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Genetic Variability Studies In Colored Pericarp Sorghum (*Sorghum bicolor* L.)

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Abstract

The present investigation entitled "Genetic variability studies in colored pericarp sorghum (*Sorghum bicolor* (L.) Moench)" was carried out during rabi 2019- 20 at experimental farm of Sorghum research station, VNMKV, Parbhani comprising 81 genotypes to elicit the information on genetic divergence in colored pericarp sorghum and shoot fly tolerance and nature and degree of genetic variability, heritability, genetic advance as percent mean Observation were recorded on 19 yield and shoot fly characters. Analysis of variance shows that there is considerable difference between the genotypes for all the traits. The result of genetic parameters revealed that moderate to high PCV, GCV, high heritability accompanied with high genetic advance was recorded for all the traits except days to 50% flowering, days to physiological maturity, 100-seed weight, threshability, and leaf angle this suggesting that the selection would be efficient for these characters to bring genetic enhancement in desired way. The traits viz., plant height, number of primaries per panicle, panicle length, panicle width, grain color, fodder yield had high heritability and positive correlation with yield so, simultaneous improvement of these traits along with grain yield is possible by simple selection.

1.INTRODUCTION

"Sorghum is one of the indispensable crops" required for the survivalof humankind (Harlan, 1971). Sorghum (*Sorghum bicolor* (L.) Moench) is the "kingof millets" and one of the most efficient, environmentally friendly, widely used & adapted crops, commonly known as "Great Millet" due to larger size of grain among millets and vast area under cultivation. It is one of the important cereal crops in the world occupying fifth position after Wheat, Maize, Rice, Barley. It is grown in arid and semi-arid regions of India, South Africa, America & Australia. It belongs to the family *Poaceae*, subfamily *panicoidae*, tribe *Andropogonae*, and sub tribe *sorghastrae* and genus *sorghum*. In India, Sorghum is cultivated over 4.10 million ha. The annual production of sorghum is 4.49 million tons of grain with a productivity of 1018 Kg/ha(Annual report, Government of India, 2024-25). In India the major sorghum growing state is Maharashtra. In Maharashtra sorghum is grown on an area of 28.58 lakhs hectares with the production of 25.07 lakh and productivity of 1971kg /ha. Sorghum is being cultivated during *rabi* as well as *kharif* season. *Kharif* sorghum is popular as animal and poultry feed while *rabi* is mainly for grain as well as fodder purpose. This pigment lies in the pericarp of sorghum. Seed color ranges from shades of white to various shades of pink, orange, red and even brown, seed color occurs due to influences of pericarp thickness. Moderately high levels of phenolic compound but absence of tannin mainly associated with red sorghum. Usually, red colored sorghum preferred in brewing industries. Whereas, flavanones which are loaded in yellow sorghum has somewhat higher total phenolic content than white sorghum. Due to existence of pigmented testa and high level of condensed tannins brown sorghum also known as tannin sorghum. The color is closely associated to the phenolic profile of the grain, mainly the bran layer of the grain. For that reason, the bran is an imperative constituent in sorghum and has an enormous influence on the appearance of grain color and phenolic profile. Colored sorghum with high levels of phenolic compounds, 3-deoxyanthocyanidins, and condensed tannins can be isolated and used as promising natural multifunctional additives and would be source of useful ingredients in drug industries and in broad food applications. Genetic improvement for polygenic characters such as yield contributing traits are depends upon the amount of variability, nature of the germplasm and amount to which the desirable characters are transmissible. Sorghum contains both wild relative and cultivated races, and it provides an ample amount of genetic diversity for the agronomical characters. In India there is an enormous, still uncultivated, reservoir of genetic variability in sorghum, represented by landraceswith respect to pericarp color and other important morphological traits for biotic stresses. Selection and screening of superior varieties for high yield from the extensive sorghum biodiversity is enormously important. Developing genes with high yield potential is the prime objective of the breeding programme. Crop development programme has become progressively more conscious of these factors that affects sorghum production and quality. Enhancement in sorghum quality and yield primarily depends on the nature and degree of genetic variability, heritability and genetic advance in the base population. One of the precious gift of nature is the genetic diversity in the crop species. To analyze the genetic diversity phenotypic characters are conventional tools.A better understanding of the genetic diversity in sorghum would greatly contribute tocrop improvement with a view of agronomic traits along with the traits conferring tolerance to various biotic stresses. Knowledge on the nature and magnitude of variability present in a crop species playsan important role in deciding a successful breeding programme for developing superiorcultivars. Hence, the study of existing variability available in the genetic resources becomes highly essential. Heritability measures the relative amount of heritable portion of total variability and it is a good index of the transmission of characters from parents to their off-springs. The estimates of broad sense heritability help the plant breeder in selection of elite genotypes fromhomozygous populations. While, the genetic advance is the deviation in the characters of selected population over the base population. The estimation of heritability along with genetic advance is more applicable than the heritability value alone. High heritability coupled with high genetic advance indicates the operation of additive gene effect in the expression of the trait and improvement could be made for that character by simple selection on phenotypic performance. Genetic variations for important traits can be used for improvement of crop in relation to heritability and genetic advance. The present investigation entitled "Genetic Variability Studies in Colored Pericarp Sorghum (*Sorghum bicolor* (L.) Moench) " for grainyield and its related traits and traits conferring shoot fly tolerance

