POPULATION DYNAMICS AND CHEMICAL CONTROL OF EARHEAD BUG *Calocoris angustatus* Leth. ON SORGHUM

BY

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1998

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This is to certify that **SHRI ZADKE SHARAD ACHYUTRAO** has satisfactorily prosecuted his course of research for a period of not less than one academic session and that the dissertation entitled **"POPULATION DYNAMICS AND CHEMICAL CONTROL OF EARHEAD BUG *Calocoris angustatus* Leth. ON SORGHUM"** submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any university.

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CERTIFICATE - II

This is to certify that the dissertation entitled **"POPULATION DYNAMICS AND CHEMICAL CONTROL OF EARHEAD BUG *Calocoris angustatus* Leth. ON SORGHUM"** submitted by **SHRI. ZADKE SHARAD ACHYUTRAO** to the Marathwada Agricultural University, Parbhani in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **AGRICULTURAL ENTOMOLOGY** has been approved by the student's advisory committee after viva-voce examination in collaboration with the External Examiner.

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THERE ALWAYS ARE IN THE WORLD FEW INSPIRED MEN WHOSE ACQUAINTANCE IS BEYOND PRICE

- PLOTO

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INTRODUCTION

Sorghum (*Sorghum bicolor* L. Monech) ranks fifth in acreage and production among the world's major cereal crops, following wheat, rice corn and barley. As compared to other countries India has largest area of about 11.74 million hectares under this crop (Anonymous, 1996). As it is third most important cereal crop after rice and wheat, grain yield on farmers fields are generally low mainly because of the insect pest damage.

Sorghum is one of the four major cereal crops of the World. India is a major sorghum growing country in the world and grows 34 per cent of world sorghum in area and around 17 per cent of total sorghum productions in the world.

Nearly 150 insects species have been reported as pests on sorghum. Among them, shoot fly, *Atherigona soccata* Rodani, Stem borer, *Chilo partellus* Swinhoe, armyworm *Mythimna separata* Walk., midge, *Contarinia sorghicola* Coquillet, earhead bug, *Calocoris angustatus* Letheirry and head caterpillars, *Heliothis armigera* Hubner, *Eublema spp.* and *Cryptoblades* spp., can be considered the major pests in India. (Reddy and Davies, 1979; Jotwani *et al.*, 1980).

Among the several heteropterous species known to infest the developing sorghum grain, earhead bug, *Calocoris angustatus* Leth. (Heteroptera, Miridae) has assumed major pest status (Anonymos, 1984). There are four mirids, *Calocoris angustatus* Leth. *Creontiades pallidus, Eurystulus bellevoyei* and *compylomma* spp. infest sorghum. The incidence of *Calocoris angustatus* Leth. is higher in crops grown in vertisols than in alfisols, and maximum number recorded in panicles at milky stage (Sharma and Lopez, 1990).

Recently earhead bug, *Calocoris angustatus* Leth. has attained the status of the major pest in Maharashtra State. Hence, systematic research programme on this pest should be initiated in this region. An attempt has been made during present investigation to test the efficacy of modern synthetic insecticides in controlling sorghum earhead bug, *Calocoris angustatus* Leth. with the following objectives:

1. To study the bioefficacy of certain insecticides against sorghum earhead bug.
2. To study the population dynamics of sorghum earhead bug.

REVIEW OF LITERATURE

Chapter II

REVIEW OF LITERATURE

Sorghum crop is subject to attack by a number of insect pests. Over 150 insects have been reported as a pest of sorghum, of which 31 are of potential economic importance. *Calocoris angustatus* Leth. reported for the first time by Lethierry during 1893 from South Arcot district of Tamil Nadu (Ballard, 1916). Recently earhead bug *C. angustatus* has attained the status of major pest in Maharashtra state. Sorghum earhead bug has become regular pest of sorghum in this region. For last three years, the incidence of the bug is increasing hence it was felt necessary to undertake the detailed studies on this pest namely population dynamics and chemical control. The research in respect of nature of damage, losses caused, population dynamics and chemical control is briefly reviewed here.

2.1 Chemical control of sorghum earhead bug, *Calocoris angustatus* Leth.

Poul (1976) evaluated that the two sprays of chlorpyriphos , leptophos, diazinon and carbaryl and dusts of carbaryl, malathion, quinalphos and BHC at complete anthesis and milky stage give significant control of *Calocoris angustatus*.

Sundararaju *et al.* (1977) showed that carbaryl 10 per cent, malathion 5 per cent and BHC 10 per cent dusts effectively controlled earhead bug population when applied at the rate of 20 kg/ha after 70 days of sowing.

Jotwani *et al.* (1978) found that dusts of BHC 10 per cent, endosulfan 4 per cent, malathion 5 per cent, phenthoate 2 per cent and sprays of phenthoate 0.05 per cent. quinalphos 0.05 per cent, carbaryl and molasses 0.2 per cent effectively reduced the pest density and substantially increased grain yield. The grain yield varied from 38.00 to 43.00 q/ha in treated plots whereas it was 24.00 q/ha in unprotected check.

Kulkarni and Parmeshwarappa (1978) obtained good control of earhead bug with carbaryl 10 per cent dust when applied at 1.5 kg a.i./ha.

Paul *et al.* (1983) conducted field trials in Andhra Pradesh, India in 1975-78 to determine the relative effectiveness of various insecticides as sprays or dusts against *C. angustatus* on sorghum. Phenthoate, carbaryl, and malathion as a dust at 1.5 kg a.i./ha, quinalphos as a dust at 0.375 kg a.i./ha were highly effective against the pest, while leptophos and carbaryl as sprays at 0.5 and 1.5 kg a.i./ha, respectively, were fairly effective. The least effective treatments were sprays containing pyrocolloid, phosalone and DDVP.

Sukhani (1986) reported that two applications of chlorpyriphos, malathion, endosulfan, lindane, trichlorophos and carbophenthion sprays at the rate of 0.5 to 2 kg a.i./ha and dust formulations of endosulfan 4 per cent, BHC 10 per cent, carbaryl 10 per cent and malathion 5 per cent at the rate of 15 to 20 kg/ha were highly effective against the bug.

Sharma and Leuschner (1987) studied chemical control of sorghum earhead bugs. On the basis of effectiveness in controlling the pest, grain yield and 1000 grain weight, carbaryl at 500 g a.i./ha was most effective of the contact insecticides followed by fenvalerate at 50 g a.i./ha and chlorpyriphos at 20 g a.i./ha.

Rao and Azam (1987) studied economic control of sorghum earhead bugs. Field trials were carried out in Andhra Pradesh, India to determine the cost benefit ratio of some effective insecticides against *C. angustatus* Leth. on sorghum. Dust formulation of carbaryl (5 %), malathion

(5 %), endosulfan (4 %), phosalone (4 %) and BHC (10 %) were each tested at 20 kg/ha as well as tapping of earheads in water mixed with kerosin at a ratio of 10:1 and spraying with neem oil at 0.5 %. The maximum reduction in the pest population was recorded in plots treated with malathion (0.5 %) followed by phosalone (82.8 %) and carbaryl (75.9 %). The highest cost benefit ratio was recorded for BHC, but because of its extended residual toxicity it was considered a health hazard and therefore, malathion with the next highest cost benefit ratio was recommended for the control of mirid.

Sharma *et al.* (1988), in field testing of 8 contact sprays reported that fenvalerate, carbaryl and chlorpyriphos at the rate of 400 g a.i./ha were effective against earhead bug.

Ramamurthy and Gopalan (1993) found that the satisfactory control of earhead bug was done by two applications of endosulfan 35 EC at the rate of 500 ml/ha or dusting of malathion 5 per cent dust at the rate of 25 kg/ha on 5th and 15th day of earhead emergence.

2.2 Population dynamics of earhead bug *C. angustatus*

Prabhakar *et al.* (1981) studied species complex on sorghum at Hyderabad. A survey was carried out on the species of Hemiptera in sorghum plant at Hyderabad, Andhra Pradesh, India in 1976. *C. angustatus* occurred in very large numbers at the panicle formation stage in both seasons.

Leuschner and Sharma (1983) studied crop losses caused due to *C. angustatus*. In different parts of India, available losses of 6.6 to 84 per cent have been computed. Adults and nymphs suck sap from the developing grains, which remain unfilled, shrivelled and in severe infestation became chaffy.

Hiremath and Thontadarya (1984) studied seasonal incidence of the sorghum earhead bug (*C. angustatus*) by sowing a sorghum at an interval of 10 days throughout the year during 1978 and 1979, as well as by sowing it at fortnightly intervals from early *kharif* to late *rabi* seasons during 1979. The milky stage of earhead was preferred to the pre-flowering, a 3rd flowering and flowering and ripening stages. The computed seasonal incidences were higher during August (230), September (222), October (224) and January (215) which coincide with blooming and milky stage of sorghum in general fields. Correlation studies between the bug population at the milky stage and maximum temperature indicated a significant negative relationship, and a significant positive relationship with relative humidity.

Maximum number of earhead bugs during the second fortnight of September at ICRISAT, Hyderabad. The initial build up of the earhead bug population was slow probably because of a prolonged drought period during August (Anonymous, 1985).

Prabhakar *et al.* (1986) undertook studies on the seasonal prevalence of the mirid *C. angustatus* on sorghum in Andhra Pradesh, India, in 1976. The populations of *C. angustatus* was significantly correlated with the average relative humidity. There was no significant correlation between the population and the average maximum temperature.

Hiremath (1986) undertook studies on host preference and biology of *C. angustatus* on 10 common host plants under field conditions in Karnataka, India, in 1978-79. The highest population was recorded on grain sorghum followed by fodder sorghum and maize. The survival of nymphs was maximum on grain sorghum (92 %) followed by fodder sorghum (80 %) and little millet (80 %). Nymphs failed to develop on maize, sugarcane, Italian millet and grass (*P. americanum*). Grain sorghum proved to be the most preferred host, with the least nymphal duration, maximum survival and greatest adult weight and size of all the plants tested, *C. angustatus* would only oviposit on sorghum earheads.

Reddy (1988) assessed the farm yield losses in sorghum due to insect pests. In many parts of Africa, field sorghum was attacked by a number of insect pests, notable among them being muscid (*A. soccata*), pyralid (*C. partellus*) and mirids (*C. angustatus*). Various methods of assessing and quantifying the effect on farm yield losses of sorghum caused by these insect pests were described.

