BIOLOGY, POPULATION DYNAMICS
VARIETAL SUSCEPTIBILITY AND
CHEMICAL CONTROL OF OKRA JASSID,
Amrasca biguttula biguttula (ISHIDA) ON
OKRA

BY

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B.Sc. (Agri.)

DEPARTMENT OF ENTOMOLOGY
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JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH
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IN
AGRICULTURAL ENTOMOLOGY

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Registration No.: 04 - 5814 - 2003
DEDICATED TO MY BELOVED PARENTS

Dinesh...
ABSTRACT

The okra jassid, Anurasca biguttula biguttula (Ishida), causes severe damage to okra crop. The investigations were, therefore, made on biological population dynamics, varietal susceptibility and chemical control of the pest during the year 2004 at the Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh.

The eggs were inserted inside the okra leaf veins. An average egg period was 5.30 ± 1.33 days at an average laboratory temperature of 28.34 ± 3.33 °C and 75% relative humidity. There were five instar and developmental stages of the jassid. A total of 25 lines of okra were screened against the jassid. All the 25 lines were susceptible at a field level. A few lines were evaluated against black cotton worm and army worm at an insect-feeding level. The lines were specifically evaluated for: (i) model plant, (ii) feeding index, (iii) mites (iv) stink bugs and (v) jassids. The results showed that out of these lines, two lines were susceptible, five lines were moderately susceptible, and 17 lines were resistant to the jassid.
The pest population increased gradually and reached a peak level of 0.22, 1.21 ± 0.42, 1.90 ± 0.60, 1.10 ± 0.20 and 2.10 ± 0.50 days, respectively at an average laboratory temperature of 29.14°C and 70.12 per cent relative humidity. The mean total nymphal duration under the same laboratory conditions was 7.40 ± 1.35 days. The mean longevity of male and female adults was 10.60 ± 1.041 and 13.10 ± 1.491 days, respectively at an average laboratory temperature of 30.80°C and 69.10 per cent relative humidity. The pre-oviposition, oviposition and post-oviposition periods occupied on an average 3.40 ± 1.03, 5.20 ± 0.88 and 4.10 ± 0.78 days, respectively at an average laboratory temperature of 30.05°C and 69.55 per cent relative humidity. The oviposition potential was on an average 16.20 ± 0.833 eggs per female at an average laboratory temperature of 30.10°C and 72.40 per cent relative humidity. The sex-ratio (male: female) was 1:1.50 at an average laboratory temperature of 29.11°C and 70.20 per cent relative humidity. Thus, it was concluded that females of *A. biguttula biguttula* outnumbered their male counterpart under laboratory conditions.

The total life span (from egg to death of adult) of male and female was on an average 23.10 ± 3.00 and 26.2 ± 3.50 days, respectively at an average laboratory temperature of 30.40°C and 70.10 per cent relative humidity.
The pest population increased gradually and reached to a peak level of 11.25 jassid nymphs per leaf on GO-2 variety of okra after 10th week of sowing. The pest population was remained active throughout kharif season. Jassid population had significant positive correlation with maximum temperature (0.5490) and significant negative correlation with minimum temperature (-0.5193). Similarly, jassid population had significant negative correlation with morning relative humidity (-0.3242) on the GO-2 variety of okra.

Twenty varieties tested for their susceptibility to this pest, the varieties Gujarat Okra-1, Aol-02-4, Aol-02-1, Aol-99-28, Gopi, Aol-99-24 were found least susceptible to this pest and varieties, 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 found most susceptible, while varieties viz., Jol-2k-18 and Jol-02-10 were found moderately susceptible under field conditions.

The results on the efficacy of different 13 insecticides against okra jassid showed that imidacloprid 7.5g/kg seeds, thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03, methyl demeton 0.03 and phosphamidon 0.03 per cent proved the most effective for quick knock down and they were also effective up to 14 days after spray under field conditions.
The higher yield of healthy okra fruits was recorded in the treatment of imidacloprid 7.5g/kg seeds (4194.23 kg/ha) and followed by thiamethoxam 4.2g/kg seeds (4035.80 kg/ha), monocrotophos 0.04 per cent (3967.03 kg/ha) and endosulphan 0.07 per cent (3822.87 kg/ha).

This is to certify that Mr. CHAUDA DINESH VIRABHAI has successfully completed the comprehensive/Preliminary examination held on 17-08-2005 as required under the regulation for Post-Graduate Studies.

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CERTIFICATE-II

This is to certify that the thesis entitled: "BIOLOGY, POPULATION DYNAMICS, VARIETAL SUSCEPTIBILITY AND CHEMICAL CONTROL OF OKRA JASSID, Aphis gossypii bivittulans biguttulans (ISHIDA) ON OKRA" submitted for the degree of MASTER OF SCIENCE in the subject of AGRICULTURAL ENTOMOLOGY embodies bonafide research work carried-out by Mr. CHAVDA VINODBHAI VIRABHAI under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged.

Place: Junagadh
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This is to certify that Mr. CHAVDA DINESH VIRABHAI student of M.Sc. (Agri), Department of Entomology, J.A.U., Junagadh has made all corrections/modifications in the thesis entitled "BIOLOGY, POPULATION DYNAMICS, VARIETAL SUSCEPTIBILITY AND CHEMICAL CONTROL OF OKRA JASSID, Amrasca biguttula biguttula (ISHIDA) ON OKRA" as suggested by the external examiner and the advisory committee in the oral examination held on 23-06-2006. The final copies of the thesis duly bound and corrected have been submitted on 6-07-2006.

Place: Junagadh
Date: 6/07/2006

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Place: Junagadh
Date: 18-2-06

(D. V. Chavda)
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INTRODUCTION

The crop is grown in severla States of India including the State of Gujarat. It is mainly cultivated in arid-transect and semi-arid areas, occupies an area of 30380 hectares and total production of 19,577 metric tonnes (Anonymous, 2001).

This crop is attacked by several species of insect pests causing considerable damage to the okra crop. The major insect pests attacking the crop are (Jain et al., 1994) as listed as under,

1. Spodoptera litura (Fabricius)
I INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) belongs to the *malvaceae* family. It is widely grown all over India for its immature tender fruits. It is rich in vitamin A and C and also contains Calcium, Phosphorus and Potassium. The young tender pods are cooked in curries stewed, cooked into soups and also canned and dried. Besides its use as vegetable, mucilage matter of okra is useful for cleaning the cane juice at the time of preparation of jaggery and brown sugar. Its ripped seeds are used as a substitute of coffee, whereas matured fruits and stems containing crude fiber are also used in paper industry. Apart from its commercial usages, it is said to be very useful against genitourinary disorders, spermatorrhoea and chronic dysentery (Krishnamurthy, 1994).

The crop is grown in the several States of India including Gujarat State. In Gujarat, it is mainly cultivated in spring-summer and rainy season, occupies an area of 30380 hectares and annual production of 196467 metric tonnes (Anonymous, 2001).

This crop is attacked by several species of insect pests causing appreciable damage to the okra crop. The major insect pests attacking the crop (Dhamdhere *et al.*, 1984) are listed as under,

(1) Shoot and fruit borer

*Erarias vittella* (Fabricius)
(2) Leaf roller
   *Sylepta derogate* (Fabricius)
(3) Green semilooper
   *Anomis flava* (Fabricius)
(4) Blister beetle
   *Mylabris pustulata* (Thumb)
(5) Petiole maggot
   *Melanagromyza hibisci* (Spencer)
(5) Grey weevil
   *Mellocerus undecimpustulatus maculosus* (Desbrochers)
(6) Jassid (Leaf hopper)
   *Amrasca biguttula biguttula* (Ishida)
(7) Whitefly
   *Bimisia tabaci* (Gennadius)
(8) Aphid
   *Aphis gossypii* (Glover)
(9) Mite
   *Tetranychus telarius* (Linnaeus)
(10) Red cotton bug
    *Dysdercus koenigii* (Fabricius)
(11) Green plant bug
    *Nezara viridula* (Linnaeus)
(12) Dusky cotton bug
    *Oxycaraenus laetus* (Kirby)

Among the various insect pests listed above, the jassid, *Amrasca biguttula biguttula* (Ishida), commonly known as cotton jassid, adversely affects the yield of okra in case of heavy infestation.
According to Maramorosch and Harris (1979), A. biguttula biguttula is cosmopolitan in distribution. Atwal (1986) reported that the pest is widely distributed in India. Though, okra and cotton are its main hosts. It also causes severe damage to brinjal, beans, castor, cucurbits, hollyhock, potato, sunflower and other malvaceous plants (Butani and Jotwani, 1984). The nymphs and adults suck the cell sap from underside of the leaves and inject their toxic saliva into the tissue causing toxaemia. The affected leaves become pale green, then yellow, reddish and finally brick red or brown in colour. This change was accompanied by curling and crinkling and the leaves gradually dry away. The plants become stunted in growth and bear less number of buds and flowers; thereby the yield was adversely affected (Butani and Jotwani, 1983). According to Krishnaiah (1980), jassid caused up to 40-60 per cent loss of okra fruit.

Looking to the importance of A. biguttula biguttula on okra crop, the following aspects were studied during the course of these investigations.

1. To study biology of A. biguttula biguttula on okra.
2. To study population dynamics of A. biguttula biguttula on okra.
3. To study the varietal susceptibility of different varieties/genotypes of okra against A. biguttula biguttula.
4. To study the efficacy of various insecticides against A. biguttula biguttula on okra.

The results obtained through these investigations form the subject matter for this dissertation.
REVIEW OF LITERATURE

Information on okra jassid, *A. biguttula biguttula* pertaining to the present investigations is reviewed and presented in this chapter for the following aspects.

2.1 Biology of *A. biguttula biguttula*

2.2 Population dynamics of *A. biguttula biguttula*

2.3 Nature of damage due to okra jassid

2.4 Susceptibility of *E. kochii* to okra jassid

2.5 Chemical control of okra jassid

2.6 Biology

Patel *et al.* (1956) found that an adult female laid about 30 to 50 eggs and the incubation period was 4 to 11 days.

Srivastava *et al.* (1965) stated that the egg laying capacity of the female was 1 to 2 eggs per day. The eggs was 5 to 10 days old. The pest completed one generation within 12 to 36 days.

Husain and Lal (1940) reported that the eggs were laid inside the leaf veins and the incubation period of eggs varied from 4 to 7 days. Single female laid maximum 20 eggs. The nymphs of *E. kochii* were yellowish in colour and their life period varied from 7 days in autumn to 21 days in summer.
II REVIEW OF LITERATURE

The information on okra jassid, *Amrasca biguttula biguttula* (Ishida), pertaining to the present investigations is reviewed and presented in this chapter for the following aspects.

2.1 Biology of *A. biguttula biguttula*

2.2 Population dynamics of *A. biguttula biguttula*

2.3 Nature of damage due to okra jassid

2.4 Susceptibility of okra varieties to *A. biguttula biguttula*

2.5 Chemical control measures against okra jassid

2.1 Biology

Patel *et al.* (1956) found that the adult female laid about 30 eggs and incubation period was 4 to 11 days.

Srivastava *et al.* (1965) stated that the egg laying capacity of a single female was 10 to 21 eggs and incubation period of eggs was 5 to 6 days. The pest completed one generation within 12 to 36 days.

Husain and Lal (1940) reported that the eggs were laid inside the cotton leaf veins and the incubation period of eggs varied from 4 to 11 days. Single female laid maximum 29 eggs. The nymph moult five times before reaching adult stage. Nymphs of *E. devastans* were yellowish green in colour and their life period varied from 7 days in autumn and 21
days in winter on cotton. An adult of *E. devastans* bears prominent black spot on each tegmina near apex of claval area.

According to Bhalani (1970), single female laid on an average 14.8 and 16.7 eggs at an average laboratory temperature of 31.9°C (Average relative humidity 79.08 per cent) and 28.75°C (Average relative humidity 80.53 per cent), respectively. Incubation period of egg varied from 2 to 5 days with an average of 4.16 days at an average laboratory temperature of 31.90°C on cotton, while it varied from 3 to 6 days with an average of 4.56 days at an average laboratory temperature of 28.21°C. The newly hatched nymph moults five times before reaching adult stage. There were five nymphal instars and duration of each instar was on an average 1.7, 1.0, 1.29, 1.66 and 1.58 days, respectively. The total nymphal period was 7.25 days at an average laboratory temperature of 31.34°C and 72.60 per cent relative humidity on cotton. Pre-oviposition, oviposition and post oviposition period varied from 3 to 5, 3 to 6 and 2 to 5 days with an average of 3.6, 3.6 and 3.4 days, respectively at an average laboratory temperature of 30.90°C on cotton. Sex-ratio of male: female was 1:1.37 for laboratory reared adults. The total life span from egg to death of adult varied from 10 to 13 days with an average of 11.6 days for male and 10 to 14 days with an average of 11.3 days for female at an average laboratory temperature of 31.52°C and 72.92 per cent relative humidity.
Saxena and Saxena (1971) reared the jassid on okra fruits and stated that incubation period of eggs was 8 to 9 days. The first instar nymphs reached to the adult stage in 7 to 8 days on okra fruits. Pre-oviposition period varied from 6 to 7 days while the oviposition period was 20 days. The average number of egg laid per female was $11.6 \pm 1.1$ and the longevity of adults varied from 33 to 50 days with an average of $37.2 \pm 3.21$ days.

