (34.15)   | 54.37de             | (47.52)   |
| M-13      | 0.75b  | (1.12)  | 0.60d                 | (1.05)  | 36.16def    | (36.96)   | 0.55d                 | (1.03)  | 23.15fgh    | (28.64)   | 51.07e              | (45.61)   |
| M-14      | 0.60d  | (1.05)  | 0.38f                 | (0.94)  | 49.78a      | (44.87)   | 0.22g                 | (0.85)  | 50.53a      | (45.31)   | 75.19a              | (60.18)   |
| M-15      | 0.80a  | (1.14)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 27.66  |         | 57.52                 |         | 15.55       |           | 59.63                 |         | 11.55       |           | 23.51               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0168 |         | 0.0288                |         | 4.4585      |           | 0.0431                |         | 5.766       |           | 4.7329              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 66: Efficacy of pesticide modules on spider population during post-kharif season in 2017**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.80a  | (1.14)* | 0.60ef                | (1.05)* | 40.00cd     | (39.23)** | 0.45f                 | (0.97)* | 37.96de     | (38.01)** | 62.78d              | (52.42)** |
| M-2       | 0.80a  | (1.14)  | 0.62de                | (1.06)  | 37.67cd     | (37.84)   | 0.40f                 | (0.95)  | 46.38bcd    | (42.92)   | 66.67cd             | (54.74)   |
| M-3       | 0.67c  | (1.08)  | 0.51g                 | (1.00)  | 39.10cd     | (38.69)   | 0.39f                 | (0.94)  | 37.00de     | (37.44)   | 61.53d              | (51.69)   |
| M-4       | 0.58d  | (1.04)  | 0.40hi                | (0.95)  | 44.32bc     | (41.73)   | 0.25g                 | (0.86)  | 48.61bc     | (44.21)   | 71.61bc             | (57.82)   |
| M-5       | 0.73b  | (1.11)  | 0.67cd                | (1.08)  | 26.58fg     | (31.03)   | 0.60cd                | (1.05)  | 25.37gh     | (30.25)   | 45.21fg             | (42.25)   |
| M-6       | 0.73b  | (1.11)  | 0.69c                 | (1.09)  | 24.38fg     | (29.54)   | 0.65c                 | (1.07)  | 21.85gh     | (27.78)   | 40.94gh             | (39.77)   |
| M-7       | 0.80a  | (1.14)  | 0.78b                 | (1.13)  | 22.33gh     | (28.15)   | 0.75b                 | (1.12)  | 19.10h      | (25.83)   | 37.22hi             | (37.58)   |
| M-8       | 0.75b  | (1.12)  | 0.67cd                | (1.08)  | 29.08ef     | (32.48)   | 0.58cde               | (1.04)  | 27.87fg     | (31.79)   | 48.63ef             | (44.20)   |
| M-9       | 0.75b  | (1.12)  | 0.55fg                | (1.03)  | 41.28bcd    | (39.98)   | 0.40f                 | (0.95)  | 39.55cde    | (38.96)   | 64.54d              | (53.45)   |
| M-10      | 0.73b  | (1.11)  | 0.75b                 | (1.12)  | 17.44h      | (24.56)   | 0.73b                 | (1.11)  | 18.95h      | (25.73)   | 33.03i              | (35.02)   |
| M-11      | 0.69c  | (1.09)  | 0.45h                 | (0.97)  | 48.20ab     | (43.97)   | 0.25g                 | (0.86)  | 54.20ab     | (47.41)   | 76.19ab             | (60.84)   |
| M-12      | 0.75b  | (1.12)  | 0.69c                 | (1.09)  | 26.72fg     | (31.12)   | 0.53e                 | (1.01)  | 35.89ef     | (36.79)   | 53.01e              | (46.73)   |
| M-13      | 0.73b  | (1.11)  | 0.60ef                | (1.05)  | 34.25de     | (35.82)   | 0.55de                | (1.03)  | 23.15gh     | (28.64)   | 49.47ef             | (44.69)   |
| M-14      | 0.60d  | (1.05)  | 0.35i                 | (0.92)  | 52.89a      | (46.66)   | 0.18h                 | (0.82)  | 58.33a      | (49.85)   | 80.37a              | (63.80)   |
| M-15      | 0.80a  | (1.14)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 25.32  |         | 60.27                 |         | 19.59       |           | 81.12                 |         | 17.93       |           | 34.46               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0183 |         | 0.0283                |         | 4.2378      |           | 0.0386                |         | 5.4985      |           | 4.3687              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 67: Efficacy of pesticide modules on spider population during post-kharif season (pooled 2016 & 2017)**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.80a  | (1.14)* | 0.60e                 | (1.05)* | 40.00de     | (39.23)** | 0.46e                 | (0.98)* | 36.57d      | (37.20)** | 61.94d              | (51.91)** |
| M-2       | 0.80a  | (1.14)  | 0.62de                | (1.06)  | 37.67de     | (37.86)   | 0.41ef                | (0.95)  | 44.93bc     | (42.09)   | 65.69cd             | (54.15)   |
| M-3       | 0.67c  | (1.08)  | 0.51f                 | (1.00)  | 39.10de     | (38.70)   | 0.39f                 | (0.94)  | 35.95d      | (36.79)   | 60.86d              | (51.29)   |
| M-4       | 0.59d  | (1.04)  | 0.40gh                | (0.95)  | 45.49bc     | (42.41)   | 0.26g                 | (0.87)  | 46.18b      | (42.81)   | 70.81bc             | (57.30)   |
| M-5       | 0.73b  | (1.11)  | 0.65d                 | (1.07)  | 29.13g      | (32.66)   | 0.58d                 | (1.04)  | 25.54e      | (30.30)   | 47.34f              | (43.47)   |
| M-6       | 0.74b  | (1.11)  | 0.70c                 | (1.10)  | 24.57h      | (29.63)   | 0.66c                 | (1.07)  | 22.09ef     | (27.94)   | 41.15g              | (39.88)   |
| M-7       | 0.80a  | (1.14)  | 0.78b                 | (1.13)  | 22.33h      | (28.19)   | 0.76b                 | (1.12)  | 19.02f      | (25.78)   | 37.08gh             | (37.50)   |
| M-8       | 0.75b  | (1.12)  | 0.65d                 | (1.07)  | 31.46fg     | (34.09)   | 0.57d                 | (1.03)  | 26.96e      | (31.26)   | 49.85ef             | (44.91)   |
| M-9       | 0.74b  | (1.11)  | 0.54f                 | (1.02)  | 41.60cd     | (40.16)   | 0.40ef                | (0.95)  | 38.33cd     | (38.25)   | 64.00d              | (53.13)   |
| M-10      | 0.74b  | (1.11)  | 0.77b                 | (1.12)  | 17.44i      | (24.66)   | 0.76b                 | (1.12)  | 17.81f      | (24.94)   | 32.12h              | (34.50)   |
| M-11      | 0.68c  | (1.09)  | 0.44g                 | (0.97)  | 48.83ab     | (44.33)   | 0.26g                 | (0.87)  | 50.37ab     | (45.21)   | 74.66ab             | (59.79)   |
| M-12      | 0.75b  | (1.12)  | 0.66cd                | (1.08)  | 30.16g      | (33.29)   | 0.52d                 | (1.01)  | 33.75d      | (35.51)   | 53.69e              | (47.12)   |
| M-13      | 0.74b  | (1.11)  | 0.60e                 | (1.05)  | 35.21ef     | (36.39)   | 0.55d                 | (1.03)  | 23.15ef     | (28.73)   | 50.27ef             | (45.15)   |
| M-14      | 0.60d  | (1.05)  | 0.37h                 | (0.93)  | 51.33a      | (45.77)   | 0.20h                 | (0.84)  | 54.43a      | (47.57)   | 77.78a              | (61.93)   |
| M-15      | 0.80a  | (1.14)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 87.44  |         | 117.12                |         | 36.80       |           | 140.18                |         | 26.22       |           | 53.32               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0095 |         | 0.0201                |         | 2.9599      |           | 0.0287                |         | 4.1726      |           | 3.3124              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 35: Efficacy of pesticide modules on spider population after 1<sup>st</sup> spray during post-kharif**

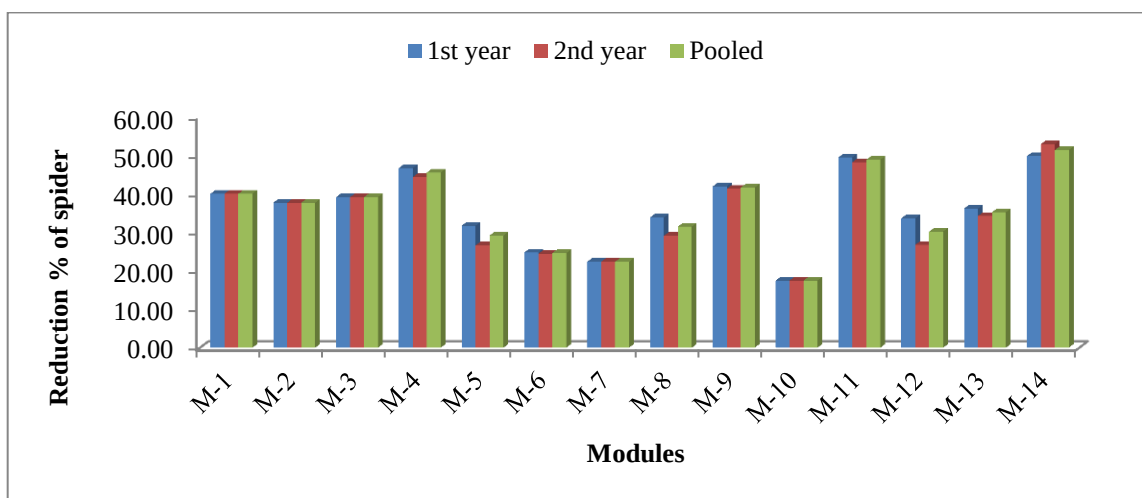


**Fig. 36: Efficacy of pesticide modules on spider population after 2<sup>nd</sup> spray during post-kharif**

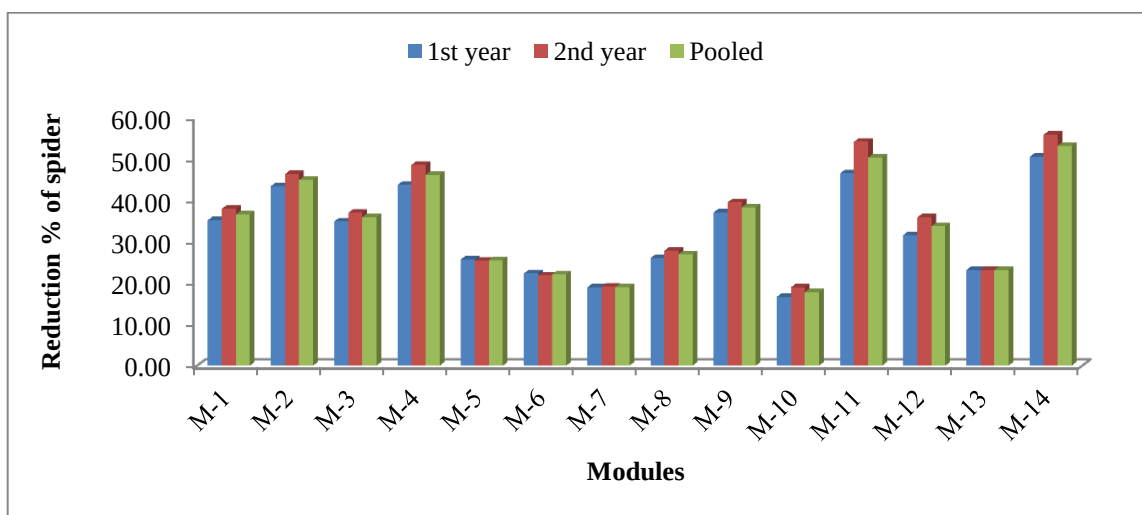
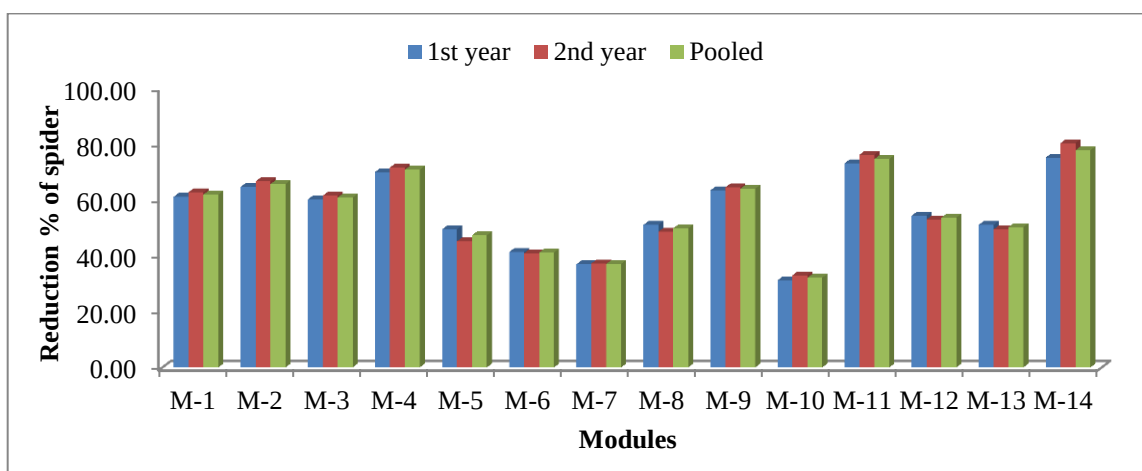


**Fig. 37: Overall efficacy of pesticide modules on spider population during post-kharif**



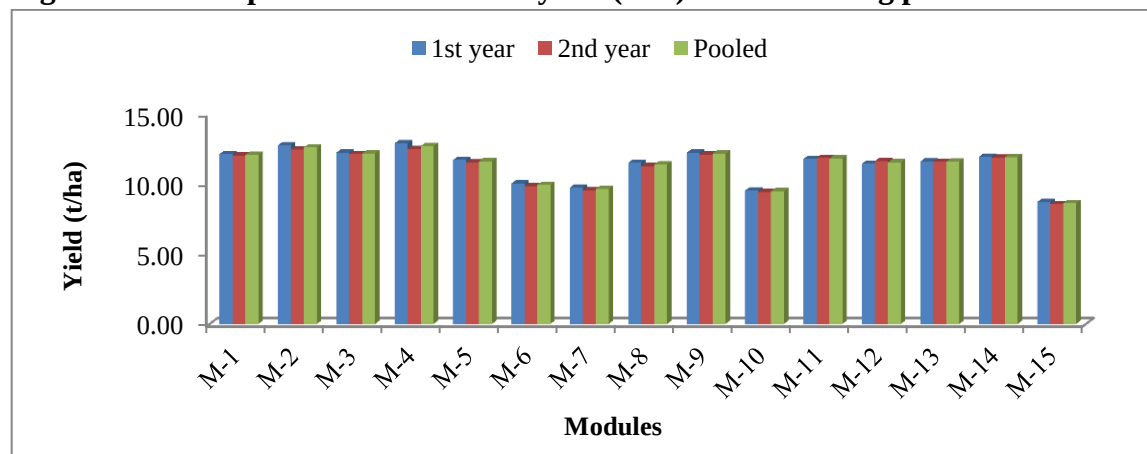
#### 4.3.1.5. Effect of different pesticide modules on yield (t/ha) of okra during post-kharif season

All the modules composed of insecticides produced significantly higher yield of okra over untreated one. The two years data in post-kharif season revealed that the higher yield was observed from M-4 (12.92, 12.51 and 12.72 t/ha) and M-2 (12.78, 12.48 and 12.63t/ha) which was at par with each other during 2016, 2017 and pooled mean of both years respectively. Whereas the lowest yield was recorded from M-15 *i.e.*, untreated plot with yield of 8.72, 8.56 and 8.64 t/ha which was followed by M-7 (9.75, 9.55 and 9.65 t/ha) and M -10 (9.54, 9.44 and 9.49 t/ha) during 2016, 2017 and pooled mean of both years respectively (table 68).

**Table 68: Efficacy of pesticide modules on yield (t/ha) of okra during post-kharif season.**

| Modules        | Yield (t/ha) |          |         |
|----------------|--------------|----------|---------|
|                | 2016         | 2017     | Mean    |
| <b>M-1</b>     | 12.15bc      | 12.04abc | 12.10b  |
| <b>M-2</b>     | 12.78a       | 12.48a   | 12.63a  |
| <b>M-3</b>     | 12.25b       | 12.14ab  | 12.20b  |
| <b>M-4</b>     | 12.92a       | 12.51a   | 12.72a  |
| <b>M-5</b>     | 11.73cde     | 11.55cd  | 11.64cd |
| <b>M-6</b>     | 10.05f       | 9.85e    | 9.95e   |
| <b>M-7</b>     | 9.75fg       | 9.55e    | 9.65ef  |
| <b>M-8</b>     | 11.52de      | 11.29d   | 11.41d  |
| <b>M-9</b>     | 12.25b       | 12.12ab  | 12.18b  |
| <b>M-10</b>    | 9.54g        | 9.44e    | 9.49f   |
| <b>M-11</b>    | 11.80bcde    | 11.88bc  | 11.84bc |
| <b>M-12</b>    | 11.46e       | 11.65bcd | 11.56cd |
| <b>M-13</b>    | 11.62de      | 11.60cd  | 11.61cd |
| <b>M-14</b>    | 11.95bcd     | 11.89bc  | 11.92bc |
| <b>M-15</b>    | 8.72h        | 8.56f    | 8.64g   |
| <b>F Value</b> | 63.89        | 51.13    | 93.73   |
| <b>Pr&gt;F</b> | <.0001       | <.0001   | <.0001  |
| <b>LSD</b>     | 0.4547       | 0.5055   | 0.3738  |

**Fig. 38: Effect of pesticide modules on yield (t/ha) of okra during post-kharif**



### 4.3.2. Pre-kharif season

#### 4.3.2.1. Jassid (*Amrasca biguttula biguttula* Ishida)

The jassid population one day before spray of insecticides showed significant variation among the plots where seed treatment was adopted. Untreated plot *i.e.*, M-15 and other plots like M-1, M-2 and M-7 ranging from (6.72 to 6.77/leaf), (7.37 to 7.40/leaf) and (7.05 to 7.08/leaf) where no seed treatment was made harboured maximum population of jassids in 2017, 2018 and in pooled mean of both years respectively. The lowest population was observed from imidacloprid 17.8 SL treated plots, M-14 with population of 6.07, 6.07 and 6.07/leaf which was followed by M-4 (6.00, 6.14 and 6.07/leaf), M-3 (6.38, 6.25 and 6.32/leaf) and M-11 (6.38, 6.24 and 6.31/leaf) during 2017, 2018 and pooled mean of both years respectively. In modules like M-5, M-6, M-8, M-9, M-10, M-12 and M-13 where seed treatment was done by bijamrita gave moderate population of jassids ranging between (6.47 to 6.55/leaf), (6.73 to 6.81/leaf) and (6.62 to 6.68/leaf) during 2017, 2018 and pooled mean of both years respectively (Table 69, 71 and 73).

The protection modules also revealed similar trend in reducing jassid population in pre-kharif season as that of post-kharif season. In first spray, M-14 was found to have least population of jassid with population of 1.49, 1.42 and 1.46/leaf followed by M-11 (1.65, 1.56 and 1.61/leaf) and module-4 (2.17, 2.01 and 2.09/leaf) during 2017, 2018 and pooled mean of both years respectively and they were significantly differed from each other.

In 2<sup>nd</sup> spray, the same trend was also observed and M-14 showed least population (1.99, 1.39 and 1.69/leaf) followed by M-11 (2.26, 1.65 and 1.95/leaf) and M-4 (3.23, 2.04 and 2.63/leaf) respectively during 2017, 2018 and pooled of both years.

All the modules performed comparatively better over untreated plot when mean efficacy of both sprays was considered. M-14 was found very good by minimising the jassid population in the tune of 83.21%, 77.75% and 80.48% during 2017, 2018 and pooled mean of both years which was followed by M-11(82.20%, 74.58% and 78.39%) and M-4 (74.66%, 72.52% and 73.59%).

Reduction percentage of jassid population on okra varied significantly among different date of spraying insecticides during pre-kharif season. In overall efficacy during the 1<sup>st</sup> spray, the highest percentage of reduction of jassid was noticed after 3 days of spraying (79.15%, 82.62% and 80.88%) which was followed by 1 day of spraying (67.76%, 71.97% and 69.87%), 7 days of spraying (57.90%, 61.72% and 59.81%) and

minimum reduction per cent was observed after 14 days of spraying (43.47%, 38.71% and 41.09%) respectively 2017, 2018 and pooled mean of both years but they were significantly differed from each other. The similar trend was observed in the 2<sup>nd</sup> spray where 3 days after spraying (76.77%, 79.10% and 77.94%) gave maximum mortality followed by 1 day (63.89%, 67.36% and 65.63%), 7 days (58.21%, 62.04% and 60.12%). Minimum mortality was recorded at 14 days after spraying (39.11%, 38.50% and 38.81%) in 2017, 2018 and pooled mean of both years respectively.