Natarajan *et al.* (1989) studied seasonal occurrence of *C. angustatus* in the main and ratoon crops of 2 sorghum hybrids in field experiments in Tamil Nadu, India, with fortnightly sowings. During April-June 1984, April sowings were severely infected, while early June sowings had lower infestation. A ratoon crop had a lower population than the main crop. In July-October 1984, the crop sown in the first fortnight of September had the lowest population (18 bugs per 10 panicles as compared with 142-159 per 10 panicles in July sown crops). The main crop had a higher population than the ratoon crops. A 3rd experiment sown in January-March, 1985 differed from the others by having a lower population in the main than in the ratoon crop. In the main crop, January sown crop had no population and the crop sown in February and March were little infested. In all the sowings except those in February and March, 1985, the dough stage of development had higher population than the preflowering, milky and maturity stages.

Hiremth (1989) conducted a survey of *C. angustatus* and its natural enemies between 1977 and 1980 in 8 sorghum growing districts in Karnataka. The mirid population was higher in the *kharif* season in Mysore, Bijapur, Chitradurga, Bellary, Dharwad and Belgaum districts as compared to other districts. During summer, the maximum incidence of the mirid was recorded at Mysore (16.55), whereas during the *rabi* season, it was highest in Bijapur (24). The natural enemies found in the survey were the formicids *Componotus compressus*, *C. paria*, the reduviid, *Rhinocoris fuscipes*, the lygacid *Gaocoris tricolor*, the mantid *Hierodula* sp., erythraeids, 16 species of spiders and the entomogenous fungus, *Cephalosporium* sp.

Sharma and Lepez (1989) undertook the studies on avoidable losses and economic injury levels (EIL) for the mirid *C. angustatus* Leth. on sorghum cultivars during 3 rainy seasons (1985-87) in Andhra Pradesh, India. Grain yield in plot protected with 2-5 insecticidal sprays between the half anthesis and dough stages was significantly higher than in untreated plots, with cost benefit ratio greater than 1. Density of the pest at half anthesis, complete anthesis and the milk and dough stages was significantly and negatively associated with grain yield.

Loss in grain yield per ha due to 1 insect/panicle at the half anthesis and that based on natural increase were 548 and 232 kg in CSH 5 during 1986 and 1987, respectively. ETL based on cost benefit ratio of 1:1 ranged from 1.3-1.4 insects/panicle for CSH 1, 0.r for ICSV. 1 and 0.4-0.6 and 0.2 to 0.4 for CSH 5 during 1986 and 1987, respectively. Simple cost estimates for insecticides sprays and the resultant savings in grain yield were useful tools for decision making in pest management.

Mote and Jadhav (1990) studied the incidence and losses caused by sorghum earhead bug. There was a significant reduction in grain weight with an increase in damage grades. Damage grades were significantly and negatively correlated with grain weight. When damage increased by 1 grade, there was a corresponding decrease of 12.55 g in grain weight per earhead, 4.43 g in 1000 grain weight and 15.49 per cent in seed germination. A decrease of 1 g in 1000 grain weight resulted in 4.66 per cent decrease in seed germination.

Sharma and Lopez (1990) studied biology and population dynamics of sorghum head bugs. Among four mirids, *Calocoris angustatus* Leth. was the predominant species. The incidence of *C. angustatus* was higher at the milky stage in Vertisols than in alfisols. Females of *C. angustatus* laid eggs inside the glumes before anthesis, whereas the other species inserted their eggs in the grain at the milky stage. The life cycle was completed in 15-20, 17-23 and 14-16 days by *C. angustatus*, *C. pillidus* and *E. bellevayei*. Lower minimum temperature (< 18°C) and relative humidity (RH < 30 %) were associated with a decline in density of *C. angustatus* density during November-January, while higher temperature (> 32°C) and lower humidity (< 30 %) restricted its number during March-June. During the rainy season, rainfall, temperature and relative humidity were generally positively associated with the population of *C. angustatus*, *C. pallidus* and *E. bellevoyei*. However, there were some exceptions in some years. During the post rainy season, higher temperature (> 32°C) and moisture deficit had a negative association with number of *C. angustatus*, *C. pallidus* and *E. bellevoyei*. However, these facts were positively associated with number of *Campylomma*. Weather parameter means for the same week and 2 preceding weeks showed a greater effect on *C. angustatus* population.

MATERIALS AND METHODS

Chapter III

MATERIALS AND METHODS

The present investigations were undertaken to study the bioefficacy of certain insecticides against sorghum earhead bug, *Calocoris angustatus* Leth. and to study the population dynamics of earhead bug.

The experimental material used and methods followed during the investigations are given below:

3.1 Location

The experiment was conducted at the Sorghum Research Station, Marathwada Agricultural University, Parbhani. It is situated at 408.5 m above the mean sea level and has sub-tropical climate. It lies between 19°-16' North latitude and 76°-47' East longitude.

3.2 Weather conditions

The data on temperature, relative humidity and rainfall during the entire crop growth period were collected from the Meteorological Observatory of the Marathwada Agricultural University, Parbhani and are presented in Appendix I.

Details of the field experiment

Sr. No.	Particular	Details
1.	Location of plot	Sorghum Research Station, M.A.U., Parbhani
2.	Soil type	Black cotton
3.	Design	Randomized Block Design
4.	Replications	Three
5.	Treatments	Ten (nine + one control)
6.	Insecticides	9 (Neemgold, Decamethrin 2.8EC, Moncrotophos 36SL, Endosulfan 35 EC, Methomyl 12.5L, Dimethoate 30 EC, Carbaryl 50 WP, Quinalphos 25 EC and Cypermethrin 10 EC).
7.	Plot size	2.25 x 3.00 m
8.	Size of the experimental area	15.25 x 23.0 m
9.	Inter plot distance	1 m
10.	Net size of experiment	14.50 x 22.70 m
11.	Spacing	Row to Row 45 cm Plant to plant 15 cm
12.	No. of rows/plot	5
13.	No. of plants/row	20
14.	Method of planting	Dibbling
15.	Crop (variety)	Sorghum: CSH-9

Management of sorghum crop

3.3 Soil

The field was selected having typical black cotton soil with uniform level and good drainage.

3.4 Cultural practices

3.4.1 Land preparation

The land was ploughed once and harrowed thrice for bringing the soil to fine texture before sowing.

3.4.2 Fertilizer applications

Recommended dose of 20 cart loads/ha of farm yard manure was applied at the was applied at the time of last harrowing. The fertilizers were applied in the form of suphala (15:15:15 N:P:K kg/ha) and superphosphate, at the rate of 80 kg N, 80 kg P2O5 and 40 K2O/ha. The urea was applied as top basal dressing. The basal dose of fertilizer viz., 40 kg N, 40 kg P2O5 and 40 K2O/ha was applied at the time of sowing in the farm of suphala (15:15:15) and superphosphate. Top dressing of 40 kg N/ha through urea by drilling method was undertaken 30 days after sowing.

3.4.3 Method of sowing, spacing and gap filling

Certified seeds of hybrid jowar CSH-9 were dibbled on 27th July, 1997 after applying phorate granules at the rate of 1 kg a.i./ha few cm below the seed in the same row to protect crop from shootfly and stemborer. The row to row and plant to plant distance of 0.45 m x 0.15 m was maintained. The seeds were germinated within a week after sowing. The gap filling was done in the second week after germination. Thinning of plants was carried out during fourth week. Finally two healthy plants were kept per hill.

3.4.4 Weeding and hoeing

Hand weedings and hoeings were done two to three times to keep plots free from weeds.

3.5 Experimental details

3.5.1 To study the bioefficacy of certain insecticides against sorghum earhead bug

To achieve the objective of chemical control, CSH-9 was sown as replicated trial (Randomised Block Design) with three replications on plot size of 2.25 x 3.0 m. The gross size of experiment was 15.25 x 23.0 m and net size was 14.50 x 22.70 m. Number of rows/plot was 5 and number of plants per row was 20.

3.5.1.1 Treatment details

Nine insecticides viz., Neemgold, decamethrin 2.8EC, moncrotophos 36SL, endosulfan 35 EC, methomyl 12.5L, dimethoate 30 EC, carbaryl 50 WP, quinalphos 25 EC and cypermethrin 10 EC were included in the trial. The first application was undertaken at the time of flowering and second was undertaken at 13 days interval (milky stage). Details of insecticides used are presented in Appendix II.

Spray solutions were prepared by adding required quantity of insecticide in water and spraying was carried out during the morning hours (9.00 to 11.00 a.m.) by hand operated compression sprayer.

3.5.1.2 Method of recording observations

Observations in respect of chemical control were taken by inverting a polythene bag over the flowering head. In this case three cobs were randomly selected from each plot and number of nymphs were recorded per panicle. Observations for different treatments were recorded separately and mean calculated. Observations were recorded. Observations for different treatments were recorded separately and mean calculated. Observations were recorded 1st day before and 3 days after the respective treatment undertaken.

3.5.1.3 Statistical analysis

In case of bug population, the same were counted into poisson values and then analysed.

3.5.2 To study the population dynamics of sorghum earhead bug *C. angustatus* Leth

Studies on population dynamics of jowar earhead bug in different stages viz., flowering, milky and dough stage of sorghum hybrid were carried out from 2nd July to 31st December, 1997. The details of material used and experimental techniques adopted in the present investigations are described below.

3.5.2.1 Method of recording observations

For this a polythene bag was put inverted over the flowering head. Nymphs were collected into the bag by shaking the cobs. Direct count of nymphs of jowar earhead bug was taken and mean calculated. The peak period of population of the pest was noted. Correlation of environmental factors such as rainfall, temperature, relative humidity was studied with population of earhead bug.

3.5.2.2 Statistical analysis

Simple correlations between different weather factors viz., rainfall, temperature and relative humidity and development of population of earhead bug were made.

3.6 Observations on yield of grains

After harvest, grain yields per plot were recorded, separately for 10 treatments in 3 replications i.e. total observations were 30.

RESULTS

Chapter IV

RESULTS

The present investigations were carried out to evaluate the efficacy of different insecticides against sorghum earhead bug *Calocoris angustatus* Leth. under field conditions. Similarly, at the same time population dynamics of earhead bug was studied under field conditions.