Naheed and Ahmed (1974) reared the jassid on okra leaves and reported that eggs period was on an average 8.4 days. The total nymphal period was on an average 11.1 days. The adult female lived for 37 days and the numbers of eggs laid were on an average 17.71 per female.

Butani and Verma (1976a) found that single female laid 15-30 eggs. Nymphs were pale green, wingless and walk diagonally. Adult was wedge shaped. Egg, nymphal and total life cycle duration occupies 4-10, 7-21 and 15-46 days, respectively.

According to Butani and Verma (1976b), Egg hatched in 1-4 days, nymphal period about 2-4 weeks and adult longevity 5-8weeks. Single female laid 15 to 30 eggs.

Bhalani and Patel (1981) studied the development of *A. biguttula biguttula* on okra at an average laboratory temperature of 27.94°C and 76.77 per cent relative humidity. They reported that the total nymphal period was on an average 8.0 days.
Thirumalaraju (1986) reported incubation, nymphal, pre-ovipositional and ovipositional period of an average 4.2, 14.90, 4.0 and 11.6 days, respectively. The fecundity was 117.2 eggs/female on cotton.

Gedia (1989) reported incubation period of eggs varied from 2 to 6 days with an average of 4.35 days at the prevailing laboratory temperature ranging from 26 to 32°C (Average 28.75°C). The duration of first, second, third, fourth and fifth instar nymphs ranged from 1 to 2, 1 to 2, 1 to 3, 1 to 2 and 1 to 3 days with an average of 1.12, 1.28, 1.93, 1.09 and 2.17 days, respectively with the total nympha! period of 5 to 12 days with an average of 7.76 days at the laboratory temperature varied from 27 to 34°C (Average 30.10°C) and relative humidity from 65 to 79 per cent (Average 72.11). Duration of male and female 8 to 11 days with an average of 9.92 days and 8 to 12 days with an average of 9.95 days, respectively at the laboratory temperature ranging from 29 to 34°C (Average 30.85°C) and relative humidity from 62 to 79 per cent (Average 69.0 per cent). The pre-oviposition, oviposition and post oviposition periods varied from 2 to 4, 2 to 6 and 2 to 4 days with an average of 3.32, 4.36 and 3.04 days, respectively at the prevailing laboratory temperature ranging from 29 to 34°C (Average 30.85°C) and relative humidity 62 to 79 per cent (Average 69.0 per cent). Number of eggs laid by single female varied from 14 to 18 eggs with an average of 16.24 eggs at the laboratory temperature ranging from 29 to 34°C (Average 31.06°C) and
relative humidity from 68 to 79 per cent (Average 73.30 per cent). The sex-ratio of male to female was 1:1.25 under laboratory temperature ranging from 29 to 34°C (Average 31.02°C) and relative humidity from 65 to 79 per cent (Average 70.60 per cent). Entire life span of male and female varied from 15 to 29 days with an average of 22.25 days and 15 to 30 days with an average of 23.16 days, respectively at the laboratory temperature ranging from 26 to 34°C (Average 29.88°C) and relative humidity from 60 to 85 per cent (Average 72.17 per cent).

Sharma and Sharma (1997) studied the biology of *A. biguttula biguttula* on okra variety Pusa Sawani and they observed incubation period of 6.27 days. The egg hatchability was 91.9%. The nymphs were pass through different five instars and the duration of each instar was 1.5, 1.1, 1.2, 1.5 and 2.0 days for I, II, III, IV and V instars, respectively. The nymphal period was 7.3 days. The mean pre-oviposition, oviposition and post-oviposition periods were 3.45, 16.57 and 3.90 days, respectively. The average fecundity was 17.5 eggs per female. The adult life span ranged from 21 to 30 days.

2.2 Population dynamics

Jayraj and Basheer (1964) reported that there was not significant effect of maximum temperature, rainfall and humidity on jassid population.
It has been reported that 7 to 11 weeks old okra plants were most susceptible to attack of jassid then its other growth stages and highest population was recorded after 8 weeks on plant. (Senapati and Khan, 1978).

According to Dhamdhere et al. (1984), the population of *A. biguttula biguttula* remained active throughout *kharif* and summer seasons. The population was maximum when the crop age was 69 to 77 days. The low humidity in *kharif* crop appeared to be conducive to the population build up on okra crop.

Pareek et al. (1986) found that the leafhopper appeared in the first week of August (2nd week after sowing) and prevailed throughout crop period. The population increased gradually and reached the maximum during September when relative humidity was more than 70 per cent and declined thereafter.

In Gujarat, jassid population on okra has been found occurring throughout the crop period during summer and *kharif* season on okra. Further, jassid population was reported higher in *kharif* season. A significant negative correlation of jassid population was observed with minimum temperature, while other weather parameters showed a non-significant correlation (Patel, 1988).

According to Srinivasan et al. (1988), there was low incidence of *A. biguttula biguttula* on okra from June to mid-January in various
weather parameters analysed. Only minimum temperature had a
significant positive correlation with the pest population

Chaudhary and Dadheech (1989) reported that *A. biguttula*
biguttula appeared on the summer crop of okra 21 days after sowing.
Gradually, the pest reached at peak (4.78 jassid nymphs/leaf) after 43
days on crop and thereafter the population started declining.

Lal *et al.* (1990) found that the cicadellid first appeared on crop
two weeks after sowing. Thereafter, the population increased with the age
of the crop, except during the 2nd half of the 4th and 5th weeks.

According to Patel (1989), the incidence of jassid started to
appeared after 2nd week of sowing. The pest population was at fluctuating
level but it was highest after 11th week of sowing. Later on, the pest
population started declining. Further, there was significant positive
correlation of jassid population with maximum temperature (*r* = 0.9058),
average temperature (*r* = 0.7571) and sunshine hours (*r* = 0.6166), while
it was significantly negative with minimum temperature (*r* = -0.7682),
evening relative humidity (*r* = -0.8210) and average relative humidity
(*r* = -0.8358). The rainfall and rainy days had also negative correlation
with jassid population.

Simwat and Gill (1992) reported that peak population of *A.*
bigutula biguttula was observed in 3rd week of July. It was claimed that
the correlation between sunshine hours and population size of *A.*
*biguttula biguttula* was significant ($r^2 = 0.35$). All other correlation with environment variables were non significant.

Ratanpara *et al.* (1994) studied the effect of weather parameters on brinjal jassid, *A. biguttula biguttula* and noted that the minimum temperature ($r = -0.56$), average temperature ($r = -0.41$) and vapour pressure ($r = -0.64$) were negatively associated with population build-up of *A. biguttula biguttula*. Sunshine hours ($r = 0.45$) had a positive association however, only vapour pressure contributed 41 per cent variation in jassid population.

The population of *A. biguttula biguttula* ranged from 0.59-2.78/plant. The jassid population ranged between 0.59 in 1st fortnight of August and 2.78 in 1st fortnight of October (Patel and Rote, 1995).

Patel *et al.* (1997b) reported significant relationship between Jassid population level and maximum temperature ($r = -0.76$) as well as hours of bright sunshine ($r = -0.82$). The population of jassid increased during the monsoon season, when temperature remained around 37 °C along with at least of 10hr of bright sunshine.

Sangha *et al.* (1997) reported that peak population of jassid nymphs was noticed during the second fortnight of July on cotton crop. Joginder Singh and Sekhon (1998) showed that the jassid population was increased whenever the mean temperature was near 30 °C.
and 5 to 8.6 hrs sunshine/day in cotton. The rainfall tended to reduce the jassid population.

Kumawat et al. (2000) carried out an experiment on seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors during kharif 1996 in the semi arid region of Rajasthan, India and concluded that the infestation of jassids on okra started in the fourth week of July and reached peaks in the second and fourth weeks of September, respectively.

2.3 Nature of damage

The nature of damage caused by the jassid, A. biguttula biguttula on okra was studied in the field conditions. Eggs were laid singly within the major leaf veins in the parenchymatous layer between vascular bundles and epidermis. It was observed that both nymph and adults were found on the lower surface of leaves of the okra plant, congregated near the stalk in between the main veins. The nymphs and adults suck the cell sap from underside of leaves and inject their toxic saliva into the tissue causing toxaemia. The affected leaves become initially pale-green then turn yellow, reddish and finally brick red or brown in colour. Curling and crinkling of leaves accompanied this change and the leaves gradually dried away. The plants become stunted in growth and bear less number of flowers; thereby yield was adversely affected. Similar observations were also reported by Butani and Jotwani (1983) on okra.
Jassid, *A. biguttula biguttula* was considered an important pest of cotton. Both nymphs and adults suck up the plant sap from the undersurface of the leaves. The leaves showed the symptoms of “hopper burn”, such as yellowing, curling, bronzing and sometimes drying up (David and Kumaraswami, 1982) on cotton.

### 2.4 Susceptibility of okra varieties

Uthamasamy *et al.* (1975) reported that the susceptible okra variety AE 26 was most preferred by *A. biguttula biguttula* for feeding and oviposition, followed by tolerant variety AE 52 and resistant variety AE 30.

Uthamasamy (1980) observed that the okra variety A.E. 22 was resistant to leafhopper for oviposition and feeding due to its hairyness on the midrib and lamina as well as its poor nutrient status for the insect then the susceptible variety Pusa Sawani.

Mahal *et al.* (1991) reported that the development of jassid took longer period and survival was reduced on the okra varieties IC 7194 and New Selection as compared to Pusa Sawani.

Significantly lower population of jassid was recorded on Gujarat Okra Hybrid-3 than Anand Okra Hybrid-55, Anand Okra Hybrid-37 and Pusa Sawani (Anonymous, 1993).
According to Mahal et al. (1993), lowest population of jassid was on okra varieties IC 7194, Punjab Padmini and New Selection as compared to Pusa Sawani.

Kaddivar ((1995) tested twenty okra varieties for its susceptibility against jassid and reported that the variety Long Green was the least susceptible which recorded 7.19 jassid nymphs/leaf. The variety HRB-55 was found most susceptible with 13.18 jassid nymphs/leaf followed by moderately susceptible varieties Arka Abhay, Pusa Sawani, Parbhani Kranti and HRB-92 as they registered 9.22, 10.43, 10.53, 10.55 and 10.70 nymphs/leaf, respectively.

Khambete and Desai (1996) screened 26 okra (A. esculentus) cultivars for resistance to jassid (A. biguttula biguttula), and shoot and fruit borer (E. vittella) in naturally infested fields. Sel-a, Ankur 35, BO1, Plon-44-13, Sel-3 and HOE301 varieties exhibited significantly low jassid populations.

Manish Kumar and Singh (2002) reported that the A. biguttula biguttula was observed 14 days after transplanting of okra cultivars. The pooled nymphal population of pest was lowest in Punjab Padmini (1.87) followed by DOV-91-4 (1.96) and Arka Anamika (1.98) and highest in Pusa sawani (3.77). The lowest leaf injury was recorded in Arka Anamika (12.61%) followed by Punjab Padmini (13.27%) and highest in Pusa Sawani (61.06%).
The pooled results of three years revealed that the Gujarat Okra Hybrid-1 significantly more tolerant as compared to Pusa Sawani against aphid, jassid and whitefly (Patel et al., 2003).

2.5 Chemical control measures

Srinivasan et al. (1973) recommended three sprays of endosulfan 0.07 per cent at 15-day interval from 21st days after sowing against okra jassids.

Agrawal and Katiyar (1975) tested 11 insecticides against cotton jassid and they concluded that monocrotophos and phosphamidon both at 0.05 per cent were highly effective against jassid.

Krishnaiah et al. (1976) evaluated 26 insecticides for the control of major insect pests of okra and concluded that monocrotophos (0.5 kg a.i/ha) and dimethoate (0.3 kg a.i/ha) suppressed Jassid population effectively for 3 weeks.

Mote (1978) evaluated the efficacy of 13 insecticides against okra pests. Out of these, monocrotophos 0.05 per cent and dimethoate 0.05 per cent at fortnightly interval were found most promising against okra jassid, *Amrasca biguttula biguttula* (Ishida).