**Table 69: Efficacy of pesticide modules on jassid population (no./leaf) during pre-kharif season in 2017**

| Treat.      | DBS         | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |              |              |
|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|--------------|--------------|
|             |             | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS        | Mean         |
| <b>M-1</b>  | 6.73a(2.69) | 1.91(1.55)            | 1.13(1.28)  | 2.73(1.80)  | 5.00(2.35)  | 2.69j(1.74) | 2.13(1.62)            | 1.82(1.52)  | 5.27(2.40)  | 9.93(3.23)   | 4.79i(2.19)  |
| <b>M-2</b>  | 6.77a(2.70) | 2.58(1.75)            | 1.62 (1.46) | 3.41(1.98)  | 5.04(2.35)  | 3.16h(1.89) | 1.53(1.42)            | 1.02(1.23)  | 4.40(2.21)  | 9.23(3.12)   | 4.05l(2.00)  |
| <b>M-3</b>  | 6.38c(2.62) | 2.42(1.71)            | 1.40(1.38)  | 3.13(1.91)  | 4.56(2.25)  | 2.88i(1.81) | 2.02(1.59)            | 1.80(1.52)  | 4.80(2.30)  | 9.53(3.17)   | 4.54j(2.14)  |
| <b>M-4</b>  | 6.00d(2.55) | 1.53(1.43)            | 0.80(1.14)  | 2.20(1.64)  | 4.13(2.15)  | 2.17l(1.59) | 1.22(1.31)            | 0.73(1.11)  | 3.49 (2.00) | 7.47(2.82)   | 3.23m(1.81)  |
| <b>M-5</b>  | 6.47b(2.64) | 2.91(1.85)            | 2.21(1.65)  | 3.71(2.05)  | 6.20(2.59)  | 3.76e(2.03) | 3.02(1.88)            | 2.73(1.80)  | 7.41(2.81)  | 13.49(3.74)  | 6.66f(2.56)  |
| <b>M-6</b>  | 6.48b(2.64) | 3.43(1.98)            | 2.58(1.75)  | 4.02(2.13)  | 6.60(2.66)  | 4.16d(2.13) | 3.51(2.00)            | 3.18(1.92)  | 8.40(2.98)  | 14.53(3.88)  | 7.41d(2.70)  |
| <b>M-7</b>  | 6.72a(2.69) | 3.71(2.05)            | 2.73(1.80)  | 4.22(2.17)  | 7.02(2.74)  | 4.42c(2.19) | 4.93(2.33)            | 4.73(2.29)  | 11.00(3.39) | 18.00(4.30)  | 9.67c(3.08)  |
| <b>M-8</b>  | 6.53b(2.65) | 2.79(1.81)            | 2.02(1.59)  | 3.52(2.00)  | 6.02(2.55)  | 3.59f(1.99) | 2.89(1.84)            | 2.61(1.76)  | 7.02(2.74)  | 12.98(3.67)  | 6.38g(2.50)  |
| <b>M-9</b>  | 6.50b(2.65) | 1.80(1.52)            | 1.02(1.23)  | 2.53(1.74)  | 4.56(2.25)  | 2.48k(1.69) | 1.82(1.52)            | 1.53(1.43)  | 4.60(2.26)  | 8.96(3.07)   | 4.23k(2.07)  |
| <b>M-10</b> | 6.53b(2.65) | 3.92(2.10)            | 2.91(1.85)  | 5.13(2.37)  | 7.27(2.79)  | 4.81b(2.28) | 5.13(2.37)            | 5.11(2.37)  | 11.53(3.47) | 19.02(4.42)  | 10.20b(3.16) |
| <b>M-11</b> | 6.38c(2.62) | 0.93(1.20)            | 0.00(0.71)  | 1.73(1.49)  | 3.93(2.11)  | 1.65m(1.38) | 0.93(1.20)            | 0.00(0.71)  | 2.52(1.74)  | 5.58(2.47)   | 2.26n(1.53)  |
| <b>M-12</b> | 6.55b(2.66) | 2.91(1.85)            | 1.95(1.56)  | 3.73(2.06)  | 6.33(2.61)  | 3.73e(2.02) | 2.36(1.69)            | 1.73(1.49)  | 6.00(2.55)  | 12.00(3.54)  | 5.52h(2.32)  |
| <b>M-13</b> | 6.48b(2.64) | 2.61(1.76)            | 1.91(1.55)  | 3.40(1.97)  | 6.02(2.55)  | 3.49g(1.96) | 5.96(2.54)            | 4.38(2.21)  | 5.02(2.35)  | 12.63(3.62)  | 7.00e(2.68)  |
| <b>M-14</b> | 6.07d(2.56) | 0.80 (1.14)           | 0.00(0.71)  | 1.56(1.43)  | 3.62(2.03)  | 1.49n(1.33) | 0.76(1.12)            | 0.00(0.71)  | 2.20(1.64)  | 5.00(2.35)   | 1.99o(1.45)  |
| <b>M-15</b> | 6.73a(2.69) | 7.84(2.89)            | 7.87(2.89)  | 7.91 (2.90) | 10.00(3.24) | 8.41a(2.98) | 13.02(3.68)           | 16.02(4.06) | 25.04(5.05) | 33.07(5.79)  | 21.79a(4.65) |
| <b>Mean</b> |             | 2.81c(1.77)           | 2.01d(1.50) | 3.53b(1.98) | 5.75a(2.48) |             | 3.42c(1.87)           | 3.16d(1.74) | 7.25b(2.66) | 12.76a(3.55) |              |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14      | 42           |
| <b>MS</b>      | 0.01   | 7.7                   | 1.92    | 0.03         | 31.17                 | 7.39    | 0.09         |
| <b>F Value</b> | 66.89  | 14699.2               | 3671.06 | 59.64        | 182438                | 43249.7 | 533.99       |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 70: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during pre-kharif season in 2017**

| Treat.      | 1 <sup>st</sup> spray |               |               |               |               | 2 <sup>nd</sup> spray |               |               |               |               | Overall Reduction |
|-------------|-----------------------|---------------|---------------|---------------|---------------|-----------------------|---------------|---------------|---------------|---------------|-------------------|
|             | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          |                   |
| <b>M-1</b>  | 75.67(60.45)          | 85.60(67.70)  | 65.48 (54.02) | 49.99(45.00)  | 69.19e(56.79) | 67.24(55.09)          | 77.25(61.51)  | 57.93(49.56)  | 39.92(39.18)  | 60.58g(51.34) | 69.96e(56.76)     |
| <b>M-2</b>  | 67.34(55.15)          | 79.50(63.08)  | 57.17(49.13)  | 49.86(44.92)  | 63.47g(53.07) | 76.70(61.14)          | 87.33(69.15)  | 65.16(53.82)  | 44.66(41.94)  | 68.46d(56.51) | 72.25d(58.21)     |
| <b>M-3</b>  | 67.44(55.21)          | 81.22(64.32)  | 58.21(49.73)  | 51.94(46.11)  | 64.70f(53.84) | 65.89(54.27)          | 75.34(60.23)  | 57.95(49.58)  | 36.71(37.29)  | 58.97h(50.34) | 69.59e(56.53)     |
| <b>M-4</b>  | 78.07(62.08)          | 88.59(70.27)  | 68.79(56.04)  | 53.62(47.07)  | 72.27c(58.86) | 77.28(61.54)          | 88.91(70.57)  | 66.29(54.51)  | 45.37(42.34)  | 69.46c(57.24) | 74.66c(59.78)     |
| <b>M-5</b>  | 61.42(51.60)          | 70.82(57.30)  | 51.21(45.69)  | 35.51(36.57)  | 54.74j(47.79) | 62.57(52.28)          | 72.49(58.36)  | 52.25(46.29)  | 34.22(35.80)  | 55.38j(48.18) | 57.57h(49.36)     |
| <b>M-6</b>  | 54.55(47.61)          | 65.98(54.32)  | 47.18(43.38)  | 31.49(34.13)  | 49.80k(44.86) | 59.16(50.28)          | 69.94(56.75)  | 49.15(44.51)  | 33.37(35.29)  | 52.90k(46.71) | 54.36i(47.50)     |
| <b>M-7</b>  | 52.64(46.51)          | 65.20 (53.85) | 46.54(43.02)  | 29.67(33.01)  | 48.51l(44.10) | 46.05(42.74)          | 57.93(49.56)  | 37.45(37.73)  | 22.48(28.30)  | 40.98m(39.58) | 45.48j(42.41)     |
| <b>M-8</b>  | 63.29(52.71)          | 73.48(59.00)  | 54.11(47.36)  | 37.89(37.99)  | 57.19i(49.27) | 63.16(52.63)          | 72.96(58.67)  | 53.44(46.97)  | 34.85(36.18)  | 56.10i(48.61) | 59.53g(50.50)     |
| <b>M-9</b>  | 76.25(60.83)          | 86.53(68.47)  | 66.84(54.84)  | 52.83(46.62)  | 70.61d(57.69) | 69.29(56.35)          | 79.00(62.73)  | 59.67(50.58)  | 40.55(39.55)  | 62.13f(52.30) | 71.96d(58.03)     |
| <b>M-10</b> | 48.51(44.15)          | 61.86(51.86)  | 33.18(35.10)  | 25.10(30.07)  | 42.16m(40.29) | 45.75(42.56)          | 56.10(48.51)  | 36.62(37.24)  | 20.83(27.15)  | 39.83n(38.87) | 40.71k(39.65)     |
| <b>M-11</b> | 87.45(69.25)          | 100.00(90.00) | 76.87(61.26)  | 58.49(49.89)  | 80.70b(67.60) | 81.84(64.77)          | 100.00(90.00) | 74.40(59.61)  | 57.11(49.09)  | 78.34b(65.87) | 82.20b(65.05)     |
| <b>M-12</b> | 61.88(51.87)          | 74.57(59.74)  | 51.50(45.86)  | 34.93(36.23)  | 55.72j(48.43) | 71.44(57.70)          | 82.92(65.59)  | 62.17(52.04)  | 42.70(40.80)  | 64.81e(54.03) | 62.71f(52.36)     |
| <b>M-13</b> | 65.48(54.02)          | 74.76(59.84)  | 55.34(48.06)  | 37.41(37.71)  | 58.25h(49.91) | 24.06(29.37)          | 54.63(47.66)  | 66.69(54.75)  | 36.56(37.20)  | 45.49l(42.25) | 60.30g(50.94)     |
| <b>M-14</b> | 88.69(70.36)          | 100.00(90.00) | 78.17(62.15)  | 59.79(50.65)  | 81.66a(68.29) | 83.98(66.41)          | 100.00(90.00) | 75.75(60.50)  | 58.25(49.75)  | 79.50a(66.67) | 83.21a(65.81)     |
| <b>M-15</b> | -                     | -             | -             | -             | -             | -                     | -             | -             | -             | -             | -                 |
| <b>Mean</b> | 67.76b(55.84)         | 79.15a(64.98) | 57.90c(49.69) | 43.47d(41.14) |               | 63.89b(53.37)         | 76.77a(63.52) | 58.21c(49.84) | 39.11d(38.56) |               |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|---------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |                   |
| <b>DF</b>      | 3                     | 13      | 39           | 3                     | 13      | 39           | 13                |
| <b>MS</b>      | 4245.54               | 827.73  | 30.07        | 4451.68               | 860.34  | 75.44        | 177.90            |
| <b>F Value</b> | 6895.87               | 1344.45 | 48.85        | 27316.6               | 5279.25 | 462.89       | 2344.79           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 71: Efficacy of pesticide modules on jassid population (no./leaf) during pre-kharif season in 2018**

| Treat.      | DBS         | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |             |              |
|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|-------------|--------------|
|             |             | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean         |
| <b>M-1</b>  | 7.37a(2.80) | 1.53(1.43)            | 0.93(1.20)  | 2.73(1.80)  | 4.98(2.34)  | 2.54j(1.69) | 1.61(1.45)            | 1.11(1.27)  | 3.52(2.01)  | 7.29(2.79)  | 3.39e(1.88)  |
| <b>M-2</b>  | 7.39a(2.81) | 1.83(1.53)            | 1.20(1.30)  | 3.09(1.89)  | 5.22(2.39)  | 2.84i(1.78) | 1.09(1.26)            | 0.56(1.03)  | 2.81(1.82)  | 6.46(2.64)  | 2.73f(1.69)  |
| <b>M-3</b>  | 6.25c(2.60) | 1.49(1.41)            | 0.91(1.19)  | 2.54(1.74)  | 4.53(2.24)  | 2.37k(1.65) | 1.44(1.39)            | 1.13(1.28)  | 3.53(2.01)  | 6.71(2.69)  | 3.20e(1.84)  |
| <b>M-4</b>  | 6.14d(2.58) | 1.22(1.31)            | 0.58(1.04)  | 2.21(1.65)  | 4.02(2.13)  | 2.01m(1.53) | 0.64(1.07)            | 0.40(0.95)  | 2.11(1.62)  | 5.00(2.35)  | 2.04g(1.49)  |
| <b>M-5</b>  | 6.77b(2.70) | 2.56(1.75)            | 2.04(1.59)  | 3.83(2.08)  | 5.41(2.43)  | 3.46e(1.96) | 2.02(1.59)            | 1.58(1.44)  | 4.46(2.23)  | 8.91(3.07)  | 4.24cd(2.08) |
| <b>M-6</b>  | 6.76b(2.69) | 2.72(1.80)            | 2.37(1.69)  | 4.11(2.15)  | 5.74(2.50)  | 3.73d(2.03) | 2.40(1.70)            | 2.03(1.59)  | 3.50(1.90)  | 9.80(3.21)  | 4.43cd(2.10) |
| <b>M-7</b>  | 7.38a(2.81) | 3.00(1.87)            | 2.79(1.81)  | 4.56(2.25)  | 6.43(2.63)  | 4.20c(2.14) | 2.92(1.85)            | 2.52(1.74)  | 6.55(2.65)  | 12.13(3.55) | 6.03b(2.45)  |
| <b>M-8</b>  | 6.80b(2.70) | 2.40(1.70)            | 1.93(1.56)  | 3.62(2.03)  | 5.33(2.42)  | 3.32g(1.93) | 1.93(1.56)            | 1.53(1.42)  | 4.41(2.22)  | 8.72(3.04)  | 4.15d(2.06)  |
| <b>M-9</b>  | 6.81b(2.70) | 1.42(1.39)            | 0.73(1.11)  | 2.44(1.72)  | 4.53(2.24)  | 2.28l(1.61) | 1.26(1.32)            | 0.89(1.18)  | 3.04(1.88)  | 6.40(2.63)  | 2.90f(1.75)  |
| <b>M-10</b> | 6.73b(2.69) | 3.27(1.94)            | 3.24(1.93)  | 5.00(2.35)  | 6.53(2.65)  | 4.51b(2.22) | 3.02(1.88)            | 2.64(1.77)  | 6.73(2.69)  | 12.44(3.60) | 6.21b(2.48)  |
| <b>M-11</b> | 6.24c(2.60) | 0.64(1.07)            | 0.00(0.71)  | 1.67(1.47)  | 3.93(2.11)  | 1.56n(1.34) | 0.48(0.99)            | 0.00(0.71)  | 1.41(1.38)  | 4.70(2.28)  | 1.65h(1.34)  |
| <b>M-12</b> | 6.80b(2.70) | 2.52(1.74)            | 2.00(1.58)  | 3.72(2.06)  | 5.39(2.43)  | 3.41f(1.95) | 1.41(1.38)            | 0.93(1.19)  | 3.47(1.99)  | 7.37(2.81)  | 3.29e(1.84)  |
| <b>M-13</b> | 6.79b(2.70) | 1.91(1.55)            | 1.38(1.37)  | 3.20(1.92)  | 5.14(2.37)  | 2.91h(1.81) | 3.53(2.01)            | 2.44(1.72)  | 2.93(1.85)  | 8.58(3.01)  | 4.37c(2.15)  |
| <b>M-14</b> | 6.07d(2.56) | 0.53(1.02)            | 0.00(0.71)  | 1.62(1.46)  | 3.51(2.00)  | 1.42o(1.30) | 0.40(0.95)            | 0.00(0.71)  | 1.18(1.29)  | 4.00(2.12)  | 1.39h(1.27)  |
| <b>M-15</b> | 7.40a(2.81) | 7.49(2.83)            | 8.91(3.07)  | 9.02(3.09)  | 9.02(3.09)  | 8.61a(3.02) | 8.98(3.08)            | 10.02(3.24) | 16.02(4.06) | 22.00(4.74) | 14.26a(3.78) |
| <b>Mean</b> |             | 2.30c(1.62)           | 1.93d(1.46) | 3.56b(1.98) | 5.32a(2.40) |             | 2.21c(1.57)           | 1.85d(1.42) | 4.38b(2.11) | 8.70a(2.97) |              |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |        |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|--------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14     | 42           |
| <b>MS</b>      | 0.02   | 7.82                  | 2.09    | 0.05         | 22.16                 | 4.36   | 0.06         |
| <b>F Value</b> | 274.31 | 51333.5               | 13691.3 | 345.14       | 2169.99               | 427.26 | 5.39         |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001 | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiometaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiometaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 72: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during pre-kharif season in 2018**

| Treat.      | 1 <sup>st</sup> spray |               |               |               |               | 2 <sup>nd</sup> spray |               |               |               |                | Overall reduction |
|-------------|-----------------------|---------------|---------------|---------------|---------------|-----------------------|---------------|---------------|---------------|----------------|-------------------|
|             | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean           |                   |
| <b>M-1</b>  | 79.43(63.03)          | 89.51(71.11)  | 69.56(56.51)  | 44.60(41.90)  | 70.77e(58.14) | 67.41(55.19)          | 79.92(63.38)  | 60.13(50.84)  | 39.89(39.17)  | 61.84de(52.15) | 66.59f(54.69)     |
| <b>M-2</b>  | 75.49(60.32)          | 86.51(68.45)  | 65.71(54.16)  | 42.03(40.42)  | 67.44g(55.84) | 79.00(62.73)          | 90.43(71.98)  | 69.66(56.58)  | 49.23(44.56)  | 72.08b(58.96)  | 70.48d(57.09)     |
| <b>M-3</b>  | 76.45(60.97)          | 87.89(69.64)  | 66.70(54.75)  | 40.48(39.51)  | 67.88f(56.22) | 67.97(55.53)          | 77.56(61.72)  | 56.15(48.53)  | 39.29(38.82)  | 60.24e(51.15)  | 63.75g(52.98)     |
| <b>M-4</b>  | 80.33(63.68)          | 92.19(73.77)  | 70.48(57.09)  | 46.28(42.86)  | 72.32c(59.35) | 83.89(66.34)          | 91.05(72.59)  | 70.45(57.08)  | 49.01(44.43)  | 73.60b(60.11)  | 72.52c(58.39)     |
| <b>M-5</b>  | 62.67(52.34)          | 74.92(59.95)  | 53.62(47.08)  | 34.43(35.93)  | 56.41k(48.82) | 62.41(52.18)          | 73.76(59.19)  | 53.54(47.03)  | 32.43(34.71)  | 55.53f(48.28)  | 55.55i(48.19)     |
| <b>M-6</b>  | 60.17(50.87)          | 70.90(57.36)  | 50.10(45.06)  | 30.36(33.43)  | 52.88l(46.68) | 57.95(49.57)          | 68.09(55.61)  | 65.64(56.07)  | 29.93(33.17)  | 55.40f(48.60)  | 51.05j(45.60)     |
| <b>M-7</b>  | 59.82(50.67)          | 68.55(55.89)  | 49.36(44.63)  | 28.50(32.27)  | 51.56m(45.86) | 54.37(47.51)          | 64.73(53.57)  | 42.69(40.79)  | 22.63(28.41)  | 46.10g(42.57)  | 44.51k(41.85)     |
| <b>M-8</b>  | 65.13(53.81)          | 76.39(60.93)  | 56.30(48.62)  | 35.68(36.68)  | 58.37i(50.01) | 63.57(52.87)          | 74.17(59.46)  | 53.47(46.99)  | 32.93(35.02)  | 56.04f(48.58)  | 56.73h(48.87)     |
| <b>M-9</b>  | 79.35(62.98)          | 91.05(72.59)  | 70.55(57.13)  | 45.38(42.35)  | 71.58d(58.76) | 72.15(58.15)          | 82.34(65.17)  | 62.18(52.05)  | 42.06(40.43)  | 64.68cd(53.95) | 68.26e(55.71)     |
| <b>M-10</b> | 52.07(46.19)          | 60.00(50.77)  | 39.09(38.69)  | 20.42(26.86)  | 42.89n(40.63) | 53.48(47.00)          | 63.67(52.93)  | 41.99(40.39)  | 21.88(27.89)  | 45.26g(42.05)  | 37.64l(37.84)     |
| <b>M-11</b> | 89.80(71.38)          | 100.00(90.00) | 78.10(62.10)  | 48.31(44.03)  | 79.05b(66.88) | 87.73(69.50)          | 100.00(90.00) | 79.86(63.34)  | 51.00(45.57)  | 79.65a(67.10)  | 74.58b(59.73)     |
| <b>M-12</b> | 63.39(52.76)          | 75.57(60.38)  | 55.09(47.92)  | 34.95(36.24)  | 57.25j(49.33) | 73.78(59.20)          | 84.53(66.84)  | 63.80(53.01)  | 43.92(41.51)  | 66.51c(55.14)  | 63.41g(52.78)     |
| <b>M-13</b> | 72.20(58.18)          | 83.16(65.77)  | 61.37(51.57)  | 37.99(38.05)  | 63.68h(53.39) | 30.86(33.74)          | 57.18(49.13)  | 67.84(55.46)  | 31.52(34.15)  | 46.85g(43.12)  | 57.40h(49.26)     |
| <b>M-14</b> | 91.30(72.87)          | 100.00(90.00) | 78.07(62.08)  | 52.55(46.46)  | 80.48a(67.85) | 88.54(70.22)          | 100.00(90.00) | 81.12(64.25)  | 53.26(46.87)  | 80.73a(67.83)  | 77.75a(61.86)     |
| <b>M-15</b> | -                     | -             | -             | -             | -             | -                     | -             | -             | -             | -              | -                 |
| Mean        | 71.97b(58.57)         | 82.62a(67.61) | 61.72c(51.96) | 38.71d(38.36) |               | 67.36b(55.70)         | 79.10a(65.11) | 62.04c(52.31) | 38.50d(38.19) |                |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 3                     | 13      | 39           | 3                     | 13     | 39           | 13                |
| <b>MS</b>      | 6371.93               | 736.4   | 28.4         | 5229.66               | 832.25 | 67.84        | 143.48            |
| <b>F Value</b> | 39561.7               | 4572.15 | 176.33       | 857.16                | 136.41 | 11.12        | 2537.31           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 73: Efficacy of pesticide modules on jassid population (no./leaf) during pre-kharif season (pooled 2017 & 2018)**