4.1 Efficacy of different insecticides for the control of sorghum earhead bug *Calocoris angustatus* Leth.

Efficacy of Neemgold 1 per cent, decamethrin 0.005 per cent, monocrotophos 0.04 per cent, endosulfan 0.05 per cent, methomyl 0.10 per cent. dimethoate 0.03 per cent, carbaryl 0.2 per cent, quinalphos 0.05 per cent and cypermethrin 0.0025 per cent was judged on the basis of number of nymphs and adults per panicle recorded before and after insecticidal treatments.

4.1.1 The incidence of nymphs of sorghum earhead bug before first spraying

Observations on number of nymphs per panicle before first spraying are presented in Table 1. Results indicated that the incidence of earhead bug was not significant. The nymph population per panicle ranged from 9.00 to 36.30.

4.1.2 Effect of insecticides on the incidence of nymphs of sorghum earhead bug after first spraying

Observation on number of nymphs in (Table 2) indicate that the incidence of earhead bug was affected by spraying of insecticides. It reveals that carbaryl treatment was significantly superior over rest of treatments in

Table 1. The incidence of nymphs of sorghum earhead bug one day before first spraying

Sr. No.	Treatment	Conc. (%)	No. of nymphs/panicle before first spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	17.00 (4.18)	23.20 (4.86)	24.00 (4.94)	21.00 (4.66)
2.	Decamethrin 2.8 EC	0.005	19.20 (4.43)	15.25 (3.96)	22.50 (4.79)	18.98 (4.39)
3.	Monocrotophos 36 SL	0.04	8.75 (3.04)	9.50 (3.16)	35.33 (5.98)	17.86 (4.06)
4.	Endosulfan 35 EC	0.05	11.25 (3.42)	19.00 (4.41)	21.33 (4.67)	17.19 (4.17)
5.	Methomyl 12.5L	0.10	17.20 (4.20)	34.00 (5.87)	13.00 (3.67)	21.40 (4.58)
6.	Dimethoate 30 EC	0.03	15.50 (4.00)	17.80 (4.27)	17.00 (4.18)	16.76 (4.15)
7.	Carbaryl 50 WP	0.20	15.50 (4.00)	18.00 (4.30)	5.33 (2.41)	12.94 (3.51)
8.	Quinalphos 25 EC	0.05	9.00 (3.08)	11.33 (3.43)	32.66 (5.75)	17.66 (4.09)
9.	Cypermethrin 10 EC	0.0025	16.00 (4.06)	13.25 (3.70)	24.66 (5.01)	17.97 (4.26)
10.	Control		10.00 (3.24)	36.30 (6.06)	19.35 (4.45)	21.88 (4.58)
	SE ±					0.56
	CD at 5 %					N.S.

Figures in parenthesis are poissions values

Table 2. Effect of insecticides on the incidence of nymphs of sorghum earhead bud three days after first spraying

Sr. No.	Treatment	Conc. (%)	No. of nymphs/panicle after first spraying R-I	R-II	R-III	Mean
1.	Neemgold	1.000	4.66 (2.27)	4.33 (2.19)	5.00 (2.34)	4.66 (2.27)
2.	Decamethrin 2.8 EC	0.005	7.00 (2.73)	7.00 (2.73)	8.00 (2.91)	7.33 (2.79)
3.	Monocrotophos 36 SL	0.04	5.33 (2.41)	7.33 (2.79)	5.00 (2.34)	5.88 (2.51)
4.	Endosulfan 35 EC	0.05	4.00 (2.12)	4.33 (2.19)	3.00 (1.87)	3.77 (2.03)
5.	Methomyl 12.5L	0.10	6.33 (2.61)	3.00 (1.87)	5.33 (2.41)	4.88 (2.29)
6.	Dimethoate 30 EC	0.03	5.33 (2.41)	4.33 (2.19)	6.33 (2.61)	5.33 (2.40)
7.	Carbaryl 50 WP	0.20	1.33 (1.35)	3.00 (1.87)	1.00 (1.22)	1.77 (1.48)
8.	Quinalphos 25 EC	0.05	9.33 (3.13)	7.00 (2.73)	6.78 (2.69)	7.70 (2.85)
9.	Cypermethrin 10 EC	0.0025	4.33 (2.19)	3.66 (2.03)	4.33 (2.19)	4.10 (2.14)
10.	Control		23.33 (4.88)	24.33 (4.98)	24.33 (4.98)	24.99 (4.94)
	SE ±					0.13
	CD at 5 %					0.39

Figures in parenthesis are poissions values

reducing the nymphal population. The population was lower in carbaryl 0.20 per cent (1.77 nymphs per panicle) and endosulfan 0.05 per cent (3.77 nymphs per panicle) which were at par with cypermethrin 0.0025 per cent Neemgold 1 per cent. methomyl 0.1 per cent and dimethoate 0.03 per cent. The next best treatments were monocrotophos 0.04 per cent, decamethrin 0.005 per cent and quinolphos 0.05 per cent. The untreated control recorded highest nymphal populations (4.948).

4.1.3 The effect of insecticides on the incidence of nymphs of sorghum earhead bug before second spraying

Nymphal population per panicle taken before second spraying are presented in Table 3. The data reveal that the incidence of earhead bug was not significant. The nymphal population fluctuated from 4.98 to 13.62.

4.1.4 Effect of insecticides on the incidence of nymphs after second spraying

Nymphal count per panicle in Table 4 reveals that all the insecticidal treatments were significantly superior in reducing the nymphal population over control. The population was lower in carbaryl 0.2 per cent (2.40 nymph per panicle) followed by endosulfan 0.05 per cent (3.73 nymphs per panicle) which were at par with decamethrin 0.005 per cent and Neemgold 1 per cent. Rest of all the treatments were best treatments. Cypermethrin 0.0025 per cent was at par with dimethoate 0.03 per cent, quinolphos 0.05 per cent and monocrotophos 0.04 per cent The untreated control recorded highest nymph population (6.705).

4.1.5 The incidence of sorghum adult earhead bug before first spraying

Adult bug population per panicle before first spraying was not significant and population fluctuated from 8.45 to 15.09 (Table 5).

Table 3. Effect of insecticides on the incidence of nymphs of sorghum earhead bug one day before second spraying

Sr. No.	Treatment	Conc. (%)	No. of nymphs/panicle before second spraying R-I	R-II	R-III	Mean
1.	Neemgold	1.000	13.20 (3.70)	12.15 (3.55)	12.22 (3.56)	12.68 (3.63)
2.	Decamethrin 2.8 EC	0.005	13.83 (3.78)	12.94 (3.66)	13.85 (3.78)	13.62 (3.74)
3.	Monocrotophos 36 SL	0.04	13.33 (3.71)	12.58 (3.61)	12.28 (3.57)	12.73 (3.63)
4.	Endosulfan 35 EC	0.05	12.00 (3.53)	12.60 (3.61)	12.40 (3.59)	12.33 (3.58)
5.	Methomyl 12.5L	0.10	12.15 (2.61)	11.59 (3.47)	5.33 (3.58)	4.88 (3.53)
6.	Dimethoate 30 EC	0.03	11.66 (3.48)	12.33 (3.58)	12.40 (3.59)	12.13 (3.55)
7.	Carbaryl 50 WP	0.20	12.83 (3.65)	12.81 (3.64)	11.12 (3.40)	12.25 (3.57)
8.	Quinalphos 25 EC	0.05	12.89 (3.65)	12.63 (3.62)	13.58 (3.75)	13.03 (3.67)
9.	Cypermethrin 10 EC	0.0025	13.33 (3.71)	12.53 (3.60)	12.60 (3.61)	12.82 (3.64)
10.	Control		13.33 (3.71)	12.40 (3.59)	12.80 (3.64)	12.84 (3.65)
	SE ±					0.04
	CD at 5 %					N.S.

Figures in parenthesis are poissions values

Table 4. Effect of insecticides on the incidence of nymphs three days after second spraying

Sr. No.	Treatment	Conc. (%)	No. of nymphs/panicle after second spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	4.55 (2.24)	3.65 (2.03)	5.12 (2.37)	4.44 (2.21)
2.	Decamethrin 2.8 EC	0.005	4.51 (2.23)	3.89 (2.09)	4.59 (2.25)	4.33 (2.19)
3.	Monocrotophos 36 SL	0.04	7.74 (2.87)	6.51 (2.64)	5.82 (2.51)	6.69 (2.67)
4.	Endosulfan 35 EC	0.05	3.40 (1.97)	4.00 (2.12)	3.80 (2.07)	3.73 (2.05)
5.	Methomyl 12.5L	0.10	5.21 (2.38)	6.52 (2.64)	5.90 (2.52)	5.87 (2.52)
6.	Dimethoate 30 EC	0.03	5.25 (1.65)	6.20 (2.72)	7.21 (2.71)	6.22 (2.58)
7.	Carbaryl 50 WP	0.20	2.00 (1.58)	3.00 (1.81)	2.20 (1.64)	2.40 (1.69)
8.	Quinalphos 25 EC	0.05	5.25 (1.65)	6.20 (2.72)	7.21 (2.71)	6.22 (2.58)
9.	Cypermethrin 10 EC	0.0025	4.53 (2.24)	5.21 (2.38)	5.81 (2.40)	4.80 (2.38)
10.	Control		41.33 (6.46)	44.33 (6.69)	47.83 (6.95)	44.56 (6.70)
	SE ±					0.08
	CD at 5 %					0.25

Figures in parenthesis are poissions values

Table 5. The incidence of adults of sorghum earhead bug one day before first spraying

Sr. No.	Treatment	Conc. (%)	No. of adults/panicle before first spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	11.35 (3.43)	8.58 (3.01)	13.55 (3.74)	11.12 (3.38)
2.	Decamethrin 2.8 EC	0.005	8.25 (2.95)	6.77 (2.69)	17.59 (4.25)	10.87 (3.30)
3.	Monocrotophos 36 SL	0.04	9.55 (3.17)	6.37 (2.62)	18.21 (4.32)	11.17 (3.37)
4.	Endosulfan 35 EC	0.05	6.35 (2.61)	13.50 (3.74)	11.95 (3.52)	10.60 (3.29)
5.	Methomyl 12.5L	0.10	11.58 (3.47)	12.35 (3.58)	21.35 (4.67)	15.09 (3.91)
6.	Dimethoate 30 EC	0.03	12.28 (3.57)	10.57 (3.32)	11.30 (3.42)	11.38 (3.44)
7.	Carbaryl 50 WP	0.20	12.35 (3.58)	13.21 (3.70)	7.38 (2.80)	10.08 (3.36)
8.	Quinalphos 25 EC	0.05	8.37 (2.97)	10.10 (3.25)	8.39 (2.98)	8.45 (3.07)
9.	Cypermethrin 10 EC	0.0025	18.30 (4.33)	9.89 (3.22)	13.10 (3.68)	13.76 (3.74)
10.	Control		10.35 (3.29)	15.10 (3.87)	7.18 (2.77)	10.87 (3.33)
	SE ±					0.33
	CD at 5 %					N.S.