2. MATERIALS AND METHODS

Experimental material for the proposed work consisted of *rabi* adapted colored pericarp sorghum lines. Total 81 lines comprising 76 germplasm were obtained from IIMR, Rajendra Nagar, ICISAT, Patencheru, Hyderabad and sorghum research station, VNMKV, Parbhani along with 5 checks were evaluated at Sorghum Research Station, VNMKV, Parbhani during *Rabi* 2019-2020.Total 81 genotypes in s single row were sown following Randomized Block Design (RBD) with two replications. The recommended spacing of 45cm between rows and 15cm between plants was adapted. The crop was given a recommended basal dose of 80 kg N: 40 kg P: 40kg K kg/ha. All recommended package of practices were followed and efforts were made to keep trial free fromweeds and pests. Sowing was done on 28th October 2021 by dibbling method. Two hand weeding were carried out, first at 30 days and second at 45 days after sowing. All recommendedagronomic practices were followed to raise healthy crop. Five plants at arbitrarily in each plot and replication were chosen and labeled for recording observed and the mean of five plants was used for statistical analysis. Observationson different morphological characteristics were recorded on these plants at different stages of crop growth. The data on the following yield and yield attributing traits and quality parameterswere recorded. The list of germplasm lines used for the study is presented in Table 1

Table 1. Experimental materials details

Germplasm line	Germplasm Name	Pericarp color (Visual observation)	Source
GP 1	RIL 40274-2	Pearly	Parbhani
GP 2	ISSVT 714	Red	IIMR, Hyderabad
GP 3	RIL 40853-1	Pearly	Parbhani
GP 4	ISSVT 346	White	IIMR, Hyderabad
GP 5	IS 11189	Grayed white	ICRISAT, Hyderabad
GP 6	RIL 40141-1	Red	Parbhani
GP 7	RIL 40261-2	Pinkish	Parbhani
GP 8	GD	Yellow	ICRISAT, Hyderabad
GP 9	ISSVT 223	Pearly	IIMR, Hyderabad
GP 10	GP 2843	Pearly	IIMR, Hyderabad
GP 11	RIL 41056-1	Peary	Parbhani
GP 12	ISSVT 108	Pinkish	IIMR, Hyderabad
GP 13	ISSVT 109	Yellow	ICRISAT, Hyderabad
GP 14	GP 2016-1	Red	IIMR, Hyderabad
GP 15	GP 595	Pearly	IIMR, Hyderabad
GP 16	RIL 40276-1-1	Pearly	Parbhani
GP 17	GP 55690	White	IIMR, Hyderabad
GP 18	GP 576	Red	ICRISAT, Hyderabad
GP 19	RIL 40261-2	Red	Parbhani
GP 20	RIL 40158-2	White	Parbhani
GP 21	GP 2375	Pearly	Parbhani
GP 22	GP 211	Red	ICRISAT, Hyderabad
GP 23	GP 2017-5	Yellow	ICRISAT, Hyderabad
GP 24	RIL 40395-2	Pearly	Parbhani
GP 25	ISSVT 325	Yellow	IIMR, Hyderabad
GP 26	GP 2028	Pearly	Parbhani