Dhamdhere et al. (1980) tested 10 insecticides against *A. biguttula biguttula*, on okra and they noted dimethoate 0.03 per cent and endosulphan 0.03 per cent had rapid knock down effect, causing 88 and 84 per cent mortality respectively, 24hrs after treatment.
Patel and Patel (1998) found that quinalphos 0.05 per cent and triazophos 0.1 per cent resulted in a resurgence of *A. biguttula biguttula* on okra. While endosulphan at 0.07 per cent and Repelin (based on *Azadirachta*) at 1 per cent were highly effective. Use of a number of botanical insecticides in conjunction with quinalphos effectively managed the pest population.

Patel *et al.* (1980) studied the effectiveness of monocrotophos 0.04, phosphamidon 0.03, dimethoate 0.03, carbaryl 0.1 per cent and aldicarb 0.5kg a.i/ha against *A. biguttula biguttula* on okra and found that dimethoate and monocrotophos were significantly superior to carbaryl and phosphamidon.

Babu and Azam (1982) determined the effectiveness of certain synthetic pyrethroidds in comparison with other insecticides against the pest complex of bhendi and they stated that monocrotophos 0.05 per cent was the most effective against jassid followed by cypermethrin 0.01 per cent.

Visvanathan and Abdul Kareem (1983) carried out three field trials with endosulfan, methyl demeton and monocrotophos against jassid on cotton. All three treatments were performed equally effective and at par with each other. The population reduction in order of effectiveness was highest in monocrotophos, followed by methyl demeton and endosulfan
in decreasing concentrations viz., 0.09, 0.07 and 0.05 per cent, respectively.

Mohan (1985) studied the efficacy of 8 insecticides for the major insect pests of okra and concluded that endosulphan @0.7 kg a.i./hectare was most effective for the control of okra jassid.

Narke and Suryawanshi (1987) tested various insecticides against the cicadellid, Amrasca biguttula biguttula (Ishida) under field conditions and observed that monocrotophos 0.05% was most effective against the pest.

Kakar and Dogra (1988) carried out an experiment on insect pest complex of okra and found that monocrotophos 0.05% was effective for the control of cicadellid, Amrasca biguttula biguttula (Ishida).

Srinivasan and Krishnakumar (1988) reported that the two applications of monocrotophos 0.05 per cent (Nuvacron 40 EC), 21 and 35 days after germination, gave effective and economical control of okra jassid.

Radadia and Patel (1993) tested 11 insecticides against okra jassid, Amrasca biguttula biguttula (Ishida) and aphid, Aphis gossypii (Glov) and concluded that monocrotophos at 0.03% was the most effective treatment against both the pests.

Patel et al. (1997a) conducted an experiment during the kharif season to determine the efficacy of conventional insecticides against pests
of okra and reported that sprays of endosulphan EC and WP were equally effective and endosulphan 0.035% was the most effective.

Imidacloprid 600 FS at 9 ml/kg seeds and 70 WP at 10 g/kg seeds were found promising against jassid (Amrasca biguttula biguttula, Ishida). Both the formulations had no adverse effect on the seed germination of okra (Bhargava et al., 2001a).

Kumar et al. (2001) studied the efficacy of imidacloprid and thiamethoxam against okra leafhopper and found that the thiamethoxam (Actara 25 WG) was at par with imidacloprid (Gaucho 600 FS) seed treatment at 12 ml/kg seeds were most effective against jassid, Amrasca biguttula biguttula (Ishida) on okra.

Manish Kumar et al. (2001) tested the efficacy of various insecticides against cotton jassid, A. biguttula biguttula and found that endosulphan 0.07 per cent was effective in controlling jassid.

Bhargava et al. (2001b) studied the bioefficacy of insecticides against two major pests of okra viz. jassid (A. biguttula biguttula) and fruit borer (E. vitella) and reported that monocrotrophos at 500 g a.i. /ha was significantly superior in reducing jassid population.

2.6 Yield

Srinivasan et al. (1973) stated that endosulphan 0.07 per cent thrice at an interval of 15 days starting from 21st day after sowing increasing the yield 87.4 per cent of okra over untreated plots.
Mote (1978) reported that monocrotophos 0.05 per cent gave higher yield (101.19q/ha) followed by endosulphan 0.05 per cent (89.91q/ha).

Jadhav and Nawale (1984) concluded that the yield of healthy okra fruits was significantly higher in the treatment of monocrotophos 0.05 per cent (69.35q/ha) then rest of the treatments except the treatment with 0.03 per cent chlorpyriphos (62.19q/ha).

Zala (1986) concluded that six applications of monocrotophos 0.04 per cent at 10 to 15 days interval starting immediately after germination were found effective as it registered highest okra fruit yield.

Borah, R. K. (1994) tested 8 insecticides against A. biguttula biguttula on okra and reported that dimethoate 0.03 per cent at 25 and 30 DAG resulted in the highest yield (65.4q/ha).

Kadivar (1995) reported that the highest yield of okra fruit was recorded in treatment of endosulphan 0.07 per cent (4062.50 kg/ha) and it was at par with monocrotophos 0.04 per cent (3493.05 kg/ha).

Bhargava et al. (2001a) reported that imidacloprid 600 FS at 9 ml/kg seeds and 70 per cent WP at 5 g/kg seeds gave maximum yield.
MATERIALS AND METHODS
III MATERIALS AND METHODS

The investigations on “biology, population dynamics, varietal screening and chemical control of okra jassid, *A. biguttula biguttula* on okra” were carried out at Department of Entomology as well as College Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *kharif* 2004. The materials and methodology adopted for the studies are described under following sub-headings.

3.1 Rearing technique

To develop the initial culture of okra jassid, *Amrasca biguttula biguttula* Ishida, a large number of nymphs were collected from the College farm, College of Agriculture, Junagadh Agricultural University, Junagadh during year 2004. The Petri dishes measuring 10 cm in diameter and 2 cm in depth having round pieces of wet blotting paper at their bottoms were used and 100 nymphs were confined in each Petri dish. Okra leaves were provided as food to the nymphs. The cut end of petiole of okra leaf was wrapped with wetted cotton wool to keep the leaf fresh and turgid for a longer period of time. The Petri dishes were kept clean and fresh food was provided to the nymphs as and when required. The last instar nymphs were place in separate Petri dishes for adult emergence.
Male and female were identified by ascertaining the presence or absence of a conspicuous black coloured straight line placed medially on the last four abdominal segments. The male possesses such black line while, it is lacking in the female. Male and female, thus obtained, were used for further study. The experimental procedures pertaining to biology and other aspects are described in the following sub-headings.

3.2 Biology of *A. biguttula biguttula*

3.2.1 Egg

As the eggs were inserted inside the leaf veins while laying, it was not possible to expose them for description as any attempt of taking out eggs from the tissue damaged the eggs.

To study the incubation period, okra plants were grown in pots and they were protected from the attack of jassids by using glass chimney (10cm x 17cm). The upper end of chimney was closed by muslin cloth with the help of rubber bands. Such fresh okra leaves were kept in specimen tubes (2.5 x15cm) in such a way that the cut end of the petiole remains dipped in water to keep the leaf fresh and turgid. A few numbers of male and female adults were confined to these specimen tubes for eggs laying. The open end of the specimen tubes was covered with fine muslin cloth kept in position with the help of rubber bands. The male and female adults were transferred to new specimen tubes every day. The egg laid leaves were kept as such in specimen tube with proper labeling upto date.
of emergence of nymphs. Thus, incubation period from date of egg laying to emergence of nymphs.

3.2.2 Nymph

With a view to determine the number and duration of different nymphal instars and total nymphal period, newly emerged nymphs were placed individually in Petri dishes (10cm x 2cm) with the help of a wet camel hair brush, and fresh okra leaves were provided as food daily. The cut end of petiole of leaves was wrapped with a cotton wool to keep the leaf fresh and turgid for a longer period of time. The observations regarding moulting were recorded daily and fresh food was provided to the nymphs. The moulting was confirmed from exuviae presence in the Petri dishes. Such study was kept continued to determine the number of nymphal instars, duration of each nymphal instar, total nymphal period and sex ratio.

3.2.3 Adult

To study the pre-oviposition, oviposition and post-oviposition periods of female, fecundity of female and longevity of adults, okra plants were grown in pots and they were protected from the attack of jassids by using glass chimney (10cm x 17cm). The upper end of chimney was closed by muslin cloth with the help of rubber bands. Such fresh okra leaves were kept in specimen tubes in such a way that the cut end of the petiole remains dipped in water to keep the leaf fresh and
turgid. A pair of newly emerged male and female was confined in each specimen tube for egg laying. The open end of specimen tubes was covered with fine muslin cloth and kept in position with the help of rubber bands. The pair of male and female adults was transferred to new specimen tubes every day. The egg laid leaves were kept as such in specimen tubes with proper labeling of date. The number and time of emergence of nymphs from such leaves were recorded. Such studies were continued up to death of the adults. The fecundity were worked out on the basis of number of nymphs emerged during the course of studies. Thus, the pre-oviposition, oviposition, and post-oviposition periods of female, fecundity of female and longevity of adults were worked out under laboratory.

3.3 Population dynamics

The experiment on the population dynamics of okra jassid, *A. biguttula biguttula* (Ishida) was carried out at College Farm, College of Agriculture, J. A. U., Junagadh on GO-2 variety of okra in isolated plot with plot size of 20x10m keeping the spacing of 60x30cm from row to row during *kharif* season of 2004.

All the recommended agronomic practices were followed. The plot of this variety was kept unsprayed throughout the crop season. Twenty plants were observed at weekly interval. The observations were recorded from two weeks after sowing to completion of the crop. The number of
jassid nymphs on three leaves one each from top, middle and bottom portion of plant were observed. Mean jassid nymphs populations were workout and data were analyzed by using statistical tools.

### 3.3.1 Correlation study

The meteorological data on temperature (maximum and minimum), relative humidity (morning and evening) and rainfall in different standard weeks were obtained from the meteorological observatory located near the experimental field during *kharif* 2004.

With view to study the impact of different weather parameters on pest incidence, simple correlation between population of the pest and weather parameters was worked out.

### 3.4 Susceptibility of okra varieties

To study the varietal susceptibility of different recommended and promising okra varieties/genotypes against jassid, (*A. biguttula biguttula*), a field experiment was conducted during *kharif* 2004. Twenty varieties/genotypes were tested for this purpose. The seeds of varieties/genotypes were taken from Vegetable Research Center, Junagadh Agricultural University, Junagadh.

The details of experiment are given below:

1. Location of experiment: College Farm, College of Agriculture, J. A. U., Junagadh.
2. Experimental design : R. B. D.

3. Replication : Three (3)

4. Plot size
   : Gross plot: 5x1.2m
   : Net plot: 4x0.6m

5. Number of treatment : Twenty (20)

6. Spacing : 60x30cm

**Methodology**

In the experimental field each variety/genotype was grown in plot size of 5x1.2m length with 60x30cm spacing.

All the recommended agronomic practices were adopted. Five plants of each variety/genotype were select randomly and for assessing the population of jassid nymphs. Three leaves were selected representing top, middle and bottom region of each plant. The observations on population count were taken as soon as the jassid nymphs were noticed on plants. Subsequent observations were recorded at an interval of 7(seven) days and were continued till harvest of crop. The average nymph population per 3(three) leaves per plant was worked out and data were statistically analyzed.