Figures in parenthesis are poissions values

4.1.6 The effect of insecticdes on the incidence of sorghum earhead bugs after first spraying

The data presented in Table 6 reveal that all the insecticidal treatments were significantly superior in reducing adult population over control. The lowest population was recorded in carbaryl 0.20 per cent (2.14 adults per panicle) and highest in control (16.31 adults per panicle). All the insecticides were significantly superior over control.

4.1.7 Effect of insecticides on the incidence of sorghum earhead bugs before second spraying

Data on number of adult bugs per panicle before second spraying was not significant with incidence varying from 6.68 to 13.70 (Table 7).

4.1.8 Effect of insecticides on the incidence of sorghum earhead bug after second spraying

Observations on number of adult bugs per panicle after second spraying presented in Table 8. The results showed that all insecticidal treatments were significantly superior over control. The population was lowest in carbaryl 0.2 per cent (1.66 bugs per panicle) whereas highest adults population of earhead bug (15.66) was recorded in control.

4.1.9 Effect of insecticides on weight of cob per plot

Weight of cob was influenced by insecticidal treatments. More cob weight was recorded in dimethoate 0.03 per cent, monocrotophos 0.04 per cent, carbaryl 0.2 per cent, Neemgold 1 per cent, methomyl 0.1 per cent, decamethrin 0.005 per cent, endosulfan 0.05 per cent, cypermethrin 0.0025 per cent and quinalphos 0.05 per cent. Among all these treatments, dimethoate

Table 6. Effect of insecticides on incidence of adults of sorghum earhead bug three days after first spraying

Sr. No.	Treatment	Conc. (%)	No. of adults/panicle after first spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	6.53 (2.65)	5.39 (2.42)	5.12 (2.37)	5.30 (2.48)
2.	Decamethrin 2.8 EC	0.005	4.12 (2.14)	5.30 (2.40)	4.85 (2.31)	4.75 (2.29)
3.	Monocrotophos 36 SL	0.04	3.21 (1.93)	6.92 (2.72)	4.22 (2.17)	4.78 (2.27)
4.	Endosulfan 35 EC	0.05	3.20 (1.92)	4.00 (2.12)	3.50 (2.00)	3.56 (2.01)
5.	Methomyl 12.5L	0.10	5.75 (2.50)	4.51 (2.23)	6.81 (2.70)	5.69 (2.48)
6.	Dimethoate 30 EC	0.03	6.60 (2.66)	4.30 (2.19)	5.50 (2.44)	5.46 (2.43)
7.	Carbaryl 50 WP	0.20	3.00 (1.87)	1.55 (1.43)	1.88 (1.54)	2.14 (1.61)
8.	Quinalphos 25 EC	0.05	9.68 (3.19)	8.50 (3.00)	10.10 (3.25)	9.42 (3.14)
9.	Cypermethrin 10 EC	0.0025	6.80 (2.70)	8.91 (3.06)	5.85 (2.51)	7.18 (2.76)
10.	Control		17.25 (4.21)	16.20 (4.08)	15.50 (4.00)	16.31 (4.09)
	SE ±					0.13
	CD at 5 %					0.39

Figures in parenthesis are poissions values

Table 7. Effect of insecticides on incidence of adults of sorghum earhead bug one day before second spraying

Sr. No.	Treatment	Conc. (%)	No. of adults/panicle before second spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	7.50 (2.82)	8.60 (3.01)	7.45 (2.81)	7.85 (2.88)
2.	Decamethrin 2.8 EC	0.005	5.90 (2.52)	7.45 (2.81)	8.65 (3.02)	7.33 (2.79)
3.	Monocrotophos 36 SL	0.04	6.50 (2.64)	7.80 (2.88)	8.76 (3.04)	7.68 (2.85)
4.	Endosulfan 35 EC	0.05	6.66 (2.67)	6.50 (2.64)	6.90 (2.72)	6.68 (2.68)
5.	Methomyl 12.5L	0.10	8.90 (3.06)	5.59 (2.46)	7.21 (2.77)	7.23 (2.77)
6.	Dimethoate 30 EC	0.03	7.56 (2.83)	6.21 (2.59)	7.54 (2.83)	7.10 (2.75)
7.	Carbaryl 50 WP	0.20	7.75 (2.87)	8.55 (3.00)	5.40 (2.42)	7.23 (2.76)
8.	Quinalphos 25 EC	0.05	8.10 (2.93)	8.60 (3.02)	9.21 (3.11)	8.65 (3.02)
9.	Cypermethrin 10 EC	0.0025	8.50 (3.00)	7.90 (2.89)	8.96 (3.15)	8.45 (2.99)
10.	Control		12.20 (3.56)	14.50 (3.87)	14.40 (3.86)	13.70 (3.19)
	SE ±					0.11
	CD at 5 %					N.S.

Figures in parenthesis are poissions values

Table 8. Effect of insecticides on incidence of adults of sorghum earhead bug three days after second spraying

Sr. No.	Treatment	Conc. (%)	No. of adults/panicle after second spraying			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	6.50 (2.64)	4.65 (2.26)	2.40 (1.70)	4.50 (2.21)
2.	Decamethrin 2.8 EC	0.005	2.00 (1.58)	3.90 (2.09)	3.40 (1.97)	3.10 (1.87)
3.	Monocrotophos 36 SL	0.04	2.22 (1.64)	1.78 (1.50)	2.00 (1.58)	2.00 (1.58)
4.	Endosulfan 35 EC	0.05	3.60 (2.02)	2.20 (1.64)	3.50 (2.00)	3.10 (1.87)
5.	Methomyl 12.5L	0.10	4.10 (2.14)	3.50 (2.00)	5.75 (2.59)	4.45 (2.20)
6.	Dimethoate 30 EC	0.03	5.50 (2.44)	3.30 (1.94)	1.00 (1.22)	3.26 (1.88)
7.	Carbaryl 50 WP	0.20	2.00 (1.58)	1.50 (1.41)	1.50 (1.41)	1.66 (1.46)
8.	Quinalphos 25 EC	0.05	6.56 (2.65)	4.25 (2.17)	3.00 (1.87)	4.60 (2.35)
9.	Cypermethrin 10 EC	0.0025	5.75 (2.50)	3.35 (1.95)	4.90 (2.32)	4.66 (2.62)
10.	Control		19.40 (4.46)	19.00 (4.41)	17.60 (4.25)	15.66 (4.37)
	SE ±					0.17
	CD at 5 %					0.51

Figures in parenthesis are poissions values

Table 9. Effect of insecticides on weight of cobs per plot (kg)

Sr. No.	Treatment	Conc. (%)	Weight of cobs/plot			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	2.15	2.20	2.85	2.40
2.	Decamethrin 2.8 EC	0.005	1.95	2.30	2.20	2.15
3.	Monocrotophos 36 SL	0.04	2.80	3.15	2.90	2.95
4.	Endosulfan 35 EC	0.05	2.15	2.05	2.25	2.15
5.	Methomyl 12.5L	0.10	2.10	2.25	2.40	2.25
6.	Dimethoate 30 EC	0.03	3.30	2.95	3.80	3.35
7.	Carbaryl 50 WP	0.20	2.50	2.80	2.80	2.70
8.	Quinalphos 25 EC	0.05	1.88	1.95	2.17	2.00
9.	Cypermethrin 10 EC	0.0025	1.90	2.10	2.15	2.05
10.	Control		2.00	2.05	2.25	2.10
	SE ±					0.10
	CD at 5 %					0.30

was significantly superior which was followed by monocrotophos 0.04 per cent and carbaryl 0.2 per cent (Table 9).

4.1.10 Effect of insecticides on grain yield

The treatments with Neemgold 1 per cent, monocrotophos 0.04 per cent, endosulfan 0.05 per cent and carbaryl 0.20 per cent gave higher grain yield than decamethrin 0.005 per cent, dimethoate 0.03 per cent, cypermethrin 0.0025 per cent, quinolphos 0.05 per cent and methomyl (Table 10).

4.2 Population dynamics of sorghum earhead bug *Calocoris angustatus* Leth.

The data regarding the population dynamics of sorghum earhead bug have been presented in Table 11 and also depicted graphically at flowering, milky and dough stages separately in Fig. I, II and III respectively. The data on population fluctuation of the pest from the sorghum crop available throughout the season were collected at the flowering, milky and dough stages during the period from 2nd July 1997 to 30th December 1997.

Data on population dynamics of sorghum earhead bug presented in Table 11 revealed that first incidence of mirid bug was noticed during 27th meteorological week. The data from the Table 9 and population dynamics of flowering stage are depicted in Fig. 1. It was observed that the nymphs were found significant in number when maximum and minimum temperature ranged from 31.4°C to 32.6°C and from 22.5 to 23.8°C respectively in the months of July and August. Nymphs increased in numbers gradually from September (17 nymphs per panicle) when maximum and minimum temperatures were 31.9°C and 22.8°C and relative humidity in the morning 79 per cent and 52 per cent respectively. The nymphal population increased sharply and reached its first peak (110 nymphs per panicle) in the month of October when maximum and minimum temperatures were 32.4°C and 18.6°C,

Table 10. Effect of insecticides on grain yield

Sr. NO. No.	Treatment	Conc. (%)	Weight of grain/plot (g)			Mean
			R-I	R-II	R-III	
1.	Neemgold	1.000	1850	1900	1300	1683.30
2.	Decamethrin 2.8 EC	0.005	1070	1000	1000	1023.83
3.	Monocrotophos 36 SL	0.04	1400	1500	1600	1500.00
4.	Endosulfan 35 EC	0.05	1400	1100	1800	1433.00
5.	Methomyl 12.5L	0.10	1025	950	1000	991.67
6.	Dimethoate 30 EC	0.03	1070	1350	1280	1206.70
7.	Carbaryl 50 WP	0.20	1150	1200	1950	1433.00
8.	Quinalphos 25 EC	0.05	1000	1000	1250	1083.33
9.	Cypermethrin 10 EC	0.0025	1300	1100	1200	1200.00
10.	Control		1125	1350	1150	1208.30
	SE ±					132.53
	CD at 5 %					393.15