Germplasm line	Germplasm Name	Pericarp color (Visual observation)	Source
GP 27	GP 1539	Red	Parbhani
GP 28	RIL 32919-2	Pearly	Parbhani
GP 29	GP 374	Pearly	IIMR, Hyderabad
GP 30	GP 920	Red	IIMR, Hyderabad
GP 31	ISSVT 306	Red	IIMR, Hyderabad
GP 32	GP 564	Pearly	ICRISAT, Hyderabad
GP 33	B-35	Yellow white	ICRISAT, Hyderabad
GP 34	GP 53	Red	ICRISAT, Hyderabad
GP 35	ICRISAT 109	Red	ICRISAT, Hyderabad
GP 36	ISSVT 712	Yellow	IIMR, Hyderabad
GP 37	GP 3104	Pearly	ICRISAT, Hyderabad
GP 38	GP 1673	Red	ICRISAT, Hyderabad
GP 39	ISSVT 324	Red	IIMR, Hyderabad
GP 40	GP 44	White	IIMR, Hyderabad
GP 41	IC-9108	Red	ICRISAT, Hyderabad
GP 42	YPT 1021	Yellow	ICRISAT, Hyderabad
GP 43	IS-23891	Creamy	ICRISAT, Hyderabad
GP 44	ISSVT 108	Red	IIMR, Hyderabad
GP 45	ICRISAT 409	Yellow	ICRISAT, Hyderabad
GP 46	RIL 32919-2	Pearly	Parbhani
GP 47	YPT-1030	Yellow	ICRISAT, Hyderabad
GP 48	ISSVT 102	Red	IIMR, Hyderabad
GP 49	ISSVT104	Pearly	Parbhani
GP 50	ISSVT-710	Yellow	IIMR, Hyderabad
GP 51	GP 93	Red	ICRISAT, Hyderabad
GP 52	GP 716	Pearly	IIMR, Hyderabad
GP 53	IS-15466	White	ICRISAT, Hyderabad
GP 54	YPT-1015	Yellow	ICRISAT, Hyderabad
GP 55	GP 3138	White	ICRISAT, Hyderabad
GP 56	ICSR-93036	Red	ICRISAT, Hyderabad
GP 57	627(ICSB)	Red	ICRISAT, Hyderabad
GP 58	RIL 40369-1	Red	Parbhani
GP 59	RIL 40679-1-2	Red	Parbhani
GP 60	RIL 40818-3-1	Yellowish	Parbhani
GP 61	GP 40053-1-2	Pearly	ICRISAT, Hyderabad
GP 62	GP 520	Red	Parbhani
GP 63	RIL 32919-1	Pearly	Parbhani
GP 64	IS-23143	White	ICRISAT, Hyderabad
GP 65	YPT 1014	Pearly	ICRISAT, Hyderabad
GP 66	RIl 40679-3-1	Grayed red	Parbhani
GP 67	GP 587	Red	ICRISAT, Hyderabad
GP 68	GD-62417	Red	ICRISAT, Hyderabad
GP 69	Bajra type	Pearly	ICRISAT, Hyderabad
GP 70	GP 75	Red	ICRISAT, Hyderabad
GP 71	BT×623	Pearly	ICRISAT, Hyderabad
GP 72	RIL 40679-1-1	Pearly	Parbhani
GP 73	RIL 40274-2	Pearly	Parbhani

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Germplasm line	Germplasm Name	Pericarp color (Visual observation)	Source
GP 74	YPT 1412	Pearly	ICRISAT, Hyderabad
GP 75	YPT-1007	Red	ICRISAT, Hyderabad
GP 76	ICSR-93026	Red	ICRISAT, Hyderabad
P.Moti	P.Moti	Pearly	Parbhani
Udgir local	Udgir local	Yellow	Parbhani
CSV 22R (C)	CSV-22R	White	IIMR, Hyderabad
IS18551 (RC)	DJ-6514	White	IIMR, Hyderabad
DJ6514 (SC)	IS-18551	White	IIMR, Hyderabad

3. RESULTS

Genetic parameters

The data was analyzed for estimation of variability i.e. phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability,genetic advance and genetic advance as percent of mean. The results revealed that genetic variance and GCV were lower than phenotypic variance and PCV, respectively. The details of these variability parameters are presented in Table 2.

Range of variability

Variability is the basis of any crop improvement programme. In present investigation, wide range of variability was observed for most of the characters. Mean variation range was higher for characters *viz.*, days to 50% flowering, plant height, days to physiological maturity, number of primaries perpanicle, panicle length, grain yield per plant, dead heart @28days, leaf angle, 100- seed weight and threshability percentage. Existence of variability provides ample scope for selecting better genotypes for their involvement in breeding programme orto release them as a variety after thorough evaluation. Wide range of variability for different yield contributing traits in sorghumwere reported by several workers including Shinde *et al.* (1979) for plant height, panicle length, Veerabhadiran and Kennedy *et al.* (2001) for days to physiological maturity, Sonone *et al.* (2015) for days to 50% flowering, 100-seed weight, Ranjith *et al.* (2015) for seedling vigor, seedling glossiness, Rekha and Biradar *et al.* (2015) for dead heart percent, number of primaries per panicle and grain yield per plant, howevermost of the reference were form white sorghum.

