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Estimation of genetic parameters for shoot fly tolerance in F_2 population of sorghum (*Sorghum bicolor* (L.) Moench)

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Abstract
An experiment was conducted to estimate the genetic variability, heritability and genetic advance for shoot fly resistance parameters in F_2 population of *rabi* sorghum [*Sorghum bicolor* (L.) Moench] at the experimental farm of Sorghum Research Station, VNMKV, Parbhani during *rabi* 2022-23. Experimental material for present investigation included 04 F_2 populations along with 06 parents and 02 checks. Analysis of variance showed the significant variability for all the studied characters. The values of phenotypic coefficient of variation were higher in magnitude than the genotypic coefficient of variation for all the traits. High phenotypic and genotypic coefficient of variation was observed for seedling vigor, leaf glossiness, trichome density (adaxial and abaxial), dead heart percent at 14 DAE and 28 DAE and grain yield per plant. High heritability coupled with high genetic advance was observed for leaf angle, trichome density (adaxial and abaxial), plant height, fodder yield per plant, grain yield per plant, dead hearts percent at 28 DAE indicating these traits are primarily controlled by additive gene effects. Hence these traits can be utilized effectively in sorghum improvement programs to develop and enhance shoot fly-resistant varieties through direct selection.

Keywords: Variability, heritability, genetic advance, shoot fly, *Sorghum bicolor*

Introduction

Sorghum is cultivated as a staple crop in the semi-arid tropics (SAT) because of its better adaptation to a wide range of ecological conditions, low input cultivation and diverse uses (Aruna *et al*. 2011) [2]. however, the negative impacts on sorghum yield are substantial, beginning from the seedling stage and continuing through to harvest. These detrimental effects are predominantly attributed to biotic stresses (Craufurd *et al*. 1999) [5]. Sorghum is attacked by more than 150 insect species causing a 32% crop loss (Borad and Mittal, 1983) [3]. Out of the important insect-pests sorghum shootfly, stem borer and midge fly. Among them, the sorghum shoot fly, *Atherigona soccata* (Rondani)
(Diptera: Muscidae), is the most destructive pest causing severe damage up to 4 weeks of sowing leading to 75.6% yield losses (Pawar *et al*. 1984) [14]. Consequently, the most practical approach to reduce grain and stored yield losses caused by insect pests, involves host plant resistance in combination with timely sowing. the knowledge of genetic variability, heritability and genetic advance is of prime importance for successful crop improvement programme. Therefore, the present study was undertaken to estimate the various genetic variability parameters of shoot fly resistance parameters in F2 population derived by crossing shootfly resistant and less tolerant sorghum genotypes with aim to isolate shootfly tolerant high yielding genotypes and to find out suitable breeding method and traits that impart resistance against shootfly.

Materials and Methods

The material used for this study was comprised of 04 F_2 populations derived from advancement of F_{1s} which were produced by crossing well adapted rabi sorghum genotypes MS 104B, IS 153 B, PR 108 and CSV 22R with shootfly resistance lines IS 2205 and IS

18551. These four F_2 populations along with 06 parents and 02 checks (DJ 6514: Susceptible check and Parbhani Moti: rabi sorghum variety) were planted in randomized block design with three replications during rabi 2022-23 at Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Parbhani is located at 19.27 °N to 76.78 °E at an elevation of 347 meters. F2 population was sown in 12 rows and parents and checks in 2 rows each of 4 m length. Likewise 960 plants were maintained in each F2 population in all three replications. Spacing of 0.45 m and 0.15 m between rows and within plants was adopted. All the agronomical practices were followed to raise good crop. Observations were recorded for thirteen shoot fly and yield related traits *viz*., seedling vigor, leaf glossiness, leaf angle, chlorophyll content, trichome density (adaxial and abaxial), plant height, days to 50 percent flowering, fodder yield per plant, grain yield per plant, 100 seed weight, dead heart percent at 14 DAE and 28 DAE.

Five random plants from parents and fifty random plants from F_2 population in each plot and replication were chosen and labeled for recording observations and the mean of these was used for statistical analysis. Analysis of variance was performed to test the significance of differences between the genotypes for all the characters as suggested by Panse and Sukhatme (1967) [11]. The genotypic and phenotypic covariance were calculated as per the formulae described by Burton (1952) [4]. Heritability (Broad sense) was calculated according to the method suggested by Allard (1960) [1] and genetic advance (at 5 percent selection intensity) was calculated for each character using the formula suggested by Johnson *et al.*, (1955) [7].

Results and Discussion

Genotypic and Phynotypic coefficient of variability

The mean sum of squares due to treatments, genotypic and phenotypic variance and co variance presented in Table 1 revealed the prevalence of significant differences among the genotypes for thirteen characters indicating presence of sufficient amount of variability among F_2 populations, parents and checks. Presence of genetic variability is an important pre requisite in any crop improvement programme. Breeder has to quantify the fixable and non-fixable component of variation for further crop improvement. Genetic variance and GCV were lower than phenotypic variance and PCV, respectively. However, magnitude of the differences was of lower for all the traits. Lower differences between GCV & PCV values suggests the less influence of environment in expression of these traits (More *et al.* 2019) [9]. Seedling vigor (26.89, 27.61), leaf glossiness (30.34, 30.99), trichome density (adaxial: 47.39 and 67.39 and abaxial: 47.65 and 68.67), dead heart percent at 14 DAE (54.99, 55.51) and 28 DAE (54.00, 54.33) and grain yield per plant (34.28, 34.86) exhibited high phenotypic and genotypic coefficient of variation. For successful crop improvement programme. Syed *et al*. (2018) [15], More *et al.* (2020) [8], Thorat *et al.* (2021) [16] also observed high GCV and PCV values for seedling vigour, leaf glossiness, trichome density, dead heart percentage and grain yield per plant. 100 seed weight, chlorophyll content, plant height, leaf angle and fodder yield exhibited moderate phenotypic and genotypic coefficient variation. Days to 50 percent flowering recorded low phenotypic and genotypic coefficient of variation. Nimbalkar *et al*. (1988) [10] recorded similar results for days to 50% flowering.