Table 11. Population dynamics of sorghum earhead bug *C. angustatus* in relation to various meteorological factors

Met. week	Date	No. of nymph/earhead at Flowering stage	No. of nymph/earhead at Milky stage	No. of nymph/earhead at Dough stage	Rain-fall (mm)	Temperature (°C) Max.	Temperature (°C) Min.	Relative Humidity (%) A.M.	Relative Humidity (%) P.M.
27	2-8	3	---	---	68.9	31.4	22.5	88	58
28	9-15	6	---	---	14.6	33.2	23.7	73	46
29	16-22	4	---	---	2.6	33.7	24.2	71	44
30	23-19	12	---	---	19.6	32.6	23.8	79	51
31	30-5 Aug.	5	---	---	24.4	31.6	23.7	79	54
32	6-12	10	9	0.66	2.4	33.4	22.5	74	42
33	13-19	16	8	0.33	23.5	33.5	23.1	74	44
34	20-26	3	5	2.00	78.0	29.7	22.6	82	65
35	27-2 Sept.	6	2	1.00	3.5	30.5	22.5	80	57
36	3-9	4	10	0.33	114.3	31.7	22.5	86	56
37	10-16	17	19	0.66	0.8	31.9	22.8	79	52
38	17-23	21	14	2.00	72.9	30.0	22.0	87	67
39	24-30	31	9	4.00	16.4	31.5	22.0	81	55
40	1-7 Oct.	67	53	8.00	2.4	32.2	19.1	83	46
41	8-14	96	112	15.00	0.0	33.0	18.8	71	43
42	15-21	110	90	7.00	47.4	32.4	18.6	74	45
43	22-28	53	80	1.00	102.8	29.3	18.7	91	59
44	29-4 Nov.	31	61	0.66	10.4	29.4	18.4	84	56
45	5-11	67	33	0.33	6.6	30.6	16.9	83	46
46	12-18	83	11	1.00	13.4	29.2	19.3	90	54
47	19-25	12	4	0.33	30.4	29.7	18.1	90	57
48	26-2 Dec.	8	5	1.00	101.0	28.5	19.6	90	66
49	03-09	4	1	1.00	38.0	27.6	17.0	90	59
50	10-16	6	3	0.33	3.6	26.5	13.2	84	46
51	17-23	4	4	0.33	24.0	27.7	17.9	94	60
52	24-31	5	9	0.33	0.0	29.6	16.0	87	49

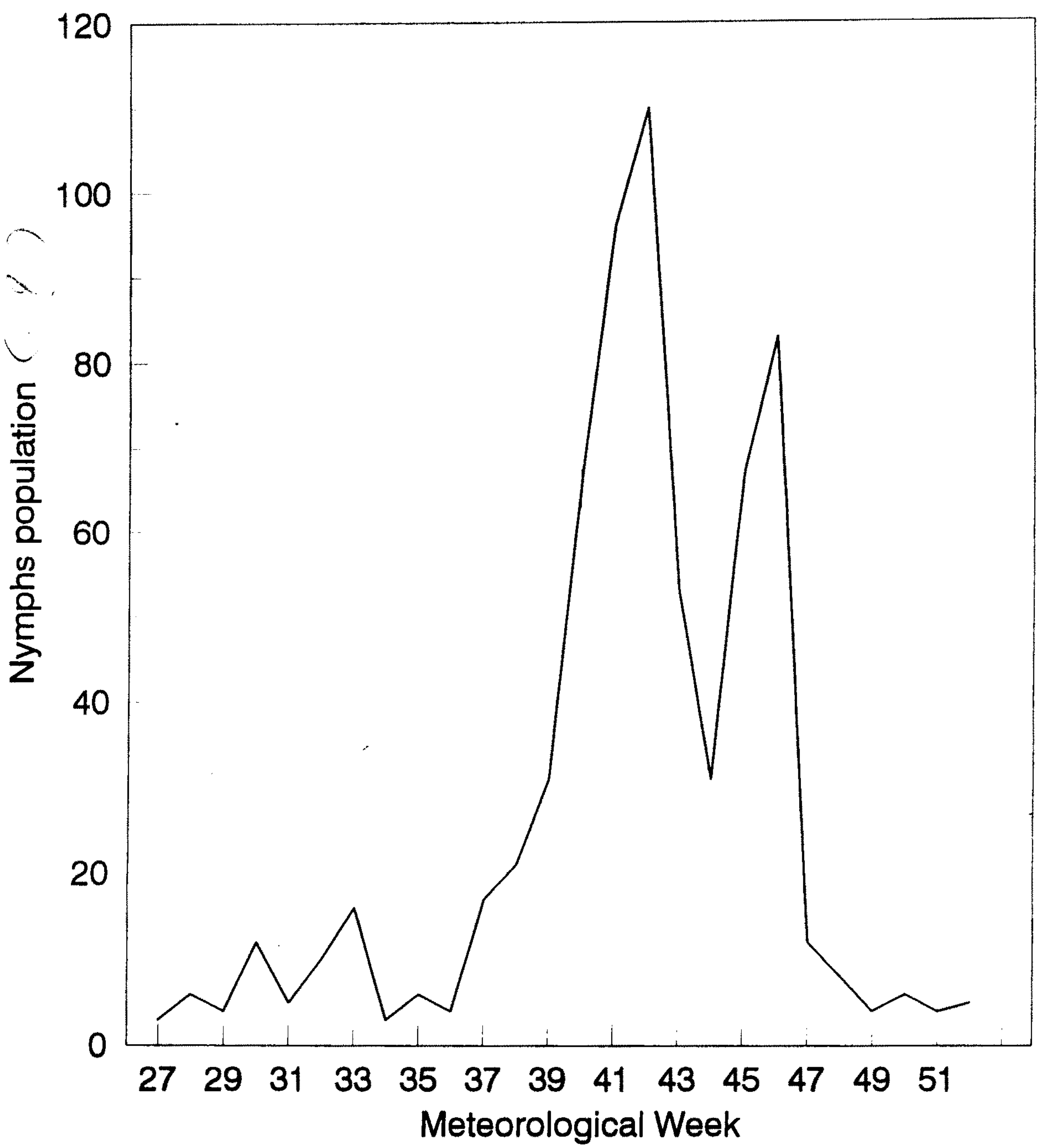

Fig. 1. Population dynamics of sorghum earhead bug *C. angustatus* at flowering stage.

and morning and evening humidities were 74 per cent and 45 per cent, respectively. Nymph population again decreased in last week of October where nymph population was 31 nymph per panicle and average maximum and minimum temperatures were 29.4°C and 18.4°C and morning and evening relative humidities were 84 per cent and 56 per cent. From second week of November nymph population again sharply increased and reached its second peak 83 nymphs per panicle when maximum and minimum temperatures were 29.2°C and 19.3°C and morning and evening humidities were 90 per cent and 54 per cent, respectively. After that the nymphal population sharply decreased upto 12 during 47th week when maximum and minimum temperatures were 29.7°C and 18.1°C and morning and evening humidities 90 per cent and 57 per cent, respectively. In December, highest nymph population was 8 nymphs per panicle when maximum and minimum temperatures were 28.5°C and 19.6°C and morning and evening humidities were 90 per cent and 66 per cent, respectively. The nymphs were not observed in the month of January 1998 and as such not presented in the Table 11.

From Table 11 and population dynamics of earhead bug at milky stage depicted in Fig. 2, revealed that first incidence of the bug was noticed in 32nd week. In the month of August, the maximum number of nymphs was 8 in 3rd week of August, when maximum and minimum temperatures were 33.5°C and 23.1°C and morning and evening humidities were 74 per cent and 44 per cent, respectively. The number ofnymphs gradually reduced to minimum number of 2 in 35th meteorological week (27.8.97 to 2.9.98) where maximum and minimum temperatures were 30.5°C and 22.6°C and morning and evening humidities were 80 per cent and 57 per cent, respectively. From 39th meteorological week, the number of nymphs sharply increased and reached at first peak (112 nymphs per panicle) in the month of October when