Table 2. Genetic variability parameters for grain yield, it's related traits and traits related to shoot fly tolerance in colored pericarp sorghum

Sr. No.	Characters	Range		Mean	σ^2(g) (Genotypic variance)	σ^2(p) (Phenotypic variance)	GCV (%)	PCV (%)	h^2 b.s. (%)	GA	GA as % of mean
		Minimum	Maximum								
1	Days to 50% flowering	67.00	84.50	75.44	14.60	17.98	5.06	5.62	81.2	7.09	9.39
2	Plant height (cm)	131.99	242.49	181.35	575.47	583.09	13.22	13.31	98.7	49.09	27.07
3	Number of primaries per panicle	32.49	84.33	57.06	148.74	150.92	21.37	21.53	98.5	24.93	43.70
4	Panicle type(1-9score)	1	9	6.09	4.41	4.54	34.45	34.93	97.3	4.26	69.99
5	Panicle length (cm)	20.27	39.00	27.59	10.81	13.92	11.92	13.52	77.7	5.97	21.64
6	Panicle width(cm)	3.83	9.16	5.58	0.97	1.16	17.63	19.30	83.4	1.85	33.18
7	Days to physiological maturity	110.50	134.50	121.93	16.43	22.65	3.32	3.90	72.5	7.11	5.83
8	Grain color(1-5score)	1	5	3.29	1.88	1.89	41.78	41.88	99.5	2.82	85.86
9	Glume color(1-6score)	1	6	3.29	2.34	2.34	46.49	46.58	99.6	3.14	95.59
10	100 seed weight	2.98	7.05	4.26	0.28	0.49	12.43	16.56	56.4	0.82	19.24
11	Threshability (%)	76.25	92.25	83.34	9.98	12.30	3.79	4.20	81.2	5.86	7.03
12	Grain yield per plant (g)	15.35	48.55	27.64	44.71	49.49	24.18	25.44	90.3	13.09	47.35
13	Fodder yield per plant (g)	1.50	3.35	2.45	0.09	0.11	12.36	13.73	81.0	0.56	22.92
14	Seedling vigor(1-5scale)	1	5	2.61	0.65	0.83	31.00	35.04	78.3	1.47	56.61
15	Seedling glossiness(1-5scale)	1	4.5	2.7	0.59	0.70	28.18	30.67	84.4	1.46	53.36
16	Dead heart @28DAS	12.50	75.83	42.15	173.76	178.43	31.26	31.68	97.4	26.79	63.56
17	Shoot fly eggs @21DAS	3.50	22.00	9.77	13.96	15.31	38.21	40.02	91.2	7.35	75.16
18	Leaf angle(°)	57.50	82.50	73.72	15.08	28.69	5.26	7.26	52.6	5.80	7.86
19	Trichome adaxial	0.00	278.50	133.75	5897.37	5903.11	57.44	57.44	99.9	158.2	118.2
20	Trichome abaxial	0.00	195.50	58.58	3227.68	3241.74	96.97	97.18	99.6	116.7	199.3

GCV, PCV, Heritability and Genetic advance

1. Genotypic and Phenotypic Coefficients of Variation

The following chart compares the Genotypic Coefficient of Variation (GCV) and the Phenotypic Coefficient of Variation (PCV) for various traits.

