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Genetic diversity and variability for morphophysiological yield and yield contributing traits in kharif sorghum (*Sorghum bicolor* L. Moench) inbred lines

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Abstract
The present investigation entitled, "Genetic diversity and variability for morpho-physiological yield and yield contributing traits" were studied in fourteen inbred lines of kharif sorghum (*Sorghum bicolor* L. Moench). The experiment was laid out in randomized block design with three replications at Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during kharif 2021. Fifteen characters or yield contributing traits i.e days to fifty percent flowering, days to maturity, plant height at physiological maturity (cm), leaf dry weight at flowering (g/m^2), stem dry weight at flowering (g/m^2), leaf area at flowering (cm^2), relative water content (RWC) at flowering (%), total chlorophyll content (TCC), chlorophyll stability index (CSI %), 1000 grain weight (g), grain no/panicle, grain yield (q/ha), fodder yield (q/ha) and harvest index (%) were evaluated for diversity and variability studies in fourteen genotypes. Significant differences were observed among all the fourteen genotypes for yield and its yield contributing traits except stem dry weight at flowering (g/m^2). The PCV was observed higher than GCV for all the traits. High estimates of genotypic and phenotypic coefficient of variation were observed for grain no per panicle, leaf dry weight, 1000 grain weight, grain yield and total chlorophyll content. High heritability coupled with high genetic advance were recorded for plant height, leaf dry weight, leaf area, chlorophyll stability index, grain no per panicle, fodder yield. Genotype SPV 2504, CSV 27, CSV 31, CSV 39 and PVK 1025 showed the better performance for all the yield contributing characters thus, should be utilized for development of hybrids in breeding programmes.

Keywords: GCV, PCV, heritability, Genetic advance, variability, inbred lines

Introduction

Sorghum is a genus of about 25 species of flowering plants in the grass (poaceae) family. Sorghum (*Sorghum bicolor*), also called great millet, Indian millet, milo, durra, orshallu. It is high in carbohydrates, with 10 percent protein, 3.4 percent fat, and contains calcium and small amounts of iron, vitamin B_1, and niacin. It is a multipurpose crop belonging to the Poaceae family, which are C4 carbon cycle plants with high photosynthetic efficiency and productivity. It is one of the five major cultivated species in the world because it has several economically important potential uses such as food (grain), feed (grain and biomass), fuel (ethanol production), fibre (paper), fermentation (methane production) and fertilizer (utilization 3 of organic by-products). Most varieties are drought- and heat-tolerant, nitrogen-efficient, and are especially important in arid regions, where the grain is one of the staples for poor and rural people.

For 2020-21, USDA has projected world sorghum area as 40.97 million hectares (101.23 million acres) and production as 59.76 million tonnes. For India, it was projected as 4.80 million hectares (11.86 lakh acres) and 4.40 million tonnes respectively. In India, as on 12 th August 2020 area under kharif sorghum during 2020-21 was 14.53 lakh hectares. Among the states, Rajasthan stood first with 5.75 lakh ha followed by Maharashtra 2.67 lakh ha, Uttar Pradesh 2.08 lakh ha, Madhya Pradesh 1.38 lakh ha and Tamil Nadu 0.74 lakh ha contributing 87% of country's total area and production.

Selection of the appropriate inbred lines to be used in hybridization is one of the main decisions faced by plant breeders that will facilitate the exploitation of maximum genetic variability and production of superior recombinant genotypes. For this purpose, utilization of variability and selection of genotypes is very necessary.

The assessment of genetic variability in inbred lines and relationship between characters are necessary step. Genetic improvement for quantitative and qualitative traits depends upon the nature and amount of variability present in the genetic stock, if desirable traits having high heritability more are the chances of crop improvement through selection. So, there is need to increase productivity of sorghum by utilizing variability and heritability present in genotypes to develop high yielding varieties and hybrids. Knowledge of interrelationship between yield and yield attributing components enables the breeders to plan the breeding programme accordingly. Efforts were made to assess the genetic variability in inbred lines of kharif sorghum to develop high yielding hybrids.

