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**D Kumar, K Rolania, BL Sharma, L Kumar and VK Saini**

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## Research Article

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## Adaptive dynamics of earhead bugs in different genotypes of sorghum under abiotic factors

D Kumar<sup>1</sup>✉, K Rolania<sup>1</sup>, BL Sharma<sup>1</sup>, L Kumar<sup>1</sup> and VK Saini<sup>2</sup><sup>1</sup>Department of Entomology, CCS Haryana Agricultural University, Hisar-125004, India<sup>2</sup>Goveronment College, Hisar-125001, India✉ Corresponding author: DKumar, E-mail: [dilipshroff@rediffmail.com](mailto:dilipshroff@rediffmail.com)

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### Abstract

Based on preliminary screening, ten sorghum genotypes were selected on the basis of head bugs infestation and grain damage rating by visual observation method and replicated thrice in a plot size of 3 metre row length. The population build-up of sorghum earhead bugs was low with mean of 18.9 bugs/5 panicles in resistant genotypes as compared to susceptible ones (66.20 bugs/panicles) and minimum temperature, relative humidity of morning and evening hours were negatively correlated while, maximum temperature and sunshine hours were positively correlated with head bug population build-up in sorghum crop. It is inferred that sorghum earhead bugs did not preferred some sorghum varieties with certain morphological as well as biochemical plant characters which in the end reflects in the population build-up of sorghum earhead bugs.

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### Introduction

The genus *Sorghum* belongs to the family Gramineae and includes both cultivated and wild species for grain, fodder, feed, syrup, commercial and other purposes. Sorghum grains have multipurpose aspects as it is eaten as *Chapatti* (Bread), biscuit, sweet corn, pop sorghum, *sankatti* or *mudda* or *kali*, used for brewing to make beer, stockfeed, pigs, poultry, used as fuel, extracting dye, making basket and fish trap and construction of hut roof (Doggett 1970). The productivity of sorghum in India is 849.05 kg/ha, is well below the world's average (1444.6 kg/ ha). In

India, a total of 3.47 million tons of sorghum grains were produced over the acreage of 4.07 million hectares during 2020 (FAO 2021). The variability of grain type and plant type is remarkable. It is this ability to give a useful yield of grain under difficult agronomic conditions which makes sorghum such a valuable cereal (Satyagopal et. al. 2014). A major reason pitifully low sorghum yields, especially in African and Asian countries, are insect attack; although reliable yield loss data are hard to come by. Over the last two decades interest in sorghum for human consumption and animal feed has increased tremendously and so has the entomology input (ICRISAT

1985). Losses to earhead caused by midge and earhead bug alone varies from 15.0 to 30.0 per cent (Ballard 1916) to 75.0 per cent (Puttarudriah 1947) in local sorghum while in commercial cultivars damage ranges from 5.8 to 84.3 per cent (Rao & Azam 1987) to 43.0 to 93.0 per cent for earhead bug (Sharma and Lopez, 1989). There are over 150 insect species known to damage sorghum plant from germination to crop harvest (Seshu Reddy & Davies 1979). Advancing date of planting returns good yield and (also eliminates shoot fly attack) most sorghum pests can be avoided.

Various earhead bugs reported damaging this crop from India and abroad are, *Calocoris angustatus*, *Dolycoris indicus*, *Creontiades pallidus*, *Eurystylus immaculatus*, *Campylomma* spp. and *Taylorilygus vosseri* (Teetes et al. 1983). Of which *C. angustatus* is most important species in India and *E. immaculatus* in West-Africa. Damage results from bugs sucking juices from the immature developing grains, resulting in shrivelling of grain thereby affecting both yield and quality. Often the damaged seeds are infected with fungus that causes the seed to turn black and results in further deterioration in quality of seed. Damaged seeds rarely develop fully and all considerably smaller, softer and lighter in weight than the undamaged seed and subject to loss during harvesting (Wood & Stark 1972). Keeping in view of the above facts, the present investigation was initiated to study the population dynamics of earhead bug in dual purpose sorghum and their relation with abiotic factors to ascertain the feeding behavior to initiate the specific control measures accordingly.