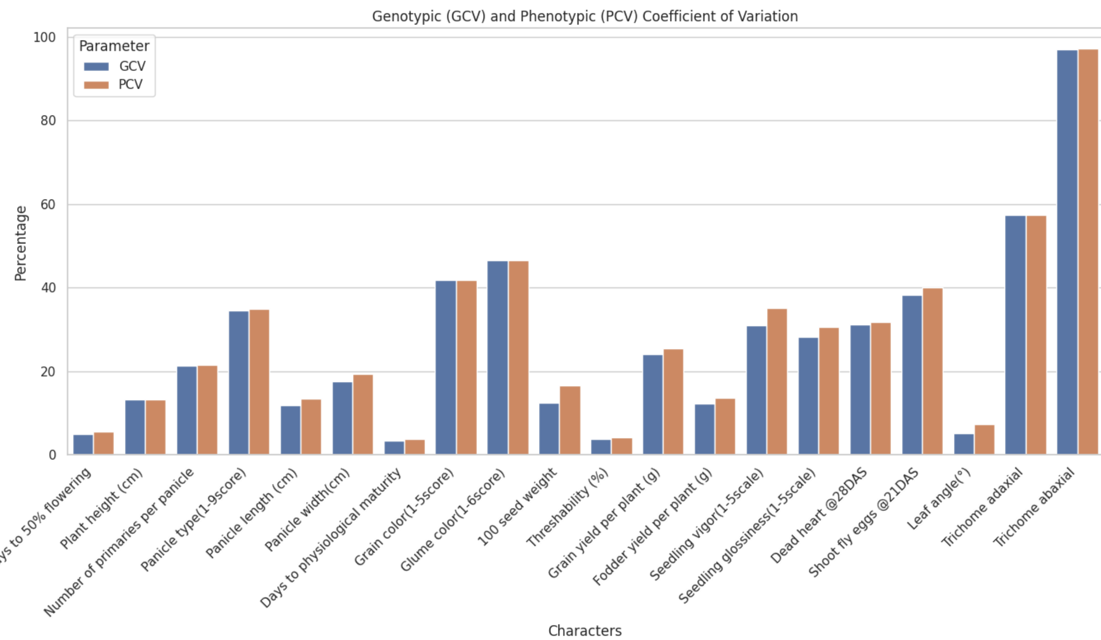

Figure 1: GCV vs PCV for different sorghum traits.

Days to 50 percent flowering

Estimates of PCV (5.62%) and GCV (5.06%) for days to 50% flowering indicated less variation among genotypes studied. Less difference between PCV and GCV indicates less influence of environment for this trait. Very high heritability (81.2%), low genetic advance (7.09) and genetic advance as percent of mean (9.39) estimates were recorded for this trait.

Plant height (cm)

Plant height showed 13.22 percent genotypic coefficient of variation (GCV) and 13.31 percent phenotypic coefficient of variation (PCV). Very high heritability (98.7%), high genetic advance (49.09) and high genetic advance as percent of mean (27.07) were also observed for this trait.

Number of primaries per panicle

The estimates of PCV (21.53%) and GCV (21.37%) for number of primaries per panicle were high. Narrow range of value between GCV and PCV indicated that the environment influence was less for this trait. Very high heritability (98.5%) accompanied with high genetic advance (24.93) and high genetic advance aspercent of mean (43.70) for this trait.

Panicle type (1-9 score)

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were 34.45 and 34.95 percent respectively. Very high heritability (97.3%), low genetic advance (4.26) and high genetic advance as percent of mean (69.99) were recorded for panicle type.

Panicle length (cm)

The estimates of PCV (13.52%) and GCV (11.92%) for panicle length were moderate indicating presence of considerable amount of variation for this trait among genotypes studied. High heritability (77.7%) accompanied with high genetic advance as percent of mean (21.64) was observed for this trait.

Panicle width (cm)

The genotypic coefficient of variation (GCV) was 17.63 percent and phenotypic coefficient of variation (PCV) was 19.30 percent. Result revealed high heritability (83.4%), very low genetic advance (1.85) and high genetic advance as percent of mean (33.18) for panicle width.

Days to physiological maturity

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were 3.32 and 3.90 percent, respectively. Days to physiological maturity showed high heritability (72.5%), low genetic advance (7.11%) and low genetic advance as percent of mean (5.83).

Grain color (1-5 score)

Grain color showed 41.78 percent genotypic coefficient of variation (GCV) and 41.88 percent of phenotypic coefficient of variation (PCV). Very high amount of heritability (99.5%), low genetic advance (2.82) and high genetic advance as percent of mean (85.86) were observed for grain color.

Glume color (1-6 score)

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were 46.49 and 46.58 percent, respectively for glume color recorded on 1-6 score. This trait showed high amount of heritability (99.6%) accompanied with low genetic advance (3.14) and very high amount of genetic advance as percent of mean (95.59).

100-seed weight (g)

100-Seed weight showed 12.43 percent genotypic coefficient of variation (GCV) and 16.56 percent phenotypic coefficient of variation (PCV).

Moderate heritability (56.4%) coupled with very low genetic advance (0.82) andmedium genetic advance as percent of mean (19.24) were observed.

Threshability (%)

The genotypic coefficient of variation (GCV) for threshability was 3.79 per cent whereas; phenotypic coefficient of variation (PCV) was 4.20 per cent. This trait showed high heritability (81.2%) coupled with low genetic advance (5.86) and genetic advance as per cent of mean (7.03).