| Treat.      | DBS         | 1 <sup>st</sup> spray |             |             |             |             | 2 <sup>nd</sup> spray |             |             |              |              |
|-------------|-------------|-----------------------|-------------|-------------|-------------|-------------|-----------------------|-------------|-------------|--------------|--------------|
|             |             | 1DAS                  | 3DAS        | 7DAS        | 14DAS       | Mean        | 1DAS                  | 3DAS        | 7DAS        | 14DAS        | Mean         |
| <b>M-1</b>  | 7.05a(2.75) | 1.72(1.49)            | 1.03(1.24)  | 2.73(1.80)  | 4.99(2.34)  | 2.62k(1.72) | 1.87(1.54)            | 1.47(1.40)  | 4.40(2.21)  | 8.61(3.02)   | 4.09h(2.04)  |
| <b>M-2</b>  | 7.08a(2.75) | 2.21(1.64)            | 1.41(1.38)  | 3.25(1.94)  | 5.13(2.37)  | 3.00i(1.83) | 1.31(1.35)            | 0.79(1.14)  | 3.61(2.03)  | 7.85(2.89)   | 3.39k(1.85)  |
| <b>M-3</b>  | 6.32c(2.61) | 1.96(1.57)            | 1.16(1.29)  | 2.84(1.83)  | 4.54(2.25)  | 2.62j(1.73) | 1.73(1.49)            | 1.47(1.40)  | 4.16(2.16)  | 8.12(2.94)   | 3.87i(2.00)  |
| <b>M-4</b>  | 6.07d(2.56) | 1.38(1.37)            | 0.69(1.09)  | 2.21(1.64)  | 4.08(2.14)  | 2.09m(1.56) | 0.93(1.20)            | 0.57(1.03)  | 2.80(1.82)  | 6.23(2.59)   | 2.63l(1.66)  |
| <b>M-5</b>  | 6.62b(2.67) | 2.73(1.80)            | 2.13(1.62)  | 3.77(2.07)  | 5.81(2.51)  | 3.61e(2.00) | 2.52(1.74)            | 2.16(1.63)  | 5.94(2.54)  | 11.20(3.42)  | 5.45e(2.33)  |
| <b>M-6</b>  | 6.62b(2.67) | 3.08(1.89)            | 2.47(1.72)  | 4.07(2.14)  | 6.17(2.58)  | 3.95d(2.08) | 2.95(1.86)            | 2.61(1.76)  | 5.95(2.53)  | 12.17(3.56)  | 5.92d(2.43)  |
| <b>M-7</b>  | 7.05a(2.75) | 3.36(1.96)            | 2.76(1.81)  | 4.39(2.21)  | 6.73(2.69)  | 4.31c(2.17) | 3.93(2.10)            | 3.63(2.03)  | 8.77(3.05)  | 15.07(3.95)  | 7.85c(2.78)  |
| <b>M-8</b>  | 6.67b(2.68) | 2.60(1.76)            | 1.98(1.57)  | 3.57(2.02)  | 5.68(2.49)  | 3.46g(1.96) | 2.41(1.71)            | 2.07(1.60)  | 5.72(2.49)  | 10.85(3.37)  | 5.26f(2.29)  |
| <b>M-9</b>  | 6.66b(2.67) | 1.61(1.45)            | 0.88(1.17)  | 2.49(1.73)  | 4.54(2.25)  | 2.38l(1.65) | 1.54(1.43)            | 1.21(1.31)  | 3.82(2.08)  | 7.68(2.86)   | 3.56j(1.92)  |
| <b>M-10</b> | 6.63b(2.67) | 3.59(2.02)            | 3.08(1.89)  | 5.06(2.36)  | 6.90(2.72)  | 4.66b(2.25) | 4.08(2.14)            | 3.87(2.09)  | 9.13(3.10)  | 15.73(4.03)  | 8.20b(2.84)  |
| <b>M-11</b> | 6.31c(2.61) | 0.79(1.14)            | 0.00(0.71)  | 1.70(1.48)  | 3.93(2.11)  | 1.61n(1.36) | 0.71(1.10)            | 0.00(0.71)  | 1.96(1.57)  | 5.14(2.37)   | 1.95m(1.44)  |
| <b>M-12</b> | 6.68b(2.68) | 2.72(1.79)            | 1.97(1.57)  | 3.73(2.06)  | 5.86(2.52)  | 3.57f(1.99) | 1.88(1.54)            | 1.33(1.35)  | 4.73(2.29)  | 9.69(3.19)   | 4.41g(2.09)  |
| <b>M-13</b> | 6.64b(2.67) | 2.26(1.66)            | 1.64(1.46)  | 3.30(1.95)  | 5.58(2.47)  | 3.20h(1.89) | 4.74(2.29)            | 3.41(1.98)  | 3.98(2.12)  | 10.61(3.33)  | 5.68d(2.43)  |
| <b>M-14</b> | 6.07d(2.56) | 0.67(1.08)            | 0.00(0.71)  | 1.59(1.45)  | 3.57(2.02)  | 1.46o(1.31) | 0.58(1.04)            | 0.00(0.71)  | 1.69(1.48)  | 4.50(2.24)   | 1.69n(1.37)  |
| <b>M-15</b> | 7.07a(2.75) | 7.67(2.86)            | 8.39(2.98)  | 8.47(2.99)  | 9.51(3.16)  | 8.51a(3.00) | 11.00(3.39)           | 13.02(3.68) | 20.53(4.59) | 27.53(5.29)  | 18.02a(4.24) |
| <b>Mean</b> |             | 2.55c(1.70)           | 1.97d(1.48) | 3.54b(1.98) | 5.53a(2.44) |             | 2.81c(1.73)           | 2.51d(1.59) | 5.81b(2.40) | 10.73a(3.27) |              |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 3                     | 14      | 42           | 3                     | 14      | 42           |
| <b>MS</b>      | 0.01   | 7.69                  | 2       | 0.04         | 26.63                 | 5.86    | 0.07         |
| <b>F Value</b> | 170.76 | 47821.7               | 12442.9 | 234.52       | 21949.7               | 4830.81 | 54.13        |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiometaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiometaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 74: Efficacy of pesticide modules on % reduction of jassid population (no./leaf) during pre-kharif season (pooled 2017 & 2018)**

| Treat.      | 1 <sup>st</sup> spray |               |               |               |               | 2 <sup>nd</sup> spray |               |               |               |                | Overall reduction |
|-------------|-----------------------|---------------|---------------|---------------|---------------|-----------------------|---------------|---------------|---------------|----------------|-------------------|
|             | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean          | 1DAS                  | 3DAS          | 7DAS          | 14DAS         | Mean           |                   |
| <b>M-1</b>  | 77.55(61.72)          | 87.56(69.35)  | 67.52(55.26)  | 47.29(43.45)  | 69.98e(57.44) | 67.33(55.14)          | 78.58(62.43)  | 59.03(50.20)  | 39.90(39.17)  | 61.21f(51.74)  | 68.27f(55.72)     |
| <b>M-2</b>  | 71.41(57.68)          | 83.00(65.65)  | 61.44(51.62)  | 45.95(42.67)  | 65.45g(54.41) | 77.85(61.93)          | 88.88(70.52)  | 67.41(55.19)  | 46.95(43.25)  | 70.27c(57.72)  | 71.37d(57.65)     |
| <b>M-3</b>  | 71.95(58.02)          | 84.56(66.86)  | 62.45(52.21)  | 46.21(42.83)  | 66.29f(54.98) | 66.93(54.90)          | 76.45(60.97)  | 57.05(49.05)  | 38.00(38.06)  | 59.61g(50.74)  | 66.67g(54.74)     |
| <b>M-4</b>  | 79.20(62.87)          | 90.39(71.94)  | 69.63(56.56)  | 49.95(44.97)  | 72.29c(59.09) | 80.59(63.86)          | 89.98(71.55)  | 68.37(55.78)  | 47.19(43.39)  | 71.53b(58.65)  | 73.59c(59.08)     |
| <b>M-5</b>  | 62.04(51.97)          | 72.87(58.61)  | 52.41(46.38)  | 34.97(36.25)  | 55.57k(48.30) | 62.49(52.23)          | 73.13(58.78)  | 52.90(46.66)  | 33.32(35.26)  | 55.46hi(48.23) | 56.56k(48.77)     |
| <b>M-6</b>  | 57.36(49.23)          | 68.44(55.82)  | 48.64(44.22)  | 30.92(33.79)  | 51.34l(45.77) | 58.55(49.92)          | 69.01(56.18)  | 57.40(49.39)  | 31.65(34.24)  | 54.15i(47.43)  | 52.70l(46.55)     |
| <b>M-7</b>  | 56.23(48.58)          | 66.88(54.87)  | 47.95(43.83)  | 29.09(32.64)  | 50.04m(44.98) | 50.21(45.12)          | 61.33(51.55)  | 40.07(39.27)  | 22.56(28.35)  | 43.54k(41.07)  | 45.00m(42.13)     |
| <b>M-8</b>  | 64.21(53.26)          | 74.93(59.96)  | 55.21(47.99)  | 36.78(37.34)  | 57.78i(49.63) | 63.36(52.75)          | 73.56(59.06)  | 53.45(46.98)  | 33.89(35.60)  | 56.07h(48.60)  | 58.13j(49.68)     |
| <b>M-9</b>  | 77.80(61.89)          | 88.79(70.44)  | 68.69(55.98)  | 49.11(44.49)  | 71.10d(58.20) | 70.72(57.24)          | 80.67(63.92)  | 60.92(51.31)  | 41.30(39.99)  | 63.40e(53.12)  | 70.11e(56.86)     |
| <b>M-10</b> | 50.29(45.17)          | 60.93(51.31)  | 36.13(36.94)  | 22.76(28.49)  | 42.53n(40.48) | 49.62(44.78)          | 59.89(50.70)  | 39.31(38.83)  | 21.36(27.53)  | 42.54k(40.46)  | 39.17n(38.75)     |
| <b>M-11</b> | 88.62(70.29)          | 100.00(90.00) | 77.49(61.67)  | 53.40(46.95)  | 79.88b(67.23) | 84.78(67.04)          | 100.00(90.00) | 77.13(61.43)  | 54.05(47.32)  | 78.99a(66.45)  | 78.39b(62.30)     |
| <b>M-12</b> | 62.63(52.32)          | 75.07(60.05)  | 53.30(46.89)  | 34.94(36.23)  | 56.49j(48.87) | 72.61(58.44)          | 83.73(66.21)  | 62.98(52.53)  | 43.31(41.16)  | 65.66d(54.58)  | 63.06h(52.57)     |
| <b>M-13</b> | 68.84(56.07)          | 78.96(62.70)  | 58.35(49.81)  | 37.70(37.88)  | 60.96h(51.61) | 27.46(31.60)          | 55.91(48.39)  | 67.27(55.10)  | 34.04(35.69)  | 46.17j(42.70)  | 58.85i(50.10)     |
| <b>M-14</b> | 90.00(71.56)          | 100.00(90.00) | 78.12(62.11)  | 56.17(48.54)  | 81.07a(68.05) | 86.26(68.25)          | 100.00(90.00) | 78.44(62.33)  | 55.76(48.31)  | 80.11a(67.22)  | 80.48a(63.78)     |
| <b>M-15</b> | -                     | -             | -             | -             | -             | -                     | -             | -             | -             | -              | -                 |
| <b>Mean</b> | 69.87b(57.19)         | 80.88a(66.25) | 59.81c(50.82) | 41.09d(39.75) |               | 65.63b(54.51)         | 77.94a(64.30) | 60.12c(51.00) | 38.81d(38.38) |                |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 3                     | 13      | 39           | 3                     | 13     | 39           | 13                |
| <b>MS</b>      | 5214.88               | 776.41  | 27.09        | 4818.93               | 842.45 | 67.41        | 158.37            |
| <b>F Value</b> | 27873.9               | 4149.95 | 144.79       | 4350.78               | 760.61 | 60.86        | 3400.29           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastara + Agniastara], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastara + Agniastara], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastara + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 39: Efficacy of pesticide modules on jassid population after 1<sup>st</sup> spray during pre-kharif**

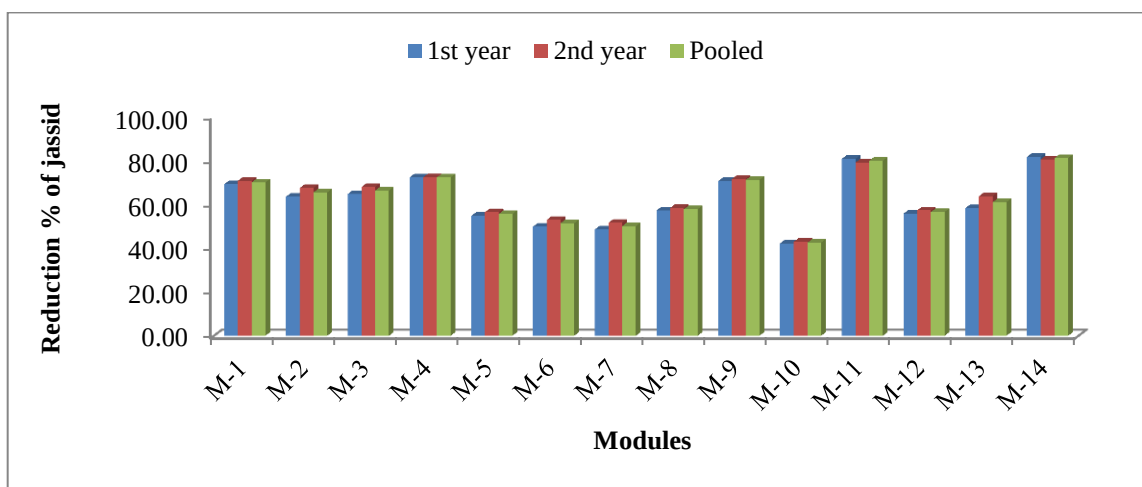


**Fig. 40: Efficacy of pesticide modules on jassid population after 2<sup>nd</sup> spray during pre-kharif**

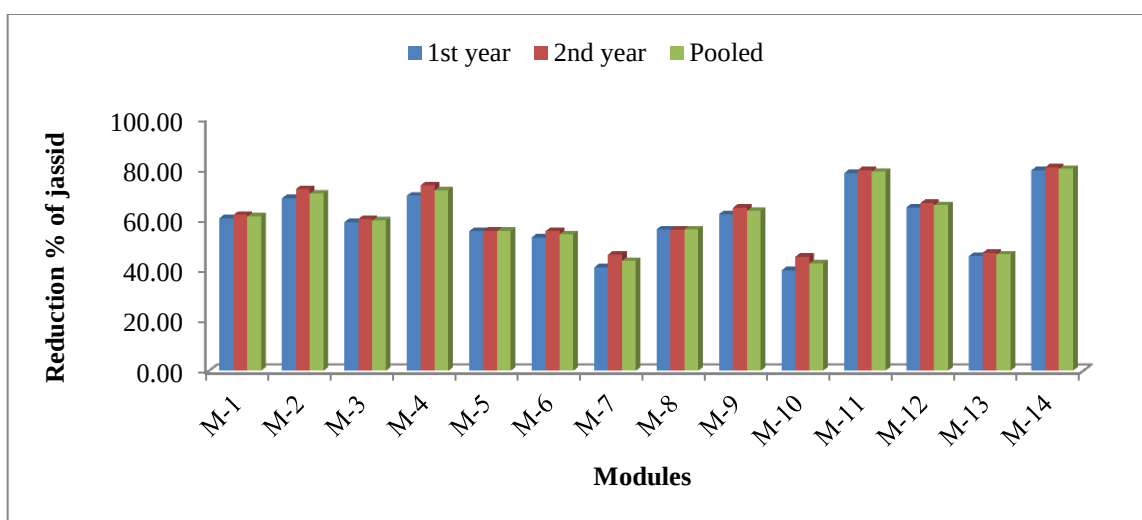
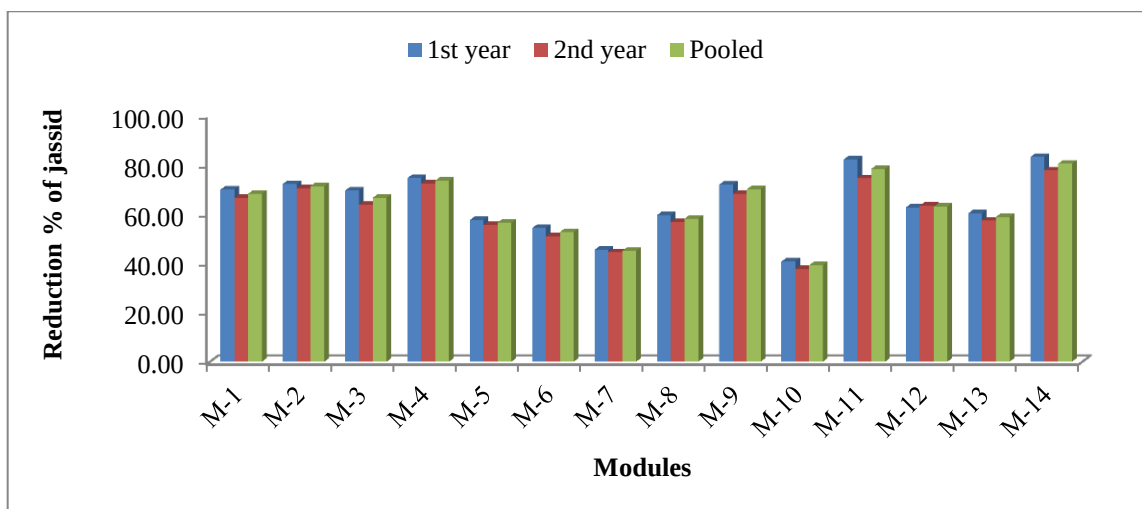


**Fig. 41: Overall efficacy of pesticide modules on jassid population during pre-kharif**



#### 4.3.2.2. Fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.)

At one day before spray of insecticides, the fruit borer (bored fruit %) population varied significantly among the plots where seed treatment has been made. Maximum population was observed in plots where no seed treatment was done in untreated plot M-15 and other plots like M-1, M-2, M-7 ranging from 9.09 to 9.11%/plant, from 11.20 to 11.23%/plant and from 10.15 to 10.17%/plant in 2017, 2018 and in pooled mean of both years respectively. The lowest population was observed from imidacloprid 17.8SL treated plot M-14 with population of 6.00%, 9.00% and 7.50%/plant followed by M-4 (6.09%, 9.05% and 7.57%/plant), M-3 (6.61%, 9.73% and 8.17%/plant) and M-11 (6.62%, 9.84% and 8.23%/plant) during 2017, 2018 and pooled of both years respectively. All the above modules where seed treatment has been made with chemicals gave maximum reduction of bored fruit per cent. The modules where seed treatment was done by bijamrita provided less fruit borer reduction as compared to chemically treated modules but gave higher reduction over untreated plot (Table 75, 77 and 79).

During 1<sup>st</sup> spray in pre-kharif season, the efficacy of different insecticides on fruit borer population was presented in table 75, 77 and 79. The maximum reduction of fruit damage was found on M-13 (72.42%, 74.11% and 73.27%) followed by M-14 (69.00%, 70.52% and 70.23%) and M-11 (68.43%, 69.84% and 69.13%) during 2017, 2018 and pooled mean of both years respectively (Table 76, 78 and 80).

In 2<sup>nd</sup> spray, M-4 was found most effective as it had been provided maximum reduction of fruit damage in the tune of 83.63% with 1.40% bored fruit/plant, 82.44% with 2.29% bored fruit/plant and 83.04% with 1.85% bored fruit/plant followed by M-2 (79.75% with 2.65% bored fruit/plant, 77.95% with 3.70% bored fruit/plant and 78.85% with 3.17%bored fruit/plant) during 2017, 2018 and pooled mean of both years respectively.

The overall fruit borer reduction per cent of two sprays revealed that M-4 was found most effective in reduction of fruit borer damage (83.63%, 82.44% and 83.04%) followed by M-2 (79.75%, 77.95% and 78.85%) while the lowest reduction was recorded from M-10 (43.49%, 43.88% and 43.69%) during 2017, 2018 and pooled mean of both years respectively excluded untreated plot (M-15).

Reduction percentage of fruit borer population on okra varied significantly among different date of observation after spraying insecticides during pre-kharif season.

In overall efficacy during the 1<sup>st</sup> spray, the highest percentage of reduction against fruit borer was noticed after 3 days of spraying (64.90%, 65.64% and 65.27%) which was followed by 7 days after spraying (54.32%, 56.29% and 55.31%) and minimum reduction was observed after 14 days of spraying (43.70%, 45.90% and 44.90%) 2017, 2018 and pooled mean of both years respectively. The similar trend was observed in the 2<sup>nd</sup> spray where 3 days after spraying (63.58%, 62.87% and 63.23%) gave maximum mortality followed by 7 days (54.19%, 54.66% and 54.42%) and minimum mortality was recorded at 14 days after spraying (42.74%, 43.63% and 43.19%) during 2017, 2018 and pooled mean of both years respectively.