Materials and Methods

The present investigation was undertaken to study the genetic diversity and variability parameters in fourteen genotypes of sorghum (*Sorghum bicolor* L. Moench) inbred lines. The study was carried out at Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during kharif 2021.The experimental material consists of fourteen inbred lines listed in (table 1). The experiment was laid out in randomized block design with three replications. Each line consists of four rows of 4 meters length at 45 cm apart. Plant to plant distance was maintained at 15cm. Seeds were initially treated with imidacloprid 48% FS in order to provide protection against sucking insects and pests. Field was prepared as per the requirement. The experimental material was sown by dibbling method. Recommended dose of fertilizer were applied @ 40:40:40 kg/ha N:P:K in the form of urea, single super phosphate, muriate of potash respectively as basal. The recommended agronomical and plant protection practices were followed regularly as per needed. Observations were recorded on 3 randomly selected plants from each genotype for days to fifty percent flowering, days to maturity, plant height at physiological maturity (cm), leaf dry weight at flowering (g/m^{2}), stem dry weight at flowering (g/m^{2}), leaf area at flowering (cm^{2}), relative water content (RWC) at flowering (%), total chlorophyll content (TCC), chlorophyll stability index (CSI) %, 1000 grain weight (g), grain no/panicle, grain yield (q/ha), fodder yield(q/ha), harvest index (%). The data was analysed statistically for mean performances of fourteen genotypes and genotypic and phenotypic coefficient of variation, heritability and genetic advance as per method (Johnson *et al*., 1955) [9].

Table 1: List of kharif inbred lines used for study

Sr. No.	Inbreds	Remarks	Source
1.	AKSV 318	Inbred	Akola
2.	AKSV 346	Inbred	Akola
3.	PDKV Kalyani	Inbred	Akola
4.	PVK 1025	Inbred	Parbhani
5.	CSV 31	Inbred	-
6.	CSV 34	Inbred	-
7.	CSV 36	Inbred	-
8.	CSV 39	Inbred	-
9.	SPV 2509	Adv Inbred	-
10.	SPV 2510	Adv Inbred	-
11.	CSV 32F	Forage inbred SC	-
12.	CSV 20	Check	-
13.	CSV 23	Check	-
14.	CSV 27	Check	

Results and Discussion

Anova and mean performances of the current investigation for fifteen characters are presented in table 2 and 3. Current investigation was carried out to estimate the genetic diversity in fourteen genotypes of sorghum inbred lines and genetic parameters like estimation of variability i.e.; genotypic coefficient variance (GCV), phenotypic coefficient variance (PCV), heritability, genetic advance and genetic advance as percent of mean. The data shows presence of significant differences for all the characters except one i.e. stem dry weight (g/m^2) at flowering based on the estimates of analysis of variance and mean performances. Differences among the treatments (genotypes) in respect of all characters studied were significant at 5% and 1% level indicating the presence of variability of these characters which provides ample scope for selection of superior and desirable genotypes for breeders for further genetic improvement and for selection of inbreds for hybrid development.

The best performance on the basis of mean values for grain yield was observed in genotypes CSV 27 (31.73) q/ha, SPV 2504 (31.57) q/ha and PVK 1025 (31.57) q/ha. While PDKV Kalyani (18.77) q/ha and AKSV 346 (19.61) q/ha showed lowest grain yield among all genotypes.

Genotypes AKSV 318 (75.00) and CSV 39 (76.00) required less days for days to 50% flowering while genotype CSV 34 (82.00) and SPV 2510 (81.33) required higher days to 50% flowering.

Similarly, Genotypes AKSV 318 (115.00) and CSV 39 (115.00) required less days to reach physiological maturity while genotypes PVK 1025 (124.00) and CSV 27 (123.67) required higher days to reach physiological maturity.