Grain yield per plant (g)

Grain yield per plant had high estimates of PCV (25.44%) and GCV (24.18%) indicates that the environment influence was less for this character. High heritability (90.3%) accompanied with medium genetic advance (13.09) and high genetic advance as percent of mean (47.35) was also observed for these traits.

Fodder yield per plant (g)
Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were 12.36 and 13.73 percent, respectively. This trait showedhigh amount of heritability (81.0%) along with very low genetic advance (0.56) and high genetic advance as percent of mean (22.92).

Seedling vigor (1-5 scale)
Seedling vigor showed 31.00 percent genotypic coefficient of variation (GCV) and 35.04 percent phenotypic coefficient of variation (PCV). Further, this trait showed high heritability (78.3%) along with low genetic advance (1.47) and high genetic advance as percent of mean (56.51).

Seedling glossiness (1-5 scale)
The seedling glossiness of genotypes had higher magnitude of GCV (28.19%) and PCV (30.67%). This trait showed high heritability (84.4%) low geneticadvance (1.46) and high genetic advance as percent of mean (53.36).

Shoot fly dead heart percent @ 28 DAS
Shoot fly dead heart showed 31.26 percent of genotypic coefficient of variation (GCV) and 31.68 percent of phenotypic coefficient of variation (PCV). Very high heritability (97.4%) along with high genetic advance (26.79) and high genetic advance as percent of mean (63.56) was observed which shows selection would be effective.

Shoot fly eggs @21DAS
Shoot fly egg count recorded at 21 days after sowing showed high PCV (40.02%) and GCV (38.21%) indicates that presence of high amount of variability in the material. High heritability (91.2%) coupled with high genetic advance as percent of mean (71.17) were obtained for this trait.

Leaf angle (˚)
Low estimates of PCV (7.26%) and GCV (5.26%) indicates less variation for the leaf angle among genotypes studied. Moderate heritability (52.6%) along with low genetic advance (5.80) and very low genetic advance as percent of mean (7.86) indicates that the character is highly influenced by environmental effect and selection would be ineffective.

Trichome density (adaxial at 10X magnification)
The genotypic coefficient of variation (GCV) for trichome density (adaxial) was 57.41 percent and 57.44 percent of phenotypic coefficient of variation (PCV) was observed for trichomes present on upper leaf surface. Very high heritability (99.9%) accompanied with very high genetic advance (158.12) and very high genetic advance as percent of mean (118.21) were also recorded.

Trichome density (abaxial at 10X magnification)
The genotypic coefficient of variation (GCV) was (96.97) percent andhigh (97.18) percent of phenotypic coefficient of variation (PCV) was observed for trichomes present on leaf surface lower side. Very high heritability (99.6%) accompanied with very high genetic advance (116.78) and very high genetic advanceas percent of mean (199.33).

In the present investigation genotypic coefficient of variation was lower than phenotypic coefficient of variation for all the traits but the differences between them were of lower magnitude. The narrow differences between PCV and GCV were indicating that there is relative resistance to environmental changes. This marked effect of environmental factors for the phenotype expression of genotypes was poor than the greater chance of improving these traits through selection depends on the outputs of phenotypes. The high values of PCV and GCV indicates that there was a chance of improvement of these traits through direct selection. According to Deshmukh *et al.* (1986) genotypic and phenotypic coefficient of variance can be grouped as low (≤ 10%), moderate (10-20%) and high(≥ 20%). In the present investigation high estimates of genotypic and phenotypic coefficient of variation were observed for number of primaries per panicle, grain yield per plant, seedling vigor, seedling glossiness, dead heart percent, shoot fly eggs, grain color, glume color, and panicle type.

Moderate PCV and GCV values were recorded for plant height, panicle length, panicle width, 100-seed weight, fodder yield per plant whereas, lower values were observed for days to 50% flowering, days to physiological maturity, threshability and leaf angle. These results are in agreement with the results reported by earlierworkers Arunkumar *et al.* (2004), Kusalkar *et al.* (2009), Sonone *et al.* (2015), Ranijth *et al.* (2015), Rekha and Biradar *et al.* (2015), Tafere mulaualem *et al.* (2018) and Gebregergs *et al.* (2020).

The genotypic coefficient of variation alone does not show the proportion to total heritable variation. High heritability shows that efficacy of selection based on phenotypic performance but does not necessarily mean a high genetic gain for single character. According to Singh (2001), heritability of a character can be categorized as very high or high when it is above 80% and moderate when lies in between 40-80% and when it is below 40% then it is categorized as low.High value of heritability indicates that there is a favorable effect of environment and the traits were under genotypic control. For such traits selection could be easy and improvement is possible by using selective breeding methods for these characters. In the present study heritability was observed from 56.4 to 99.9%. High value of heritability in broad sense were observed for days to 50% flowering, plant height, number of primaries per panicle, panicle type, panicle width, grain color, glume color, threshability, grain yield per plant, fodder yield per plant, seedling glossiness, seedling vigor, dead heart per cent, shoot fly eggs and trichome density.