**3.5 Chemical control**

A field experiment was conducted at the College Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during kharif
Table 1. Insecticides used for evaluation of their efficacy against okra jassid, *A. biguttula biguttula*

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Common name</th>
<th>Trade name</th>
<th>Formulation</th>
<th>Concentration (%)</th>
<th>Manufacturing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chlorpyriphos</td>
<td>Durmet</td>
<td>20EC</td>
<td>0.05</td>
<td>BASF India Limited, Mumbai</td>
</tr>
<tr>
<td>2</td>
<td>Dimethoate</td>
<td>Rogor</td>
<td>30EC</td>
<td>0.03</td>
<td>Rallis India Limited, Mumbai</td>
</tr>
<tr>
<td>3</td>
<td>Imidacloprid</td>
<td>Gaucho</td>
<td>70WP</td>
<td>7.5g/kg</td>
<td>Bayer India Limited, Mumbai</td>
</tr>
<tr>
<td>4</td>
<td>Demeton-o-methyl</td>
<td>Metasystox</td>
<td>25EC</td>
<td>0.03</td>
<td>Bayer India Limited, Mumbai</td>
</tr>
<tr>
<td>5</td>
<td>Monocrotophos</td>
<td>Nuvracton</td>
<td>36SL</td>
<td>0.04</td>
<td>Syngenta India Limited, Mumbai</td>
</tr>
<tr>
<td>6</td>
<td>Phoshamidon</td>
<td>Don</td>
<td>40EC</td>
<td>0.03</td>
<td>Devidayal Agrichemicals Guj.</td>
</tr>
<tr>
<td>7</td>
<td>Profenophos</td>
<td>Curacron</td>
<td>50EC</td>
<td>0.05</td>
<td>Syngenta India Limited, Mumbai</td>
</tr>
<tr>
<td>8</td>
<td>Quinalphos</td>
<td>Shakti</td>
<td>25EC</td>
<td>0.05</td>
<td>Parry India Limited, Chennai</td>
</tr>
<tr>
<td>9</td>
<td>Thiamefoxam</td>
<td>Ektara</td>
<td>25WG</td>
<td>4.2g/kg</td>
<td>Syngenta India Limited, Mumbai</td>
</tr>
<tr>
<td>10</td>
<td>Deltamethrin + Triazophos</td>
<td>Dhadkan</td>
<td>36EC</td>
<td>0.05</td>
<td>Hindustan Pulverising Mills</td>
</tr>
<tr>
<td>11</td>
<td>Endosulfan</td>
<td>Endocel</td>
<td>35EC</td>
<td>0.07</td>
<td>Exel Industries Limited, Mumbai</td>
</tr>
<tr>
<td>12</td>
<td>Cypermethrin</td>
<td>Cyperguard</td>
<td>25EC</td>
<td>0.005</td>
<td>Gharda Chemicals Limited, Mumbai</td>
</tr>
<tr>
<td>13</td>
<td>Profenofos + Cypermethrin</td>
<td>Ajanta super</td>
<td>44EC</td>
<td>0.088</td>
<td>Parry India Limited, Chennai</td>
</tr>
</tbody>
</table>
2004 on GO-2 variety of okra to determine the efficacy of various insecticides against jassid, (*A. biguttula biguttula*).

The details of experiment are given below:

2. Location of experiment: College Farm,
   College of Agriculture,
   J. A. U., Junagadh.

2. Experimental design: R. B. D.

3. Replication: Three (3)

4. Plot size: Gross plot: 5x3m
   Net plot: 4x2.4m

5. Number of treatment: 13

6. Spacing: 60x30cm

Randomization of the treatments was done in each block separately. Plots were numbered and labeled. The spraying of insecticides was done with the help of knapsack sprayer and obtains uniform coverage of insecticide in each plot and seed treatments were done before sowing.

Two spraying of insecticides were carried out at an interval of 15 days. First spray was carried out 30 days after sowing and second, 15 days after first spray. Pre and post treatment observations on jassid nymphs were recorded on five plants select at random in each plot. Three leaves were selected representing top, middle and bottom region of the plant for assessing the population of jassid nymphs. Pre and post
PLATE-4: Experimental site
treatment observations on jassid nymphs were recorded at 24 hours before and 1 day, 3 days, 7 days, and 14 days after treatment. The per cent mortality due to treatment was calculated by using the following modified formula given by Henderson and Tilton (1955):

\[
\text{Per cent mortality} = 100 \times \left[1 - \frac{(T_a \times C_b)}{(T_b \times C_a)}\right]
\]

Where,

Tb = No. of Nymphs collected before treatment

Ta = No. of Nymphs collected after treatment

Cb = No. of Nymphs collected from the check plot before treatment

Ca = No. of Nymphs collected from the check plot after treatment

The data thus obtained were subjected to angular transformation for statistical analysis.

3.6 Yield

The yield of healthy fruits was recorded at each picking in every plot and total yield data thus obtained were analyzed statistically.
RESULTS AND DISCUSSION
IV RESULTS AND DISCUSSION

The studies on different aspects viz., “biology, population dynamics, varietal screening and chemical control of okra jassid, A. biguttula biguttula on okra” were carried out during kharif at Department of Entomology as well as College Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. Results obtained through the investigations are presented as under.

4.1 Biology

The present investigations on the biological parameters of the okra jassid, Amrasca biguttula biguttula (Ishida), were carried out under the laboratory conditions. The results obtained are presented under following heads:

4.1.1 Egg

The eggs of E. devastans were elongate and slightly hooked toward the anterior end. Freshly laid egg was translucent which turn to greenish yellow later on, just before hatching of egg, a pair of brownish red eyes shine through the chorion near the anterior end. Similar observations were also reported by Husasin and Lal (1940) and Bhalani (1970) on cotton.
4.1.2 Incubation period

The incubation period of the eggs was worked out under the laboratory conditions during the month of September 2004. The results obtained are summarized in Table 2.

The results presented in Table 2 indicates that the incubation period of eggs varied from 3 to 7 days with an average of 5.30 ± 1.33 days at the prevailing laboratory temperature ranging from 27 to 31°C (Average 28.34°C) and relative humidity from 65 to 75 per cent (Average 70.66 per cent).

Husain and Lal (1940) and Patel et al. (1956) reported that the incubation period of eggs was varied from 4 to 11 days on cotton. According to Srivastava et al. (1965), incubation period of eggs was 5 to 6 days. Bhalani (1970) stated that the incubation period of eggs varied from 2 to 5 days with an average of 4.16 days and 3 to 6 days with an average of 4.56 days at an average laboratory temperature of 31.90°C and 28.75°C, respectively. According to Butani and Verma (1976a), incubation period of eggs was 4 to 10 days on okra. Gedia (1989) observed incubation period of egg varied from 2 to 6 days with an average of 4.35 days at the prevailing laboratory temperature ranging from 26 to 32°C (Average 28.75°C) and relative humidity from 60 to 85 per cent (Average 75.55 per cent) on okra.
With a view to study the various nympha! instars of A. biguttula biguttula under laboratory conditions,
when jassids were reared on okra leaves, the following observations were made:

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>No of eggs observed</th>
<th>Duration (days)</th>
<th>Av± S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-8-2004 to 26-8-2004</td>
<td>Min. 27.00</td>
<td>65.00</td>
<td>0</td>
<td>3</td>
<td>5.30 ± 1.33</td>
</tr>
<tr>
<td></td>
<td>Av. 31.00</td>
<td>70.66</td>
<td>100</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. 33.00</td>
<td>75.00</td>
<td>100</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

The newly emerged nymphs were pale greenish yellow in colour and turned reddish brown in colour and oval in shape. The maxillary palp were reddish brown in colour and oval in shape. The maxillary palp were reddish brown in colour and oval in shape.

The newly emerged nymphs were pale greenish yellow in colour and turned reddish brown in colour. The maxillary palp were reddish brown in colour and oval in shape.
4.1.3 Nymph

With a view to study the various nymphal instars of *A. biguttula biguttula*, newly hatched nymphs were reared individually on separated piece of okra leaves.

4.1.3.1 Description of the various nymphal instars

4.1.3.1.1 First instar nymph (Plate 1A)

The newly emerged nymphs were yellowish in colour and turned greenish yellow later on. Its eyes were reddish brown in colour and oval in shape. Six dorsal spines were visible along the anterior margin of head. Meta thoracic pair of legs was slightly longer than the pair of prothoracic legs. Abdomen was nine segmented first of which is almost as broad as thorax, second with lateral conical projections distinctly broader than the other segments, third to eight with long prominent lateral spines, knobbed at extremities, ninth segment narrowest and only slightly longer than the eight. Similar observations were also reported by Husain and Lal (1940) and Bhalani (1970) on cotton

4.1.3.1.2 Second instar nymph (Plate 1B)

The second instar nymph was differed from the first instar nymph in having eyes white superficially and dark reddish in colour. Rudimentary wing pads along posterior ends of the sides of meso-and meta-thorax were developed. Tibia of the hind pair of legs was seen with
two single rows of spines. The abdomen was broadest at the third segment, ninth segment longer and narrower than others with a ring of spines along posterior margin and a pair of dorsum. The similar observations were also reported by Husain and Lal (1940) on cotton.

4.1.3.1.3 Third instar nymph (Plate 1C)

The third instar nymph was yellowish green in colour and wing pads were more prominent. The abdomen was broadest at the fourth segment. These characters differed from the second instar nymph. Similar trend was also reported by Husain and Lal (1940) and Bhalani (1970) on cotton.

4.1.3.1.4 Fourth instar nymph (Plate 1D)

Head and thorax of fourth nymph were greenish yellow, abdomen was bluish green and eyes were grayish purple in colour. Nymph of this instar differed from third instar nymph in having proboscis reaching first abdominal segment, each thoracic segment with a pair of spines on dorsum, wing pads reaching fourth abdominal segment, fourth dark grayish round spots at posterior margin of meso-thorax and two at posterior margin of meta-thorax, a rudimentary tenth segment at the end of abdomen. Similar observations were reported by Husain and Lal (1940) and Bhalani (1970) on cotton.
PLATE: 1

The second instar nymphs also differed from the first instar in having a ring made up of annuli along the tergal region on the second and similar annuli were also apparent by the second instar nymph. Measurements of the second instar nymph measured from 0.039 to 0.050 mm in length and 0.256 to 0.494 mm in width. Similar observations on body length were also reported by Rosey et al. (1976) on australian grasshoppers.
4.1.3.1.5 Fifth instar nymph (Plate 1F)

The nymph of this instar was greenish yellow with bright green legs and abdomen. It bears greyish brown spots on the meso and metathorax. Rudiments of the tenth segment became visible in the form of anal tube. Similar observations were also reported by Husain and Lal (1940) and Bhulani (1970) on cotton.

4.1.3.2 Number and duration of nymphal instars

For study of numbers and duration of nymphal instars, newly emerged nymphs were reared individually and observations on number of mouls and duration complete each instar were recorded. The results obtained indicate that the duration of various nymphal instars is presented in Table 1. It is obvious that there were five nymphal instars of Amrasca biguttula biguttula (Ishida) and the number of nymphal instars was also reported by Husain and Lal (1940) and Bhulani (1970) on cotton.

The duration of first, second, third, fourth and fifth instar nymphs ranged from 1 to 2, 1 to 3, 1 to 3, 2 to 3 and 7 to 4 days with an average of 1.13 ± 0.22, 1.21 ± 0.12, 1.90 ± 0.60, 1.10 ± 0.20 and 2.10 ± 0.50 days, respectively, with the total nymphal period of 8 to 13 days with an average of 7.40 ± 1.33 days at the laboratory temperature varied from 27 to 32°C (Average 29.14°C) and relative humidity from 69 to 71 per cent (average 70.17 per cent) during the months of September-October, 2009.

PLATE-1

Amrasca biguttula biguttula (Ishida)

A. First instar nymph
B. Second instar nymph
C. Third instar nymph
D. Fourth instar nymph
E. Fifth instar nymph
4.1.3.1.5 Fifth instar nymph (Plate 1€)

The nymph of this instar was greenish yellow with bluish green legs and abdomen. It bears greyish brown spots on the meso and meta-thorax. Rudiments of the tenth segment become visible in the form of anal tube. Similar observations were also reported by Husain and Lal (1940) and Bhalani (1970) on cotton.

4.1.3.2 Number and duration of nymphal instar

For study of number and duration of different nymphal instars, newly emerged nymphs were reared individually and observations on number of moults and time taken to complete each instar were recorded. The results obtained on number and duration of various nymphal instars is presented in Table 3 from the data it is obvious that there were five nymphal instars of this pest. Similar number of nymphal instars was also reported by Husain and Lal (1940) and Bhalani (1970) on cotton.

The duration of first, second, third, fourth and fifth instar nymphs ranged from 1 to 2, 1 to 2, 1 to 3, 1 to 2 and 2 to 4 days with an average of 1.23 ± 0.22, 1.21 ± 0.42, 1.90 ± 0.60, 1.10 ± 0.20 and 2.10 ± 0.50 days, respectively with the total nymphal period of 6 to 13 days with an average of 7.40 ± 1.35 days at the laboratory temperature varied from 27 to 32°C (Average 29.14°C) and relative humidity from 69 to 71 per cent (Average 70.12 per cent) during the month of September-October, 2004.
Table 3. Number and duration of various nymphal instars of jassid, *A. biguttula biguttula* under laboratory conditions, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Nymphal instar</th>
<th>Number of nymphs observed</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-8-2004 to 5-9-2004</td>
<td>27.00</td>
<td>32.00</td>
<td>29.14</td>
<td>69.00</td>
<td>71.00</td>
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</tr>
</tbody>
</table>
Husain and Lal (1940) reported that total nymphal period was 7 days in autumn and 21 days in winter on cotton. Bhalani (1970) stated that the duration of each instar was on an average 1.7, 1.0, 1.29, 1.66 and 1.58 days, respectively being the total nymphal period of 7.25 days at an average laboratory temperature of 31.34°C and 72.60 per cent relative humidity on cotton. Saxena and Saxena (1971) stated that the first instar nymph reached to the adult stage in 7 to 8 days on okra fruits. Naheed and Ahmed (1974) found that the total nymphal period was on an average 11.1 days on okra leaves. According to Butani and Verma (1976a), total nymphal period varied from 7 to 21 days. Bhalani and Patel (1981) reported that the total nymphal period was on an average 8.0 days at an average laboratory temperature of 27.9°C and 76.8 per cent relative humidity on okra. Gedia (1989) reported that the duration of each instar was on an average 1.12, 1.28, 1.93, 1.09 and 2.17 days, respectively with the total nymphal period 5 to 12 days with an average of 7.76 days at the laboratory temperature varied from 27 to 34°C (Average 30.10°C) and relative humidity from 65 to 79 per cent (Average 72.11 per cent).