**Table 75: Efficacy of pesticide modules on fruit borer population (% bored fruit) during pre-kharif season in 2017**

| Treat. | DBS          | 1 <sup>st</sup> spray |              |              |               |              |              | 2 <sup>nd</sup> spray |               |      |  |      |  |       |  |
|--------|--------------|-----------------------|--------------|--------------|---------------|--------------|--------------|-----------------------|---------------|------|--|------|--|-------|--|
|        |              | 3DAS                  |              | 7DAS         |               | 14DAS        |              | Mean                  |               | 3DAS |  | 7DAS |  | 14DAS |  |
| M-1    | 9.09a (3.10) | 4.19 (2.17)           | 5.41 (2.43)  | 8.07 (2.93)  | 5.89f (2.51)  | 2.60 (1.76)  | 3.87 (2.09)  | 5.11 (2.37)           | 3.86g (2.07)  |      |  |      |  |       |  |
| M-2    | 9.09a (3.10) | 4.71 (2.28)           | 5.98 (2.54)  | 9.02 (3.09)  | 6.57c (2.64)  | 1.41 (1.38)  | 2.47 (1.72)  | 4.07 (2.14)           | 2.65l (1.75)  |      |  |      |  |       |  |
| M-3    | 6.61c (2.67) | 3.31 (1.95)           | 4.21 (2.17)  | 6.47 (2.64)  | 4.66h (2.25)  | 2.20 (1.64)  | 3.15 (1.91)  | 4.21 (2.17)           | 3.19j (1.91)  |      |  |      |  |       |  |
| M-4    | 6.09d (2.57) | 2.35 (1.69)           | 3.19 (1.92)  | 5.09 (2.36)  | 3.54i (1.99)  | 0.72 (1.10)  | 1.29 (1.34)  | 2.20 (1.64)           | 1.40m (1.36)  |      |  |      |  |       |  |
| M-5    | 7.62b (2.85) | 4.93 (2.33)           | 5.65 (2.48)  | 8.42 (2.99)  | 6.33d (2.60)  | 4.18 (2.16)  | 5.19 (2.38)  | 6.77 (2.70)           | 5.38e (2.41)  |      |  |      |  |       |  |
| M-6    | 7.55b (2.84) | 4.29 (2.19)           | 6.02 (2.55)  | 9.00 (3.08)  | 6.44d (2.61)  | 4.25 (2.18)  | 6.00 (2.55)  | 7.78 (2.88)           | 6.01d (2.53)  |      |  |      |  |       |  |
| M-7    | 9.11a (3.10) | 6.24 (2.60)           | 7.43 (2.82)  | 11.03 (3.40) | 8.23b (2.94)  | 6.23 (2.59)  | 7.73 (2.87)  | 9.81 (3.21)           | 7.92b (2.89)  |      |  |      |  |       |  |
| M-8    | 7.55b (2.84) | 4.53 (2.24)           | 5.54 (2.46)  | 8.17 (2.94)  | 6.08e (2.55)  | 3.66 (2.04)  | 4.82 (2.31)  | 6.36 (2.62)           | 4.94f (2.32)  |      |  |      |  |       |  |
| M-9    | 7.58b (2.84) | 3.37 (1.97)           | 4.48 (2.23)  | 6.58 (2.66)  | 4.81g (2.29)  | 2.00 (1.58)  | 3.00 (1.87)  | 4.24 (2.18)           | 3.08k (1.88)  |      |  |      |  |       |  |
| M-10   | 7.63b (2.85) | 6.19 (2.59)           | 7.44 (2.82)  | 10.48 (3.31) | 8.04b (2.91)  | 6.09 (2.57)  | 7.46 (2.82)  | 9.52 (3.17)           | 7.69c (2.85)  |      |  |      |  |       |  |
| M-11   | 6.62c (2.67) | 1.82 (1.52)           | 2.96 (1.86)  | 5.11 (2.37)  | 3.30j (1.92)  | 2.23 (1.65)  | 2.92 (1.85)  | 4.00 (2.12)           | 3.05k (1.87)  |      |  |      |  |       |  |
| M-12   | 7.63b (2.85) | 4.51 (2.24)           | 5.64 (2.48)  | 8.41 (2.98)  | 6.19e (2.57)  | 2.00 (1.58)  | 3.27 (1.94)  | 4.93 (2.33)           | 3.40i (1.95)  |      |  |      |  |       |  |
| M-13   | 7.62b (2.85) | 1.61 (1.45)           | 3.00 (1.87)  | 5.38 (2.42)  | 3.33j (1.92)  | 3.36 (1.96)  | 3.00 (1.87)  | 4.60 (2.26)           | 3.65h (2.03)  |      |  |      |  |       |  |
| M-14   | 6.00d (2.55) | 1.60 (1.45)           | 2.67 (1.78)  | 4.52 (2.24)  | 2.93k (1.82)  | 1.81 (1.52)  | 2.49 (1.73)  | 3.53 (2.01)           | 2.61l (1.75)  |      |  |      |  |       |  |
| M-15   | 9.10a (3.10) | 12.90 (3.66)          | 12.94 (3.67) | 16.00 (4.06) | 13.95a (3.80) | 17.34 (4.22) | 18.23 (4.33) | 20.10 (4.54)          | 18.56a (4.36) |      |  |      |  |       |  |
| Mean   |              | 4.44c (2.15)          | 5.50b (2.41) | 8.12a (2.90) |               | 4.00c (2.00) | 4.99b (2.24) | 6.48a (2.55)          |               |      |  |      |  |       |  |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.10   | 6.45                  | 2.31    | 0.01         | 3.53                  | 4.64    | 0.02         |
| <b>F Value</b> | 569.05 | 6202.57               | 2218.23 | 13.6         | 4962.12               | 6512.05 | 23.68        |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 76: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during pre-kharif season in 2017**

| Treat. | 1 <sup>st</sup> spray |         |        |         |        |         | 2 <sup>nd</sup> spray |         |        |         |        |         | Overall reduction |         |         |         |               |
|--------|-----------------------|---------|--------|---------|--------|---------|-----------------------|---------|--------|---------|--------|---------|-------------------|---------|---------|---------|---------------|
|        | 3DAS                  |         | 7DAS   |         | 14DAS  |         | Mean                  |         | 3DAS   |         | 7DAS   |         |                   | 14DAS   |         | Mean    |               |
| M-1    | 67.46                 | (55.22) | 58.18  | (49.71) | 49.53  | (44.73) | 58.39d                | (49.89) | 70.31  | (56.98) | 57.93  | (49.56) | 49.55             | (44.74) | 59.26de | (50.43) | 74.55c(59.70) |
| M-2    | 63.48                 | (52.82) | 53.77  | (47.16) | 43.55  | (41.29) | 53.60e                | (47.09) | 85.54  | (67.65) | 75.95  | (60.63) | 64.12             | (53.20) | 75.20b  | (60.50) | 79.75b(63.25) |
| M-3    | 64.69                 | (53.54) | 55.22  | (47.99) | 44.29  | (41.72) | 54.73e                | (47.75) | 68.62  | (55.93) | 57.22  | (49.15) | 48.20             | (43.97) | 58.01e  | (49.68) | 71.14e(57.51) |
| M-4    | 72.77                 | (58.55) | 63.12  | (52.61) | 52.51  | (46.44) | 62.80c                | (52.53) | 86.87  | (68.76) | 77.66  | (61.80) | 65.33             | (53.94) | 76.62a  | (61.50) | 83.63a(66.14) |
| M-5    | 54.35                 | (47.50) | 47.83  | (43.75) | 37.16  | (37.56) | 46.45g                | (42.94) | 54.24  | (47.43) | 45.92  | (42.66) | 35.95             | (36.84) | 45.37h  | (42.31) | 59.75g(50.62) |
| M-6    | 59.95                 | (50.76) | 43.89  | (41.49) | 32.20  | (34.57) | 45.35g                | (42.27) | 56.43  | (48.72) | 41.48  | (40.09) | 31.20             | (33.96) | 43.04i  | (40.92) | 53.36h(46.92) |
| M-7    | 51.64                 | (45.94) | 42.65  | (40.77) | 31.09  | (33.89) | 41.79h                | (40.20) | 47.87  | (43.78) | 38.47  | (38.33) | 29.23             | (32.73) | 38.52j  | (38.28) | 51.24i(45.71) |
| M-8    | 57.64                 | (49.40) | 48.43  | (44.10) | 38.48  | (38.34) | 48.18f                | (43.95) | 58.67  | (50.00) | 48.19  | (43.96) | 38.02             | (38.07) | 48.29g  | (44.01) | 61.87f(51.87) |
| M-9    | 68.62                 | (55.93) | 58.48  | (49.88) | 50.68  | (45.39) | 59.26d                | (50.40) | 71.94  | (58.01) | 59.96  | (50.74) | 48.63             | (44.22) | 60.18d  | (50.99) | 74.66c(59.78) |
| M-10   | 42.83                 | (40.87) | 31.46  | (34.11) | 21.89  | (27.89) | 32.06i                | (34.29) | 46.41  | (42.94) | 37.55  | (37.79) | 27.62             | (31.69) | 37.19k  | (37.47) | 43.49j(41.26) |
| M-11   | 80.57                 | (63.85) | 68.59  | (55.91) | 56.13  | (48.52) | 68.43b                | (56.09) | 59.64  | (50.56) | 49.75  | (44.85) | 37.63             | (37.84) | 49.01g  | (44.42) | 72.64d(58.46) |
| M-12   | 58.30                 | (49.79) | 47.96  | (43.83) | 37.31  | (37.65) | 47.86f                | (43.76) | 78.05  | (62.06) | 65.89  | (54.27) | 53.28             | (46.88) | 65.74c  | (54.40) | 70.71e(57.24) |
| M-13   | 85.12                 | (67.31) | 72.30  | (58.24) | 59.85  | (50.68) | 72.42a                | (58.75) | 42.39  | (40.63) | 51.02  | (45.58) | 31.88             | (34.38) | 41.76i  | (40.19) | 72.65d(58.47) |
| M-14   | 81.19                 | (64.30) | 68.67  | (55.96) | 57.15  | (49.11) | 69.00b                | (56.46) | 63.11  | (52.60) | 51.65  | (45.94) | 37.76             | (37.91) | 50.84f  | (45.49) | 73.33d(58.91) |
| M-15   | -                     |         | -      |         | -      |         | -                     |         | -      |         | -      |         | -                 |         | -       |         | -             |
| Mean   | 64.90a                | (53.98) | 54.32b | (47.54) | 43.70c | (41.27) |                       |         | 63.58a | (53.29) | 54.19b | (47.53) | 42.74c            | (40.74) |         |         |               |

| Source         | 1 <sup>st</sup> spray |        |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|--------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 2                     | 13     | 26           | 2                     | 13     | 26           | 13                |
| <b>MS</b>      | 1697.47               | 431    | 4.12         | 1657.33               | 534.16 | 9.51         | 151.02            |
| <b>F Value</b> | 2551.42               | 647.82 | 6.19         | 2391.79               | 770.88 | 13.72        | 1450.87           |
| <b>Pr&gt;F</b> | <.0001                | <.0001 | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 77: Efficacy of pesticide modules on fruit borer population (% bored fruit) during pre-kharif season in 2018**

| Treat.      | DBS           | 1 <sup>st</sup> spray |              |              |               | 2 <sup>nd</sup> spray |              |              |               |
|-------------|---------------|-----------------------|--------------|--------------|---------------|-----------------------|--------------|--------------|---------------|
|             |               | 3DAS                  | 7DAS         | 14DAS        | Mean          | 3DAS                  | 7DAS         | 14DAS        | Mean          |
| <b>M-1</b>  | 11.22a (3.42) | 4.21 (2.17)           | 6.06 (2.56)  | 8.96 (3.08)  | 6.41h (2.60)  | 3.05 (1.88)           | 4.21 (2.17)  | 5.80 (2.51)  | 4.35g (2.19)  |
| <b>M-2</b>  | 11.20a (3.42) | 4.74 (2.29)           | 6.56 (2.66)  | 9.49 (3.16)  | 6.93g (2.70)  | 2.21 (1.64)           | 3.40 (1.97)  | 5.49 (2.45)  | 3.70j (2.02)  |
| <b>M-3</b>  | 9.73c (3.20)  | 3.77 (2.07)           | 5.30 (2.41)  | 8.11 (2.93)  | 5.73i (2.47)  | 2.79 (1.81)           | 3.89 (2.10)  | 5.44 (2.44)  | 4.04h (2.12)  |
| <b>M-4</b>  | 9.05d (3.09)  | 2.78 (1.81)           | 4.01 (2.12)  | 6.22 (2.59)  | 4.34j (2.18)  | 1.31 (1.35)           | 2.04 (1.59)  | 3.53 (2.01)  | 2.29l (1.65)  |
| <b>M-5</b>  | 10.09b (3.25) | 5.72 (2.49)           | 7.41 (2.81)  | 10.07 (3.25) | 7.73ef (2.85) | 4.40 (2.21)           | 5.98 (2.55)  | 8.25 (2.96)  | 6.21e (2.57)  |
| <b>M-6</b>  | 10.13b (3.26) | 6.02 (2.55)           | 7.26 (2.78)  | 10.76 (3.35) | 8.01d (2.90)  | 5.20 (2.39)           | 6.71 (2.68)  | 9.75 (3.20)  | 7.22d (2.76)  |
| <b>M-7</b>  | 11.23a (3.43) | 6.80 (2.70)           | 8.73 (3.04)  | 12.17 (3.56) | 9.23c (3.10)  | 7.02 (2.74)           | 8.62 (3.02)  | 11.93 (3.53) | 9.19c (3.10)  |
| <b>M-8</b>  | 10.13b (3.26) | 5.64 (2.48)           | 7.24 (2.78)  | 10.00 (3.24) | 7.63f (2.83)  | 4.22 (2.17)           | 6.10 (2.57)  | 8.07 (2.93)  | 6.13e (2.56)  |
| <b>M-9</b>  | 10.26b (3.28) | 3.82 (2.08)           | 5.38 (2.43)  | 8.26 (2.96)  | 5.82i (2.49)  | 2.70 (1.79)           | 3.60 (2.03)  | 5.27 (2.40)  | 3.86i (2.07)  |
| <b>M-10</b> | 10.29b (3.28) | 7.20 (2.78)           | 9.02 (3.09)  | 12.50 (3.61) | 9.58b (3.16)  | 7.70 (2.86)           | 9.60 (3.18)  | 12.83 (3.65) | 10.04b (3.23) |
| <b>M-11</b> | 9.84c (3.22)  | 2.42 (1.71)           | 4.03 (2.13)  | 6.55 (2.65)  | 4.33j (2.16)  | 2.57 (1.75)           | 3.61 (2.03)  | 5.31 (2.41)  | 3.83i (2.06)  |
| <b>M-12</b> | 10.18b (3.27) | 5.60 (2.47)           | 7.51 (2.83)  | 10.45 (3.31) | 7.85e (2.87)  | 3.00 (1.87)           | 4.41 (2.22)  | 6.71 (2.69)  | 4.71f (2.26)  |
| <b>M-13</b> | 10.14b (3.26) | 2.09 (1.61)           | 3.41 (1.98)  | 6.04 (2.56)  | 3.85k (2.05)  | 4.13 (2.15)           | 3.66 (2.04)  | 5.52 (2.45)  | 4.44g (2.21)  |
| <b>M-14</b> | 9.00d (3.08)  | 2.21 (1.65)           | 3.61 (2.03)  | 5.80 (2.51)  | 3.87k (2.06)  | 2.34 (1.68)           | 3.21 (1.93)  | 4.81 (2.30)  | 3.45k (1.97)  |
| <b>M-15</b> | 11.20a (3.42) | 14.29 (3.85)          | 15.27 (3.97) | 18.11 (4.31) | 15.89a (4.04) | 20.08 (4.54)          | 21.43 (4.68) | 24.89 (5.04) | 22.13a (4.75) |
| <b>Mean</b> |               | 5.15c (2.31)          | 6.72b (2.64) | 9.56a (3.14) |               | 4.85c (2.19)          | 6.03b (2.45) | 8.24a (2.86) |               |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.04   | 7.76                  | 2.44    | 0.01         | 5.21                  | 5.16    | 0.02         |
| <b>F Value</b> | 84.09  | 12694                 | 3984.55 | 18.07        | 4611.25               | 4572.53 | 16.61        |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 78: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during pre-kharif season in 2018**

| Treat.      | 1 <sup>st</sup> spray |                |                |                 | 2 <sup>nd</sup> spray |                |                |                 | Overall reduction |
|-------------|-----------------------|----------------|----------------|-----------------|-----------------------|----------------|----------------|-----------------|-------------------|
|             | 3DAS                  | 7DAS           | 14DAS          | Mean            | 3DAS                  | 7DAS           | 14DAS          | Mean            |                   |
| <b>M-1</b>  | 70.57 (57.15)         | 60.35 (50.97)  | 50.60 (45.34)  | 60.51d (51.16)  | 69.29 (56.35)         | 60.26 (50.92)  | 52.92 (46.67)  | 60.82de (51.32) | 76.73cd(61.16)    |
| <b>M-2</b>  | 66.81 (54.82)         | 57.07 (49.06)  | 47.61 (43.63)  | 57.16f (49.17)  | 79.04 (62.76)         | 69.72 (56.62)  | 57.91 (49.55)  | 68.89b (56.31)  | 77.95b(62.00)     |
| <b>M-3</b>  | 69.60 (56.54)         | 60.06 (50.80)  | 48.47 (44.13)  | 59.38e (50.49)  | 69.01 (56.17)         | 59.45 (50.45)  | 51.14 (45.65)  | 59.87e (50.76)  | 74.83e(59.89)     |
| <b>M-4</b>  | 75.93 (60.62)         | 67.47 (55.22)  | 57.50 (49.31)  | 66.96c (55.05)  | 81.01 (64.16)         | 72.23 (58.20)  | 58.67 (49.99)  | 70.64a (57.45)  | 82.44a(65.23)     |
| <b>M-5</b>  | 55.54 (48.18)         | 46.09 (42.76)  | 38.27 (38.22)  | 46.63gh (43.05) | 60.61 (51.13)         | 49.78 (44.87)  | 40.36 (39.44)  | 50.25g (45.15)  | 63.19g(52.65)     |
| <b>M-6</b>  | 53.40 (46.95)         | 47.48 (43.55)  | 34.35 (35.88)  | 45.07i (42.13)  | 56.42 (48.69)         | 47.29 (43.44)  | 33.99 (35.66)  | 45.90h (42.60)  | 56.67h(48.83)     |
| <b>M-7</b>  | 52.53 (46.45)         | 43.01 (40.98)  | 33.03 (35.07)  | 42.86j (40.84)  | 47.92 (43.81)         | 40.13 (39.31)  | 28.60 (32.33)  | 38.89i (38.48)  | 52.19i(46.26)     |
| <b>M-8</b>  | 56.39 (48.67)         | 47.61 (43.63)  | 38.98 (38.63)  | 47.66g (43.64)  | 61.94 (51.91)         | 48.47 (44.12)  | 41.30 (39.99)  | 50.57g (45.34)  | 64.17g(53.24)     |
| <b>M-9</b>  | 70.80 (57.29)         | 61.53 (51.67)  | 50.22 (45.13)  | 60.85d (51.36)  | 70.47 (57.08)         | 63.11 (52.60)  | 53.52 (47.02)  | 62.37cd (52.23) | 76.86bc(61.25)    |
| <b>M-10</b> | 45.12 (42.20)         | 35.67 (36.67)  | 24.84 (29.88)  | 35.21k (36.25)  | 44.47 (41.83)         | 35.08 (36.32)  | 25.32 (30.21)  | 34.96j (36.12)  | 43.88j(41.48)     |
| <b>M-11</b> | 80.72 (63.95)         | 69.98 (56.77)  | 58.82 (50.08)  | 69.84b (56.94)  | 64.65 (53.52)         | 53.50 (47.01)  | 40.98 (39.80)  | 53.04f (46.78)  | 75.70de(60.47)    |
| <b>M-12</b> | 56.88 (48.95)         | 45.88 (42.64)  | 36.51 (37.17)  | 46.42h (42.92)  | 74.07 (59.39)         | 64.35 (53.34)  | 53.26 (46.87)  | 63.89c (53.20)  | 70.32f(56.99)     |
| <b>M-13</b> | 83.84 (66.30)         | 75.34 (60.23)  | 63.14 (52.62)  | 74.11a (59.71)  | 38.31 (38.24)         | 48.89 (44.36)  | 33.48 (35.35)  | 40.23i (39.32)  | 75.49e(60.32)     |
| <b>M-14</b> | 80.79 (64.00)         | 70.55 (57.13)  | 60.21 (50.90)  | 70.52b (57.35)  | 63.02 (52.58)         | 53.00 (46.73)  | 39.33 (38.82)  | 51.79fg (46.04) | 75.94cde(60.63)   |
| <b>M-15</b> | -                     | -              | -              | -               | -                     | -              | -              | -               | -                 |
| <b>Mean</b> | 65.64a (54.43)        | 56.29b (48.72) | 45.90c (42.57) |                 | 62.87a (52.69)        | 54.66b (47.74) | 43.63c (41.24) |                 |                   |

| Source         | 1 <sup>st</sup> spray |        |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|--------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 2                     | 13     | 26           | 2                     | 13     | 26           | 13                |
| <b>MS</b>      | 1478.47               | 464.86 | 1.51         | 1384.28               | 394.92 | 10.57        | 144.11            |
| <b>F Value</b> | 3397.73               | 1068.3 | 3.47         | 1078.14               | 307.58 | 8.23         | 692.20            |
| <b>Pr&gt;F</b> | <.0001                | <.0001 | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 79: Efficacy of pesticide modules on fruit borer population (% bored fruit) during pre-kharif season (pooled 2017 & 2018)**