Genetic advance as per cent of mean ranges from 95.59 for glume color to 5.83 for days to physiological maturity. Deshmukh *et al.* (1986) differentiate genetic advance as per cent mean as low (≤ 10%), moderate (10-20%), and high(≥ 20). Based on this, all traits had high to moderate genetic advance as per cent of mean except days to 50% flowering, days to physiological maturity, threshability and leaf angle.

It was advised that the importance of considering both heritability and genetic advance of characters rather than considering them individually in determining how much progress can be made through selection (Johnson *et al.* 1955). The heritability accompanied with excepted genetic advance is more effective for predicating yield under phenotypic selection than heritability estimates alone. High heritability with high genetic advance indicates that most likely the heritability is due to additive gene effects and selection may be effective. The traits plant height, No. of primaries per panicle, panicle type, panicle length, panicle width, grain color, glume color, grain yield per plant, fodder yield per plant, seedling vigor, seedling glossiness, dead heart percent, shoot fly eggs, trichome density shows high estimates of heritability accompanied with high genetic advance as percent of mean indicating additive gene action and thus selection for these traits in genetically diverse material would be effective for desired genetic improvement.

3. Mean Values of Traits
The chart below displays the mean values for various traits (excluding those with significantly different scales like plant height and trichome density for better visualization).

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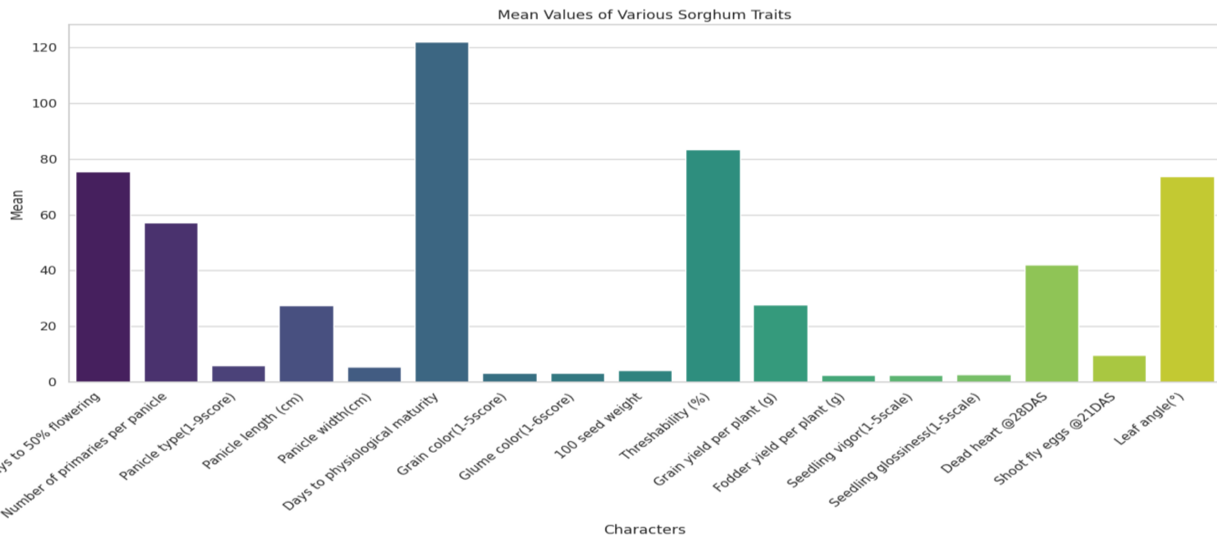

Figure 3: Mean values for selected sorghum traits.

2. Heritability and Genetic Advance

This chart shows the broad-sense heritability (%) and the Genetic Advance (GA) as a percentage of the mean for each trait.