The variation in the duration of various nymphal instars and total nymphal periods might be due to prevailing laboratory temperature, humidity and host plant.
4.1.4 Adult (Plate 2A)

4.1.4.1 Description

The adult was wedge shaped yellowish green in colour and walked diagonally in a characteristic manner. The most important feature for identification of adult was the presence of prominent black spot on each of the tegmina near the apex of claval area. Similar observations were also reported by Husain and Lal (1940), Bhalani (1970) on cotton and Butani and Verma (1976b) on brinjal.

Male and female adults were identified by ascertaining the presence or absence of a conspicuous black coloured straight line placed medially on the last four abdominal segments. The male possessed such black line (Plate 2B) while, it was lacking in female (Plate 2C).

4.1.4.2 Longevity of adult

A study was under taken to know the longevity of adult of *A. biguttula biguttula* under the laboratory conditions. The results obtained are presented in Table 4.

The data presented in Table 4 indicates that the male and female adults lived for 10 to 12 days with an average of $10.60 \pm 1.041$ days and 11 to 15 days with an average of $13.10 \pm 1.491$ days, respectively at the laboratory temperature ranging from 31 to $30^\circ C$ (Average $30.80^\circ C$) and relative humidity from 66 to 74 per cent (Average 69.10 per cent).
PLATE: 2

A

2 mm

B

C
# Plate 2

*Amrasca biguttula biguttula* (Ishida)

A. Adult  
B. Last four abdominal segments of male adult  
C. Last four abdominal segments of female adult

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>28.10.2004</td>
<td>31.00 ± 3.00</td>
<td>30.00</td>
<td>27.00</td>
<td>34.00</td>
<td>25.00</td>
<td>± 1.00</td>
<td>± 0.50</td>
</tr>
<tr>
<td>17-20.02.2004</td>
<td>28.00 ± 2.00</td>
<td>27.00</td>
<td>26.00</td>
<td>30.00</td>
<td>23.00</td>
<td>± 0.50</td>
<td>± 0.25</td>
</tr>
</tbody>
</table>

Table 4: Longevity of adult of *Amrasca biguttula biguttula* reared on okra.
Table 4. Longevity of adult of jassid, *A. biguttula biguttula* under laboratory conditions, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Sex</th>
<th>No. of adults observed</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-8-2004 to 17-9-2004</td>
<td>Min. 31.00 Max. 30.00 Av. 30.80</td>
<td>Min. 66.00 Max. 74.00 Av. 69.10</td>
<td>Male</td>
<td>15</td>
<td>Min. 10 Max. 12 Av. ± S.D. 10.60 ± 1.041</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Female</td>
<td>15</td>
<td>Min. 11 Max. 15 Av. ± S.D. 13.10 ± 1.491</td>
</tr>
</tbody>
</table>
According to Husain and Lal (1940), the longevity of adults was 5 weeks in summer and 7 weeks in winter on cotton. Bhalani (1970) stated that the male and female lived for 4 to 5 days with an average of 4.4 days and 3 to 6 days with an average of 4.1 days at an average laboratory temperature of 29.22\(^{0}\)C and 73.90 per cent relative humidity, respectively on cotton. Saxena and Saxena (1971) reared the pest on okra fruits and stated that the longevity of adults varied from 33 to 50 days with an average of 37.2 \pm 3.21 days. Naheed and Ahmed (1974) reported that adult female lived for 37 days on okra. Butani and Verma (1976a) found that the adults lived for 15 to 46 days on okra. According to Butani and Verma (1976b), adults lived for 5 to 8 weeks on brinjal. Gedia (1989) stated that the male and female adults lived for 8 to 11 days with an average of 9.92 and 8 to 12 days with average of 9.95 days, respectively at the laboratory temperature from 29 to 34\(^{0}\)C (Average 30.85\(^{0}\)C) and relative humidity from 62 to 79 per cent (average 69.0 per cent).

More or less similar observations were also reported by Butani and Verma (1976a) and Gedia (1989).

4.1.5 Oviposition duration

During the study of fecundity of female of *A. biguttula biguttula*, observations were recorded on the pre-oviposition, oviposition and post-oviposition periods. The data are presented in Table 5.
Table 5. Pre-oviposition, oviposition and post oviposition periods of jassid, A. biguttula biguttula under laboratory conditions, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>No of pair observed</th>
<th>Pre-oviposition period</th>
<th>Oviposition period</th>
<th>Post oviposition period</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-8-2004 to 17-9-2004</td>
<td>Min. 27</td>
<td>Max. 33</td>
<td>Av. 30.5</td>
<td>Min. 64</td>
<td>Max. 76</td>
<td>Av. 69.55</td>
</tr>
</tbody>
</table>
The data presented in Table 5 reveals that the pre-oviposition, oviposition and post-oviposition periods varied from 3 to 4, 4 to 6 and 3 to 5 days with an average of $3.40 \pm 1.03$, $5.20 \pm 0.88$ and $4.10 \pm 0.78$ days, respectively at the prevailing laboratory temperature ranging from 27 to $33^0\text{C}$ (Average $30.05^0\text{C}$) and relative humidity 64 to 76 per cent (Average 69.55 per cent) during the month of September-October, 2004.

According to Husain and Lal (1940), pre-oviposition period varied from 4 to 11 days on cotton. Bhalani (1970) stated that the pre-oviposition, oviposition and post-oviposition periods varied from 3 to 5, 3 to 6 and 2 to 5 days with an average of 3.6, 3.6 and 3.4 days, respectively at an average laboratory temperature of $30.90^0\text{C}$ on cotton. Saxena and Saxena (1971) stated that pre-oviposition period varied from 6 to 7 days with the oviposition period of 20 days on okra fruits. Gedia (1989) observed pre-oviposition, oviposition and post oviposition periods varied from 2 to 4, 2 to 6 and 2 to 4 days with an average of 3.32, 4.36 and 3.04 days, respectively at the prevailing laboratory temperature ranging from 29 to $34^0\text{C}$ (Average $30.85^0\text{C}$) and relative humidity 62 to 79 per cent (Average 69.0)

4.1.6 Fecundity

To study the fecundity, newly emerged male and female adults were paired and okra leaves were provided for food and oviposition. The number of nymphs emerged were counted daily. The results obtained are
presented in Table 6. The data given in the Table 6 indicates that number of eggs laid by a single female varied from 15 to 18 eggs with an average of 16.20 ± 0.833 eggs at the laboratory temperature varied from 28 to 32°C (Average 30.10°C) and relative humidity from 70 to 75 per cent (Average 72.40 per cent), during the month of September-October, 2004.

According to Husain and Lal (1940), a single female laid maximum 29 eggs on cotton. Srivastava et al. (1965) reported that the egg laying capacity of a single female was 10 to 11 eggs. Bhalani (1970) stated that a single female laid on an average 14.8 and 16.7 eggs at an average laboratory temperature of 31.9°C (Average relative humidity 79.08 per cent) and 28.75°C (Average relative humidity 80.53 per cent), respectively on cotton. According to Saxena and Saxena (1971), the average number of eggs laid per female was 11.6 ± 1.1 on okra fruit. Naheed and Ahmed (1974) reported that the number of eggs laid was on an average 17.71 per female on okra. Butani and Verma (1976a) concluded that the single female laid 15 to 30 eggs on okra. Number of eggs laid by single female varied from 14 to 18 with an average of 16.24 at the laboratory temperature varied from 29 to 34°C (average 31.06°C) and relative humidity from 68 to 78 per cent (Average 73.30 per cent) (Gedia, 1989). According to Sharma and Sharma (1997), average fecundity was 17.5 eggs per female. Thus, the results are more or less similar to earlier report
4.1.7 Sex ratio of jassid, *A. biguttula biguttula* under laboratory conditions, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Number of eggs laid/female</th>
<th>Av. ± S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>16.20 ± 0.833</td>
</tr>
</tbody>
</table>

The data presented in Table 6 show that 20 eggs were found on okra when 50 adults of *A. biguttula biguttula* were reared under laboratory conditions. The sex ratio (male to female) was 1:1.5. The relative humidity (%) was 75 per cent (Average 70.20) and temperature (°C) was 28 to 30°C. 70 per cent (Average 69.11°C) and relative humidity (%) was 75 per cent (Average 70.20). Thus, it was concluded that female of *A. biguttula biguttula* outnumbered their male counterpart.

Bhalani (1989) worked on the rearing of laboratory-reared adults of *A. biguttula biguttula* on cotton and found that the sex ratio (male to female) was 1:1.37. Oudia (1989) reported that the sex ratio (male to female) was 1:1.25 under laboratory conditions. The slight variances in the sex ratio are due to food plant and weather parameters. The results of study are presented in Table 6.

![Table 6. Fecundity of jassid, *A. biguttula biguttula* under laboratory conditions, when jassids were reared on okra.](image)

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-8-2004 to 8-9-2004</td>
<td>Max. 32.00, Min. 28.00</td>
<td>Max. 75.00, Min. 70.00</td>
</tr>
</tbody>
</table>

4.1.8 Entire life cycle of *A. biguttula biguttula*

The duration of entire life cycle of adult of *A. biguttula biguttula* was 30-35 days. The results are presented in Table 8.
4.1.7 Sex ratio of jassid, *A. biguttula biguttula*

The sex ratio was worked out from the laboratory-reared nymphs. After emergence of adults, the numbers of male and female were counted. Results thus obtained are given in Table 7.

The data presented in Table 7 reveals that out of 50 adults observed 20 were found male while 30 of them were female. The sex-ratio (male to female) was 1:1.50 under laboratory temperature ranging from 28 to 30°C (Average 29.11°C) and relative humidity from 64 to 75 per cent (Average 70.20) during the month of September-October, 2004. Thus, it was concluded that female of *A. biguttula biguttula* outnumbered their male counterpart.

Bhalani (1970) worked out the sex ratio of laboratory-reared adults on cotton and found that the sex ratio of male: female was 1:1.37. Gedia (1989) reported that the sex ratio (male to female) was 1:1.25 under laboratory temperature ranging from 29 to 34°C (Average 31.02°C) and relative humidity from 65 to 79 per cent (Average 70.60) on okra.

The slight variation in the sex- ratio might be due to food plant and weather parameters under study.

4.1.8 Entire life span

The duration of entire life span from egg to death of adult of *A. biguttula biguttula* was studied. The results obtained are presented in Table 8.
Table 7. Sex-ratio of jassid, *A. biguttula biguttula* under laboratory conditions, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Number of adults observed</th>
<th>Sex</th>
<th>Sex-ratio (Male: Female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-8-2004 to 4-9-2004</td>
<td>Min. 28.00 Max. 30.00 Av. 29.11</td>
<td>Min. 64.00 Max. 75.00 Av. 70.20</td>
<td>50</td>
<td>Number of male 20 Number of female 30</td>
<td>1:1.50</td>
</tr>
</tbody>
</table>
Table 8. Duration of entire life span from egg to death of adult of jassid, *A. biguttula biguttula*, when jassids were reared on okra

<table>
<thead>
<tr>
<th>Period of study</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Sex</th>
<th>No. of individual observed</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-8-2004 to 17-9-2004</td>
<td>Min. 27.00 Max. 33.00 Av. 30.40</td>
<td>Min. 67.00 Max. 72.00 Av. 70.10</td>
<td>Male</td>
<td>20</td>
<td>Min. 15 Max. 30 Av. ± S.D. 23.10 ± 3.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Female</td>
<td>20</td>
<td>20 33 Av. ± S.D. 26.20 ± 3.50</td>
</tr>
</tbody>
</table>
Data presented in Table 8 reveals that the entire life span of male and female varied from 15 to 30 days with an average of 23.10 ± 3.00 days and 20 to 33 days with an average of 26.2 ± 3.50 days, respectively at the laboratory temperature ranging from 27 to 33\(^\circ\)C (Average 30.40\(^\circ\)C) and relative humidity from 67 to 72 per cent (Average 70.10 per cent).