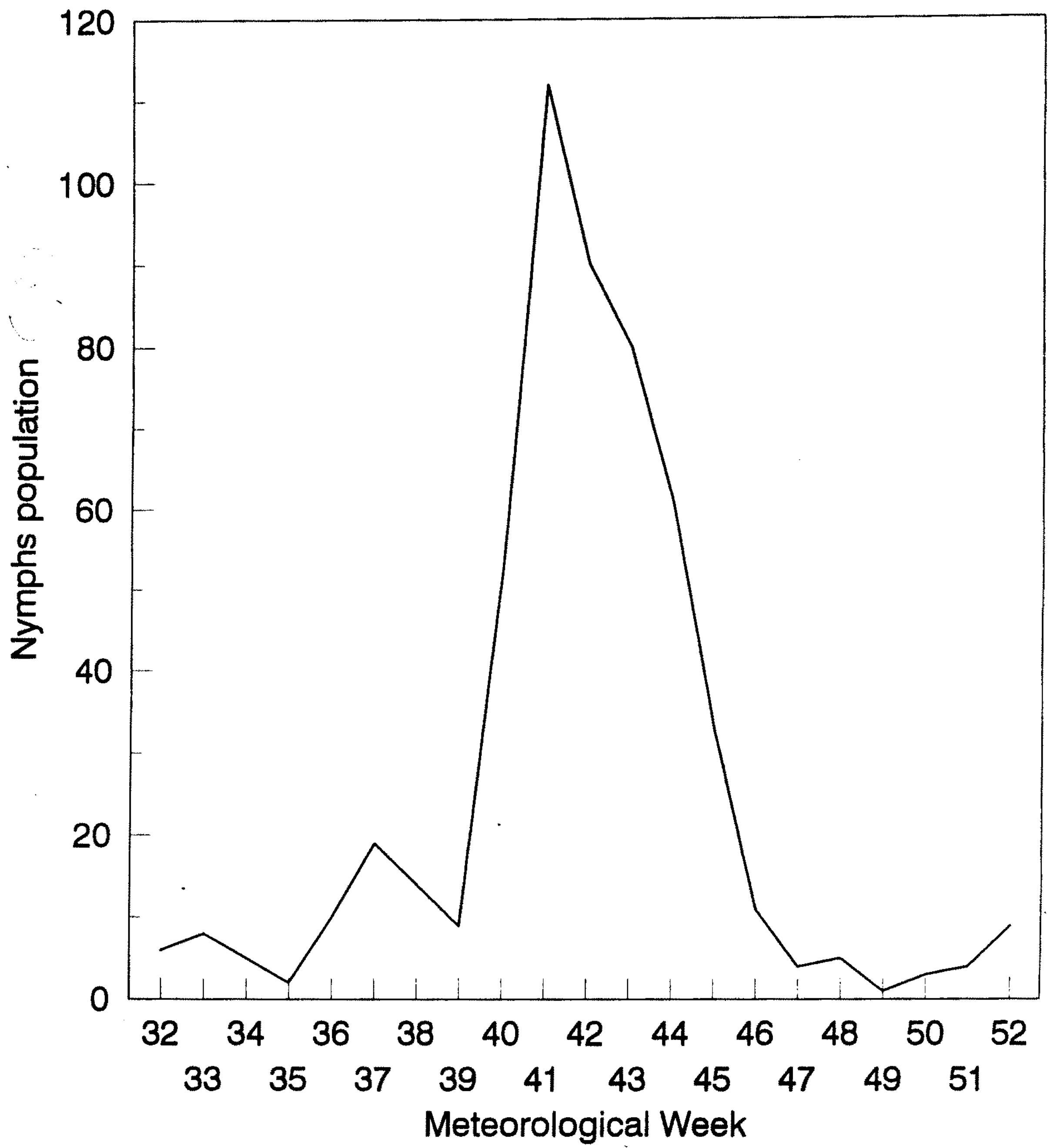

Fig. 2. Population dynamics of sorghum earhead bug
C. angustatus at milky stage.

maximum and minimum temperatures were 33.0°C and 18.8°C and morning and evening humidities were 71 per cent and 43 per cent, respectively. The number of nymphs per panicle decreased gradually in the month of October and reached a minimum (61 nymphs per panicle) when maximum and minimum temperatures were 29.4°C and 18.4°C and morning and evening humidities were 84 per cent and 56 per cent, respectively. In the month of November, the number reached the lowest (5 nymphs per panicle) in the last week of November, when maximum and minimum temperatures were 28.5°C and 19.6°C, and morning and evening humidities were 90 per cent and 66 per cent, respectively. In the month of December, it was least low (1 nymph per panicle) in the 49th week and comparatively high in the 52nd week (9 nymphs per panicle), when temperature and relative humidity ranged from 17.0 to 27.6°C and 59 to 90 per cent and from 16.0 to 29.6°C and 49 to 87 per cent, respectively. After that nymph population was not observed.

Population dynamics from data recorded in Table 11 and Fig. 3 during dough stage revealed that first incidence of the bug was noticed in 32nd meteorological week. The nymphs population in the month of August and September were negligible when temperature and humidity ranges were 30.0 to 33.4°C maximum; 22 to 23.1°C minimum, 74 to 87 per cent morning and 42 to 67 per cent evening relative humidities. In the month of October, population sharply increased and reached first peak in the 2nd week of October (15 nymphs per panicle) when maximum and minimum temperatures were 33.0°C and 18.8°C and morning and evening relative humidities were 71 and 43 per cent, respectively. It was reduced in 4th week of October upto 1 nymph per panicle when maximum and minimum temperatures were 29.3°C and 18.7°C and morning and evening relative humidity were 91 and 59 per cent, respectively. In the month of November and December the nymphal

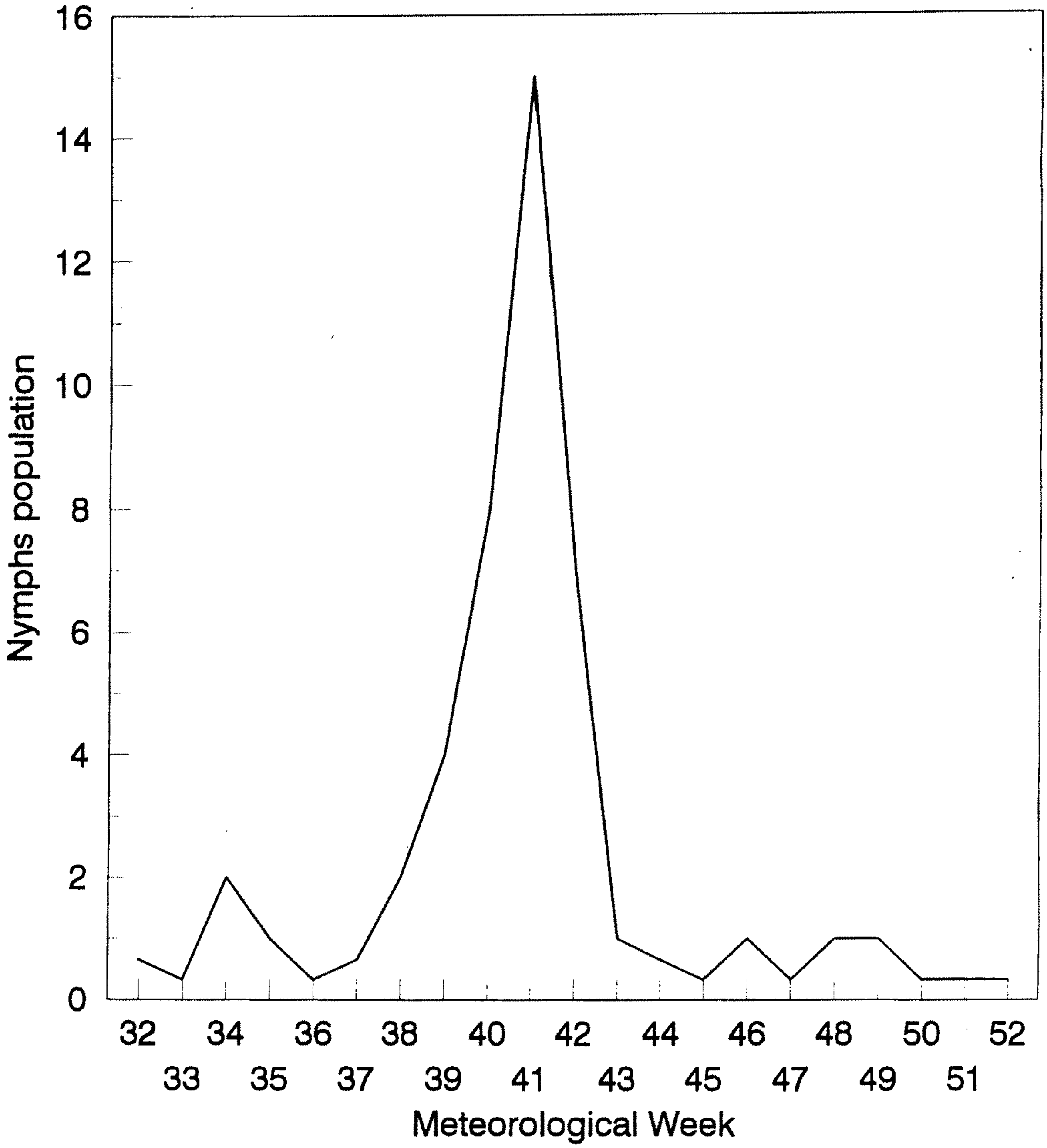

Fig. 3. Population dynamics of sorghum earhead bug *C. angustatus* at dough stage.

population sharply decreased and remained constant when maximum and minimum temperature ranges were 26.5 to 30.6°C and 16.9 to 18.4°C respectively and morning and evening relative humidity ranged from 83 to 90 per cent and 46 to 66 per cent, respectively. The nymphs were not observed in the month of January 1998 and as such not presented in Table 11.

4.3 Correlation coefficient between population of earhead bug and meteorological parameters

The correlation data at flowering stage are presented in Table 12 revealed that maximum temperature exhibited significant positive correlation with population of earhead bug. The minimum temperature showed negative non significant correlation with earhead bug population while relative humidity both in the morning and in the evening exhibited significant negative correlation with the bug population.

The correlation data at milky stage are presented in Table 13. It revealed that maximum temperature exhibited significant positive correlation with bug population. While the minimum temperature exhibited negative non significant correlation with bug population. Relative humidity in the morning and evening exhibited significant negative correlation with bug population.

Data on correlation at dough stage presented in Table 14 revealed that maximum temperature exhibited significant positive correlation with the bug population. Relative humidity both in the morning and in the evening showed significant negative correlation with bug population.

Table 12. Correlation between different meteorological parameters and earhead bug *C. angustatus* population at flowering stage

Abiotic factors	Rain-fall (mm)	Temperature °C		Relative humidity (%)		Correlation with *C. angustatus* Population
		Max.	Min.	A.M.	P.M.	
Rainfall (mm)	1.000	-0.225	0.124	0.445	0.663	0.110
Temperature °C (Max.)		1.000	0.702	-0.814	-0.586	0.398*
Temperature °C (Min.)			1.000	-0.476	0.045	-0.300
Relative humidity (%) (Morning)				1.000	0.715	-0.503*
Relative humidity (%) (Evening)					1.000	-0.493*

* Significant at 5 % level

Table 13. Correlation between different meteorological parameters and earhead bug *C. angustatus* population at milky stage

Abiotic factors	Rain-fall (mm)	Temperature °C		Relative humidity (%)		Correlation with *C. angustatus* Population
		Max.	Min.	A.M.	P.M.	
Rainfall (mm)	1.000	-0.172	0.241	0.381	0.639	-0.015
Temperature °C (Max.)		1.000	0.619	-0.796	-0.554	0.397*
Temperature °C (Min.)			1.000	-0.369	0.198	-0.114
Relative humidity (%) (Morning)				1.000	0.677	-0.471*
Relative humidity (%) (Evening)					1.000	-0.363*

* Significant at 5 % level

Table 14. Correlation between different meteorological parameters and earhead bug *C. angustatus* population at dough stage

Abiotic factors	Rain-fall (mm)	Temperature °C		Relative humidity (%)		Correlation with *C. angustatus* Population
		Max.	Min.	A.M.	P.M.	
Rainfall (mm)	1.000	-0.172	0.241	0.381	0.839	0.159
Temperature °C (Max.)		1.000	0.619	-0.796	-0.554	0.427*
Temperature °C (Min.)			1.000	-0.369	0.198	0.029
Relative humidity (%) (Morning)				1.000	0.677	-0.423*
Relative humidity (%) (Evening)					1.000	-0.439*

* Significant at 5 % level

DISCUSSION

Chapter V

DISCUSSION

Field experiments were conducted at Sorghum Research Station, Marathwada Agricultural University, Parbhani, to study the effect of insecticides on earhead bug control. Effect of climatic factors on occurrence of this pest was also studied.