### Materials and Methods

Based on preliminary screening, ten sorghum genotypes were selected on the basis of head bugs infestation (earhead bugs/5 panicles) and grain damage rating (GDR) by

visual observation method given by Sharma et al. (1992) for observations on population dynamics. Sorghum genotypes selected for their studies were ICSV 714, AKENT 7-1, ICSV 711, SPH 1352 and DJ 6514 from resistant group, while IS 2312, IS 112, SR 1048-1, SRF 2102 and SFCR 1111 from susceptible group. These genotypes were sown on 20<sup>th</sup> July, 2020 replicated thrice in a plot size of 3 metre row length. The observations on population dynamics of head bugs on these varieties were reared at weekly intervals. The total number of earhead bugs per plant were recorded at interval of one week on 5 randomly selected plants in each replication of each variety. The first observation was recorded on 20<sup>th</sup> September at initiation of 50 per cent flowering and successive observations were recorded at one week interval on 27 September, 4 October, 11 October and 18 October in cropping season of 2020. Data on abiotic factors were also collected and correlation ship with head bug incidence was worked statistically by using standard analysis of variance (ANOVA) procedures (Sheoran et al. 1998). The data on abiotic factors was from the preceding week of the observation on number of earhead bugs on panicle.

### Results and Discussion

Ten sorghum genotypes were selected on the basis of earhead bug infestation (earhead bugs/5 panicles) and grain damage rating (GDR). Five genotypes were from resistant group while other five were from susceptible group. These genotypes were sown during July, 2020 and observations on earhead bugs were recorded at weekly interval. The data presented in Table 1 revealed that the mean number of head bugs per 5 panicles during *kharif*, 2020 in different resistant sorghum genotypes ranged from 17.36 to 20.33. The mean number of head bugs per 5 earhead were minimum (17.36) in

genotype ICSV 711 and were maximum (20.33) in genotype SPH 1352. Irrespective of the genotypes, the mean number of bugs varied between 2.6 to 5.8 on different dates of observation, being maximum (5.8) when observed on 4<sup>th</sup> Oct., 2020 (D<sub>3</sub>) and was least (2.6) on 18<sup>th</sup> Oct., 2020 (D<sub>5</sub>). All the differences amongst different genotypes for different dates were significant. In case of susceptible genotypes, irrespective of date of observation, mean number of bugs/5 earheads (cumulative total) ranged from 42.68 to 92.97 in different genotypes, being maximum (92.97 bugs) in genotype SFCR 1111 and least (42.68) in genotype SRF 2102. Irrespective of genotypes, the mean number of bugs/5 earheads ranged from 10.0 to 18.4 in different genotypes, being maximum (18.4) when observed on 4<sup>th</sup> Oct., 2020 and were least (10.0) on 20<sup>th</sup> September, 2020. The mean number of bugs/5 panicles ranged from 8.53 to 18.59 in different genotypes, irrespective of date of observation. It can be concluded that

mean number of bugs/5 earheads were more on susceptible genotypes in comparison to resistant ones. Amongst the resistant genotypes, ICSV 711 was the most resistant genotype and amongst the susceptible ones SFCR 1111 was the most susceptible ones. From the above observations, the inference can be drawn that low initial population/low number of bugs included largely adults and nymphs were scanty, because at the time of flowering, adult females showed their preference to oviposit eggs inside the glumes, of developing ovary/grain. Eggs hatch and develop into nymphs and at the item of recording third observation; population of head bugs included more number of nymphs and less adults. Such type of observations had already been recorded by different workers (Hall & Teetes 1982a, b; Sharma & Lopez 1990a; Raja Sekhar 1997 & Malgwi et al. 2000; Haldhar et al. 2013; Haldhar et al. 2019).

