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# Genetic variability and heritability in sorghum (*Sorghum bicolor* (L.) Moench) germplasm lines

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**Abstract**
Sorghum shoot fly (*Atherigona soccata* Rond.) one of the major constraints in sorghum production and host plant resistant is one of the component to control to sorghum shoot fly. The present study was carried out to assess the variability in sorghum germplasm lines for shoot fly resistant traits. The experiment was conducted in Randomized block design (RBD) with two replication on the farm of Sorghum research station, VNMKV, Parbhani during *rabi* 2015 with 116 sorghum germplasm lines and four checks. Observation were recorded on sixteen characters *viz.*, deadheart percentage, trichome density, leaf glossiness, seedling vigour, leaf wetness, Plumule and leaf sheath pigmentation, chlorophyll content, plant height, leaf length, leaf breadth, leaf angle, days to 50% flowering, days to maturity, 100 seed weight and grain yield per plant. The data were collected and analyzed for genotypic and phenotypic coefficient of variation (GCV and PCV), heritability, and expected genetic advance. Analysis of variance showed the significant variability for all the traits studied and suggesting presence of wide range of variation among the genotypes for all the characters. The genotypic coefficient of variation was lower than the phenotypic coefficient of variation for all the characters, indicating the importance in hybridization programme for generating variability. High estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for the traits dead heart percent at 14 (31.60 and 33.57) and 28 (35.85 and 36.57) DAE, trichome density (adaxial (74.36 and 74.47) and abaxial (111.53 and 111.66), Plumule and leaf sheath pigmentation (41.93 and 44.26), number of tillers (27.00 and 46.33) and grain yield per plant (42.56 and 46.19). The traits dead heart %, trichome density both at adaxial and abaxial side of leaf surfaces, leaf glossiness, Plumule and leaf sheath pigmentation and grain yield per plant, exhibiting higher gcv and pcv values along with high estimates of heritability and genetic advance were considered most important and selection for these characters could be more effective for improving shoot fly resistance.

**Keywords:** *Sorghum bicolor, Atherigona soccata,* variability, heritability, GCV, PCV, genetic advance

## Introduction
Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important cereal crop globally after rice, maize, wheat and barley. It is predominantly cultivated in semi-arid tropics (SAT) and is the dietary staple of more than 500 million people in 30 countries. But the yield penalties to sorghum is very high starting from seedling stages to marketing and the maximum losses is caused due to biotic stress. Seven to eight major pests causes economic losses to this crop. Out of this sorghum shoot fly (*Atherigiona soccata* Rond.) one of the most important pest and owing to limitations like high costs and toxic hazards of chemicals.

In Maharashtra sorghum shoot fly is one of the major constraints that limit he production and causes heavy losses up to 75.60% in grain and 68.90% in fodder. The adult fly lays white, elongated, cigar shaped eggs single on the under surface of the leaves, parallel to the midrib after egg hatch the larvae crawl to the plant whorl and move downward between the folds of the young leaves till they reach growing point. They cut the growing tip resulting in deadheart formation. Sorghum shoot fly completes its life cycle in 17-21 days. Host plant resistance is one of the most effective means of keeping shoot fly population below economic threshold levels, as it does not involve any cost input by the farmers.

The number of improved varieties has been identified and developed by using landraces, but the level of resistance are low to moderate. Plant resistance to sorghum shoot fly appears to be complex character and depend on the interplay of number of componential characters which finaly sum up in the expression of resistance shoot fly. According to Briggs and Knowles (1967) the heritability of quantitative characters is usually high because breeding behavior can be predicted. Furthermore high heritability coupled with genetic advance indicates that additive gene effect are operating and selection for superior genotype is possible. In the view of merge genetic information available, the present investigation was undertaken to study the variability for shoot fly resistance in germplasm lines among the character related to shoot fly resistance.