| Treat.      | DBS           | 1 <sup>st</sup> spray |              |              |               | 2 <sup>nd</sup> spray |              |              |               |
|-------------|---------------|-----------------------|--------------|--------------|---------------|-----------------------|--------------|--------------|---------------|
|             |               | 3DAS                  | 7DAS         | 14DAS        | Mean          | 3DAS                  | 7DAS         | 14DAS        | Mean          |
| <b>M-1</b>  | 10.15a (3.26) | 4.20 (2.17)           | 5.74 (2.50)  | 8.51 (3.00)  | 6.15g (2.56)  | 2.82 (1.82)           | 4.04 (2.13)  | 5.46 (2.44)  | 4.11g (2.13)  |
| <b>M-2</b>  | 10.15a (3.26) | 4.72 (2.29)           | 6.27 (2.60)  | 9.26 (3.12)  | 6.75f (2.67)  | 1.81 (1.52)           | 2.93 (1.85)  | 4.78 (2.30)  | 3.17j (1.89)  |
| <b>M-3</b>  | 8.17c (2.94)  | 3.54 (2.01)           | 4.75 (2.29)  | 7.29 (2.79)  | 5.19i (2.36)  | 2.49 (1.73)           | 3.52 (2.01)  | 4.83 (2.31)  | 3.61h (2.01)  |
| <b>M-4</b>  | 7.57d (2.84)  | 2.56 (1.75)           | 3.60 (2.03)  | 5.65 (2.48)  | 3.94j (2.09)  | 1.01 (1.23)           | 1.67 (1.47)  | 2.87 (1.83)  | 1.85l (1.51)  |
| <b>M-5</b>  | 8.85b (3.06)  | 5.33 (2.41)           | 6.53 (2.65)  | 9.24 (3.12)  | 7.03d (2.73)  | 4.29 (2.19)           | 5.58 (2.47)  | 7.51 (2.83)  | 5.79e (2.49)  |
| <b>M-6</b>  | 8.84b (3.06)  | 5.15 (2.38)           | 6.64 (2.67)  | 9.88 (3.22)  | 7.22c (2.76)  | 4.72 (2.28)           | 6.35 (2.62)  | 8.77 (3.04)  | 6.61d (2.65)  |
| <b>M-7</b>  | 10.17a (3.27) | 6.52 (2.65)           | 8.08 (2.93)  | 11.60 (3.48) | 8.73b (3.02)  | 6.63 (2.67)           | 8.18 (2.95)  | 10.87 (3.37) | 8.56c (3.00)  |
| <b>M-8</b>  | 8.84b (3.06)  | 5.09 (2.36)           | 6.39 (2.62)  | 9.08 (3.10)  | 6.85e (2.69)  | 3.94 (2.11)           | 5.46 (2.44)  | 7.21 (2.78)  | 5.54f (2.44)  |
| <b>M-9</b>  | 8.92b (3.07)  | 3.60 (2.02)           | 4.93 (2.33)  | 7.42 (2.81)  | 5.31h (2.39)  | 2.35 (1.69)           | 3.30 (1.95)  | 4.76 (2.29)  | 3.47i (1.98)  |
| <b>M-10</b> | 8.96b (3.08)  | 6.69 (2.68)           | 8.23 (2.95)  | 11.49 (3.46) | 8.81b (3.03)  | 6.89 (2.72)           | 8.53 (3.00)  | 11.18 (3.42) | 8.87b (3.05)  |
| <b>M-11</b> | 8.23c (2.95)  | 2.12 (1.62)           | 3.49 (2.00)  | 5.83 (2.52)  | 3.81k (2.04)  | 2.40 (1.70)           | 3.26 (1.94)  | 4.66 (2.27)  | 3.44i (1.97)  |
| <b>M-12</b> | 8.90b (3.07)  | 5.05 (2.36)           | 6.58 (2.66)  | 9.43 (3.15)  | 7.02d (2.72)  | 2.50 (1.73)           | 3.84 (2.08)  | 5.82 (2.51)  | 4.05g (2.11)  |
| <b>M-13</b> | 8.88b (3.06)  | 1.85 (1.53)           | 3.20 (1.92)  | 5.71 (2.49)  | 3.59l (1.98)  | 3.75 (2.06)           | 3.33 (1.96)  | 5.06 (2.36)  | 4.04g (2.12)  |
| <b>M-14</b> | 7.50d (2.83)  | 1.90 (1.55)           | 3.14 (1.91)  | 5.16 (2.38)  | 3.40m (1.95)  | 2.07 (1.60)           | 2.85 (1.83)  | 4.17 (2.16)  | 3.03k (1.87)  |
| <b>M-15</b> | 10.15a (3.26) | 13.59 (3.75)          | 14.11 (3.82) | 17.06 (4.19) | 14.92a (3.92) | 18.71 (4.38)          | 19.83 (4.51) | 22.49 (4.79) | 20.34a (4.56) |
| <b>Mean</b> |               | 4.80c (2.24)          | 6.11b (2.53) | 8.84a (3.02) |               | 4.43c (2.10)          | 5.51b (2.35) | 7.36a (2.71) |               |

| Source         | DBS    | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |         |              |
|----------------|--------|-----------------------|---------|--------------|-----------------------|---------|--------------|
|                |        | Day                   | Module  | Day x Module | Day                   | Module  | Day x Module |
| <b>DF</b>      | 14     | 2                     | 14      | 28           | 2                     | 14      | 28           |
| <b>MS</b>      | 0.06   | 7.09                  | 2.35    | 0.01         | 4.35                  | 4.89    | 0.02         |
| <b>F Value</b> | 297.22 | 19509.7               | 6471.38 | 29.27        | 9324.36               | 10468.6 | 34.92        |
| <b>Pr&gt;F</b> | <.0001 | <.0001                | <.0001  | <.0001       | <.0001                | <.0001  | <.0001       |

Figure in parenthesis indicates square root transformed value, DBS: Day before spray, DAS: Day after spray, DF: Degrees of freedom, MS: Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 80: Efficacy of pesticide modules on % reduction of fruit borer population (% bored fruit) during pre-kharif season (2017 & 2018)**

| Module | 1 <sup>st</sup> spray |         |        |         |        |         |         |         | 2 <sup>nd</sup> spray |         |        |         |        |         |        |         | Overall reduction |
|--------|-----------------------|---------|--------|---------|--------|---------|---------|---------|-----------------------|---------|--------|---------|--------|---------|--------|---------|-------------------|
|        | 3DAS                  |         | 7DAS   |         | 14DAS  |         | Mean    |         | 3DAS                  |         | 7DAS   |         | 14DAS  |         | Mean   |         |                   |
| M-1    | 69.02                 | (56.18) | 59.26  | (50.34) | 50.07  | (45.04) | 59.45e  | (50.52) | 69.80                 | (56.67) | 59.10  | (50.24) | 51.23  | (45.71) | 60.04e | (50.87) | 75.64c(60.43)     |
| M-2    | 65.14                 | (53.81) | 55.42  | (48.11) | 45.58  | (42.46) | 55.38g  | (48.13) | 82.29                 | (65.12) | 72.83  | (58.59) | 61.02  | (51.37) | 72.05b | (58.36) | 78.85b(62.62)     |
| M-3    | 67.15                 | (55.03) | 57.64  | (49.39) | 46.38  | (42.92) | 57.06f  | (49.12) | 68.81                 | (56.05) | 58.33  | (49.80) | 49.67  | (44.81) | 58.94f | (50.22) | 72.98e(58.68)     |
| M-4    | 74.35                 | (59.57) | 65.29  | (53.91) | 55.00  | (47.87) | 64.88d  | (53.78) | 83.94                 | (66.38) | 74.95  | (59.96) | 62.00  | (51.95) | 73.63a | (59.43) | 83.04a(65.68)     |
| M-5    | 54.95                 | (47.84) | 46.96  | (43.26) | 37.72  | (37.89) | 46.54i  | (42.99) | 57.43                 | (49.27) | 47.85  | (43.77) | 38.16  | (38.15) | 47.81i | (43.73) | 61.47h(51.63)     |
| M-6    | 56.67                 | (48.84) | 45.68  | (42.52) | 33.27  | (35.23) | 45.21j  | (42.20) | 56.43                 | (48.70) | 44.38  | (41.77) | 32.60  | (34.82) | 44.47j | (41.76) | 55.01i(47.88)     |
| M-7    | 52.08                 | (46.19) | 42.83  | (40.88) | 32.06  | (34.48) | 42.32k  | (40.52) | 47.89                 | (43.79) | 39.30  | (38.82) | 28.92  | (32.53) | 38.71l | (38.38) | 51.71j(45.98)     |
| M-8    | 57.02                 | (49.03) | 48.02  | (43.86) | 38.73  | (38.49) | 47.92h  | (43.79) | 60.31                 | (50.95) | 48.33  | (44.04) | 39.66  | (39.03) | 49.43h | (44.67) | 63.02g(52.55)     |
| M-9    | 69.71                 | (56.61) | 60.00  | (50.77) | 50.45  | (45.26) | 60.05e  | (50.88) | 71.20                 | (57.55) | 61.53  | (51.67) | 51.07  | (45.62) | 61.27d | (51.61) | 75.76c(60.51)     |
| M-10   | 43.97                 | (41.54) | 33.56  | (35.40) | 23.36  | (28.90) | 33.63l  | (35.28) | 45.44                 | (42.39) | 36.32  | (37.06) | 26.47  | (30.95) | 36.08m | (36.80) | 43.69k(41.37)     |
| M-11   | 80.64                 | (63.90) | 69.28  | (56.34) | 57.48  | (49.30) | 69.13c  | (56.51) | 62.15                 | (52.03) | 51.62  | (45.93) | 39.31  | (38.83) | 51.03g | (45.60) | 74.17d(59.45)     |
| M-12   | 57.59                 | (49.37) | 46.92  | (43.24) | 36.91  | (37.41) | 47.14hi | (43.34) | 76.06                 | (60.71) | 65.12  | (53.80) | 53.27  | (46.88) | 64.82c | (53.79) | 70.52f(57.11)     |
| M-13   | 84.48                 | (66.80) | 73.82  | (59.23) | 61.50  | (51.65) | 73.27a  | (59.22) | 40.35                 | (39.44) | 49.95  | (44.97) | 32.68  | (34.87) | 41.00k | (39.76) | 74.07d(59.39)     |
| M-14   | 80.99                 | (64.15) | 69.61  | (56.54) | 60.09  | (50.84) | 70.23b  | (57.18) | 63.07                 | (52.58) | 52.33  | (46.33) | 38.54  | (38.37) | 51.31g | (45.76) | 74.64d(59.76)     |
| M-15   | -                     |         | -      |         | -      |         | -       |         | -                     |         | -      |         | -      |         | -      |         | -                 |
| Mean   | 65.27a                | (54.20) | 55.31b | (48.13) | 44.90c | (41.98) |         |         | 63.23a                | (52.97) | 54.42b | (47.63) | 43.19c | (40.99) |        |         |                   |

| Source         | 1 <sup>st</sup> spray |         |              | 2 <sup>nd</sup> spray |        |              | Overall reduction |
|----------------|-----------------------|---------|--------------|-----------------------|--------|--------------|-------------------|
|                | Day                   | Module  | Day x Module | Day                   | Module | Day x Module |                   |
| <b>DF</b>      | 2                     | 13      | 26           | 2                     | 13     | 26           | 13                |
| <b>MS</b>      | 1568.45               | 448.45  | 1.82         | 1513.18               | 452.42 | 9.27         | 146.47            |
| <b>F Value</b> | 5136.39               | 1468.57 | 5.96         | 3125.92               | 934.6  | 19.14        | 1444.05           |
| <b>Pr&gt;F</b> | <.0001                | <.0001  | <.0001       | <.0001                | <.0001 | <.0001       | <.0001            |

Figure in parenthesis indicates angular transformed value, DAS : Day after spray, DF : Degrees of freedom, MS : Mean square,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP]**M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]**M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]**M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 42: Efficacy of pesticide modules on fruit borer population (bored fruit %) after 1<sup>st</sup> spray during pre-kharif**

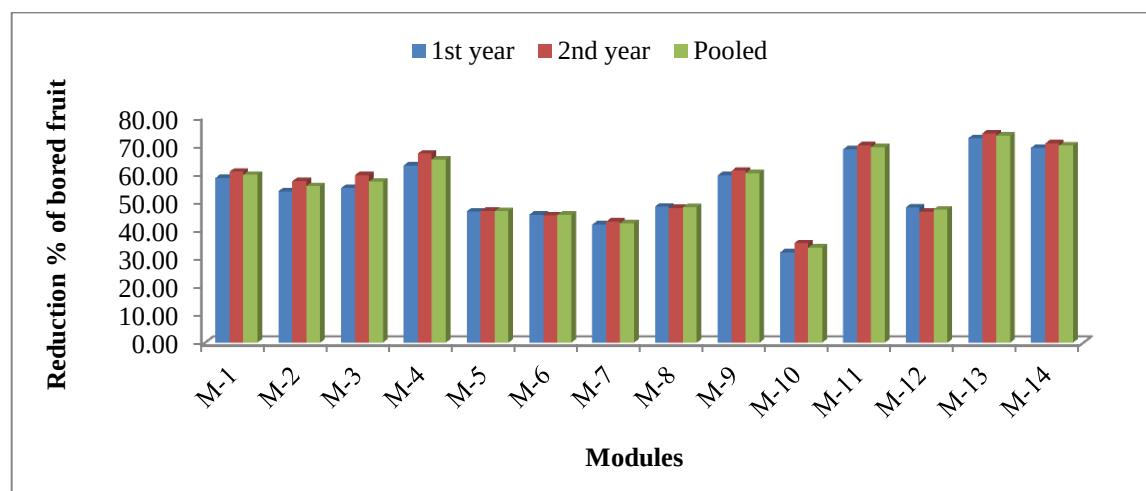


**Fig. 43: Efficacy of pesticide modules on fruit borer population (bored fruit %) after 2<sup>nd</sup> spray during pre-kharif**

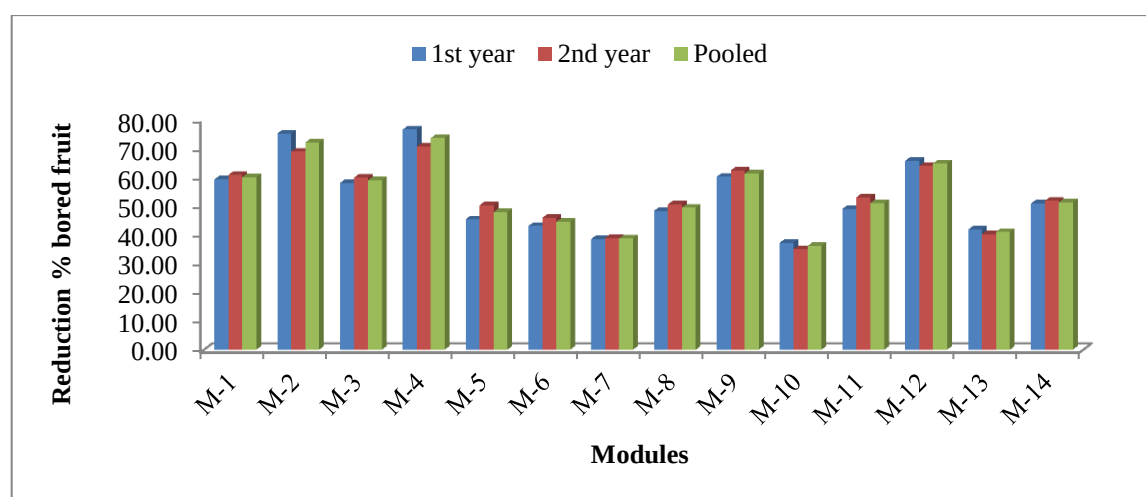
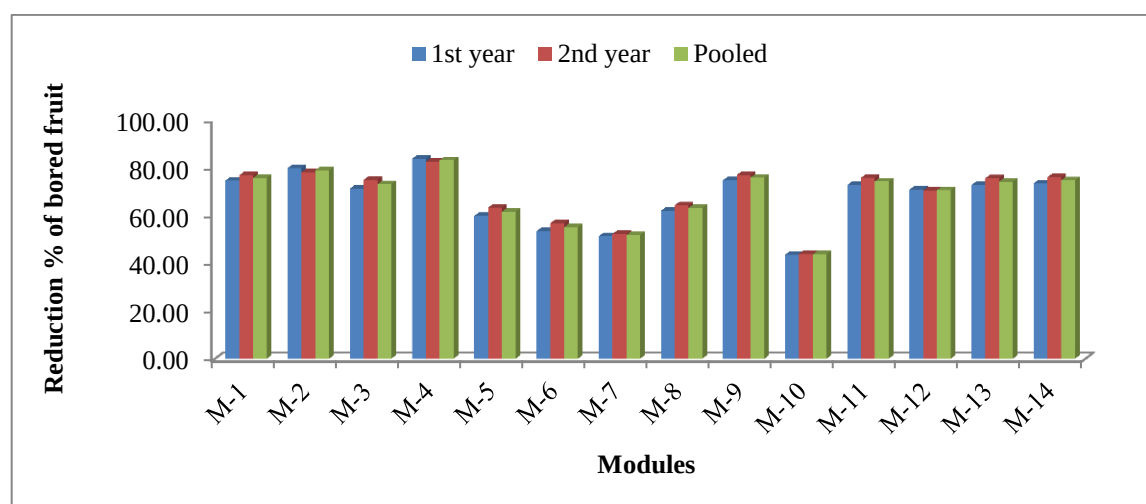


**Fig. 44: Overall efficacy of pesticide modules on fruit borer population (bored fruit %) during pre-kharif**



#### 4.3.2.3. Coccinellid

Among the different seed treated modules, minimum population of coccinellids was observed in M-14 with 0.44, 0.40 and 0.42/plant which was followed by M-4 (0.45, 0.40 and 0.42/plant), M-3 (0.53, 0.51 and 0.52/plant) and M-11 (0.53, 0.51 and 0.52/plant) during 2017, 2018 and pooled mean of both years respectively. Maximum population was recorded in untreated plot *i.e.*, M-15 and other plots like M-1, M-2, M-7 in range between (0.67 to 0.71/plant), (0.65 to 0.67/plant) and (0.66 to 0.68/plant) where no seed treatment was done in 2017, 2018 and in pooled mean of both years respectively (Table 81, 82 and 83).

The coccinellid population was observed only at 14 DAS and population after 1<sup>st</sup> spray revealed that M-14 showed the maximum reduction of coccinellid *i.e.* 49.82% with population of 0.27/plant, 50.32% with 0.25/plant and 50.07% with 0.26/plant which was found to be at par with M-11 of 47.85% with 0.33/plant, 47.68% with 0.33/plant and 47.77% with 0.33/plant during 2016, 2017 and pooled of both years, respectively. The minimum reduction of 16.25% coccinellid with population of 0.60/plant, 16.25% with 0.60/plant and 16.25% with 0.60/plant was recorded from M-10 during 2016, 2017 and pooled of both years respectively. After second spray also minimum and maximum reduction % of coccinellid population was observed from the same treatment as that of 1<sup>st</sup> spray.

The overall mean of first and second spray depicted that M-10 was found to be the safest module with population reduction of 30.39%, 31.61% and 31.00% during 2016, 2017 and pooled of both years respectively and which was followed by M-7, M-6. But M-14 and M-11 recorded the maximum reduction of coccinellid population of 73.15% and 71.77% during 2016, 73.06% and 69.36% during 2017, 73.10% and 70.56% in pooled mean of two years respectively.