Plant height at physiological maturity was observed superior highest in genotypes CSV 32F (258.00cm) and PDKV Kalyani (258.00cm), higher in CSV 39 (256.33cm), PVK 1025 (247.00cm), CSV 31 (251.33cm), CSV 23 (251.33cm) and lowest height was observed in genotype CSV 34 (181.00cm) and CSV 36 (182.00cm).

The best performance for leaf dry weight was observed in genotype CSV 27 (72.33) g/m^2, followed by SPV 2504 (55.33) g/m^2, AKSV 318 (55.33) g/m^2, CSV 34 (53.67) g/m^2, CSV 20 (53.00) g/m^2, AKSV 346 (52.00) g/m^2, CSV 39 (51.33) g/m^2 while the lowest dry weight observed in CSV 31 (20.67) g/m^2.

Differences for stem dry weight (g/m^2) at flowering was observed non-significant for all the genotypes, while leaf area (cm^2) at flowering observed significant differences for all genotypes. Among the highest leaf area was observed in genotypes CSV 36 (861.67) cm^2 and SPV 2510 (846.33) cm^2, while lowest leaf area observed in CSV 32F (570.33) cm^2.

The best genotypes for relative water content (RWC) was observed in PVK 1025 (87.33%) and lowest value observed in CSV 39 (77.70%) respectively.

Table 2: Analysis of variance for fifteen characters in inbred lines of kharif sorghum

Sr. No.	Sources of variation	Degrees of freedom	Dfif	Days to maturity	Plant height at physiological maturity (cm)	Leaf dry wt at flowering (g/m2)	Stem dry wt at flowering (g/m2)	Leaf area at flowering (cm2)	RWC (%) at 50% flowering
1.	Replication	2	2.000	2.667	41.810	2.310	17179.167	224.357	0.937
2.	Treatment	13	12.082*	23.971*	2584.793*	420.625*	123645.342 NS	22631.159*	31.661*
3.	Error	26	1.000	0.872	24.040	6.822	75081.782	84.203	6.183

Table 2: Contd…

Sr. No.	Sources of variation	Degrees of freedom	SPAD value at 50% flowering	TCC (mg/ml)	CSI (%)	1000 grain wt (g)	Grain no/panicle	Grain yield (q/ha)	Fodder yield (q/ha)	HI (%)
1.	Replication	2	8.595	0.000	50.167	0.197	18347.881	2.214	132.578	20.738
2.	Treatment	13	39.436*	0.005*	324.332*	23.204*	566582.908*	72.292*	613.329*	26.236*
3.	Error	26	10.057	0.000	10.013	0.171	2557.035	1.418	10.567	1.995

*Significant at 5% level, NSNon-significant.

Table 3: The Mean performances of fifteen characters studied in kharif sorghum inbred lines