## Methods and Materials

The material used for this study was comprised Hundred and sixteen genotypes and four checks (One resistant check IS-18851, one susceptible check DJ-6514 and two varietal checks SPV-1411 and PVK-801). The material was collected from Indian Institute of Millet Research, Hyderabad and Sorghum Research Station, VNMKV, Parbhani. The experiment was conducted at the field of Sorghum Research Station, VNMKV, Parbhani during rabi 2015-2016. The experiment was conducted in randomized block design, replicated twice with a spacing 45 cm between rows and 15 cm between plants. Five plants at random in each plot and replication were chosen and labeled for recording observations and the mean of five plants was used for statistical analysis. Observations on different morphological characteristics were recorded on these plants at different stages of crop growth. The data on the following morphological and yield contributing traits *viz.*, plant height, leaf length, leaf breadth, number of tillers per plant, days to 50% flowering, days to maturity, 100 seed weight and Shoot fly resistance characters like leaf glossiness, seedling vigour, deadheart incidence % at 14 and 28 DAE, leaf angle, Trichome density (both at adaxial and abaxial leaf surface), chlorophyll content, Plumule and leaf sheath pigmentation and leaf wetness were recorded. The genotypic and phenotypic coefficients of variation were calculated according to Burton (1952) [5]. Heritability was estimated according to the method suggested by and genetic advance was estimated according to Johnson *et al.*, (1955) [10].

## Results and Discussion

The results of analysis of variance for hundred and twenty genotypes (table 1) in *rabi* sorghum observed highly significant differences among the genotypes for sixteen characters indicating presence of sufficient amount of variability among genotypes for these sixteen characters for character under study. This indicated ample scope for exploitation of all the above characters. Observed similar results for plant height, days to 50 percent flowering and grain yield per plant. Observed similar results for plant height and days to 50 percent flowering.

**Table 1:** Analysis of Variance for Eighteen characters studied for resistance to sorghum shoot fly.

| Sr. No | Characters | Source of variation | | |
|---|---|---|---|---|
| | | Treatments | Replication | Error |
| 1 | Dead hearts % at 14 DAE | 107.35** | 65.312 | 6.49 |
| 2 | Dead hearts % at 28 DAE | 416.28** | 112.27 | 8.30 |
| 3 | Trichome Density (Adaxial) | 1630.25** | 4.86 | 22.46 |
| 4 | Trichome Density (Abaxial) | 7579.35** | 34.50 | 8.61 |
| 5 | Leaf Glossiness | 1.34 | 0.05 | 0.10 |
| 6 | Seedling Vigour | 0.822 | 0.85 | 0.11 |
| 7 | Leaf Wetness | 0.683 | 0.75 | 0.10 |
| 8 | Plumule and Leaf sheath pigmentation | 1.477* | 0.37 | 0.07 |
| 9 | Plant Height | 1092.30** | 36.81 | 10.91 |
| 10 | Leaf Length | 71.80** | 0.17 | 3.10 |
| 11 | Leaf Breadth | 1.39* | 0.08 | 0.06 |
| 12 | Number of Tillers | 0.54 | 0.006 | 0.26 |
| 13 | Leaf Angle | 190.95** | 18.70 | 4.65 |
| 14 | Chlorophyll content | 96.50** | 0.36 | 3.50 |
| 15 | Days to 50% Flowering | 95.91** | 16.53 | 4.10 |
| 16 | Days to Maturity | 41.42** | 81.66 | 4.33 |
| 17 | 100-seed weight (g) | 0.41 | 0.002 | 0.03 |
| 18 | Grain yield (g/plant) | 174.04** | 39.04 | 14.22 |