According to Srivastava et al. (1965), the pest completed whole life within 12 to 36 days on cotton. According to Bhalani (1970), total life span from egg to death of adult varied from 10 to 13 days with an average of 11.6 days for male and 10 to 14 days with an average of 11.3 days for female at an average laboratory temperature of 31.52\(^\circ\)C and 72.92 per cent relative humidity on cotton. Butani and Verma (1976a) found that the total life duration was 15 to 46 days on okra. Gedia (1989) found that the entire life span of male and female varied from 15 to 19 days with an average of 22.25 and 15 to 30 days with an average of 23.16 days, respectively at the laboratory temperature ranging from 26 to 34\(^\circ\)C (Average 29.88\(^\circ\)C) and relative humidity from 60 to 85 per cent (Average 72.17 per cent) on okra.

More or less similar observations were also reported by Srivastava et al. (1965) and Gedia (1989).

4.2 Population dynamics of jassid, *A. biguttula biguttula*

The field experiment was conducted at College Farm, College of Agriculture, J. A. U., Junagadh on okra varieties GO-2 to study the
population dynamic of okra jassid during *kharif* – 2004. The results obtained are presented in Table 9 and Fig. 1

4.2.1 Mean jassid nymph per leaf

The results presented in Table 9 and Fig. 1 reveals that the incidence of jassid was ranged from 0.18 and 11.25 jassid nymphs per leaf during *kharif* season. The incidence of this pest started after 2\textsuperscript{nd} week of sowing i.e. 1\textsuperscript{st} week of August with a low level of 0.18 jassid nymph per leaf on GO – 2 variety of okra. The pest population increased gradually and reached to a peak level of 11.25 jassid nymphs per leaf on okra after 10\textsuperscript{th} week of sowing. Later on the population declined.

From the result, it can be seen that jassid population was active on okra throughout the crop period during *kharif*.

It has been reported that 7 to 11 weeks old okra plants were most susceptible to attack of jassid then its other growth stages and highest population was recorded on 8 weeks old plant (Senapati and Khan, 1978). According to Dhamdhere *et al.* (1984), the population of *A. biguttula biguttula* remained active throught *kharif* and summer seasons. The population was maximum when the crop age 69 to 77 days. Pareek *et al.* (1986) found that the leafhopper appeared in the first week of August (2\textsuperscript{nd} week after sowing) and prevailed throughout crop period. In Gujarat, the jassid population on okra has been found throughout the crop period during summer and *kharif* season. Further, jassid population was
Table 10 Meteorological data with population dynamics of jassid, *A. biguttula biguttula* recorded during kharif, 2004

<table>
<thead>
<tr>
<th>Standard week</th>
<th>Date</th>
<th>Week after germination of crop</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Rainfall (mm)</th>
<th>Mean no of jassid population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Morning (0800 hr)</td>
<td>Afternoon (1400 hr)</td>
</tr>
<tr>
<td>32</td>
<td>02/08/04 to 08/08/04</td>
<td>2</td>
<td>28.5</td>
<td>24.3</td>
<td>96</td>
<td>82</td>
</tr>
<tr>
<td>33</td>
<td>09/08/04 to 15/08/04</td>
<td>3</td>
<td>29.5</td>
<td>24.9</td>
<td>93</td>
<td>80</td>
</tr>
<tr>
<td>34</td>
<td>16/08/04 to 22/08/04</td>
<td>4</td>
<td>29.7</td>
<td>24.4</td>
<td>94</td>
<td>74</td>
</tr>
<tr>
<td>35</td>
<td>23/08/04 to 29/08/04</td>
<td>5</td>
<td>31.3</td>
<td>24.3</td>
<td>90</td>
<td>91</td>
</tr>
<tr>
<td>36</td>
<td>30/08/04 to 05/09/04</td>
<td>6</td>
<td>33.6</td>
<td>23.9</td>
<td>82</td>
<td>54</td>
</tr>
<tr>
<td>37</td>
<td>06/09/04 to 12/09/04</td>
<td>7</td>
<td>32.5</td>
<td>23.8</td>
<td>86</td>
<td>58</td>
</tr>
<tr>
<td>38</td>
<td>13/09/04 to 19/09/04</td>
<td>8</td>
<td>33</td>
<td>24.3</td>
<td>90</td>
<td>61</td>
</tr>
<tr>
<td>39</td>
<td>20/09/04 to 26/09/04</td>
<td>9</td>
<td>35.1</td>
<td>23.8</td>
<td>88</td>
<td>62</td>
</tr>
<tr>
<td>40</td>
<td>27/09/04 to 03/10/04</td>
<td>10</td>
<td>32.9</td>
<td>24.1</td>
<td>84</td>
<td>63</td>
</tr>
<tr>
<td>41</td>
<td>04/10/04 to 10/10/04</td>
<td>11</td>
<td>33.3</td>
<td>21.5</td>
<td>78</td>
<td>38</td>
</tr>
<tr>
<td>42</td>
<td>11/10/04 to 17/10/04</td>
<td>12</td>
<td>35.1</td>
<td>18.7</td>
<td>69</td>
<td>27</td>
</tr>
<tr>
<td>43</td>
<td>18/10/04 to 24/10/04</td>
<td>13</td>
<td>35.1</td>
<td>18</td>
<td>62</td>
<td>21</td>
</tr>
<tr>
<td>44</td>
<td>25/10/04 to 31/10/04</td>
<td>14</td>
<td>36.3</td>
<td>20.8</td>
<td>59</td>
<td>26</td>
</tr>
<tr>
<td>45</td>
<td>1/11/04 to 7/11/04</td>
<td>15</td>
<td>35.5</td>
<td>19.9</td>
<td>55</td>
<td>23</td>
</tr>
</tbody>
</table>
Fig: 1 Meteorological data with population dynamics of okra jassid, A. niguttula niguttula recorded during kharif 2004.
reported higher in kharif season (Patel, 1988). Lal et al. (1990) found that cicadellid first appeared on crop two weeks after sowing. Jassid population ranged between 0.59 in 1st fortnight of August to 2.78 mean population/plant in 1st fortnight of October (Patel and Rote, 1995).

4.2.2 Correlation studies between jassid population and weather parameters.

Studies on effect of various weather parameters on the fluctuation of jassid population on okra GO-2 variety were carried out and the data are presented in Table 10.

The result presented in Table 10 indicates that jassid population exhibited significant positive correlation with maximum temperature (0.5490) and significant negative correlation with minimum temperature (-0.5193). Similarly, jassid population had significant negative correlation with morning relative humidity (-0.3242) on the GO-2 variety of okra. The population of jassid showed non-significant correlation with all other parameters during kharif season.

According to Dhamdhere et al. (1984), low humidity in kharif crop appeared to be conducive to the population build up of jassid on okra crop. Significant negative correlation of jassid population was observed with minimum temperature, while other weather parameters showed a non-significant correlation (Patel, 1988). Positive relationship between jassid population and maximum temperature and negative relationship
Table 10. Correlation co-efficient between weather parameters and population of jassid on GO-2 variety of okra during *kharif*, 2004

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of pest</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Morning (0800 hr)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$X_1$</td>
<td>$X_2$</td>
<td>$X_3$</td>
</tr>
<tr>
<td>1</td>
<td>Jassid</td>
<td>0.5490*</td>
<td>-0.5193*</td>
<td>-0.3242*</td>
</tr>
</tbody>
</table>

* Significant at 0.05 level (n=14)
between minimum temperature and evening relative humidity on okra crop (Patel, 1989). Patel et al. (1997) reported that the significant relationship between jassid population and maximum temperature ($r = 0.76$) as well as hours of bright sunshine ($r = 0.82$). Thus the above reports are agreement with present findings.

4.3 Nature of damage

The nymphs and adults were observed on the lower surface of leaves, congregated near the stalk in between the main veins. They were also observed all over the leaf surface under the condition of heavy infestation. The nymphs and adults suck the cell sap from underside of the leaves and inject their toxic saliva into the tissue causing toxaemia. The affected leaves initially become pale green, then yellow, reddish and finally brick red or brown in colour. Curling and crinkling of the leaves accompanied this change and the leaves gradually dried away. The plants become stunted in growth and bear less numbers of flowers; thereby the yield was adversely affected.

4.4 Varietal susceptibility

A field experiment was conducted during kharif season of the year 2004 at the College Farm, Junagadh for testing the susceptibility of different okra varieties to *Amrasca biguttula biguttula* (Ishida). Twenty varieties were screened against this pest. Population of jassid nymphs on
A - Healthy akra leaves

B - Damaged akra leaves
different varieties was recorded from 3 leaves per plant at an interval of 7
days till the maturity of the crop.

The data on mean nymphal population (Table 11 and Fig 2) revealed that the infestation of this pest ranged from 5.81 to 14.06
nymphs on different varieties of okra.

Among twenty varieties of okra, Gujarat okra-1 was found the least
susceptible (5.81 jassid nymphs per leaf). However, it was at par with
varieties, Aol-99-28, Aol-02-1, Aol-02-4, Gopi and Aol-99-24, which showed 8.03, 8.23, 8.44, 6.27 and 6.33 jassid nymphs per leaf,
respectively. The variety HRB-55 was found most susceptible with 14.06
jassid nymphs per leaf and it was at par with Pusa Sawni, 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 which showed 13.67, 13.57 13.54,
10.35, 10.74, 11.14, 11.42, 11.62, 12.19, 12.45 and 12.57 jassid nymphs
per leaf, respectively. While varieties Jol 2k-18 and Jol-02-10 were found
moderately susceptible which showed 9.81, 10.03 jassid nymphs per leaf,
respectively under field conditions.

According to Mahal et al. (1993), the okra varieties IC 7194,
Punjab Padmini and New Selection harbored low jassid populations as
compared to Pusa Sawani. Kaddivar ((1995) tested twenty okra varieties
for its susceptibility against jassid and reported that variety HRB-55 was
most susceptible. The pooled result of three years revealed that Gujarat
### Table 12. Varietal susceptibility of different varieties/genotypes of okra against jassid, *A. biguttula biguttula* under unprotected condition during kharif, 2004

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Variety</th>
<th>Mean number of jassid nymphs per leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aol-99-28</td>
<td>2.92 (8.03)</td>
</tr>
<tr>
<td>2</td>
<td>Parbhani Kranti</td>
<td>3.35 (10.74)</td>
</tr>
<tr>
<td>3</td>
<td>Pusa Sawani</td>
<td>3.76 (13.67)</td>
</tr>
<tr>
<td>4</td>
<td>Gujarat Okra-1</td>
<td>2.51* (5.81)</td>
</tr>
<tr>
<td>5</td>
<td>Aol-02-1</td>
<td>2.95 (8.23)</td>
</tr>
<tr>
<td>6</td>
<td>Gujarat okra-2</td>
<td>3.29 (10.35)</td>
</tr>
<tr>
<td>7</td>
<td>Jol 2k-18</td>
<td>3.21 (9.81)</td>
</tr>
<tr>
<td>8</td>
<td>Jol-02-10</td>
<td>3.25 (10.03)</td>
</tr>
<tr>
<td>9</td>
<td>Aol-02-4</td>
<td>2.99 (8.44)</td>
</tr>
<tr>
<td>10</td>
<td>Gopi</td>
<td>2.74 (6.27)</td>
</tr>
<tr>
<td>11</td>
<td>Jo (2k)-19</td>
<td>3.41 (11.14)</td>
</tr>
<tr>
<td>12</td>
<td>HRB-55</td>
<td>3.82 (14.06)</td>
</tr>
<tr>
<td>13</td>
<td>Jol-02-12</td>
<td>3.48 (11.62)</td>
</tr>
<tr>
<td>14</td>
<td>Jo (2k)-1</td>
<td>3.56 (12.19)</td>
</tr>
<tr>
<td>15</td>
<td>Jo (2k)-20</td>
<td>3.75 (13.57)</td>
</tr>
<tr>
<td>16</td>
<td>Jo(2k)-14</td>
<td>3.62 (12.57)</td>
</tr>
<tr>
<td>17</td>
<td>Jo(2k)-17</td>
<td>3.73 (13.54)</td>
</tr>
<tr>
<td>18</td>
<td>Jo (2k)-13</td>
<td>3.60 (12.45)</td>
</tr>
<tr>
<td>19</td>
<td>Aol-99-24</td>
<td>2.87 (6.33)</td>
</tr>
<tr>
<td>20</td>
<td>Jol-2</td>
<td>3.45 (11.42)</td>
</tr>
</tbody>
</table>

S. Em. + 0.5 transformation

Figures in parenthesis are original values
Fig. 2. Varietal susceptibility of different varieties/genotypes of okra against jassid A. biguttula under unprotected conditions during kharif 2004.
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
<th>Sr. No.</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gujarat Okra-1</td>
<td>11</td>
<td>Jo (2k)-19</td>
</tr>
<tr>
<td>2</td>
<td>Gopi</td>
<td>12</td>
<td>Jol-2</td>
</tr>
<tr>
<td>3</td>
<td>Aol-99-24</td>
<td>13</td>
<td>Jol-02-12</td>
</tr>
<tr>
<td>4</td>
<td>Aol-99-28</td>
<td>14</td>
<td>Jo (2k)-1</td>
</tr>
<tr>
<td>5</td>
<td>Aol-02-1</td>
<td>15</td>
<td>Jo (2k)-13</td>
</tr>
<tr>
<td>6</td>
<td>Aol-02-4</td>
<td>16</td>
<td>Jo(2k)-14</td>
</tr>
<tr>
<td>7</td>
<td>Jol 2k-18</td>
<td>17</td>
<td>Jo(2k)-17</td>
</tr>
<tr>
<td>8</td>
<td>Jol-02-10</td>
<td>18</td>
<td>Jo (2k)-20</td>
</tr>
<tr>
<td>9</td>
<td>Gujarat Okra-2</td>
<td>19</td>
<td>Pusa Sawani</td>
</tr>
<tr>
<td>10</td>
<td>Parbhani Kranti</td>
<td>20</td>
<td>HRB-55</td>
</tr>
</tbody>
</table>

Okra Hybrid-1 significantly more tolerant as compared to Pusa Sawani against aphid, jassid and whitefly (Patel et al., 2003). Thus, the present findings are more or less similar to earlier reports.
Okra Hybrid-1 significantly more tolerant as compared to Pusa Sawani against aphid, jassid and whitefly (Patel et al., 2003). Thus, the present findings are more or less similar to earlier reports.