**Table 1.** Population dynamics of earhead bug complex in resistant and susceptible sorghum genotype during *khariif*, 2020

| Mean number of earhead bugs/5 panicles |                      |                        |          |           |         |                             |                               |        |           |                 |           |       |
|----------------------------------------|----------------------|------------------------|----------|-----------|---------|-----------------------------|-------------------------------|--------|-----------|-----------------|-----------|-------|
| Resistant sorghum genotypes            |                      |                        |          |           |         |                             | Susceptible sorghum genotypes |        |           |                 |           |       |
| Date of observations                   | ICSV 714             | AKENT 7-1              | ICSV 711 | SPH 1352  | DJ 6514 | Mean                        | IS 2312                       | IS 112 | SR 1048-1 | SRF 2102        | SFCR 1111 | Mean  |
| D <sub>1</sub>                         | 3.67                 | 4.33                   | 2.01     | 3.66      | 2.02    | 3.1                         | 11.35                         | 9.67   | 9.03      | 6.01            | 4.32      | 10.0  |
| D <sub>2</sub>                         | 3.67                 | 4.02                   | 3.01     | 3.01      | 4.67    | 3.6                         | 13.65                         | 11.01  | 9.67      | 7.67            | 17.33     | 11.8  |
| D <sub>3</sub>                         | 4.67                 | 6.00                   | 5.01     | 6.33      | 7.01    | 5.8                         | 22.26                         | 14.00  | 12.65     | 12.00           | 31.33     | 18.4  |
| D <sub>4</sub>                         | 3.32                 | 3.33                   | 4.01     | 4.33      | 4.00    | 3.8                         | 14.65                         | 16.00  | 11.32     | 10.33           | 20.66     | 14.5  |
| D <sub>5</sub>                         | 2.66                 | 2.00                   | 3.32     | 3.00      | 2.33    | 2.6                         | 12.64                         | 11.33  | 7.65      | 6.67            | 19.33     | 11.5  |
| Total                                  | 17.99                | 19.68                  | 17.36    | 20.33     | 20.03   | 18.90                       | 74.55                         | 62.01  | 50.32     | 42.68           | 92.97     | 66.20 |
| Mean                                   | 3.54                 | 3.93                   | 3.47     | 4.06      | 4.00    | -                           | 14.91                         | 12.40  | 10.06     | 8.53            | 18.59     |       |
| S.Em. ±                                | 0.045                | 0.004                  | 0.005    | 0.003     | 0.003   | -                           | 0.031                         | 0.003  | 0.008     | 0.009           | 0.004     | -     |
| CD (P=0.05)                            | 0.150                | 0.014                  | 0.018    | 0.010     | 0.011   | -                           | 0.103                         | 0.009  | 0.027     | 0.030           | 0.012     | -     |
| Date of observations                   | Week                 | Temperature range (°C) |          |           |         | Relative humidity range (%) |                               |        |           | Sunshine (Hrs.) |           |       |
|                                        |                      | Max.                   |          | Min.      |         | Mor.                        |                               | Even   |           |                 |           |       |
| D <sub>1</sub> 20 September, 2020      | 13-19 Sept., 20      | 28.2-35.5              |          | 20.3-24.0 |         | 79-100                      |                               | 40-76  |           | 3.0-10.5        |           |       |
| D <sub>2</sub> 27 September, 2020      | 20-26 Sept., 20      | 33.6-36.4              |          | 17.6-22.5 |         | 69-95                       |                               | 29-40  |           | 8.7-10.5        |           |       |
| D <sub>3</sub> 4 October, 2020         | 27 Sept.-10 Oct., 20 | 35.5-36.6              |          | 16.1-20.4 |         | 80-92                       |                               | 22-38  |           | 9.6-10.1        |           |       |
| D <sub>4</sub> 11 October, 2020        | 4-10 Oct., 20        | 34.2-39.1              |          | 16.0-21.7 |         | 69-90                       |                               | 13-45  |           | 9.6-10.2        |           |       |
| D <sub>5</sub> 18 October, 2020        | 11-17 Oct., 20       | 31.2-34.4              |          | 16.7-21.7 |         | 75-96                       |                               | 29-45  |           | 8.2-9.5         |           |       |