** and * Significant at 1 percent and 5 percent level respectively.

## Genotypic and phenotypic co-efficient of variation

Results of genotypic and phenotypic coefficient of variances along with heritability in broad sence and expected genetic advance are given in table 2. In general, the estimates of PCV were higher than those for GCV for all the traits however the differences between these parameters were of lower magnitude suggesting lower influence of environment in expression of these characters. Similar results were reported by High estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for the traits dead heart percent at 14 (31.60 and 33.57) and 28 (35.85 and 36.57) DAE, trichome density (adaxial (74.36 and 74.47) and abaxial (111.53 and 111.66), Plumule and leaf sheath pigmentation (41.93 and 44.26), number of tillers (27.00 and 46.33) and grain yield per plant (42.56 and 46.19). The result also revealed that the medium GCV and PCV for the trait leaf glossiness (26.34 and 28.45), seedling vigour (21.89 and 21,86), leaf wetness (16.97 and 19.72), plant height (17.83, and 18.01), leaf length (10.78 and 11.26), leaf breadth (14.81 and 15.55), leaf angle (17.13 and 17.56), chlorophyll content (15.09 and 15.65) and 100 seed weight (17.94 and 19.46), where as lowest GCV and PCV was observed for the trait days to 50% flowering (8.77 and 9.15)and days to maturity (3.48 and 3.87). (2015). also reported high GCV and PCV for grain yield per plant. reported low GCV and PCV for days to 50 percent flowering. Similar results were also observed by Gloria buraw *et al.*, (2012).

**Table 2:** Genetic Variability Parameters for Eighteen characters studied for resistance to sorghum shoot fly.

| Sr. No. | Characters | Range | | Mean | $\sigma^2$ (g) (Genotypic variance) | $\sigma^2$ (p) (Phenotypic variance) | GCV (%) | PCV (%) | $h^2$ b.s (%) | GA | GA as % of mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | minimum | maximum | | | | | | | | |
| 1 | Deadheart % 14 DAE | 8.30 | 38.40 | 22.4700 | 50.4310 | 56.9256 | 31.6043 | 33.5777 | 88.59 | 13.7693 | 61.2785 |
| 2 | Deadheart % 28 DAE | 17.90 | 68.55 | 39.8357 | 203.9720 | 212.2761 | 35.8519 | 36.5745 | 96.09 | 28.8395 | 72.3960 |
| 3 | Tichome Density (adaxial) | 0.00 | 277.50 | 121.3833 | 8148.9057 | 8171.3694 | 74.3688 | 74.4712 | 99.73 | 185.7031 | 152.9889 |
| 4 | Tichome Density (abaxial) | 0.00 | 194.00 | 55.1625 | 3785.3704 | 3793.9839 | 111.5348 | 111.6616 | 99.77 | 126.5983 | 229.5007 |
| 5 | Leaf Glossiness | 1.50 | 5.00 | 2.9938 | 0.6220 | 0.7256 | 26.3444 | 28.4531 | 85.73 | 1.5043 | 50.2475 |
| 6 | Seedling Vigour | 1.75 | 5.00 | 3.1388 | 0.3518 | 0.4711 | 18.8973 | 21.8671 | 74.68 | 1.0559 | 33.6415 |
| 7 | Leaf Wetness | 2.00 | 4.75 | 3.1771 | 0.2909 | 0.3927 | 16.9762 | 19.7245 | 74.07 | 0.9562 | 30.0983 |
| 8 | Plumule and Leafsheath Pimentation | 1.00 | 3.00 | 1.9938 | 0.6990 | 0.7788 | 41.9347 | 44.2644 | 89.75 | 1.6317 | 81.8391 |
| 9 | Plant Height (cm) | 67.50 | 198.00 | 130.3833 | 540.6956 | 551.6131 | 17.8342 | 18.0134 | 98.02 | 47.4245 | 36.3731 |
| 10 | Leaf Length (cm) | 38.95 | 70.45 | 54.3425 | 34.3499 | 37.4549 | 10.7851 | 11.2620 | 91.71 | 11.5622 | 21.2764 |
| 11 | Leaf Breadth (cm) | 3.20 | 7.90 | 5.4942 | 0.6628 | 0.7308 | 14.8177 | 15.5593 | 90.69 | 1.5971 | 29.0696 |
| 12 | Number of Tillers | 0.30 | 2.40 | 1.3800 | 0.1389 | 0.4088 | 27.0094 | 46.3336 | 33.98 | 0.4476 | 32.4340 |
| 13 | Leaf angle (degree) | 37.00 | 84.50 | 56.3125 | 93.1482 | 97.8019 | 17.1389 | 17.5618 | 95.24 | 19.4030 | 34.4559 |
| 14 | Chlorophyll content | 34.00 | 63.40 | 45.1850 | 46.4991 | 50.0087 | 15.0914 | 15.6505 | 92.98 | 13.5453 | 29.9775 |
| 15 | Days to 50% flowering | 64.00 | 96.00 | 77.2458 | 45.9077 | 50.0082 | 8.7714 | 9.1547 | 91.80 | 13.3731 | 17.3124 |
| 16 | Days to Maturity | 108.50 | 138.00 | 123.4750 | 18.5442 | 22.8831 | 3.4876 | 3.8742 | 81.04 | 7.9858 | 6.4675 |
| 17 | 100-seed weight (g) | 1.45 | 3.90 | 2.4433 | 0.1922 | 0.2262 | 17.9417 | 19.4644 | 84.97 | 0.8324 | 34.0684 |
| 18 | Grain yield (g/plant) | 6.40 | 52.85 | 21.0017 | 79.9107 | 94.1354 | 42.5646 | 46.1979 | 84.89 | 16.9666 | 80.7871 |