4.5 Chemical control

4.5.1 Before first spray

The data regarding population of jassid nymphs/3 leaves before 1st spray in all the treatments were found non-significant. The population of jassid nymphs/3 leaves was ranged from 82.54 to 90.00.

4.5.2 First spray

4.5.2.1 First day after spray

The mean percentage mortality of jassid nymphs (Table 12 and Fig. 3) recorded 1 day after application of different insecticides reveals that all the insecticides were found significantly superior over control (unsprayed plots). Among the different insecticides tested, an imidacloprid 7.5g/kg seed was found most effective insecticide as it gave 95.65 per cent mortality. However, it was statistically at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03, methylidemeton 0.03 and phosphamidon 0.03 per cent as they registered 94.74, 93.55, 92.73, 91.81, 91.57 and 91.4 per cent mortality, respectively. Chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05, quinalphos 0.05, cypermethrin 0.005 and profenophos 0.05 per cent were the next best
Table 12. Efficacy of different insecticides against okra jassid A. biguttula biguttula

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
<th>Corrected per cent mortality of jassid nymph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before spray</td>
<td>Days after 1st spray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st</td>
</tr>
<tr>
<td>1.</td>
<td>Profenophos 0.05 %</td>
<td>82.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(98.52)</td>
</tr>
<tr>
<td>2.</td>
<td>Profenofos + Cypermethrin 0.088%</td>
<td>84.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(99.20)</td>
</tr>
<tr>
<td>3.</td>
<td>Quinalphos 0.05%</td>
<td>82.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(98.32)</td>
</tr>
<tr>
<td>4.</td>
<td>Methyl demeton 0.03%</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>5.</td>
<td>Endosulfan 0.07%</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>6.</td>
<td>Phosphamidon 0.03%</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>7.</td>
<td>Chlorpyriphos 0.05%</td>
<td>86.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(99.30)</td>
</tr>
<tr>
<td>8.</td>
<td>Monocrotophos 0.04%</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>9.</td>
<td>Imidacloprid 7.5g/kg seeds</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>10.</td>
<td>Thiamethoxam 4.2g/kg seeds</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>11.</td>
<td>Dimethoate 0.03%</td>
<td>90.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
<tr>
<td>12.</td>
<td>Deltamethrin+ Triazophos 0.05 %</td>
<td>84.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(99.10)</td>
</tr>
<tr>
<td>13.</td>
<td>Cypermethrin 0.005 %</td>
<td>82.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(98.28)</td>
</tr>
<tr>
<td></td>
<td>S.Em. ±</td>
<td>5.54</td>
</tr>
<tr>
<td></td>
<td>C.D. at 5 %</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>C.V. %</td>
<td>11.00</td>
</tr>
</tbody>
</table>

* Figures in parenthesis are retransformed value.
Fig. 3: Efficacy of different insecticides against okra jassid A. biguttula biguttula after 1st spray.
Fig. 4: Efficacy of different insecticides against okra jassid *A. biguttula biguttula* after 2\textsuperscript{nd} spray
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profenophos 0.05%</td>
</tr>
<tr>
<td>2</td>
<td>Profenofos +Cypermethrin 0.09%</td>
</tr>
<tr>
<td>3</td>
<td>Quinalphos 0.05%</td>
</tr>
<tr>
<td>4</td>
<td>Methyl demeton 0.03%</td>
</tr>
<tr>
<td>5</td>
<td>Endosulfan 0.07%</td>
</tr>
<tr>
<td>6</td>
<td>Phosphamidon 0.03%</td>
</tr>
<tr>
<td>7</td>
<td>Chlorpyriphos 0.05%</td>
</tr>
<tr>
<td>8</td>
<td>Monocrotophos 0.04%</td>
</tr>
<tr>
<td>9</td>
<td>Imidacloprid 7.5g/kg</td>
</tr>
<tr>
<td>10</td>
<td>Thiamethoxam 4.2g/kg</td>
</tr>
<tr>
<td>11</td>
<td>Dimethoate 0.03%</td>
</tr>
<tr>
<td>12</td>
<td>Deltamethrin + Triazophos 0.05%</td>
</tr>
<tr>
<td>13</td>
<td>Cypermethrin 0.01%</td>
</tr>
</tbody>
</table>

The data on per cent mortality (Table 12 and Fig 3) obtained 7 days after first spray revealed that the insecticide imidacloprid 7.5g/kg seeds proved the most effective insecticide and gave 73.55 per cent mortality. However, it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, and dimethoate 0.03 per cent which registered 70.83, 68.10, 62.10 and 60.72 per cent mortality, respectively. The next
treatments which gave 79.93, 79.20, 79, 77.72, 77.68 and 75.92 per cent mortality, respectively.

4.5.2.2 Third days after spray

The data on per cent mortality (Table 12 and Fig 3) obtained 3 days after first spray revealed that the insecticide imidacloprid 7.5g/kg seeds proved the most effective insecticide and gave 93.70 per cent mortality. However it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03, methyldemeton 0.03 and phoshamidon 0.03 per cent as they also registered 93.70, 93.60, 93.10, 91.71, 91.45, 90.94 and 89.87 per cent mortality, respectively. The next best treatments were chlorpyriphos 0.05, profenophos + cypermethrin 0.088 and deltamethrin + triazophos 0.05 per cent which registered 79.90, 77.03 and 65.61 per cent mortality, respectively. Whereas, quinalphos 0.05, cypermethrin 0.005 and profenophos 0.05 per cent were found least effective.

4.5.2.3 Seven days after spray

The data on per cent mortality (Table 12 and Fig 3) obtained 7 days after first spray revealed that the insecticide imidacloprid 7.5g/kg seeds proved the most effective insecticide and gave 73.55 per cent mortality. However it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07 and dimethoate 0.03 per cent which registered 70.83, 68.10, 62.10 and 60.72 per cent mortality, respectively. The next
best treatments were methyldemeton 0.03, phosphamidon 0.03, chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05 and quinalphos 0.05 per cent as they also registered 55.38, 54.11, 45.60, 42.65, 41.63 and 38.70 per cent mortality, respectively. While cypermethrin 0.005 and profenophos 0.05 per cent were found least effective.

4.5.2.4 Fourteen days after spray

The mortality data (Table 12 and Fig 3) recorded 14 days after first spray indicated that an imidacloprid 7.5g/kg seed was found most effective insecticide and it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03 and methyl demeton 0.03 and phosphamidon 0.03 per cent and gave 46.32, 43.55, 42.90, 38.12, 34.87 35.91 and 33.14 per cent mortality of the pest, respectively. Chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05, quinalphos 0.05, cypermethrin 0.005 and profenophos 0.05 per cent were found next best effective treatments.

4.5.3 Before second spray

The data regarding the population of jassid nymphs/3 leaves before 1st spray in all the treatments were found non-significant. The population of jassid nymphs/3 leaves was ranged from 84.44 to 77.52.
4.5.4 Second spray

4.5.4.1 First day after spray

The data on per cent mortality (Table 12 and Fig 4) obtained 1 day after second spray reveals that all insecticides were found very effective against the pest. Among the different insecticidal treatments, imidacloprid 7.5g/kg seeds proved the most effective insecticide and gave 95.19 per cent mortality. However it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03, methyl demeton 0.03 and phosphamidon 0.03 per cent as they also registered 94.95, 94.88, 94.38, 93.97, 93.92 and 93.30 per cent mortality of the pest, respectively. Profenophos 0.05 per cent was found least effective. However, it gave 77.68 per cent mortality of the pest. The next best treatments were chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05, quinalphos 0.05, cypermethrin 0.005 and profenophos 0.05 per cent which registered 82.03, 79.80, 79.20, 79, 77.72 and 77.68 per cent mortality, respectively.

4.5.4.2 Third days after spray

The mortality data recorded 3 days after spray (Table 12 and Fig 4) indicates that imidacloprid 70 7.5g/kg seeds most effective insecticide and gave 95.00 per cent mortality. However it was at par with thiamethoxam 4.2g/kg seeds (94.06), monocrotophos 0.04 per cent (93.95), endosulphan 0.07 per cent (93.61), dimethoate 0.03 per cent
(90.60), methyl demeton 0.03 per cent (89.40) and phosphamidon 0.03 per cent (87.03). The next best treatments were chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05, quinalphos 0.05, profenophos 0.05 and cypermethrin 0.005 per cent which registered 76.90, 65.61, 65.04, 62.99, 61.92 and 60.90 per cent mortality, respectively.

4.5.4.3 Seven days after spray

The data on per cent mortality (Table 12 and Fig 4) 7 days after second spray reveals that among all the insecticidal treatments, imidacloprid 7.5g/kg seeds were most effective insecticide and gave 71.78 per cent mortality. However it was at par with thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulphan 0.07, dimethoate 0.03 and methyl demeton 0.03 per cent as they gave, 60.40, 59.27, 59.10, 55.82 and 46.18 per cent mortality, respectively. phosphamidon 0.03, chlorpyriphos 0.05, profenophos + cypermethrin 0.088, deltamethrin + triazophos 0.05, quinalphos 0.05, profenophos 0.05 and cypermethrin 0.005 per cent were found next best effective treatments as they also registered 67.15, 42.65, 41.63, 39.64, 38.70, 37.72 and 36.70 per cent mortality, respectively.

4.5.4.4 Fourteen days after spray

The data presented in Table 12 and Fig 4 indicates that imidacloprid 7.5g/kg seeds was found significantly superior over rest of
the treatments and gave 56.45 per cent mortality. However, it was at par with thiamethoxam 4.2g/kg seeds which registered 52.55 per cent mortality. The next best treatments were found monocrotophos 0.04 and endosulfan 0.07 which registered 40.85, 40.04, per cent mortality, respectively. Profenophos 0.05 per cent was found least effective.

Thus, on the basis of above results it could be seen that imidacloprid 7.5g/kg seeds was found most effective followed by thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulphan 0.07, dimethoate 0.03, methyl demeton 0.03 and phosphamidon 0.03 per cent and they were also effective up to 14 days after spray under field conditions.

According to Mote (1973), monocrotophos 0.05 per cent and dimethoate 0.05 per cent at fortnightly intervals found most promising against okra jassid. Srinivasan et al. (1973) recommended three sprays of endosulfan 0.07 per cent at 15-days interval from 21st days after sowing. Agrawal and Katiyar (1975) tested 11 different insecticides against jassid and they concluded that monocrotophos 0.05 and phosphamidon at 0.05 per cent were highly effective against okra jassid. Krishnaiah et al. (1976) concluded that monocrotophos @ 0.5 kg a. i./ha and dimethoate @ 0.3 kg a. i./ha suppressed jassid population effectively for 3 weeks. Dhamdhere et al. (1980) tested 10 insecticides against A. biguttula biguttula and they recommended dimethoate 0.03 and endosulphan 0.03
had rapid knock down effect, causing 88 and 84 per cent mortality, respectively, 24 hrs after treatment. Visvanathan and Abdul Kareem (1983) carried out three field trials with endosulfan, methyl demeton and monocrotophos against jassid on cotton and they observed that all three treatments were equally effective and at par with each other. The population reduction in order of effectiveness was highest in monocrotophos followed by methyl demeton and endosulphan in decreasing concentration viz., 0.09, 0.07 and 0.05 per cent, respectively. Mohan (1985) concluded that endosulphan @7 kg a.i./ha was most effective for the control of okra jassid. Srinivasan and Krishnakumar (1988) reported that two applications of monocrotophos 0.05 per cent (Nuvacron 40 EC), 21 and 35 days after germination, gave effective and economical control of okra jassid. Imidacloprid 600 FS at 9 ml/kg seeds and 70 per cent WP at 10 g/kg seeds were found promising against jassid (Amrasca biguttula biguttula, Ishida). (Bhargava et al., 2001).