Keeping in view the major objectives, the data were generated on different parameters. The result of experiment were compiled and statistically analysed The results have been presented in previous chapter. The significance of results are discussed under different heads in this chapter.

5.1 Chemical control of sorghum earhead bug *C. angustatus*

During experimentation, the mean number of nymphs varied between 12.94 to 21.88 nymphs per panicle before first spraying. Subsequently carbaryl appeared to be most effective followed by endosulphan, cypermethrin, Neem gold methomyl, dimethoate, monocrotophos, decamethrin and quinalphos insecticides after first spray.

After 13 days interval, the second spraying was administered. At this stage the mean nymphal population varied between 4.88 and 13.65 nymphs per paniclein various treatments. The data regarding the effect of different insecticides on the nymphal population are given in Table 4.

As regards the reduction in nymphs number due to chemical treatments, it revealed that after second application of insecticides, the nymphal population of earhead bugs was significantly reduced in all the treatment plots than untreated control (44.56 nymphs per panicle).

Among the insecticides tested. carbaryl 0.2 per cent (2.40 nymphs per panicle) was significantly more effective than endosulphan 0.05 per cent (3.73 nymphs per panicle) which was at par with decamethrin 0.005 per cent (4.33 nymphs per panicle) and Neemgold (4.44 nymphs per panicle). The other insecticides were best insecticides viz., cypermethrin 0.0025 per cent, methomyl 0.1 per cent, dimethoate 0.03 per cent, quinalphos and monocrotophos were significantly effective over control (44.56 nymphs per panicle).

The results obtained in the present investigation are similar to the results of Sharma and Leuschner (1987).They conducted field trials at ICRISAT. Hyderabad to determine the effectiveness of 8 contact and 3 systemic insecticides against the sorghum earhead bug *C. angustatus*. The insecticides were applied at the complete anthesis and milky stages at the rate of 500 g a.i./ha. On the basis of effectiveness in controlling pest, carbaryl at 500 g a.i./ha was the most effective insecticide.

During experimentation mean adult bug population fluctuated from 8.45 to 15.09 bugs per panicle before first spraying. After first spraying carbaryl was most effective (2.14 bugs per panicle). It was followed by endosulphan 0.05 per cent. monocrotophos 0.04 per cent. decamethrin 0.005 per cent which were at par with each other. The other insecticides viz., dimethoate 0.03 per cent, methomyl 0.1 per cent, Neemgold 1 per cent, cypermethrin 0.0025 per cent and quinalphos 0.05 per cent were significantly effective over untreated control (16.31 adults bug per panicle).

Before second spraying, the mean population of earhead bug fluctuated from 6.68 to 13.70 bugs per panicle. After second spray, carbaryl 0.2 per cent, which was at par with monocrotophos 0.04 per cent, decamethrin 0.005 per cent, endosulphan 0.03 per cent and dimethoate. The other insecticides were methomyl 0.1 per cent, Neemgold 1 per cent, quinalphos 0.05 per cent and cypermethrin 0.0025 per cent were better than control. All these insecticide proved to be significantly effective over untreated control (15.66 bugs per panicle).

The results of the present investigation are in conformity with the results obtained by Sharma *et al.* (1988).Sharma et al. (1988) tested tested 8 contact insecticides and found that carbaryl, chlorpyriphos and fenvalerate at the rate of 400 g a.i./ha were effective against earhead bug.

The results of the present investigations are similar to the results obtained by Rammurthy and Gopalan(1993).They obtained satisfactory control of earhead bug by two applications of endosulphan 35EC at the rate of 500 ml/ha.

Higher cob weight per plot was recorded in the plots treated with dimethoate followed by monocrotophos, carbaryl, Neemgold, methomyl, decamethrin, endosulphan, cypermethrin and quinalphos.The infestation of earhead bug got reduced and due to which the chaffy grains were not observed.These finally resulted into higher yeild.

Higher grain yield per plot was recorded with Neemgold, followed by monocrotophos, endosulphan, carbaryl, decamethrin, dimethoate, cypermethirn, quinalphos and methomyl. The results are in conformity with the results obtained by Jotwani *et al.* (1978). They noted that the sprays of carbaryl, quinalphos 0.05 per cent and phenthoate 0.05 per cent reduced the pest density and substantially increased grain yield.

5.2 Population dynamics of sorghum earhead bug *C. angustatus*

For studying this aspect, observations on sorghum panicles were recorded once in a week for different stages viz., at flowering, milky and dough stages of sorghum sown on different dates on all available sorghum hybrids. For this purpose, quadrates of 1 x 1 m were fixed in these general available sorghum plots and weekly observations were recorded on earhead bug.

First incidence of pest was noticed during 27th meteorological week at flowering stage of crop, when maximum and minimum temperatures were 31.4°C and 22.5°C and relative humidities in the morning and evening were 88 and 58 per cent, respectively. The meteorological data for the period of 27th to 52nd meteorological week (Table 9 and Fig. 1, 2 and 3) revealed that weather played an important role in the population buildup of earhead bug.

Incidence of the pest was found negligible from July to August and started gradually increasing from September, reaching its first peak (110 nymphs per panicle) in the month of October (42nd week) when maximum and minimum temperature were 32.4°C and 18.6°C and morning and evening humidities were 74 per cent and 45 per cent, respectively. The nymphal population again decreased during 44th week (31 nymphs per panicle). The nymphal population was from 45th week sharply increased and reached its second peak (83 nymphs per panicle) during the 46th meteorological week when maximum and minimum temperatures were 29.2°C and 19.3°C and morning and evening humidities were 90 per cent and 54 per cent, respectively. The population of the nymph sharply decreased upto 12 nymphs per panicle during the subsequent week (47th week). The population was very less during 51st week when maximum and minimum temperatures were 27.7°C and 17.9°C and morning and evening humidities were 94 per cent and 60 per cent, respectively.

Statistical analysis of the data showing correlation coefficient in Table 12 at flowering stage revealed that maximum temperature, minimum relative humidity in the morning and evening, and minimum temperature favoured the development of bugs. There was significantly positive correlation with maximum temperature and nymphs population. Relative humidities in the morning and in the evening showed significant negative correlation with the bug population.

The data on population dynamics (Table 13 and Fig. 2) at milky stage revealed that the first incidence of the mirid was noticed during 32nd week. The population was less upto 35th week (2 to 8 nymphs per panicle). The population increased gradually from subsequent week and reached its first peak (112 nymphs per panicle) during 41st week. After that the population decreased gradually and reached at the least as 1 nymphs per panicle during 49th week.

Statistical analysis of the data showing correlation coefficient in Table 13 at milky stage revealed that the maximum temperature had significant positive correlation with bug population. Morning and evening humidities showed significant negative relation with bug population.

In the present investigation, nymphal population was increasing from 36th week (September) onwards reaching its highest peak during 41st week (October).The observations are same to the observtions reported by Anonymous (1986). These researchers reported maximum number of earhead bugs during the second fortnight of September at ICRISAT, Hyderabad (Anonymous, 1986).

Above findings of present investigations are also in conformity with results obtained by Sharma and Lopez (1990). Sharma and Lopez (1990) studied population dynamics of sorghum earhead bugs at ICRISAT, Hyderabad. Lower minimum temperature and relative humidity were associated with a decline in density of *C. angustatus* during November to January.

The data on the population dynamics of earhead bug at dough stage (Table 11 and Fig. 3) revealed that the first incidence of the mirid was noticed during 31st week. The nymphal population was negligible upto 36th week. After that, the population increased and reached its peak in the 41st week (15 nymphs per panicle), when maximum and minimum temperatures were 33.0°C and 18.8°C, and morning and evening humidities were 71 per cent and 43 per cent, respectively. The population decreased and reached its minimum (0.33 nymphs per panicle) in the 45th week. The population of the bug in the month of November and December remained constant (0.33 nymphs per panicle). The bugs were not observed in the month of January 1998 and as such are not presented in Table 11.

Correlation studies (Table 14) at dough stage revealed that the maximum temperature had significant positive correlation with bug population. While morning and evening humidities had significant negative correlation with bug population.

Present investigation shows the positively significant correlation between bug population and maximum temperature. While minimum temperature exhibited negative non significant correlation with bug population. These findings are in conformity with results obtained by Prabhakar *et al.* (1986) and Sharma and Lopez (1990). Studies on the seasonal prevalence of the *C. angustatus* by Prabhakar *et al.* (1986) revealed that the population of *C. angustatus* were positively significant with the average maximum temperature.Sharma and Lopez (1990) reported that the maximum number of *C. angustatus*, *C. pallidus* and *E. belleroyei* were recorded during September - October. Lower minimum temperature (< 18°C) and RH (< 30 %)were associated with a decline in density of *C. angustatus* during November to January.

SUMMARY

Chapter VI

SUMMARY

The sorghum is an important staple crop which suffers heavy losses due to damage by earhead bug, *Calocoris angustatus* Leth. in late sown crop Both nymphs and adults suck the sap from developing grains and make them shriveled. Damage at early stage results in complete loss of grain while at milky stage, grains become shriveled and small. Damaged grains show distinct brown feeding punctures which affect the food quality both in terms of consumers acceptance and nutritional values. For the last five years the pest appeared in serious form in the region. Hence systematic research programme on this pest is need of the day in this region. An attempt was made during present investigations to study the bio-efficacy of certain insecticides on sorghum earhead bug *C. angustatus* and to study the population dynamics of sorghum earhead bug *C. angustatus*.

In respect of chemical control two spray of nine insecticides viz., Neemgold, decamethrin 2.8 EC, moncrotophos 36 SL, endosulphan 35 EC, methomyl 12.5L, dimethoate 30 EC, Carbaryl 50 WP, quinalphos 25 EC and cypermethrin 10 EC were used with three replications. keeping one untreated control for comparison.

Among these treatments carbaryl 50 WP 0.2 per cent proved to be significantly superior to rest of the treatments.

The data on nymphal count after second spraying shows that carbaryl 0.2 per cent was significantly superior over all other treatments.

As regards the adult bug population first spray, the data showed that carbaryl 0.2 per cent was significantly superior to rest of the treatments including control.