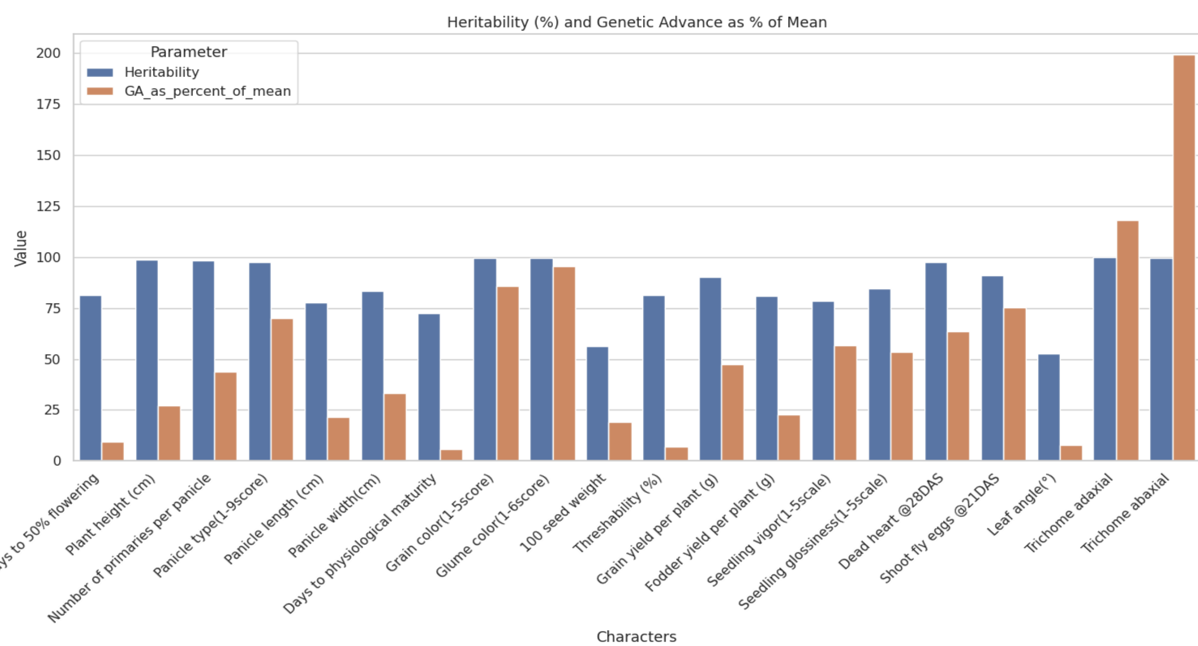

Figure 2: Heritability and Genetic Advance as % of Mean.

High heritability coupled with low genetic advance is indicative of nonadditive gene action. Improvement in such traits would be achieved through heterosis breeding. The characters days to 50% flowering, threshability shows high heritability accompanied with low genetic advance. Further 100-seed weight showed moderate heritability but did not show equally high genetic advance. The traits accompanied with high heritability with high genetic advance would be responding to selection better than those with high heritability accompanied with low genetic advance. Similar results were reported by Arunkumar *et al.* (2004), Gebregergs *et al.* (2020), Sonone *et al.* (2015), Ranjith *et al.* (2015), Rekha and Biradar *et al.* (2015).

Heritability which is ratio of genotypic variance to total or phenotypic variance is mainly due to the additive gene action in narrow sense, but in the broad sense it has both non-additive as well as additive gene effects. The heritability values recorded in the present investigation are expressed in broad sense. Board sense heritability, however gives only a rough data. If heritability was primarily due to additive effects it would be accompanied with high genetic gain and if it is due tonon- additive, genetic gain would be low (Panse, 1985).

Thus, the estimates of genetic parameters like PCV, GCV, heritability and genetic advance altogether it is evident that the traits *viz.*, No. of primaries per panicle, grain color, glume color, dead heart per cent, shoot fly eggs, grain yield per plant, seedling vigor seedling glossiness which show high value for PCV, GCV, heritability and genetic advance were considered most valuable and selection of these traits could be more effective for improving grain yield and tolerance against shoot fly in colored pericarp *rabi* sorghum.

4. CONCLUSION

Moderate to high PCV and GCV recorded for plant height, panicle length, panicle width, 100-seed weight, fodder yield per plant, number of primaries per panicle, grain yield, seedling vigor, seedling glossiness, dead heart @28DAS, shoot fly @21DAS, grain color, glume color and panicle type these pointed out the presence of more variability for all these characters. High heritability together with high genetic advance as percent of mean noticed at for plant height, number of primaries per panicle, panicle type, panicle length, panicle width, grain color, glume color, grain yield, fodder yield, seedling vigor, seedling glossiness, dead heart percent, shoot fly eggs, trichome density supported the predominance of additive gene controlling these characters. Selection could be effective for improvement of grain yield and its attributing characters. Secondly, additional information on restoration potential of this germplasm may leads for the development of high performing colored pericarp sorghum hybrids.

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