### Correlation with temperature (°C)

The correlation between bug population and various abiotic factors like temperature, relative humidity and sunshine hours were worked out and results are presented in Table 2. The population build-up of sorghum earhead bugs on resistant and susceptible genotypes showed a positive correlation with maximum mean temperature (°C) whereas the correlation was negative with minimum mean temperature (°C). The correlation coefficient (r) of resistant sorghum genotypes (ICSV 714, AKENT 7-1, ICSV 711, SPH 1352 and DJ 6514) with mean maximum temperature was 0.376, 0.314, 0.759, 0.557 and 0.710, respectively and with minimum temperature (mean) was -0.109, -0.031, -0.901, -0.503 and -0.606, respectively (Table 2). The correlation between bug population and maximum temperature was significantly positive in resistant genotypes ICSV 711, SPH 1352 and DJ 6514 and the relationship between bug population and minimum temperature was significantly negative in these three varieties.

The correlation coefficient (r) of susceptible genotypes viz., IS 2312, IS 112, SR 1048-1, SRF 2102 and SFCR 1111 with maximum mean temperature (°C) was 0.602, 0.919, 0.825, 0.871 and 0.577, respectively and with minimum mean temperature (°C) was -0.706, -0.639, -0.411, -0.694 and -0.822, respectively (Table 2) under Hisar condition, head bug population showed a positive correlation with maximum temperature and negative correlation with minimum temperature. Similar results have earlier been reported where population of earhead bugs had shown a positive correlation with maximum temperature (Sharma and Lopez, 1990; Ramamurthy and Gopalan, 1993). Average minimum temperature was highly correlated with population of *C. angustatus* (Prabhakar et al. 1986). The results reported in

these studies are contradictory to those reported by Hiremath & Thontadarya (1984) they observed a significant negative correlation between bug population and maximum temperature.

### Correlation with relative humidity (%)

In case of relative humidity (%), all the entries had shown negative correlation with morning and evening relative humidity (%) except resistant genotypes ICSV 714 and AKENT 7-1 which exhibited positive correlation i.e. 0.081 and 0.129 that too only with relative humidity (%) morning (Table 2). The correlation between bug population and resistant and susceptible sorghum genotypes was negative. The correlation ship between bug population and mean relative humidity of morning hour was significantly negative in resistant sorghum genotype ICSV 711. In susceptible sorghum genotypes, this correlation was significantly negative in genotypes IS 112, SR 1048-1 and SRF 2102. The correlation coefficient (r) for bug population and morning relative humidity (%) for entries ICSV 711, SPH 1352 and DJ 6514 (resistant group) were -0.594, -0.292 and -0.311 respectively and the values for entries in susceptible genotypes viz. IS 2312, IS 112, SR 1048-1, SRF 2102 and SFCR 1111 were -0.273, -0.941, -0.527, -0.646 and -0.328, respectively. The relative humidity (%) evening was negatively correlated with bug populations both in resistant and susceptible group. In resistant entries ICSV 714, AKENT 7-1, ICSV 711, SPH 1352 and DJ 6514, the coefficients of correlation (r) was -0.259, -0.162, -0.787, -0.372 and -0.755, respectively, while in susceptible genotypes the value of 'r' was -0.603, -0.747, -0.617, -0.761 and -0.606 for IS 2312, IS 112, SR 1048-1, SRF 2102 and SFCR 1111 genotypes, respectively.

It can be concluded from the data obtained during both the year that bug population in most of genotypes studied (both

resistant and susceptible) had negative correlation with morning and evening relative humidity. These results are in contradiction to those earlier reports (Hiremath & Thontadarya 1984; Sharma & Lopez 1990). They observed a positive correlation between headbug population and relative humidity. This variation in results may be due to the difference in climatic conditions of two places and also there were rains before the recording of first observation on population and thereafter it was a complete dry spell during the season (Kharif, 2020).