Thus, the present investigations are in agreement with the reports made by earlier workers.

4.6 Yield

The data on yield of healthy okra fruits obtained in various insecticidal treatments are summarized in Table 13 and Fig 5. The data reveals that imidacloprid 7.5g/kg seeds gave highest yield of 4194.23kg/ha through it was statistically at par with thiamethoxam
Table 13. Effect of different insecticidal treatments on yield of okra fruits

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
<th>Fresh okra fruits (Kg/ha)</th>
<th>Per cent increase over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chlorpyriphos 0.05%</td>
<td>2896.40</td>
<td>54.50</td>
</tr>
<tr>
<td>2</td>
<td>Cypermethrin 0.005%</td>
<td>3040.97</td>
<td>62.21</td>
</tr>
<tr>
<td>3</td>
<td>Deltamethrin + Triazophos 0.05%</td>
<td>2621.70</td>
<td>39.84</td>
</tr>
<tr>
<td>4</td>
<td>Dimethoate 0.03%</td>
<td>3325.13</td>
<td>77.37</td>
</tr>
<tr>
<td>5</td>
<td>Endosulfan 0.07%</td>
<td>3822.87</td>
<td>103.92</td>
</tr>
<tr>
<td>6</td>
<td>Imidacloprid 7.5g/kg</td>
<td>4194.23</td>
<td>123.72</td>
</tr>
<tr>
<td>7</td>
<td>Methyl demeton 0.03%</td>
<td>3257.33</td>
<td>73.75</td>
</tr>
<tr>
<td>8</td>
<td>Monocrotophos 0.04%</td>
<td>3967.03</td>
<td>111.61</td>
</tr>
<tr>
<td>9</td>
<td>Phosphamidon 0.03%</td>
<td>3106.30</td>
<td>65.69</td>
</tr>
<tr>
<td>10</td>
<td>Profenophos 0.05%</td>
<td>2726.63</td>
<td>45.44</td>
</tr>
<tr>
<td>11</td>
<td>Profenofos+Cypermethrin 0.088%</td>
<td>2040.73</td>
<td>8.85</td>
</tr>
<tr>
<td>12</td>
<td>Quinalphos 0.05%</td>
<td>2478.60</td>
<td>32.21</td>
</tr>
<tr>
<td>13</td>
<td>Thiamethoxam 4.2g/kg</td>
<td>4035.80</td>
<td>115.27</td>
</tr>
<tr>
<td>14</td>
<td>Control</td>
<td>1874.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. EM. ±</td>
<td>269.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.D. at 5%</td>
<td>783.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C.V. at 5%</td>
<td>15.05</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 5: Effect of different insecticidal treatments on yield of okra fruits
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chlorpyriphos 0.05%</td>
</tr>
<tr>
<td>2</td>
<td>Cypermethrin 0.005%</td>
</tr>
<tr>
<td>3</td>
<td>Deltamethrin + Triazophos 0.05%</td>
</tr>
<tr>
<td>4</td>
<td>Dimethoate 0.03%</td>
</tr>
<tr>
<td>5</td>
<td>Endosulfan 0.07%</td>
</tr>
<tr>
<td>6</td>
<td>Imidacloprid 7.5g/kg</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
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<td>9</td>
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</tr>
<tr>
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<td>Profenophos 0.05%</td>
</tr>
<tr>
<td>11</td>
<td>Profenofos+Cypermethrin 0.088%</td>
</tr>
<tr>
<td>12</td>
<td>Quinalphos 0.05%</td>
</tr>
<tr>
<td>13</td>
<td>Thiamethoxam 4.2g/kg</td>
</tr>
<tr>
<td>14</td>
<td>Control</td>
</tr>
</tbody>
</table>
4.2g/kg seeds, monocrotophos 0.04 and endosulphan 0.07 per cent which recorded 4035.80kg/ha, 3967.03 kg/ha and 3822.87kg/ha okra fruits, respectively. Dimethoate 0.03, demeton-o-methyl 0.03, phosphamidon 0.03, cypermethrin 0.005, chlorpyriphos 0.05 and profenophos 0.05 per cent were next best treatments, which registered 3325.13kg/ha, 3257.33kg/ha, 3106.30kg/ha, 3040.97kg/ha, 2896.40kg/ha and 2726.63kg/ha okra fruits, respectively. The remaining treatments could not increase yield of okra fruits, as they were as good as untreated control.

Considering the per cent increase in the yield of healthy okra fruits over control due to imidacloprid 7.5g/kg seeds it was found that there was 123.72 per cent increase in yield due to this treatment. The next effective treatment in regards to per cent increase in yield over control were thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulfan 0.07, dimethoate 0.03, demeton-o-methyl 0.03, phosphamidon 0.03, cypermethrin 0.005, chlorpyriphos 0.05 and profenophos 0.05 per cent which registered 115.27, 111.61, 103.92, 77.37, 73.75, 65.69, 3040.97, 2896.40 and 2726.63 per cent increased in yield over control, respectively.

Thus, on the basis of above results it can be seen that treatments of imidacloprid 7.5g/kg seeds and thiamethoxam 4.2g/kg seeds,
monocrotophos 0.04 per cent and endosulphan 0.07 per cent treatments were most effective for increasing marketable okra fruit yield.

Mote (1978) reported higher yield of okra fruit in monocrotophos 0.03 per cent followed by endosulphan 0.05 per cent. Jadhav and Nawale (1984) concluded that the yield of healthy okra fruits was significantly higher in the treatment of monocrotophos 0.05 per cent. Six applications of monocrotophos 0.04 per cent at 10 to 15 days interval starting immediately after germination were found to be the best as it registered highest okra fruit yield (Zala, 1986). Borah, R. K. (1994) reported that dimethoate 0.03 per cent at 25 and 30 DAG resulted in the highest yield. Endosulphan 0.07 per cent gave highest yield of okra fruit (4062.50 kg/ha) it was at par with monocrotophos 0.04 per cent (34.93.05 kg/ha) (Kadivar, 1995). Bhargava et al. (2001) reported that imidacloprid 600 FS at 9ml/kg seeds and 70 per cent WP at 5g/kg seeds gave maximum yield.
SUMMARY AND CONCLUSIONS

5.1 Biology

5.1.1 The mean incubation period was 5.30 ± 1.33 days in an average laboratory temperature of 28.34°C and 70.66 per cent relative humidity. The duration of the pupal stage and the average duration of each instar was 1.23 ± 0.22, 1.21 ± 0.42, 1.90 ± 0.60, 1.10 ± 0.20 and 2.10 ± 0.50 days, respectively at an average laboratory temperature of 29.14°C and 70.12 per cent relative humidity. The pre-oviposition period under the same laboratory conditions was 13.90 ± 0.60 days.
V SUMMARY AND CONCLUSIONS

The jassid, *Amrasca biguttula biguttula* (Ishida), is one of the important pests of okra. Investigations were, therefore, carried out on the biology, population dynamics, varietal susceptibility and chemical control of this pest at Junagadh during the year 2004. The main findings under different aspects of these studies are summarized below.

5.1 Biology

Biology of jassid, *A. biguttula biguttula* was studied at Junagadh during the year 2004 on okra under the laboratory conditions.

5.1.1 The mean incubation period of eggs was 5.30 ± 1.33 days at an average laboratory temperature of 28.34°C and 70.66 per cent relative humidity.

5.1.2 The nymphs of *A. biguttula biguttula* passed through five distinct instars and the average duration of each instar was 1.23 ± 0.22, 1.90 ± 0.60, 1.10 ± 0.20 and 2.10 ± 0.50 days, respectively at an average laboratory temperature of 29.14°C and 70.12 per cent relative humidity. The mean nymphal duration under the same laboratory conditions was 7.40 ± 1.35 days.
5.1.3 The adult was wedge shaped, yellowish green in colour and walk diagonally in a characteristic manner. The most important feature for identification of adult was the presence of prominent black spot on each of the tegmina near apex. Male and female adults were identified by ascertaining the presence or absence or conspicuous black coloured straight line placed medially on the last four abdominal segments. The male possessed such black line and it was lacking in female.

5.1.4 The average longevity of male and female adult was 10.60 ± 1.041 and 13.10 ± 1.491 days, respectively at an average laboratory temperature of 30.80°C and 69.10 per cent per cent relative humidity.

5.1.5 The pre-oviposition, oviposition and post-oviposition periods occupied on an average 3.40 ± 1.03, 5.20 ± 0.88 and 4.10 ± 0.78 days, respectively at an average laboratory temperature of 30.05°C and 69.55 per cent relative humidity.

5.1.6 The oviposition potential was on an average 16.20 ± 0.833 eggs per female at an average laboratory temperature of 30.10°C and 72.40 per cent relative humidity.

5.1.7 The sex-ratio (male: female) was 1:1.50 at an average laboratory temperature of 29.11°C and 70.20 per cent relative humidity. Thus, it was
concluded that female of *A. biguttula biguttula* outnumbered their male counterpart under laboratory conditions.

5.1.8 The total life span (from egg to death of adult) of male and female was on an average 23.10 ± 3.00 and 26.2 ± 3.50 days, respectively an average laboratory temperature of 30.40°C and 70.10 per cent relative humidity.

5.2 Populations dynamics

Okra, *Abelmoschus esculentus* (L.) Moench is one of the most popular and favourite vegetable in Indian meal. It is cultivated all over India. Okra is vulnerable to attack of jassid right from sowing of seed to harvest of the crop causing considerable damage to the crop. Attempts were, therefore made on study of population dynamics of jassid on okra at Junagadh. The important conclusions accured from these investigations are summarized hereafter.

The study on population dynamic of jassid reveals that in *kharif* season, jassid appeared after second week of sowing (1st week of September). The pest population increased gradually and reached to a peak level of 11.25 jassid nymphs per leaf on GO-2 variety of okra after 10th week of sowing. The pest population was remained active throughout in *kharif* season. Jassid population had significant positive correlation with maximum temperature (0.5490) and significant negative correlation with minimum temperature (-0.5193). Similarly, jassid population had significant negative
correlation with morning relative humidity (-0.3242) on the GO-2 variety of okra.

5.3 Nature of damage

The nymphs and adults were observed on the lower surface of leaves, congregated near the stalk in between the main veins. They were also observed all over the leaf surface under the condition of heavy infestation. The nymphs and adults suck the cell sap from underside of the leaves and inject their toxic saliva in to the tissue causing toxaemia. The affected leaves initially become pale green, then yellow, reddish and finally brick red or brown in colour. Curling and crinkling of the leaves accompanied this change and the leaves gradually dried away. The plants become stunted in growth and bear less numbers of flowers; thereby the yield was adversely affected.

5.4 Varietal susceptibility

Twenty varieties of okra were tested for their susceptibility against okra jassid and varieties, Gujarat Okra-1, Aol-02-4, Aol-02-1, Aol-99-28, Gopi, Aol-99-24 were found least susceptible to this pest and varieties 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 found most susceptible, while varieties viz., Jol 2k-18 and Jol-02-10 were found moderately susceptible under field conditions.

5.5 Chemical control

The results on the efficacy of different insecticides against okra jassid showed that imidacloprid 7.5g/kg seeds, thiamethoxam 4.2g/kg seeds, monocrotophos 0.04, endosulphan 0.07, dimethoate 0.03, methyl demeton 0.03 and phosphamidon 0.03 per cent proved to be the most effective for quick knock down and they were also effective up to 14 days after spray under field conditions.

5.6 Yield

The results on the yield of healthy okra fruits in different insecticidal treatments showed that imidacloprid 7.5g/kg seeds gave higher yield of healthy okra fruits followed by thiamethoxam 4.2g/kg seeds (4035.80 kg/ha), monocrotophos 0.04 per cent (3967.03 kg/ha) and endosulfan 0.07 per cent (3822.87 kg/ha).
REFERENCES
REFERENCES