**Heritability**

The coefficient of variation indicates only the extent of variability existing for various characters, whereas amount of heritability permits greater effectiveness of selection by separating out the environmental influence from the total variability and to indicate accuracy with which a genotype can be identified phenotypically. In the present study high estimates of heritability were observed for the traits viz., trichome density on adaxial (99.73) and abaxial (99.77) leaf surface, deadheart percent 14(88.59) and 24 (96.09), leaf glossiness (85.73), seedling vigour (74.68), leaf wetness (74.07), Plumule and leaf sheath pigmentation (89.75), plant height (98.02), leaf length (91.71), leaf breadth (90.69), leaf angle (95.24), chlorophyll content (92.98), days to 50% flowering (91.80), days to maturity (81.04), grain yield per plant (84.89),100 seed weight (84.97), except number of tillers (33.98). Similar observations were made by Kalpande *et al.*, (2014) [12] and Sonone *et al.*, (2015) [17]. If heritability is 100 percent, the phenotypic performance will be perfect indication of genotypic performance ($6^2$ph = $6^2$g). The GCV along with heritability estimates would provide a better picture of the amount of genetic advance expected by phenotypic selection (Burton, 1952) [5]. Reported that if the heritability is due to additive effect, it would be associated with high genetic gain and if with non additive, genetic gain will be low.

**Genetic Advance**

The genetic advance expressed as percentage of mean is the product of genotypic coefficient of variation, the square root of heritability ratio and selection intensity. Johnson *et al.*, (1955) [10] suggested that heritability estimates in conjunction with genetic advance were reliable in predicting the resultant effect from selecting the best individuals. Yield being a complex character is influenced by many factors. In the present study, high heritability coupled with high genetic advance as percent mean was observed for deadheart percent (14 and 28 DAE), trichomes density (Adaxial and Abaxial), leaf glossiness. Plumule and leaf sheath pigmentation, plant height, grain yield per plant and suggesting that these traits are under the control of additive gene action and can be improved through simple selection procedure, Similar results were reported by This indicates the lesser influence of environments in expression of characters and prevalence of additive gene action in their inheritance, since are amenable for simple selection. While the character leaf length, leaf breadth, chlorophyll content, days to 50 percent flowering and 100 seed weight showed high heritability but low genetic advance as percent of mean, thereby indicating that expression of these characters may be due to non-additive gene action.

The overall result indicated that there is adequate genetic variability present in the material used. The traits dead heart %, trichome density both at adaxial and abaxial side of leaf surfaces, leaf glossiness, Plumule and leaf sheath pigmentation and grain yield per plant, exhibiting higher gcv and pcv values along with high estimates of heritability and genetic advance were considered most important and selection for these characters could be more effective for improving shoot fly resistance.

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