#### Correlation with sunshine hours

The correlation between population dynamics of different sorghum entries and

sun-shine showed a positive correlation (Table 2). The population of earhead bugs on resistant sorghum genotypes i.e. ICSV 714, ICSV 711, SPH 1352 and DJ 6514 elicited positive correlation with sun shine hours ( $r = 0.058, 0.045, 0.774, 0.250$  and  $0.636$ , respectively) along with these susceptible entries IS 2312, IS 112, SR 1048-1, SRF 2102 and SFCR 1111 also displayed their positive reaction with sunshine hours ( $r = 0.530, 0.669, 0.416, 0.645$  and  $0.587$ , respectively). No studies in relation with population build-up of earhead bugs and sun-shine hours had earlier been reported.

**Table 2.** Correlation coefficients between sorghum genotypes and weather parameters

| Abiotic factors | Sorghum genotypes   |                      |          |          |         |         |         |           |          |           |
|-----------------|---------------------|----------------------|----------|----------|---------|---------|---------|-----------|----------|-----------|
|                 | ICSV 714            | AKENT 7-1            | ICSV 711 | SPH 1352 | DJ 6514 | IS 2312 | IS 112  | SR 1048-1 | SRF 2102 | SFCR 1111 |
| Tmax (°C)       | 0.376**             | 0.314*               | 0.759**  | 0.557**  | 0.710** | 0.602** | 0.919** | 0.825**   | 0.871**  | 0.577**   |
| Tmin (°C)       | -                   | -0.031 <sup>NS</sup> | -        | -        | -       | -       | -       | -         | -        | -         |
| RHm (%)         | 0.109 <sup>NS</sup> | 0.129 <sup>NS</sup>  | 0.901**  | 0.503**  | 0.606** | 0.706** | 0.639** | 0.411**   | 0.694**  | 0.822**   |
| RHe (%)         | 0.081 <sup>NS</sup> | 0.129 <sup>NS</sup>  | 0.594**  | -0.292*  | -0.311* | -0.273* | 0.941** | 0.527**   | 0.646**  | -0.328*   |
| Sun shine (hrs) | 0.259 <sup>NS</sup> | -0.162 <sup>NS</sup> | 0.787**  | 0.372**  | 0.755** | 0.603** | 0.747** | 0.617**   | 0.761**  | 0.606**   |

\*Significant at  $P = 0.05$ , \*\*Significant at  $P = 0.01$ , <sup>NS</sup>Non-significant

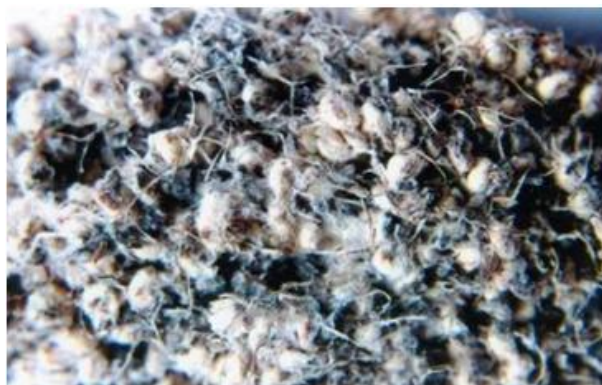
association with insect-pests particularly head bugs.

#### Grain mould

During the studies on population dynamics of earhead bugs complex on sorghum panicles, it was observed that the panicles which were heavily infested by bugs, developed fungus growth leading to development of mould on these panicles (Fig 1 and 2). This finding in this experiment is in conformity with those reported by Sharma et al. (1995, 2000); Wood and Starks (1972) and Marley & Malgwi (1999). They had reported the presence of mould on sorghum grains in



**Figure 1.** Development of mould on panicles



**Figure 2.** Development of mould on panicles (close-up)

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