Also after second spray carbaryl 0.2 per cent was at par with moncrotophos 36 SL, decamethrin 2.8 EC, endosulphan 35 EC and dimethoate 30 EC. While these were significantly superior to control and rest of four insecticides.

As regards the weight of cob highest weight of cob was observed in dimethoate 0.03 per cent followed by monocrotophos 36 SL, carbaryl 50 WP, Neemgold, mehomyl 12.5L, decamethrin 2.8 EC, endosulphan 35 EC and quinalphos 25 EC.

As regards the grain yield, Neemgold 1 per cent proved to be the best insecticide and it was at par with monocotophos 0.04 per cent, endosulfan 0.05 per cent and carbaryl 0.2 per cent.

The studies on the population dynamics were carried out to correlate the meteorological factors such as maximum temperature, minimum temperature, morning relative humidity and evening relative humidity with population fluctuations of nymphs and adults of sorghum earhead bug at different stages viz., flowering, milky and dough stage.

The data regarding correlation of these factors with number of bug at flowering, milky and dough stages showed that maximum temperature exhibited positive correlation with bug population while, morning and evening relative humidities exhibited significant negative correlation with bug population.

Thus, it can be concluded that two sprays of carbaryl 0.2 per cent at flowering and milky stage are effective in controlling nymphs and adults of C. *angustatus* and increasing the grain yield.

At the three earhead stages of sorghum, correlation data showed that maximum temperature was significantly positively correlated with nymhal population and morning and evening humidities were negatively correlated with nymphal population.

LITERATURE CITED

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Anonymous (1984). Insect pest report. International Crops Research Institute for Semi-Arid Tropics, Annual Report, pp. 28-34.

Anonymous (1985). Sorghum insect pest. International Crop Research Institute for Semi-Arid Tropics. Annual Report, pp. 42-48.

Anonymous (1986). Sorghum insect pest. International Crop Research Institute for Semi-Arid Tropics. Annual Report, pp. 34-40.

Anonymous (1996). Districtwise Agricultural Statistical Information of Maharashtra, Part II (1995-96). Commissionerate of Agriculture, Pune.

Ballard, B.A. (1916). Bulletin No. 58, Agricultural Research Institute, Pusa, Calcutta, Supt. Govt. Printing Press, India, 8.

Hiremath, I.G. and T.S. Thontadaraya (1984). Seasonal incidence of the sorghum earhead bug *Calocoris angustatus* (Hemiptera : Miridae). Insect Sci. Appl. 5:467-674.

Hiremath, I.G. (1986). Host prefernece of sorghum earhead bug *Calocoris angustatus* Lethierry. Entomon. 11(2):121-125.

Hiremath, I.G. (1989). Survey of sorghum earhead bug and its natural enemies in Karnataka. J. Biol. Control, 3(1):13-16.

Jotwani, M.G., Premkishore, K.P., Shrivastava, Sukhani, T.R. and Verma, K.K. (1978). Studies on earhead pests of sorghum and its chemical control. Sorghum Newsletter, 21:21-61.

Jotwani, M.G., YOung, W.R. and Teetes, G.L. (1980). Elements of integrated control of sorghum pests. FAO Plant Production and Protection Paper Rome :FAO, pp. 159.

Jadhav, U.N. (1993). Studies on crop loss assessment and chemical control of sorghum earhead bug *Calocoris angustatus* Leth. M.Sc. Thesis submitted to MAU, parbhani.

Kulkarni, K.A. and Parmeshwarappa, R. (1978). Chemical control of sorghum earhead bug, *Calocoris angustatus* Leth. Sorghum Newsletter, 21:36.

Leuschner. K. (1985). Sorghum entomology research programme and need in the developing world. In Proceeding of the International Sorghum Entomology Workshop. 15-21 July. ICRISAT. Patancheru, pp 13-20.

Leuschner, K. and Sharma, H.C (1983). Assessment of losses caused by sorghum panicle pest. In All India Workshop on crop losses due to insect pest, 7-9 January, 1983, APAU, Rajendranagar, A.P., India, 53.

Mote, U.N. and Jadhav, S.S. (1990). Incidence and losses caused by sorghum earhead bug. J. Maharashtra agric. Univ., **15**(1):121-122.

Natarajan, N. and Soundrababu, P.C. (1988). Economic injury level for sorghum earhead bug *Calocoris angustatus* Leth. Sci. and Appli. **9**(3):396-398.

Natarajan, N., Babu, P.C.S. and Chelliah, S. (1989). Seasonal occurrence of sorghum earhead bug *Calocoris angustatus* Lethierry in South India. Tropical Pest Manag. **35**(1):70-77.

Paul, M.D. (1976). Evaluation of certain insecticides for the control of earhead bug *Calocoris angustatus*. Sorghum Newsletter. **19**:20.

Paul, M.D., Rao, D.V.S. and Narayana, K.L. (1983, recd 1985). Evaluation of insecticides as sprays and dusts for the control of sorghum earhead bug. Indian J. Pl. Prot., **11**(1/2):13-16.

Prabhakar. B., Rao, P.K. and Rao, B.H.K.M. (1981). Note on hemipterous species complex on sorghum at Hyderabad. Indian J. agric. Sci., **51**(11):818-819.

Prabhakar, B., Rao, P.K. and Rao, B.H.K.M. (1986). Studies on the seasonal prevalence of certain Hemiptera occurring on sorghum. Entomon. **11**(2):95-99.

Ramamurthy, R. and S. Gopalan (1993). Appropriate time of insecticidal application to control sorghum earhead bug *Calocoris angustatus* Leth. Pestology. **XVII**(5):14-15.

Rao, D.V. and Azam, K.M. (1987). Economic control of sorghum earhead bug. Indian J. Pl. Prot. **15**(2):194-197.

Reddy, K.V.S. (1988). Assessment of on-farm yield losses in sorghum due to insect pests. Insect Science and its Application, 9(6):679-685,

Reddy, K.V.S. and Davies, J.C. (1979). Pests of sorghum and pearl millet, and their parasites and predators recorded at ICRISAT Centre upto August, 1979. Cereal Entomology Progress Report, 2, Patancheru, India, pp. 58-61.

Sharma, H.C. and Leuschner, K. (1987). Chemical control of sorghum earhead bugs. Crop Protection Bulletin, ICRISAT Patancheru, Andhra Pradesh, India, 6(5):334-340.

Sharma, H.C. and Lopez, V.F. (1989). Assessment of avoidable losses and economic injury levels for the sorghum head bug *Calocoris angustatus* Lethierry in India. Crop Protection. 8(6):429-435, ICRISAT, Patancheru, P.O., Andhra Pradesh, India.

Sharma, H.C. and Lopez, V.F. (1990). Biology and population dynamics of sorghum head bug. Crop Protection, 9(3):164-173.

Sharma, H.C., Vidyasagar, P. and Leuschner, K. (1988). Field screening sorghum for resistance to sorghum head bug. J. econ. Ent., 81(1):327-334.

Sukhani, T.R. (1986). Insect pest management in sorghum plant. Plant Protection Bull., Divn. of Entomology., IARI, New Delhi, India, 62.

Sundararaju, D., Rangarajan, A.V., Ganapati, N. and Kaliachelvan, D. (1977). Chemical control of sorghum earhead bug *Calocoris angustatus* Leth. Sorghum Newsletter, 20:70.

Usman, S. (1967). Control of the sorghum earhead bug and webbing caterpillar in Mysore (Raichur). Sorghum Newsletter, 10:57.

APPENDIX - I

Mean weekly weather data for experiment

Met. week No.	Date	Rain-fall (mm)	RD (No.)	Temperature °C Max.	Temperature °C Min.	Humidity % AM	Humidity % PM
22	28-3 June	2.0	0	39.8	24.3	44	21
23	4-10	0.0	0	38.6	25.3	43	24
24	11-17	11.8	1	36.2	24.5	63	33
25	18-24	57.6	4	33.6	23.3	75	43
26	25-1 Jul	14.2	1	35.1	23.9	74	39
27	2-8	68.9	5	31.4	22.5	88	58
28	9-15	14.6	2	33.2	23.7	73	46
29	16-22	2.6	1	33.7	24.2	71	44
30	23-19	19.5	2	32.6	23.8	79	51
31	30-5 Aug	24.4	1	31.6	23.7	79	54
32	6-12	2.4	0	33.4	22.5	74	42
33	13-19	23.5	1	33.5	23.1	74	44
34	20-26	78.0	3	29.7	22.6	82	65
35	27-2 Sep	3.5	0	30.5	22.6	80	57
36	3-9	144.3	4	31.7	22.5	86	56
37	10-16	0.8	0	31.9	22.8	79	52
38	17-23	72.7	4	30.0	22.0	87	67
39	24-30	16.4	2	31.5	22.0	81	55
40	1-7 Oct.	2.4	0	32.2	19.1	80	46
41	8-14	0.0	0	33.0	18.8	71	43
42	15-21	47.4	1	32.4	18.6	74	45
43	22-28	102.8	4	29.3	18.7	91	59
44	29-4 Nov	10.4	1	29.5	18.4	84	56
45	5-11	6.6	1	30.7	16.9	83	46
46	12-18	13.4	1	29.2	19.3	90	54
47	19-25	30.4	2	29.7	18.1	90	56
48	26-2 Dec	101.0	3	28.5	19.6	90	66
49	03-09	38.0	2	27.6	17.0	90	59
50	10-16	3.6	1	26.5	13.2	84	46
51	17-23	24.0	2	27.7	17.9	94	60
52	24-31	00.0	0	19.6	16.0	87	49

APPENDIX - II

Details of insecticides used

Sr.No.	Name of the insecticides	Trade name	Source of supply
1.	Azardicatin	Neemgold	Murkumbi, Belgaon
2.	Decamethrin 2.8EC	Decis	Cynamid, Mumbai
3.	Moncrotophos 36SL	Nevacron	Hindustan Cibba-Geigy Ltd., Mumbai.
4.	Endosulfan 35 EC	Thiodon	National Pesticides & Chemicals, Mumbai.
5.	Methomyl 12.5L	Lannate	Du-pond, Mumbai
6.	Dimethoate 30 EC	Rogar	Rallis India Ltd., Mumbai
7.	Carbaryl 50 WP	Sevin	Rhone-Phonic, Mumbai
8.	Quinalphos 25 EC	Ekalux	Sandoz India Ltd., Mumabi.
9.	Cypermethrin 10 EC	Ripcord	Cyanamid, Mumbai