Sr. No.	Genotypes	Dfif	Days to maturity	Plant height at physiological maturity (cm)	Leaf dry wt at flowering (g/m2)	Stem dry wt at flowering (g/m2)	Leaf area at flowering (cm2)	RWC (%) at 50% flowering	SPAD value at 50% flowering	TCC & CSI at 50% flowering		1000 grain wt (g)	Grain no/panicle	Grain yield (q/ha)	Fodder yield (q/ha)	HI (%)
										TCC (mg/ml)	CSI (%)					
1.	AKSV 318	75.00	115.00	206.00	55.33	2031.67	773.00	82.73	57.00	0.13	54.00	7.03	1194.33	22.14	63.13	25.67
2.	AKSV 346	80.67	121.33	236.00	52.00	2431.33	703.33	86.57	60.00	0.18	77.00	15.47	1309.33	19.61	81.65	19.00
3.	PDKV Kalyani	80.67	122.00	258.00	46.33	2443.33	682.00	84.80	59.33	0.21	81.00	15.93	2002.33	18.77	85.86	17.67
4.	PVK 1025	80.00	124.00	247.00	44.67	2671.33	783.67	87.33	72.33	0.21	76.00	8.84	1946.00	31.57	105.22	22.33
5.	CSV 31	79.00	121.67	251.33	20.67	2571.33	766.00	86.73	63.00	0.18	51.33	9.98	1761.67	27.86	78.28	25.67
6.	CSV 34	82.00	123.00	181.00	53.67	2431.00	831.67	86.57	60.67	0.09	84.00	11.90	1732.67	21.46	65.66	24.33
7.	CSV 36	81.00	123.00	182.00	34.67	2204.00	861.67	84.60	61.67	0.12	58.33	8.92	1761.00	20.20	65.66	25.33
8.	CSV 39	76.00	115.00	256.33	51.33	2243.00	679.67	77.70	60.67	0.21	72.00	12.20	2701.33	20.20	79.97	19.67
9.	SPV 2504	79.33	119.67	210.67	55.33	2331.33	639.00	86.77	64.67	0.16	72.00	9.08	2223.33	31.57	85.02	27.00
10.	SPV 2510	81.33	121.33	248.67	51.33	2513.67	846.33	83.93	61.00	0.22	59.00	6.57	1333.67	29.71	105.22	21.33
11.	CSV 32F	81.00	121.67	258.00	38.67	2566.67	570.33	85.30	62.67	0.14	62.67	9.55	1659.33	27.44	89.23	23.33
12.	CSV 20	79.33	121.00	195.33	53.00	2202.67	741.67	78.60	61.67	0.14	66.00	8.11	1446.33	22.73	65.66	25.33
13.	CSV 23	81.00	123.00	251.33	46.33	2349.00	636.67	79.57	60.33	0.17	75.00	10.82	1180.00	22.56	90.07	19.67
14.	CSV 27	80.67	123.67	252.67	72.33	2781.33	786.00	86.27	58.33	0.20	77.33	10.55	1322.00	31.73	98.48	24.00
	General mean	79.79	121.10	231.02	48.26	2412.26	735.79	84.10	61.67	0.17	68.98	10.35	1683.81	24.83	82.79	22.88
	SE (m)	0.577	0.539	2.831	1.508	158.200	5.298	1.436	1.831	0.006	1.827	0.239	29.195	0.687	1.876	0.815
	CD at 5%	1.679	1.567	8.231	4.385	N/A	15.404	4.174	5.324	0.017	5.312	0.694	84.888	2.010	5.485	2.371
	C.V	1.253	0.771	2.122	5.412	11.359	1.247	2.957	5.143	6.067	4.588	3.993	3.003	4.796	3.925	6.172

Significant differences were observed among the genotypes for SPAD at 50% flowering. Among PVK 1025 (72.33), SPV 2504 (64.67) showed highest followed by CSV 31 (63.00), CSV 32F (62.27), CSV 36 (61.67) observed superior higher values while least in genotype AKSV 318 (57.00), PDKV Kalyani (59.33) and CSV 27 (58.33).

Differences in total chlorophyll content (TCC) was observed significant for all the genotypes. Among SPV 2510 (0.22) mg/ml, CSV 39 (0.21) mg/ml, PDKV Kalyani (0.21) mg/ml and PVK 1025 (0.21) mg/ml observed highest total chlorophyll content, while lowest in CSV 34 (0.09) mg/ml.

Chlorophyll stability index (CSI) was observed significant differences among all the genotypes. Highest stability was observed in genotype CSV 34 (84.00%) and PDKV Kalyani (81.00%) followed moderately by CSV 27 (77.33%), AKSV 346 (77.00%), PVK 1025 (76.00%), CSV 23 (75.00%) and lowest stability observed in CSV 31 (51.33%) followed by SPV 2510 (59.00%), CSV 36 (58.33%) and AKSV 318 (54.00%).

The test weight i.e.; 1000 grain weight was observed higher in PDKV Kalyani (15.93g) and AKSV 346 (15.47g), and lowest weight in AKMS 90B SPV 2510 (6.57g) and AKSV 318 (7.03g).