Table 1: Mean, range, treatment mean square and Genetic Variability parameters for thirteen characters

Sr. No.	Characters	Treatment MSS	Genotypic variance ($\sigma^2 g$)	Phenotypic variance ($\sigma^2 p$)	GCV (%)	PCV (%)
1.	Seedling vigor (1-5 scale)	1.40**	0.46	0.48	26.89	27.61
2.	Leaf glossiness (1-5 scale)	2.07**	0.68	0.71	30.34	30.99
3.	Leaf angle (Degrees)	801.50**	265.78	269.94	17.22	17.35
4.	Chlorophyll content (SPAD)	263.30**	85.99	91.31	15.63	16.10
5.	Trichome Density (Adaxial)	8034.7**	2668.16	2698.34	47.39	47.65
6.	Trichome Density (Abaxial)	335.61**	110.46	114.69	67.39	68.67
7.	Plant Height (cm)	2863.09**	946.18	970.72	15.16	15.36
8.	Days to 50% Flowering	4.397**	1.23	1.94	1.51	1.89
9.	Fodder yield per plant (g)	753.45**	248.37	256.71	16.34	16.61
10.	Grain yield per plant (g)	629.64**	207.49	214.64	34.28	34.86
11.	100 seed weight (g)	0.986**	0.32	0.35	18.78	19.52
12.	Dead hearts % at 14 DAE	207.72**	68.81	70.10	54.99	55.51
13.	Dead hearts % at 28 DAE	929.04**	308.46	312.12	54.00	54.33

Heritability and Genetic advance

High heritability coupled with high genetic advance was observed for leaf angle (98.46% and 33.32), trichome density at adaxial (98.88% and 105.81) and abaxial surface (96.31% and 21.25), plant height (97.47% and 62.56), fodder yield per plant (96.75% and 31.93), grain yield per plant (96.67% and 29.43), dead hearts percent at 28 DAE (98.83% and 35.97) (Table 2)indicating the preponderance of additive gene effect and selection for these traits would be more effective. Similar results were reported by Paul *et al.* (1984) [12] for deadheart incidence, Hallali *et al*. (1985) [6] for non-preference ovipsotion, trichome density and deadheart incidence, More *et al*. (2020) [9] for grain yield, dead heart percentage and trichome density at adaxial and abaxial surface.

While, moderate genetic advance was recorded for chlorophyll content and dead hearts percent at 14 DAE. High heritability accompanied with low genetic advance for the characters seedling vigour, leaf glossiness, days to 50 percent flowering and 100 seed weight suggests the trait is under the control of non-additive gene action. Similar results were obtained by Patil *et al*. (2016) [13], Syed *et al*. (2018) [15], More *et al*. (2020) [8] and Thorat *et al*. (2021) [16].

Table 2: Heritability and genetic advance for thirteen characters studied for shootfly resistance parameters

Sr. No.	Characters	Range		Mean	Heritability B.S. (%)	GA	GA as % of mean
		Minimum	Maximum				
1.	Seedling vigor (1-5 scale)	1.90	4.23	2.52	94.90	1.36	53.98
2.	Leaf glossiness (1-5 scale)	1.30	3.87	2.71	95.80	1.66	61.18
3.	Leaf angle (Degrees)	67.67	118.67	94.69	98.46	33.32	35.19
4.	Chlorophyll content (SPAD)	46.20	75.33	59.34	94.18	18.54	31.24
5.	Trichome Density (Adaxial)	7.27	184.47	109.00	98.88	105.81	97.07
6.	Trichome Density (Abaxial)	2.40	31.6	15.59	96.31	21.25	136.25
7.	Plant Height (cm)	134.3	243.33	202.84	97.47	62.56	30.84
8.	Days to 50% Flowering	71	75	73.61	63.56	1.82	2.47
9.	Fodder yield per plant (g)	71.27	122.37	96.44	96.75	31.93	33.11
10.	Grain yield per plant (g)	27.03	65.67	42.02	96.67	29.18	69.43
11.	100 seed weight (g)	2.012	4.09	3.01	92.59	1.12	37.23
12.	Dead hearts % at 14 DAE	4.49	34.94	15.08	98.15	16.93	112.23
13.	Dead hearts % at 28 DAE	10.89	71.56	32.52	98.83	35.97	110.60

Conclusion

High magnitude of broad-sense heritability, coupled with significant genetic advances for shoot fly resistance traits (leaf angle, trichome density (adaxial and abaxial) and morphological (plant height, fodder yield per plant, grain yield per plant) traits indicates that these traits are primarily controlled by additive genes. This insight suggests that these traits can be utilized effectively in sorghum improvement programs to develop and enhance shoot fly-resistant varieties/genotypes simply by selection.

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