**Table 81: Efficacy of pesticide modules on coccinellid population during pre-kharif season in 2017**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.69a  | (1.09)* | 0.52ef                | (1.01)* | 37.30b      | (37.63)** | 0.42ef                | (0.96)* | 34.26bcd    | (35.77)** | 58.76b              | (50.06)** |
| M-2       | 0.67ab | (1.08)  | 0.53def               | (1.01)  | 33.75b      | (35.52)   | 0.40f                 | (0.95)  | 39.62ab     | (39.01)   | 60.00b              | (50.77)   |
| M-3       | 0.53d  | (1.01)  | 0.40g                 | (0.95)  | 36.79b      | (37.34)   | 0.33g                 | (0.91)  | 34.00bcd    | (35.67)   | 58.28b              | (49.77)   |
| M-4       | 0.45e  | (0.97)  | 0.33h                 | (0.91)  | 37.77b      | (37.88)   | 0.25h                 | (0.86)  | 40.20ab     | (39.29)   | 62.59b              | (52.37)   |
| M-5       | 0.60c  | (1.05)  | 0.55cde               | (1.03)  | 22.76de     | (28.37)   | 0.51d                 | (1.00)  | 26.13def    | (30.66)   | 43.05c              | (41.00)   |
| M-6       | 0.60c  | (1.05)  | 0.58cd                | (1.04)  | 19.51def    | (26.07)   | 0.58c                 | (1.04)  | 20.00fg     | (26.57)   | 35.61d              | (36.61)   |
| M-7       | 0.71a  | (1.10)  | 0.69b                 | (1.09)  | 18.54ef     | (25.43)   | 0.71b                 | (1.10)  | 17.61g      | (24.71)   | 32.84d              | (34.91)   |
| M-8       | 0.62bc | (1.06)  | 0.55cde               | (1.03)  | 25.34cd     | (29.99)   | 0.49d                 | (0.99)  | 29.15cde    | (32.68)   | 47.11c              | (43.33)   |
| M-9       | 0.62bc | (1.06)  | 0.47fg                | (0.98)  | 37.44b      | (37.69)   | 0.38fg                | (0.94)  | 35.18bc     | (36.36)   | 59.49b              | (50.48)   |
| M-10      | 0.60c  | (1.05)  | 0.60c                 | (1.05)  | 16.25f      | (23.77)   | 0.62c                 | (1.06)  | 16.89g      | (24.06)   | 30.39d              | (33.41)   |
| M-11      | 0.53d  | (1.01)  | 0.33h                 | (0.91)  | 47.85a      | (43.77)   | 0.22h                 | (0.85)  | 45.86a      | (42.58)   | 71.77a              | (57.96)   |
| M-12      | 0.62bc | (1.06)  | 0.58cd                | (1.04)  | 22.42de     | (28.15)   | 0.48de                | (0.99)  | 33.24bcd    | (35.18)   | 48.23c              | (43.98)   |
| M-13      | 0.62bc | (1.06)  | 0.51ef                | (1.01)  | 31.26bc     | (33.94)   | 0.49d                 | (0.99)  | 23.97efg    | (29.18)   | 47.62c              | (43.62)   |
| M-14      | 0.44e  | (0.97)  | 0.27i                 | (0.88)  | 49.82a      | (44.90)   | 0.18i                 | (0.82)  | 46.75a      | (43.13)   | 73.15a              | (58.88)   |
| M-15      | 0.67ab | (1.08)  | 0.80a                 | (1.14)  | -           |           | 1.00a                 | (1.22)  | -           |           | -                   |           |
| F Value   | 20.24  |         | 45.28                 |         | 20.55       |           | 103.12                |         | 10.25       |           | 30.16               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0256 |         | 0.0301                |         | 4.3215      |           | 0.0289                |         | 5.6268      |           | 4.2385              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 82: Efficacy of pesticide modules on coccinellid population during pre-kharif season in 2018**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall<br>Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|------------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                        |           |
| M-1       | 0.65a  | (1.07)* | 0.49def               | (0.99)* | 38.77bc     | (38.50)** | 0.47def               | (0.98)* | 36.64ab     | (37.22)** | 61.13bcd               | (51.45)** |
| M-2       | 0.67a  | (1.08)  | 0.53cde               | (1.01)  | 36.06cd     | (36.89)   | 0.49d                 | (0.99)  | 38.36ab     | (38.08)   | 60.91cd                | (51.33)   |
| M-3       | 0.51c  | (1.00)  | 0.40gh                | (0.95)  | 37.16cd     | (37.54)   | 0.40ef                | (0.95)  | 34.39abc    | (35.76)   | 58.68de                | (50.04)   |
| M-4       | 0.40d  | (0.95)  | 0.27ij                | (0.88)  | 45.63abc    | (42.42)   | 0.24hi                | (0.86)  | 39.09a      | (38.63)   | 67.01abc               | (55.12)   |
| M-5       | 0.55bc | (1.03)  | 0.51def               | (1.00)  | 25.24ef     | (29.92)   | 0.56cd                | (1.03)  | 27.46bcd    | (31.55)   | 45.76fg                | (42.54)   |
| M-6       | 0.58b  | (1.04)  | 0.55cd                | (1.03)  | 22.42efg    | (28.15)   | 0.62c                 | (1.06)  | 24.87cd     | (29.91)   | 39.88gh                | (39.12)   |
| M-7       | 0.65a  | (1.07)  | 0.65b                 | (1.07)  | 19.17fg     | (25.85)   | 0.78b                 | (1.13)  | 19.89d      | (26.49)   | 35.28h                 | (36.42)   |
| M-8       | 0.55bc | (1.03)  | 0.49def               | (0.99)  | 28.41de     | (32.17)   | 0.53cd                | (1.02)  | 27.56bcd    | (31.61)   | 48.22fg                | (43.98)   |
| M-9       | 0.55bc | (1.03)  | 0.40g                 | (0.95)  | 41.45abc    | (40.07)   | 0.38fg                | (0.94)  | 37.22ab     | (37.55)   | 63.14bcd               | (52.66)   |
| M-10      | 0.58b  | (1.04)  | 0.60bc                | (1.05)  | 16.25g      | (23.77)   | 0.73b                 | (1.11)  | 18.34d      | (25.32)   | 31.61h                 | (34.20)   |
| M-11      | 0.51c  | (1.00)  | 0.33hi                | (0.91)  | 47.68ab     | (43.67)   | 0.29gh                | (0.89)  | 41.41a      | (40.02)   | 69.36ab                | (56.41)   |
| M-12      | 0.53bc | (1.01)  | 0.47efg               | (0.98)  | 28.32de     | (32.11)   | 0.47def               | (0.98)  | 33.33abc    | (35.26)   | 52.21ef                | (46.27)   |
| M-13      | 0.55bc | (1.03)  | 0.44fg                | (0.97)  | 35.78cd     | (36.73)   | 0.49de                | (0.99)  | 26.11cd     | (30.17)   | 50.68ef                | (45.39)   |
| M-14      | 0.40d  | (0.95)  | 0.25j                 | (0.86)  | 50.32a      | (45.19)   | 0.20i                 | (0.84)  | 44.86a      | (41.99)   | 73.06a                 | (58.74)   |
| M-15      | 0.65a  | (1.07)  | 0.80a                 | (1.14)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                      |           |
| F Value   | 14.74  |         | 31.10                 |         | 11.33       |           | 49.12                 |         | 4.78        |           | 19.59                  |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | 0.0003      |           | <.0001                 |           |
| LSD       | 0.03   |         | 0.0372                |         | 5.7857      |           | 0.0479                |         | 6.7929      |           | 4.9555                 |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 83: Efficacy of pesticide modules on coccinellid population during pre-kharif season (pooled 2017 & 2018)**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.67a  | (1.08)* | 0.50e                 | (1.00)* | 38.04bcd    | (38.06)** | 0.45f                 | (0.97)* | 35.45bcd    | (36.52)** | 59.94bc             | (50.75)** |
| M-2       | 0.67a  | (1.08)  | 0.53de                | (1.01)  | 34.90cd     | (36.21)   | 0.45f                 | (0.97)  | 38.99abc    | (38.60)   | 60.45bc             | (51.04)   |
| M-3       | 0.52c  | (1.01)  | 0.40g                 | (0.95)  | 36.98bcd    | (37.45)   | 0.36g                 | (0.93)  | 34.19cde    | (35.75)   | 58.48c              | (49.89)   |
| M-4       | 0.42d  | (0.96)  | 0.30hi                | (0.89)  | 41.70b      | (40.20)   | 0.25h                 | (0.86)  | 39.65abc    | (38.96)   | 64.80b              | (53.67)   |
| M-5       | 0.58b  | (1.04)  | 0.53de                | (1.02)  | 24.00ef     | (29.16)   | 0.53d                 | (1.02)  | 26.80ef     | (31.12)   | 44.40e              | (41.77)   |
| M-6       | 0.59b  | (1.04)  | 0.57cd                | (1.03)  | 20.97fg     | (27.15)   | 0.60c                 | (1.05)  | 22.44fgh    | (28.27)   | 37.74f              | (37.88)   |
| M-7       | 0.68a  | (1.09)  | 0.67b                 | (1.08)  | 18.86g      | (25.71)   | 0.74b                 | (1.12)  | 18.75gh     | (25.63)   | 34.06fg             | (35.70)   |
| M-8       | 0.59b  | (1.04)  | 0.52de                | (1.01)  | 26.88e      | (31.21)   | 0.51de                | (1.01)  | 28.36def    | (32.16)   | 47.66de             | (43.66)   |
| M-9       | 0.59b  | (1.04)  | 0.43fg                | (0.97)  | 39.44bc     | (38.89)   | 0.38g                 | (0.94)  | 36.20bcd    | (36.98)   | 61.32bc             | (51.56)   |
| M-10      | 0.59b  | (1.04)  | 0.60c                 | (1.05)  | 16.25g      | (23.77)   | 0.68b                 | (1.09)  | 17.61h      | (24.72)   | 31.00g              | (33.81)   |
| M-11      | 0.52c  | (1.01)  | 0.33h                 | (0.91)  | 47.77a      | (43.72)   | 0.26h                 | (0.87)  | 43.64ab     | (41.30)   | 70.56a              | (57.18)   |
| M-12      | 0.58b  | (1.04)  | 0.52de                | (1.01)  | 25.37ef     | (30.24)   | 0.48ef                | (0.99)  | 33.29cde    | (35.23)   | 50.22d              | (45.13)   |
| M-13      | 0.59b  | (1.04)  | 0.48ef                | (0.99)  | 33.52d      | (35.36)   | 0.49def               | (0.99)  | 25.04fg     | (29.79)   | 49.15de             | (44.51)   |
| M-14      | 0.42d  | (0.96)  | 0.26i                 | (0.87)  | 50.07a      | (45.04)   | 0.19i                 | (0.83)  | 45.80a      | (42.57)   | 73.10a              | (58.79)   |
| M-15      | 0.66a  | (1.08)  | 0.80a                 | (1.14)  | -           |           | 1.10a                 | (1.26)  | -           |           | -                   |           |
| F Value   | 27.32  |         | 60.39                 |         | 32.72       |           | 130.94                |         | 10.41       |           | 50.88               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0219 |         | 0.0265                |         | 3.3851      |           | 0.0274                |         | 5.0622      |           | 3.1549              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyriphos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 45: Efficacy of pesticide modules on coccinellids population after 1<sup>st</sup> spray during pre-kharif**

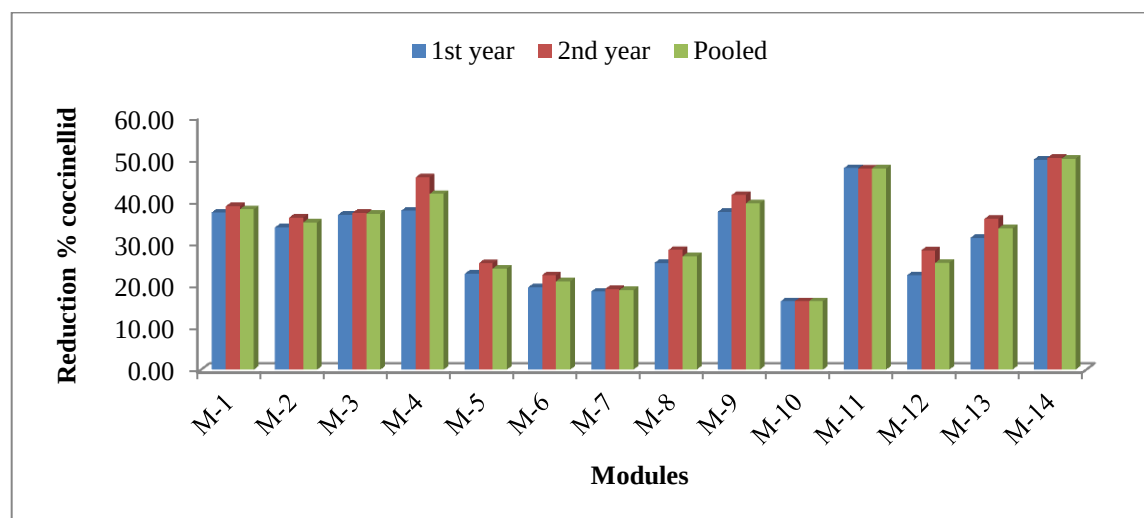


**Fig. 46: Efficacy of pesticide modules on coccinellids population after 2<sup>nd</sup> spray during pre-kharif**

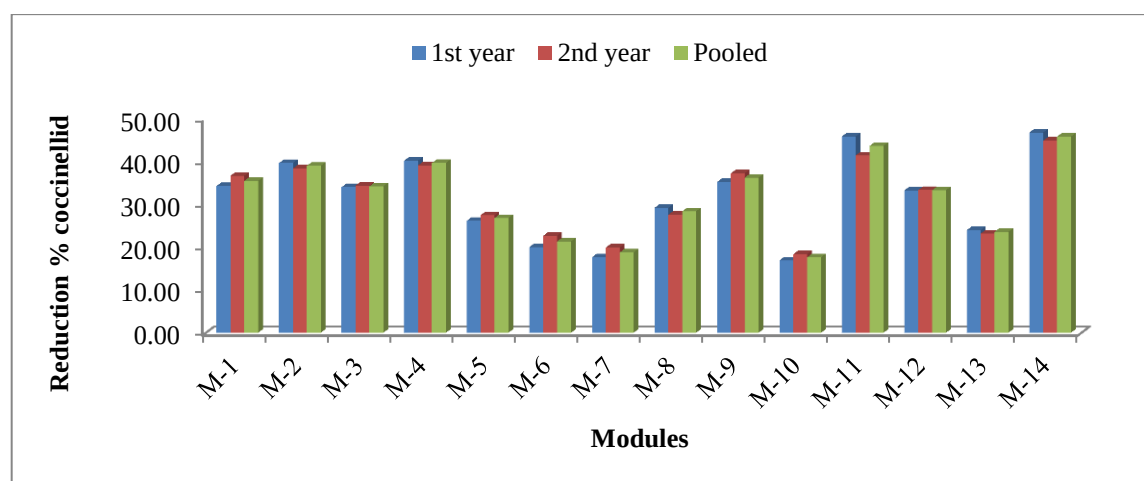
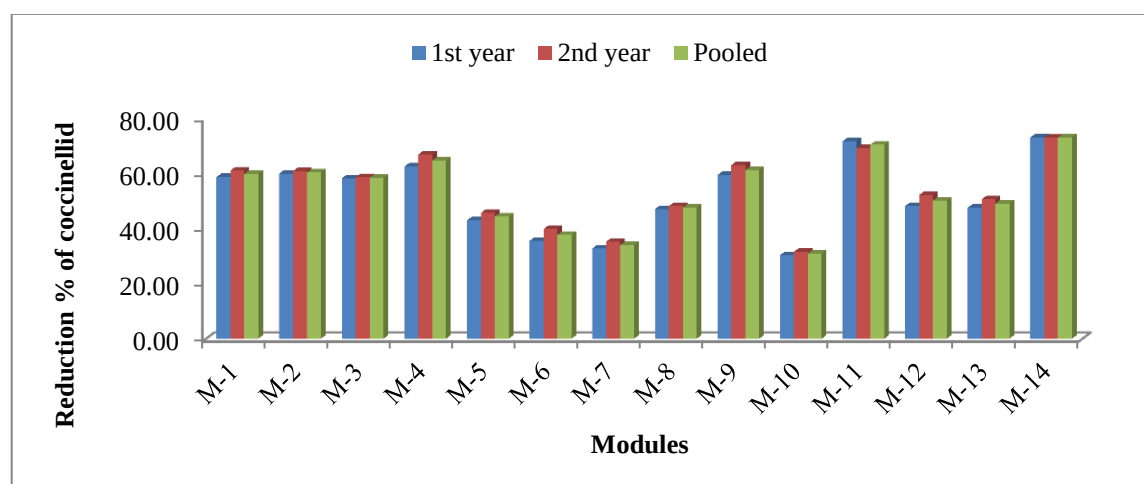


**Fig. 47: Overall efficacy of pesticide modules on coccinellids population during pre-kharif**



#### 4.3.2.4. Spider

At one day before spray of insecticides, the spider population varied significantly among the plots where seed treatment was adopted. Maximum population was observed in untreated plot M-15 and other plots like M-1, M-2, M-7 where no chemicals were applied for seed treatment and their population were in range between (0.67 to 0.69/plant), (0.60 to 0.60/plant) and (0.63 to 0.65/plant) in 2017, 2018 and in pooled mean of both years respectively. The lowest population was observed from M-14 (0.40, 0.38 and 0.39/plant) which was followed by M-4 (0.40, 0.38 and 0.39/plant, M-3 (0.47, 0.45 and 0.46/plant) and M-11 (0.47, 0.45 and 0.46/plant) during 2017, 2018 and pooled mean of both years respectively. The next effective treatments were bijamrita treated plot like M-5, M-6, M-8, M-9, M-10, M-12 and M-13 whose population ranged between (0.58 to 0.60/plant), (0.51 to 0.53/plant) and (0.54 to 0.57/plant) during 2017, 2018 and pooled mean of both years respectively (Table 84, 85 and 86).

After 1<sup>st</sup> spray, the spider population observed at 14 DAS revealed that M-14 recorded the maximum reduction 53.43% spider population with the tune of 0.27/plant during 2016, 56.64% spider population with the tune of 0.27/plant during 2017 and 55.03% spider population with the tune of 0.27/plant during pooled mean of both years which was found to be at par with M-11 having reduction of 51.55% with 0.33/plant, 52.44% with 0.35/plant and 51.99% with 0.34/plant while minimum reduction was recorded from M-10 containing 17.94% reduction of spider in tune of 0.69/plant, 19.37% with 0.69/plant and 18.66% with 0.69/plant during 2016, 2017 and pooled of both years respectively. After second spray also minimum and maximum reduction was observed from same treatment as that of 1<sup>st</sup> spray.

The overall mean of first and second spray indicated that the safest module was M-10 as it caused to minimum reduction of spider population of (33.57%, 32.81% and 33.19%) during 2016, 2017 and pooled of both years respectively and which was followed by M-7, M-6 while M-14 and M-11 recorded the maximum reduction of spider population of 77.76% and 75.53% during 2016, 79.68% and 77.48% during 2017, 78.72% and 76.51% in pooled mean of two years respectively.

**Table 84: Efficacy of pesticide modules on spider population during pre-kharif season in 2017**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.69a  | (1.09)* | 0.64cd                | (1.07)* | 35.44bc     | (36.46)** | 0.47efg               | (0.98)* | 39.38bc     | (38.87)** | 60.89b              | (51.30)** |
| M-2       | 0.67a  | (1.08)  | 0.64cd                | (1.07)  | 33.54bc     | (35.39)   | 0.44fg                | (0.97)  | 42.80abc    | (40.85)   | 61.97b              | (51.93)   |
| M-3       | 0.47c  | (0.98)  | 0.45f                 | (0.97)  | 34.33bc     | (35.78)   | 0.33hi                | (0.91)  | 38.08cd     | (38.06)   | 59.63cd             | (50.55)   |
| M-4       | 0.40d  | (0.95)  | 0.35g                 | (0.92)  | 38.82b      | (38.42)   | 0.24ij                | (0.86)  | 43.41abc    | (41.14)   | 64.66b              | (53.70)   |
| M-5       | 0.60b  | (1.05)  | 0.65cd                | (1.07)  | 25.56de     | (30.22)   | 0.55de                | (1.03)  | 28.61def    | (32.29)   | 47.04de             | (43.30)   |
| M-6       | 0.60b  | (1.05)  | 0.69c                 | (1.09)  | 20.52ef     | (26.59)   | 0.62cd                | (1.06)  | 24.75efg    | (29.83)   | 40.13ef             | (39.26)   |
| M-7       | 0.69a  | (1.09)  | 0.80b                 | (1.14)  | 20.00ef     | (26.57)   | 0.75b                 | (1.12)  | 21.53fg     | (27.57)   | 37.22f              | (37.58)   |
| M-8       | 0.60b  | (1.05)  | 0.62cde               | (1.06)  | 28.39cd     | (32.16)   | 0.53def               | (1.02)  | 28.83def    | (32.42)   | 49.06d              | (44.46)   |
| M-9       | 0.60b  | (1.05)  | 0.55e                 | (1.03)  | 36.21b      | (36.91)   | 0.40gh                | (0.95)  | 39.55bc     | (38.96)   | 61.67b              | (51.75)   |
| M-10      | 0.58b  | (1.04)  | 0.69c                 | (1.09)  | 17.94f      | (24.81)   | 0.67bc                | (1.08)  | 19.53g      | (25.68)   | 33.57f              | (35.09)   |
| M-11      | 0.47c  | (0.98)  | 0.33gh                | (0.91)  | 51.55a      | (45.89)   | 0.20jk                | (0.84)  | 49.49ab     | (44.71)   | 75.53a              | (60.36)   |
| M-12      | 0.58b  | (1.04)  | 0.62cde               | (1.06)  | 25.44de     | (30.29)   | 0.49efg               | (0.99)  | 34.51cde    | (35.98)   | 51.17cd             | (45.67)   |
| M-13      | 0.58b  | (1.04)  | 0.58de                | (1.04)  | 31.00bcd    | (33.81)   | 0.51ef                | (1.00)  | 26.29efg    | (30.85)   | 49.14d              | (44.51)   |
| M-14      | 0.40d  | (0.95)  | 0.27h                 | (0.88)  | 53.43a      | (46.97)   | 0.15k                 | (0.81)  | 52.67a      | (46.54)   | 77.76a              | (62.03)   |
| M-15      | 0.69a  | (1.09)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 23.82  |         | 43.49                 |         | 16.96       |           | 56.88                 |         | 8.60        |           | 20.12               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0286 |         | 0.0393                |         | 4.688       |           | 0.0468                |         | 6.3088      |           | 5.1878              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 85: Efficacy of pesticide modules on spider population during pre-kharif season in 2018**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.60a  | (1.05)* | 0.55de                | (1.03)* | 44.67bc     | (41.93)** | 0.45ef                | (0.97)* | 32.64b      | (34.79)** | 66.67cd             | (54.79)** |
| M-2       | 0.60a  | (1.05)  | 0.60cd                | (1.05)  | 40.00c      | (39.23)   | 0.38f                 | (0.94)  | 47.69a      | (43.67)   | 68.61cd             | (55.95)   |
| M-3       | 0.45cd | (0.97)  | 0.42fg                | (0.96)  | 42.98bc     | (40.95)   | 0.35f                 | (0.92)  | 29.80bc     | (32.73)   | 65.35d              | (53.94)   |
| M-4       | 0.38d  | (0.94)  | 0.33gh                | (0.91)  | 47.14abc    | (43.35)   | 0.20g                 | (0.84)  | 48.70a      | (44.24)   | 73.23bc             | (58.87)   |
| M-5       | 0.51bc | (1.00)  | 0.60cd                | (1.05)  | 29.19de     | (32.64)   | 0.55de                | (1.03)  | 23.15bcd    | (28.64)   | 45.67ef             | (42.51)   |
| M-6       | 0.51bc | (1.00)  | 0.64cd                | (1.07)  | 24.28ef     | (29.35)   | 0.62cd                | (1.06)  | 19.91cd     | (26.37)   | 39.10fg             | (38.63)   |
| M-7       | 0.60a  | (1.05)  | 0.78b                 | (1.13)  | 22.33ef     | (28.15)   | 0.76b                 | (1.12)  | 18.95cd     | (25.73)   | 36.94g              | (37.39)   |
| M-8       | 0.53b  | (1.01)  | 0.62cd                | (1.06)  | 29.43de     | (32.81)   | 0.55de                | (1.03)  | 26.05bcd    | (30.69)   | 47.80e              | (43.74)   |
| M-9       | 0.53b  | (1.01)  | 0.47ef                | (0.98)  | 46.79abc    | (43.16)   | 0.38f                 | (0.94)  | 33.22b      | (34.76)   | 68.24cd             | (55.70)   |
| M-10      | 0.51bc | (1.00)  | 0.69bc                | (1.09)  | 19.37f      | (26.06)   | 0.69bc                | (1.09)  | 16.67d      | (24.09)   | 32.81g              | (34.93)   |
| M-11      | 0.45cd | (0.97)  | 0.35gh                | (0.92)  | 52.44ab     | (46.40)   | 0.20g                 | (0.84)  | 52.44a      | (46.41)   | 77.48ab             | (61.69)   |
| M-12      | 0.51bc | (1.00)  | 0.67c                 | (1.08)  | 21.64ef     | (27.11)   | 0.58d                 | (1.04)  | 28.36bc     | (32.11)   | 50.94e              | (45.54)   |
| M-13      | 0.53ab | (1.02)  | 0.56de                | (1.03)  | 37.67cd     | (37.84)   | 0.51de                | (1.00)  | 22.81bcd    | (28.42)   | 50.28e              | (45.16)   |
| M-14      | 0.38d  | (0.94)  | 0.27h                 | (0.88)  | 56.64a      | (48.82)   | 0.15g                 | (0.81)  | 52.67a      | (46.54)   | 79.68a              | (63.29)   |
| M-15      | 0.60a  | (1.05)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 10.32  |         | 26.64                 |         | 14.62       |           | 45.82                 |         | 9.35        |           | 39.86               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0342 |         | 0.0499                |         | 5.7483      |           | 0.0538                |         | 7.5099      |           | 4.3265              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Table 86: Efficacy of pesticide modules on spider population during pre-kharif season (pooled 2017 & 2018)**