Highest grain no per panicle observed in genotype CSV 39 (2701) and SPV 2504 (2223.33) while lowest in AKSV 318 (1194.33) and CSV 23 (1180).

The best performance for fodder yield was found in genotypes PVK 1025 (105.22) q/ha and SPV 2510 (105.22) q/ha while poor performance was observed in AKSV 318 (63.13) q/ha, CSV 34, CSV 36 and CSV 20 (65.66) q/ha. Genotype SPV 2504 (27.00%) showed highest harvest index and lowest in PDKV Kalyani (17.67%).

Genotypic and phenotypic variation

The results of estimated genetic variability, heritability and genetic advance for grain yield and other traits are presented in (table 4). According to Sivasubramanian and Menon (1973) [13] GCV and PCV were categorized as low (0-10%), moderate (10-20%) and high (20% and above).

Table 4: Mean and genetic variability parameters for 15 characters in inbred lines of kharif sorghum

Characters	Range		Mean	GCV	PCV	Heritability %	Genetic advance	Genetic Advance value % means
	Min	Max						
Dfif	75	82	79.79	2.409	2.716	78.69	3.512	4.40
Days to maturity	115	124	121.10	2.291	2.418	89.82	5.418	4.47
Plant height at physiological maturity (cm)	181	258	231.02	12.646	12.823	97.26	59.355	25.69
Leaf dry wt at flowering (g/m2)	20.67	72.33	48.26	24.335	24.930	95.28	23.617	48.93
Stem dry wt at flowering (g/m2)	2031.67	2781.33	2412.26	5.274	12.524	17.73	110.381	4.57
Leaf area at flowering (cm2)	570.33	861.67	735.79	11.782	11.848	98.89	177.595	24.13
RWC at 50% flowering (%)	77.7	87.33	84.11	3.465	4.555	57.87	4.567	5.43
SPAD value at 50% flowering	57	72.33	61.67	5.075	7.225	49.33	4.528	7.34
TCC (mg/ml)	0.09	0.22	0.17	24.033	24.787	94.00	0.081	48.00
CSI (%)	51.33	84	68.98	14.840	15.533	91.27	20.145	29.20
1000 grain wt (g)	6.57	15.93	10.35	26.765	27.061	97.82	5.646	54.53
Grain no/panicle	1180	2701.33	1683.81	25.751	25.926	98.65	887.202	52.69
Grain yield (q/ha)	18.77	31.73	24.825	19.576	20.155	94.33	9.725	39.16
Fodder yield (q/ha)	63.13	105.22	82.793	17.121	17.566	95.00	28.461	34.37
HI (%)	17.67	27	22.88	12.424	13.872	80.20	5.244	22.92

The PCV was observed higher than GCV for all the traits which indicated that all the traits were highly influenced by the environment. But the differences between them were of lower magnitude. High estimates of genotypic and phenotypic coefficient of variation were observed for grain no per panicle, leaf dry weight, 1000 grain weight, grain yield and total chlorophyll content. Moderate GCV and PCV were observed for plant height, leaf area, chlorophyll stability index, fodder yield and harvest index. Low GCV and PCV were observed for days to 50% flowering, days to maturity, relative water content (RWC), stem dry weight and SPAD value. Godbharle *et al*., (2010) [7] also observed similar results.

Heritability and genetic advance

According to Johnson *et al*., (1955) [9], heritability was categorized as low (0-30%), medium (31-60%) and high (61% and above). Johnson (1955) [9] classified genetic advance as per cent of mean (GAM) in category of low (< 10%), moderate (10-20%) and high (> 20%). High heritability coupled with high genetic advance were recorded for plant height, leaf dry weight, leaf area, chlorophyll stability index, grain no per panicle, fodder yield. These traits are expected to respond to selection better in plant breeding programme as compared to traits with high heritability and low genetic advance. High heritability and low genetic advance were recorded for days to fifty % flowering, days to maturity, TCC, 1000 grain weight, grain yield and harvest index. Similar results were recorded high heritability coupled with high genetic advance for fodder yield by Tirkey *et al*., (2021) [14].