| Treatment | DBS    |         | 1 <sup>st</sup> spray |         |             |           | 2 <sup>nd</sup> spray |         |             |           | Overall Reduction % |           |
|-----------|--------|---------|-----------------------|---------|-------------|-----------|-----------------------|---------|-------------|-----------|---------------------|-----------|
|           |        |         | 14 DAS                |         | Reduction % |           | 14 DAS                |         | Reduction % |           |                     |           |
| M-1       | 0.64a  | (1.07)* | 0.60de                | (1.05)* | 40.05bc     | (39.25)** | 0.46ef                | (0.98)* | 36.01d      | (36.87)** | 63.78c              | (53.00)** |
| M-2       | 0.63a  | (1.06)  | 0.62cde               | (1.06)  | 36.77bc     | (37.33)   | 0.41fg                | (0.95)  | 45.24d      | (42.27)   | 65.29bc             | (53.91)   |
| M-3       | 0.46c  | (0.98)  | 0.44g                 | (0.97)  | 38.65bc     | (38.42)   | 0.34h                 | (0.92)  | 33.94d      | (35.60)   | 62.49c              | (52.23)   |
| M-4       | 0.39d  | (0.94)  | 0.34h                 | (0.92)  | 42.98b      | (40.92)   | 0.22i                 | (0.85)  | 46.06bc     | (42.74)   | 68.95b              | (56.19)   |
| M-5       | 0.56b  | (1.03)  | 0.62cde               | (1.06)  | 27.37ef     | (31.54)   | 0.55d                 | (1.03)  | 25.88fg     | (30.58)   | 46.35d              | (42.91)   |
| M-6       | 0.56b  | (1.03)  | 0.67c                 | (1.08)  | 22.40fg     | (28.02)   | 0.62c                 | (1.06)  | 22.33gh     | (28.17)   | 39.62e              | (38.95)   |
| M-7       | 0.65a  | (1.07)  | 0.79b                 | (1.14)  | 21.17g      | (27.38)   | 0.76b                 | (1.12)  | 20.24hi     | (26.68)   | 37.08ef             | (37.50)   |
| M-8       | 0.57b  | (1.03)  | 0.62cde               | (1.06)  | 28.91de     | (32.50)   | 0.54d                 | (1.02)  | 27.44ef     | (31.58)   | 48.43d              | (44.10)   |
| M-9       | 0.57b  | (1.03)  | 0.51f                 | (1.01)  | 41.50b      | (40.10)   | 0.39gh                | (0.94)  | 36.38d      | (37.07)   | 64.95bc             | (53.70)   |
| M-10      | 0.54b  | (1.02)  | 0.69c                 | (1.09)  | 18.66g      | (25.51)   | 0.68c                 | (1.08)  | 18.10i      | (25.04)   | 33.19f              | (35.09)   |
| M-11      | 0.46c  | (0.98)  | 0.34h                 | (0.92)  | 51.99a      | (46.14)   | 0.20ij                | (0.84)  | 50.97ab     | (45.56)   | 76.51a              | (61.01)   |
| M-12      | 0.54b  | (1.02)  | 0.65cd                | (1.07)  | 23.54efg    | (28.89)   | 0.53d                 | (1.02)  | 31.43de     | (34.09)   | 51.06d              | (45.61)   |
| M-13      | 0.56b  | (1.03)  | 0.57ef                | (1.03)  | 34.33cd     | (35.87)   | 0.51de                | (1.00)  | 24.55fg     | (29.68)   | 49.71d              | (44.83)   |
| M-14      | 0.39d  | (0.94)  | 0.27i                 | (0.88)  | 55.03a      | (47.89)   | 0.15j                 | (0.81)  | 52.67a      | (46.55)   | 78.72a              | (62.60)   |
| M-15      | 0.65a  | (1.07)  | 1.00a                 | (1.22)  | -           |           | 1.20a                 | (1.30)  | -           |           | -                   |           |
| F Value   | 27.84  |         | 51.04                 |         | 28.97       |           | 115.97                |         | 46.56       |           | 63.69               |           |
| Pr>F      | <.0001 |         | <.0001                |         | <.0001      |           | <.0001                |         | <.0001      |           | <.0001              |           |
| LSD       | 0.0238 |         | 0.036                 |         | 3.7675      |           | 0.0332                |         | 2.9906      |           | 3.1443              |           |

\*Figure in parenthesis indicates square root transformed value, \*\* Figure in parenthesis indicates angular transformed value, DBS : Day before spray, DAS : Day after spray, LSD : Least significant difference,

**M-1**=[No seed treatment + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP] **M-2**=[No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] **M-3**= [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP] **M-4**= [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC], **M-5**=[Bijamrita (Seed treatment) + NPK + Agniastra + Agniastra], **M-6**=[Bijamrita (Seed treatment) + NPK + Neem oil 0.03 EC + Neem oil 0.03 EC], **M-7**=[No seed treatment + NPK + Neem oil 0.03 EC + Neem leaf extract], **M-8**=[Bijamrita (Seed treatment) + Jeevamrita + Agniastra + Agniastra], **M-9**=[Bijamrita (Seed treatment) + NPK + Imidacloprid 17.8 SL + Thiodicarb 75 WP], **M-10**=[Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract], **M-11**=[Chlorpyrifos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-12**= [Bijamrita (Seed treatment) + NPK + Agniastra + Emamectin benzoate 5 SG], **M-13**=[Bijamrita (Seed treatment) + NPK + emamectin benzoate 5 SG + *Beauveria bassiana*], **M-14**=[Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)], **M-15**=Untreated [No seed treatment + NPK]

**Fig. 48: Efficacy of pesticide modules on spider population after 1<sup>st</sup> spray during pre-kharif**

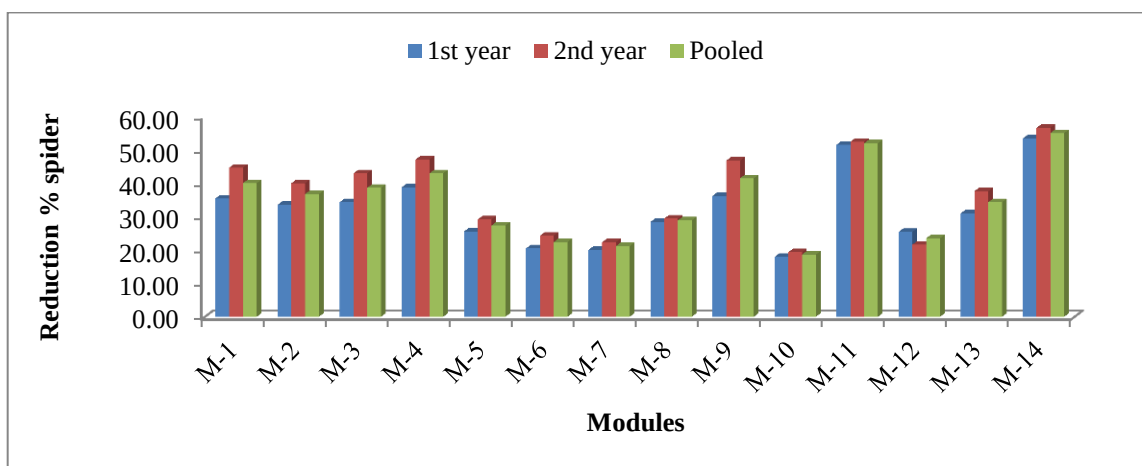


**Fig. 49: Efficacy of pesticide modules on spider population after 2<sup>nd</sup> spray during pre-kharif**

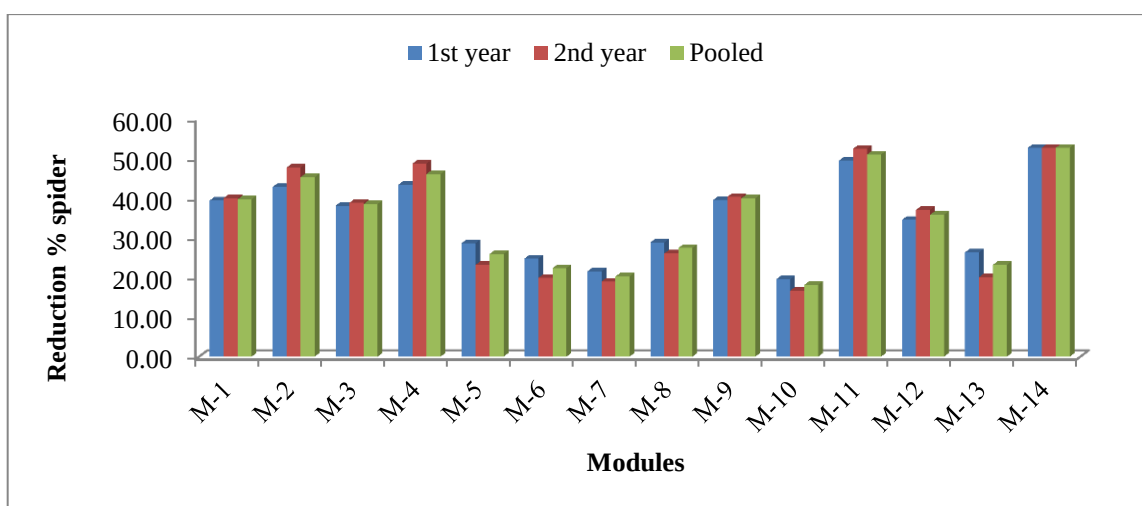
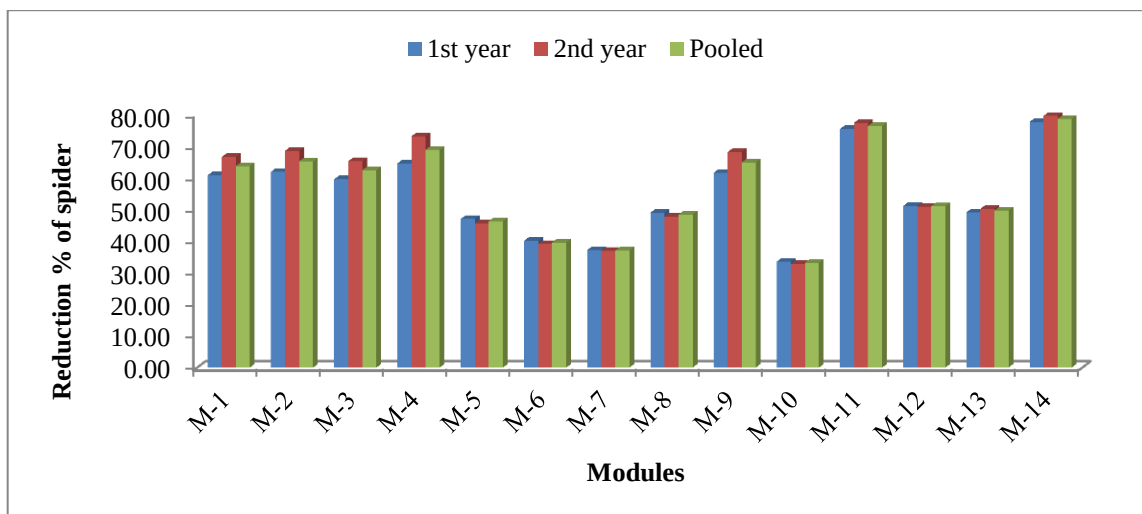


**Fig. 50: Overall efficacy of pesticide modules on spider population during pre-kharif**



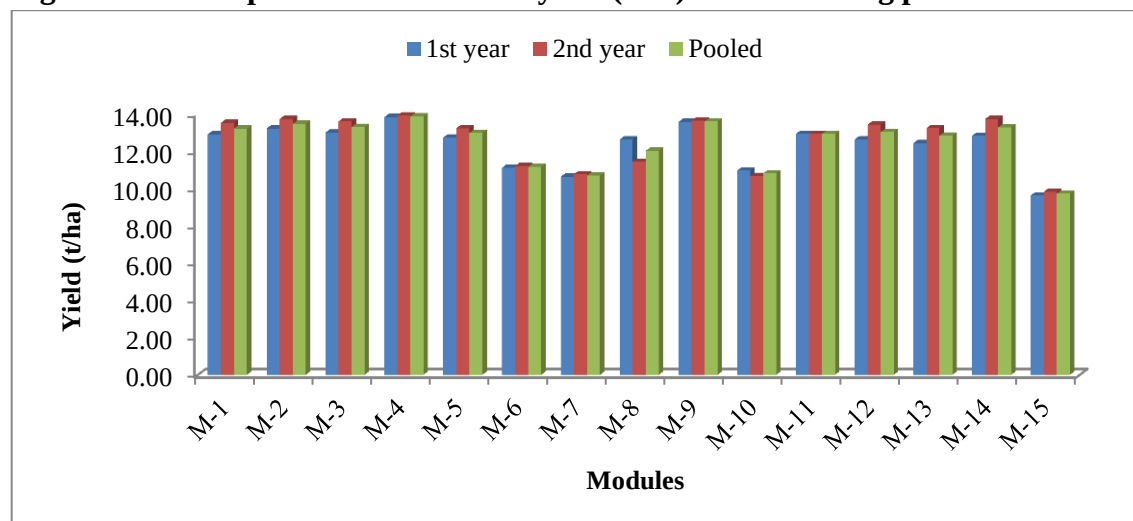
#### 4.3.2.5. Effect of different pesticide modules on yield (t/ha) of okra during pre-kharif season

All the modules produced significantly higher yield of okra over untreated plot. The two year data in pre-kharif season revealed maximum yield in M-4 (13.85, 13.95 and 13.90 t/ha) followed by M-9 (13.59, 13.66 and 13.63t/ha) and M-2 (13.24, 13.75 and 13.50 t/ha) during 2017, 2018 and pooled mean of both years respectively. Whereas, M-15 the untreated plot recorded lowest yield (9.64, 9.84 and 9.74 t/ha) during pre-kharif season (table 87).

**Table 87: Efficacy of pesticide modules on yield (t/ha) of okra during pre-kharif season**

| Modules | Yield (t/ha) |          |          |
|---------|--------------|----------|----------|
|         | 2017         | 2018     | Mean     |
| M-1     | 12.93cd      | 13.54abc | 13.24bcd |
| M-2     | 13.24abc     | 13.75ab  | 13.50ab  |
| M-3     | 13.02bcd     | 13.62ab  | 13.32bc  |
| M-4     | 13.85a       | 13.94a   | 13.90a   |
| M-5     | 12.75cd      | 13.25bc  | 13.00cd  |
| M-6     | 11.13e       | 11.23de  | 11.18f   |
| M-7     | 10.65e       | 10.78e   | 10.72g   |
| M-8     | 12.65cd      | 11.45d   | 12.05e   |
| M-9     | 13.59ab      | 13.66ab  | 13.63ab  |
| M-10    | 10.98e       | 10.68e   | 10.83fg  |
| M-11    | 12.95cd      | 12.95c   | 12.95cd  |
| M-12    | 12.65cd      | 13.45abc | 13.05cd  |
| M-13    | 12.45d       | 13.26bc  | 12.86d   |
| M-14    | 12.85cd      | 13.75ab  | 13.30bc  |
| M-15    | 9.64f        | 9.84f    | 9.74h    |
| F Value | 30.43        | 39.32    | 76.98    |
| Pr>F    | <.0001       | <.0001   | <.0001   |
| LSD     | 0.6262       | 0.6418   | 0.4182   |

**Fig. 51: Effect of pesticide modules on yield (t/ha) of okra during pre-kharif**



## Jassid

The maximum reduction of jassid population was recorded in pre-kharif crop followed by post-kharif and population was found higher in pre-kharif crop ranging from 1.69 to 18.02/leaf as compared to 0.61 to 9.41/leaf in post-kharif. This might be due to climatic variation in two seasons. The low level of jassid population was observed in M-14 comprising imidacloprid 17.8 SL (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) + lancer gold, which was followed by M-11 comprising chlorpyrifos 20 EC (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) + lancer gold (acephate 50 + imidacloprid 1.8 SP) and M-4 imidacloprid 17.8 SL (seed treatment) + NPK + imidacloprid 17.8 SL + flubendamide 39.35 SC. In these protection modules, the jassid population was found low because seed treatment was done with imidacloprid 17.8 SL and chlorpyrifos 20 EC which protected the crop in the early stages of crop growth. The present findings were confirmed by Misra (2002) who reported similar result that seed treatment with imidacloprid @ 25 g a.i./ha was most effective in controlling the jassid in okra. Kumar and Singh (2001) and Dey *et al.* (2005) reported that seed treatment with imidacloprid at different dosages was efficient in reducing jassid infestation on okra plants that corroborated the present findings. In present finding the lower jassid population was observed in imidacloprid comprising module M-4 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC] which was followed by thiomethaxam comprising modules like M-2 [No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] and M-3 [Chlorpyrifos 20 EC (Seed treatment) + NPK + Thiomethaxam 25 WG + Thiodicarb 75 WP]. This present finding was comparable with report of Rahman *et al.* (2009) who revealed that the lowest mean number of jassid (1.33/leaf) population on okra was recorded in imidacloprid 200 SL treated plot followed by thiamethoxan 25 WG. Misra (2002) revealed that imidacloprid and thiamethoxam, both used @ 25 g a.i./ha proved significantly superior in controlling jassid on okra compared to other insecticides. Similar result also given by Mohanasundaram and Sharma (2011) who reported that thiamethoxam @ 20 g a.i./ha effectively reduced the jassid population. Acharya *et al.* (2002) reported that application of imidacloprid @ 25 g a.i./ha was effective against okra leafhopper, followed by emamectin benzoate @ 20 g a.i./ha which also confirmed the present result. In the present finding M-8 comprising bijamrita (seed treatment) + jeevamrita + agniastara + agniastara and M-5 comprising bijamrita (seed treatment) + NPK + agniastara + agniastara as an organic component caused moderate

reduction of jassid population which was supported by Dhanalakshmi (2006) who also 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*. Jayakumar (2002) also found that NSKE + cow urine + garlic extract, chilli extract + cow urine, garlic extract + cow urine, neem oil + garlic extract and clerodendron extracts + *Vitex negundo* leaf extract were found as much effective as that of oxydemeton methyl against leafhoppers on okra. Garlic extract alone or in combination with neem, ginger, tobacco, chilli and cow urine were also effective against sucking insect pests and mites of several crops reported by Lakshmanan, (2001). Among all the insecticidal modules the botanical neem leaf extract contained M-10 (seed treatment with bijamrita + NPK + neem leaf extract + neem leaf extract) and M-7 (no seed treatment + NPK + neem oil + neem leaf extract) revealed its low toxic nature against the pest but it was found safe against natural enemies. The present result in pre-kharif and post kharif crop was supported by Jat and Jeyakumar (2006) who recorded 20.4, 34.4 and 42.5% reduction of jassid population with 1, 2 and 3% neem oil respectively.

### **Fruit borer complex**

The present investigation revealed that the M-4 comprising imidacloprid 17.8 SL (seed treatment) + NPK + imidacloprid 17.8 SL + flubendamide 39.35 SC and M-2 comprising no seed treatment + NPK + thiomethoxam 25 WG + flubendamide 39.35 SC were found most effective in reducing the per cent fruit damage on number basis. The results were in conformity with Jagginavar *et al.* (2009) who reported that flubendiamide 480 SC @ 90 and 72 g a.i. /ha recorded lowest per cent shoot damage. Similar result also observed by Katti and Swetha (2015) who reported that flubendiamide 480 SC @ 60 g a.i. /ha and flubendiamide 480 SC @ 48 g a.i. /ha were superior in recording less shoot damage (8.7 and 10.00 per cent, respectively), lower fruit damage (5.70 and 9.00 per cent, respectively) in okra. Bansode *et al.* (2015) reported that flubendiamide @ 60 g a.i. /ha was the most effective treatment by recording lowest per cent (13.42 per cent) fruit infestation. It was at par with emamectin benzoate @ 9.5 g a.i. /ha (13.61 %). Sinha *et al.* (2009) revealed the efficacy of insecticides viz. bifenthrin, endosulfan, indoxacarb, fipronil, acetamiprid, thiamethoxam, imidacloprid and chlorpyrifos + cypermethrin and applied at different dosages on *E. vittella* infestation and found that all the treatments except @ 20 g imidacloprid and @ 700 g endosulfan/ha were highly effective. The treatment with two foliar sprays of acetamiprid and endosulfan was most effective as it

gave 1.8% damage. Deepak *et al.*, (2017) evaluated flubendiamide @ 60 g a. i. per ha and recorded lowest fruit borer infestation 14.40 per cent on number basis and 15.90 per cent on weight basis that also showed conformity with present results. The findings of Kattia *et al.* (2015) also supported the present results as they reported the efficacy of flubendiamide 480 SC against okra fruit and shoot borer, *Earias vitella* (Fab.) and found that newer insecticide molecules, flubendiamide 480 SC @ 60 g a.i/ha and flubendiamide 480 SC @ 48 g a.i/ha were superior in recording less shoot damage (8.7 % and 10.00 %), lower fruit damage (5.70 % and 9.00 %).

The next best modules were M-9 comprising bijamrita (seed treatment) + NPK + imidacloprid 17.8 SL + thiodicarb 75 WP and M-1 comprising no seed treatment + NPK + imidacloprid 17.8 SL + thiodicarb 75 WP that were confirmed by the earlier worker Rajashekhar *et al.* (2016) as they reported lowest incidence of shoot and fruit borer due to application of imidacloprid in okra. Similar type of work was reported by Banger *et al.*, (2012) and revealed that flubendiamide 39.35 SC recorded significantly lower per cent fruit damage as compared to thiodicarb, chlorfenapyr, endosulfan and novaluron while, it was at par with emamectin benzoate, cypermethrin + chlorpyrifos, indoxacarb and spinosad. Novaluron was at par with thiodicarb, chlorfenapyr and endosulfan for fruit damage. Dhamdhare *et al.*, (1984) evaluated the efficacy of 15 insecticides against *Earias vittella*, and found that the fenvalerate (0.01 %) and thiodicarb (0.15 %) were the most effective insecticides.

The module M-14 comprising imidacloprid 17.8 SL (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) + lancer gold and M-11 comprising chlorpyrifos 20 EC (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) + lancer gold were gave 77.31% and 77.08%, 74.64% and 74.17% reduction of fruit damage during post and pre karif respectively. The results were in conformity with Kamble *et al.*, (2014) who received lower infestation of fruits in number and weight basis (21.06% and 19.54%) by the application of acephate 50 WP+ imidacloprid 1.8 WP. Choudhary *et al.* (2008) observed lowest fruit damage (13.08%) due to *Earias vittella* in module comprising imidacloprid 100 ml/ha, acephate 1000 g/ha and indoxacarb 500 ml/ha.

The next best effective module was M-13 comprising bijamrita (seed treatment) + NPK + emamectin benzoate 5 WG + *Beauveria bassiana* and M-12 having bijamrita (seed treatment) + NPK + agniastara + emamectin benzoate 5 WG, which was partially supported by earlier worker Parthiban *et al.*, (2014) who reported emamectin benzoate 5

WG (125 and 150 g/ha) was best insecticide and reduced more than 90 per cent population of *Earias vittella* on okra. Laichattiwat *et al.* (2014) also supported present findings by observing that emamectin benzoate @ 0.36 g /lit was most effective in controlling fruit damage by *Earias vittella*. Jayakumar (2002) tested some indigenous components against the insect pests of okra. Among the products tested, garlic extract + chilli extract + cow urine (8+3+5%), NSKE + cow urine (8+10%), neem oil + garlic extract (2+5%) and garlic extract + cow urine (10+10%) exhibited minimum fruit damage as that of insecticide endosulfan which was comparable with agniastra in the present study.

The minimum reduction of fruit damage was observed from M-7 comprising bijamrita (seed treatment) + NPK + neem leaf extract + neem leaf extract and M-10 comprising no seed treatment + NPK + neem oil 0.03% EC + neem leaf extract, which was more or less supported by Rao *et al.* (2008) who revealed lower incidence of shoot damage (1.05%) and fruit damage (16.40 %) in module comprising of seed treatment and alternate spray of NSKE 5% and neem oil 5%.

#### **Predators (Coccinellids and Spider)**

In the present investigation, the components of modules significantly influenced the abundance of coccinellids and spider population on okra crop. Maximum reduction in the population of coccinellid and spider was noticed in chemically treated modules like M-14 comprising imidacloprid 17.8 SL (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) + lancer gold (acephate 50 + imidacloprid 1.8 SP) followed by M-11 comprising chloropyrifos 20 EC (seed treatment) + NPK + lancer gold (acephate 50 + imidacloprid 1.8 SP) +lancer gold (acephate 50 + imidacloprid 1.8 SP) and the present work was supported by Shabozoil *et al* (2011), who reported that the population of natural enemies viz. lady bird beetles, spiders and predatory bugs was minimum in synthetic insecticides treated fields compared to botanical. M-7 comprising no seed treatment + NPK + neem oil 0.03% + neem leaf extract and M-10 comprising bijamrita (seed treatment) + NPK + neem leaf extract + neem leaf extract were relatively safer to predators as indicated by higher coccinellid and spider population at different intervals during the entire study period which was more or less similar to the findings of Jayakumar *et al.*, (2008), Sunitha *et al.* (2010), Ghosh, (2013a) who revealed that the safety of neem and Bt products to coccinellids and spiders by their unique mode of action witnessed higher population of predators. Similarly, in M-12 comprising bijamrita (seed treatment) + NPK + agniastra + emamectin benzoate 5 SG and M-13 comprising

bijamrita (seed treatment) + NPK + emamectin benzoate 5 SG+ *Beauveria bassiana* were moderately safest, which was also confirmed by earlier worker Udikeri *et al.* (2004), Dhanalakshmi and Mallapur (2008) and Mohanasundarm and Sharma (2011) reported higher population of coccinellids and spiders on the cotton and okra crop treated with emamectin benzoate 5 SG. Dhanalakshmi and Mallapur (2010) reported that among different newer molecules, emamectin benzoate, spinosad and acetamiprid was proved to be quite safe to natural enemies. Imidacloprid 200SL @ 0.5 ml/1, fenazaquin 10EC @ 1.0 ml/1 and oxydemeton methyl 25EC @ 1.5 ml/L were slightly toxic while, indoxacarb was relatively more toxic.

### **Yield**

In the present study highest yield *i.e.* 13.37 t/ha and 12.72t/ha were obtained from M-4 (imidacloprid 17.8 SL (seed treatment) + NPK + imidacloprid 17.8 SL + flubendamide 39.35 SC) during pre kharif and post kharif season respectively and M-2 comprising no seed treatment + NPK + thiomethoxam 25 WP + flubendamide 39.35 SC gave at par yield of okra with 13.04 t/ha during pre kharif and 12.62 t/ha during post kharif. The present finding was satisfactorily supported by Banger *et al.*, (2012) who reported that flubendiamide (76.73 q/ha) treated plots produced significantly higher fruit yield followed by cypermethrin + chlorpyrifos (64.84 q/ha) treated plots. Kattia *et al.*, (2015) reported that among the newer insecticide molecules evaluated, the both dosages of flubendiamide 480 SC @ 60 g a.i/ha and flubendiamide 480 SC @ 48 g a.i/ha had produced higher fruit yield (113.00 q/ha and 104.00 q/ha) than cypermethrin @ 10 EC g a.i/ha as check. Choudhary *et al.* (2008) observed that the maximum fruit yield (80.72 q/ha) were recorded in M-1 comprising imidacloprid 100 ml/ha, acephate 1000 g/ha and indoxacarb 500 ml/ha, which was comparable with M-11 and M-14 in the present experiment.

From overall observation it is found that among the fifteen protection modules, M-14 (Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP) had been given maximum protection against okra jassids which was closely followed by M-11. When reduction of fruit borer was concerned, M-4 (Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC), was found to be most effective as it provided maximum fruit borer reduction which was followed by M-2. In case of natural enemies particularly coccinellids and spiders, M-10 (Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract) was found to be the safest as maximum

natural enemies harboured in this module but this module gave moderate insect pests control also. In the other hand, among these modules, the highest fruit yield was recorded from M-4 (13.90t/ha in pre kharif and 12.72t/ha in post kharif season) and was closely followed by M-2.

By considering all the above stated facts it may be concluded that module M-4 is the best protection modules against okra in terai region of West Bengal as it provided maximum reduction of fruit borer, moderate reduction of jassid and highest fruit yielder. Module-14 was found to be the best for suppressing jassid population and Module-10 was considered as best for maximum harbouring of natural enemies.

## CHAPTER-V

### SUMMARY AND CONCLUSION

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Investigations were carried out with an objective to find out the seasonal incidence of different insect pests and natural enemies of okra and also the effect of abiotic parameters on the population fluctuation of them in terai region of West Bengal during post-kharif and pre-kharif season of 2015-16 and 2016-17 at Uttar Banga Krishi Viswavidhyalaya, Pundibari, Cooch Behar. Screening of the available genotypes of okra in this region was also carried out with a view to separate out resistance/susceptible varieties against different insect pests based on physical and chemical characters of the cultivars. Region-specific pest management modules against insect pests of okra were also formulated through integration of various pest management strategies in order to standardize the pest management modules befitting the terai region.

Seasonal incidence on okra pests and their predators on cultivar was conducted on highly susceptible variety Bhindi No.10 obtained after screening of cultivars during post-kharif and pre-kharif season and the result revealed that the activity of pest and predators were found more during pre-kharif season as compared to post-kharif season except aphid, coccinellid and spider. The peak incidence of insect-pests & predators viz. jassid (10.57/leaf), aphid (8.50/leaf), whitefly (4.89/leaf), fruit borer complex (28.43%/plant), flea beetle (1.37 /plant), leaf folder (0.90/plant), semilooper (0.97/plant), coccinellid (1.27/plant) and spider (0.93/plant) were observed in 47 SW, 43 SW, 44 SW, 45 SW, 47 SW, 46 SW, 45 SW, 45 SW and 48 SW respectively, during post-kharif season.

Correlation of incidence of different insect pests with abiotic factors revealed that jassid population and fruit bore (bored fruit %) had significantly negative correlation with maximum and minimum temperature of all weeks.

During pre-kharif season, the peak incidence of insect-pests & predators viz. jassid (39.81/leaf), aphid (1.77/leaf), whitefly (1.32/leaf), mite (31.03/leaf) fruit borer (33.22%/plant), flea beetle (1.40/plant), leaf folder (0.80/plant), semilooper (1.00/plant), coccinellid (0.90/plant) and spider (0.83/plant) were observed in 18 SW, 14 SW, 14SW, 24SW, 20SW, 18SW, 18 SW, 17SW, 18SW and 21 SW respectively.

Correlation of incidence of different insect pests with abiotic factors revealed that all environmental parameters of all the weeks had non-significant positive influence except morning RH of 2-lag week which showed negative non-significant effect on jassid population. In case of fruit borer the maximum temperature of current week,

minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer damage.

Fourteen cultivars of okra namely Arka Anamika, Subarna, Aparupa DG, Tiger Green, JKOH-7315, Parvani Kranti, Basanti, Miss-717, Meena-117, Bhindi No.10, PAN-2127, Tanvi, Kaveri and Chameli-015 were taken into consideration for conducting the experiment in two seasons viz. pre-kharif and post-kharif for screening out suitable variety against insect-pests. The plant characters namely plant height (cm), number of branches/plant, number of leaf/plant, number of fruit/plant, number of flower/plant, length and breadth/fruit, number of seeds/fruit, area of the leaf lamina (cm<sup>2</sup>), leaf thickness and trichome density as well as chemical characters of plants like viz. proteins, phenols, OD phenol and lipid, macro nutrient like NPK and micro nutrients like zinc in leaves and fruits were also considered as these characters provide susceptibility/resistance against insect pests.

Among the different cultivars, two cultivars like Kaveri and Chameli-015 may be considered as less susceptible, nine cultivars as moderately susceptible and three cultivars, Meena-117, Bhindi No.10 and Tanvi as highly susceptible with respect to insect-pests intensity during post-kharif season. While during pre-kharif season, two cultivars Kaveri and Chameli-015 again may be treated as less susceptible, eight cultivars as moderately susceptible and four cultivars like Meena-117, Bhindi No.10, PAN-2127 and Tiger Green as highly susceptible with respect to insect-pests

Regarding morphological characters of plants it was found that the plant height, number of leaves and branches per plant, thickness and area of leaf were significantly more in Bhindi No.10 (79.69cm, 21.73/plant, 1.94/plant, 1.69mm and 157.97cm<sup>2</sup> respectively) and less in Kaveri (48.67cm, 14.21/plant, 0.93/plant, 1.18mm and 137.70cm<sup>2</sup> respectively) and Chameli-015 (48.47cm, 14.51/plant, 1.07/plant, 1.29mm and 137.26cm<sup>2</sup> respectively). The trichomes density of both upper and lower leaf surface was maximum in Chameli-015 (11.40/cm<sup>2</sup> and 17.47/cm<sup>2</sup>) and the corresponding minimum density was observed in Bhindi No 10 (6.00/cm<sup>2</sup> and 9.53/cm<sup>2</sup>) during post-kharif season.

In the same way during pre-kharif season, the plant height, number of leaves and branches per plant, thickness and area of leaf were significantly maximum in same variety i.e., Bhindi No.10 (80.27cm, 22.93/plant, 2.00/plant, 1.75mm and 159.20cm<sup>2</sup>) and the lowest values of the same were found in Aparupa DG (49.27cm, 16.00/plant, 0.93/plant, 1.30mm and 139.40cm<sup>2</sup>), Kaveri (50.00cm, 14.80/plant, 1.00/plant, 1.40mm

and 139.10cm<sup>2</sup>) and Chameli (51.20cm, 16.87plant, 1.20/plant, 1.43mm and 141.07cm<sup>2</sup>). The trichomes density of both upper and lower leaf surface was maximum in Chameli-015 (11.00/cm<sup>2</sup> and 17.07/cm<sup>2</sup>). The minimum trichome density of both surfaces was observed in Meena-117 (5.00/cm<sup>2</sup> and 8.60/cm<sup>2</sup>) and Bhindi No.10 (5.73/cm<sup>2</sup> and 9.20/cm<sup>2</sup>).

In respect to fruit characters within the cultivars, the different fruit parameters varied among them with similar trend in both pre-kharif and post-kharif season but only values were different. The number of flowers and fruits were found highest in JKOH 7315. The maximum fruit length was recorded in Tiger Green and minimum in Kaveri. The fruit breadth of different okra cultivars varied among them having higher in Kaveri and lower in Bhindi No.10. The cultivar Miss-717 had maximum number of seeds/fruit and lowest in Kaveri. The density of trichome/cm<sup>2</sup> in fruit varied significantly among different okra cultivars. The maximum and minimum trichome density was recorded in Chameli-015 and Meena-117 respectively.

The correlation studies between jassid, aphid and white fly population and physico-morphic characters revealed that plant height, number of leaves and branch per plant, thickness (mm) and area (cm<sup>2</sup>) of leaf had significant positive influence on pest population fluctuation while trichome density of leaves (upper and lower surface) showed significant negative correlation during post-kharif and pre-kharif season except aphid population with plant height and whitefly with number of branch/plant during post-kharif and during pre-kharif season number of leaves and branch per plant, leaf thickness, area of leaf and trichome density of leaf surface (lower) on aphid population and number of branch per plant on jassid population had non-significant effect. The correlation between fruit borer damage and physico-morphic characters of okra fruit revealed that number of seeds/fruit had significant positive effect while trichome/cm<sup>2</sup> had significant negative effect during post-kharif season. However, only trichome/cm<sup>2</sup> had significant negative effect during pre-kharif season. The similar trend was existed in both pre-kharif and post-kharif season, only values were slightly differed.

Biochemical basis of resistance to insect-pest of okra during post-kharif season revealed that the chlorophyll content of leaf was highest in Bhindi No. 10 (value of SPAD 53.39) whereas the value was lowest in Kaveri (value of SPAD 35.95). The highest content of moisture, protein, nitrogen and phosphorous in leaf (80.78%, 51.33mg/g, 3.36% and 0.23%) and fruit (89.02%, 53.81mg/g, 4.20% and 0.45%) were recorded in Bhindi No.10. The minimum level of moisture, protein, nitrogen and

phosphorous in Kaveri (74.44%, 23.08mg/g, 1.80% and 0.16 %) in (82.45%, 27.53mg/g, 2.41% and 0.29%) in fruit. The minimum content of lipid, OD-phenol, phenol, potassium and zinc were recorded in Bhindi No.10 [(0.98%, 0.40mg/g, 4.94mg/g, 1.54% and 42.50mg/kg) in leaf and (1.09%, 0.51mg/g, 9.01mg/g, 1.54% and 64.68 mg/kg) in fruit] whereas the cultivar Kaveri was accounted for significantly maximum concentrations of lipid, OD-phenol, phenol, potassium and zinc [(1.84%, 0.62mg/gm, 8.37mg/g, 2.08% and 67.90mg/kg) in leaf and (2.00%, 0.93mg/gm, 14.98mg/g, 2.60% and 80.99mg/kg) in fruit].

During pre-kharif season, the bio-chemical analysis depicted that the chlorophyll content of leaf was highest in Bhindi No. 10 (value of SPAD 55.67) and lowest value was observed in Kaveri (value of SPAD 37.43). The highest content of moisture, protein, nitrogen and phosphorous in leaf (82.15%, 53.83mg/g, 3.70% and 0.25%) and fruit were recorded (90.12%, 55.06mg/g, 4.15% and 0.53%) in Bhindi No.10 which was closely followed by Meena-117 (81.12%, 52.17mg/g, 3.25% and 0.24%) in leaf and (89.28%, 52.67mg/g, 3.94% and 0.52%) in fruit. The minimum level of moisture, protein, nitrogen and phosphorous in leaf and fruit were recorded in Chameli-015 [(77.18%, 23.33mg/g, 1.90% and 0.18%) in leaf and (82.07%, 28.06mg/g, 1.92% and 0.36%) in fruit] followed by Kaveri [(77.31%, 25.58mg/g, 1.84% and 0.17%) in leaf and (84.84%, 29.89mg/g, 2.70% and 0.35%) in fruit]. The minimum content of lipid, OD-phenol, phenol, potassium and zinc in leaf (1.01%, 0.44mg/g, 5.78mg/g, 1.67% and 44.37mg/kg) and fruit (1.12%, 0.71mg/g, 10.77mg/g, 1.72% and 65.71mg/kg) were recorded in Bhindi No.10 and Meena-117 (1.09%, 0.48mg/g, 5.63mg/g, 1.43% and 45.50mg/kg in leaf and 1.24%, 0.74mg/g, 10.88mg/g, 1.79% and 64.79mg/kg in fruit). The cultivar Kaveri accounted for significantly maximum concentrations of lipid, OD-phenol, phenol, potassium and zinc [(1.93%, 0.64mg/gm, 8.87mg/g, 2.19% and 69.13mg/kg) in leaf and (2.09%, 1.18mg/gm, 16.76mg/g, 2.78% and 82.68mg/kg) in fruit] followed by Chameli-015 [(1.91%, 0.61mg/gm, 9.22 mg/g, 2.12% and 68.40mg/kg) in leaf and (2.19%, 1.11mg/gm, 17.04mg/g, 2.66% and 82.93mg/kg) in fruit].

Correlation of incidence of different pests with the bio-chemical constituents of the okra leaves and fruits showed similar trends in both the seasons. Among the various bio-chemical concentration in leaf and fruit like moisture, nitrogen, phosphorus and protein were positively correlated with jassid, aphid, whitefly and fruit borer population while lipid, OD phenol, phenol, potassium and zinc, were found to have significantly negative effect except potassium and zinc on aphid population during pre-kharif season.

The chlorophyll content in leaf had positive and significant effect on sucking pest of okra.

The efficacy fifteen modules were tested in order to find out the best possible protection module in managing the major insect pests of okra in this zone under consideration. Among these modules, M-14 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)] and M-11 [Chloropyriphos 20 EC (Seed treatment) + NPK + Lancer gold (acephate 50 + imidacloprid 1.8 SP) + Lancer gold (acephate 50 + imidacloprid 1.8 SP)] were found superior in controlling jassid population over rest of the modules during pre-kharif and post-kharif season. The higher population of fruit borer (bored fruit %) was observed in M-10 [Bijamrita (Seed treatment) + NPK + Neem leaf extract + Neem leaf extract] whereas lowest bored fruit % observed from M-4 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC] followed by M-2 [No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC]. The population of spiders and coccinellids was significantly lower in the M-14 and M-11 as compared to other modules. The highest yield 12.72 t/ha was harvested in okra plots under M-4 [Imidacloprid 17.8 SL (Seed treatment) + NPK + Imidacloprid 17.8 SL + Flubendamide 39.35 SC] which was at par with M-2 [No seed treatment + NPK + Thiomethaxam 25 WG + Flubendamide 39.35 SC] with a yield of 12.63 t/ha with respect to the untreated control.

M-14 and M-11 were found superior in controlling jassid population over rest of the modules during pre-kharif season. The higher population of fruit borer (bored fruit %) was observed in M-10 whereas lower population was recorded in M-4 which was closely followed by M-2 and both modules were at par with each other. The population of spiders and coccinellids was significantly lower in the M-14 and M-11 compared to a good number of these predators recorded in M-10 and untreated control (M-15). The highest yield 13.90 and 13.63 t/ha was harvested in okra plots receiving M-4 which was at par with M-9, while the lower yield 10.72 t/ha recorded in M-7 during post-kharif but it was significantly higher than the untreated control.

From the above results it may be concluded that the okra variety Bhindi No.10 showed highly susceptible while Kaveri and Chameli-015 depicted less susceptible cultivar against insect-pests of okra by considering various morphological characters of leaf and fruits as well as different biochemical analysis of fruits and leaves. Again Kaveri and Chameli-015 had produced medium fruit yield though they were less susceptible

against insect-pests. In the other hand, variety JKOH-7315 gave higher yield (12.09t/ha) and showed moderate reaction to insect-pests of okra. In pre-kharif season, the most vulnerable spell of different insect pests of okra like aphid, jassid, white flies, fruit borer etc. was found between 14<sup>th</sup> SW to 20<sup>th</sup> SW whereas in post-kharif season, the same spell was existed from 42<sup>th</sup> SW to 47<sup>th</sup> SW since the population became maximum during this time. Therefore great care should be taken during this time in managing these insect pests but unfortunately the population of natural enemies like coccinellids and spiders was found very close to their peak period at this time. Among the different protection modules, the highest yield were obtained from M-4 comprising of seed treatment with imidacloprid 17.8 SL + NPK + imidacloprid 17.8 SL + flubendamide 39.35 SC and M-2 comprising of no seed treatment + NPK + thiomethoxam 25 WP + flubendamide 39.35 SC gave at par yield of okra with 13.37, 13.04 t/ha during pre-kharif and 12.72, 12.62 t/ha during post-kharif. Therefore these two protection modules are very promising in managing insect pests of okra.

The present investigation covers a wide area on the activities of okra insect-pests and their management to derive practical tools for developing formulation of pest management modules of okra, *Abelmoschus esculentus* (L) under terai agro-ecology of West Bengal. For the purpose, studies have been conducted on seasonal fluctuation of the insect-pests attacking okra as influenced by prevailing weather conditions and contribution of the weather parameters (single and combined effects), screening of the available cultivars of okra for resistance/susceptibility to different pests based on physical and chemical characters of the cultivars, formulation of region-specific pest management modules of okra through integration of various pest management strategies, like, mechanical, botanical, microbial and chemical.

Thus, based on the outcome of the present studies the present investigation opens newer areas for further studies on the following aspects.

- More research should be carried out on relative efficacy of different new molecules against insect pest complex of okra to provide better yield and quality production.
- Studies can also be made to identify the vulnerable periods of insect-pests attacks with an objective to find out the proper timing of insecticide spray.
- Multilocation trials should be conducted for screening the suitable resistant varieties.
- Comparatively safer insecticides or less harmful to natural enemies and human health as well as environment should be identified or can be incorporated in future IPM programme.
- Studies can also be carried out to evaluate the residual toxicity of insecticides on the crop and development of insecticide resistance against insect pests.

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