Conclusion

The present study revealed that inbred lines *viz.* SPV 2504, CSV 27, CSV 31, CSV 39 and PVK 1025 showed better performances for nearly all characters. The characters *viz* grain no per panicle, leaf dry weight, 1000 grain weight, grain yield and total chlorophyll content observed high estimates of genotypic and phenotypic coefficient of variation. Also, the characters for plant height, leaf dry weight, leaf area, chlorophyll stability index, grain no per panicle, fodder yield, exhibited high heritability coupled with high genetic advance. Further selection of these characters will improve the breeding efficiency of the genotypes. Hence, due consideration should be given for the traits while selecting inbred lines.

References

1. Anjana S. Genetic variability and divergence studies in B and R lines of Kharif sorghum MSC (Agril.). Thesis submitted to Marathwada Agril. Univ. Parbhani, 2006.
2. Arun Kumar B. Studies on genetic parameters and interrelationships among yield contributing traits in sorghum. The Bioscan. 2013;8(4):1311-1314.
3. Al-Naggar AMM, Salam Abd RM, Hovny MRA, Yaseen YS. Variability, heritability, genetic advance and interrelationships for agronomic and yield traits of sorghum B lines under different environment. Asian Journal of Biochemistry, Genetics and Molecular Biology 2018;1(1):1-13.
4. Damor HI, Parmar HP, Gohil DP, Patel AA. Genetic variability, character association, coefficient in forage sorghum (*Sorghum bicolour* L. Moench), Green Farming. 2018;9(2):218-233.
5. Dhutmal RR, More AW, Bhakad KR. Variability studies in kharif sorghum. Journal of Pharmacognosy and Phytochemistry. 2020;9(6):1518-1521.
6. Ghorade RB, Kalpande VV, Sonone CV. Variability studies for various biometrical parameters in kharif sorghum. Plant Archives. 2015;15(1):201-203.
7. Godbharle AR, More AW, Ambekar SS. Genetic variability an correlation studies in elite ‘B’ and ‘R’ lines in kharif sorghum. Electronic Journal of Plant Breeding 2010;1(4):989-993.
8. Jain SK, Patel PR. Characters Association and Path Analysis in Sorghum (*Sorghum bicolor* (L.) Moench) F1S and Their Parents. Annals of Plant and Soil Research. 2014;16(2):107-110.
9. Johnson HW, Robinson HF, Comstock. Estimation of genetic and environmental variability in soybeans. Agron. J. 1955;47:314-318.
10. Ravali K, Jahagirdar JE, Dhutmal RR, Wankhade MP, Kalyankar SV. Diversity analysis for yield and yield contributing traits for drought tolerance in rabi sorghum (*Sorghum bicolor* L. Moench). The Pharma Innovation Journal. 2021;10(6):151-154.
11. Ravali K, Jahagirdar JE, Dhutmal RR. Genetic variability studies for morpho-physiological traits in relation to drought tolerance in rabi sorghum (*Sorghum bicolor* L. Moench). The Pharma Innovation Journal. 2021;10(6):313-317.
12. Singh SK, Gangwar LK, Chaudhary Mayank. Studies on

character association and path analysis in forage sorghum. International Journal of Chemical Studies. 2019;7(5):2939-2942.

13. Sivasubramanian S, Menon M. Heterosis and inbreeding depression in rice. Madras Agricultural Journal. 1973;60:11-39.
14. Tirkey S, Jawale LN, More AW Genetic variability, correlation and path analysis studies in B parental lines of kharif sorghum (*Sorghum bicolor* (L.) Moench). The Pharma Innovation Journal. 2021;10(8):624-628.
15. Vara BV, Prasad, Sridhar V. Studies on Genetic Variability, Correlation and Path Analysis in Yellow Pericarp Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes. Int. J Curr. Microbiol. App. Sci. 2019;8(12):367-373.