The Pharma Innovation Journal 2021; 10(10): 156-158

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 156-158

www.thepharmajournal.com
Received: 11-07-2021
Accepted: 23-08-2021

SS Deshmukh
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

RR Dhutmal
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

HV Kalpande
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

AV Shinde
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Corresponding Author:
SS Deshmukh
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Studies on genetic variability for yield and yield contributing traits in Colored pericarp sorghum (*Sorghum bicolor* (L.) Moench)

SS Deshmukh, RR Dhutmal, HV Kalpande and AV Shinde

Abstract
Genetic variability in any crop is pre-requisite for selection of superior genotypes over the existing cultivars. Knowledge of variability and heritability of yield and its contributing traits helps in the selection of appropriate strategy for a breeding programme for evolving superior varieties. Therefore, the present investigation was conducted to assess the variability present in colored pericarp sorghum for yield and yield contributing traits. In present study, 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 this suggesting that the selection would be efficient for these characters to bring genetic enhancement in desired way.

Keywords: Colored pericarp sorghum, heritability, variability, genetic advance

Introduction
Sorghum is the major cereal crop grown on dryland ecosystem of Maharashtra and parts of Andhra Pradesh, Tamil Nadu, Madhya Pradesh and Karnataka. It is 100 percent gluten free consist of flavonoids and phenolic acid, it is good resource of protein and fiber. Due to presence of phenolic, flavonoid pigments, anthocyanin and flava-4-ols pigments in the pericarp of sorghum, seed color ranges from shades of white to various shades of pink, orange, red and brown. Local landraces present in various tracts of sorghum growing areas of India are very good resource as donor parent to develop the new strain. Existence of genetic variability in the population if pre-requisite for the development of varieties by selection and more effective use of plant genetic resources is crucial for the sustainable of the food of the country.

Material and Methods
The present investigation was undertaken to study genetic variability and character associated studies in eighty one genotypes of [*Sorghum bicolor* (L.) Moench] including five checks.
Eighty one genotypes of colored pericarp sorghum including five checks were sown during *rabi* 2019 in Randomized Block Design with two replications. The experiment was conducted at research farm, Sorghum Research Station, VNMK, Parbhani. All the recommended cultural practices and packages were applied for growing healthy and good crop, in each entry, five plants are randomly selected from each replication and following observations were recorded for plant height, number of primary branches per plant, days to 50 per cent flowering, panicle type, panicle length, panicle width, days to physiological maturity, grain color, glume color, threshability, 100-seed weight, grain yield per plant, fodder yield per plant. The variability parameters were estimated as follows a range Panse and Sukhatme (1978), co-efficient of variation was calculated by the formulae given by Burton (1952), Heritability in broad sense and genetic advance were estimated by the following formula given by Johnson *et al.* (1955) [8] and Allard (1960) [1] respectively.

Results and discussion
Considerable genetic variability among 81 lines was observed for characters are presented in (Table 1) under study. Analysis of variance revealed significant differences. This indicated presense of considerable genetic variability between genotypes and there is ample scope for exploitation of all the above characters.

The findings were similar with Shinde *et al.* (1979) for plant height, panicle length, Veerabhadiran and Kennedy *et al.* (2001) for days to physiological maturity, Sonone *et al.* (2015) [12] for days to 50 percent flowering, 100-seed weight, Rekha and Biradar *et al.* (2015) [11] for number of primaries per panicle, grain yield per plant and fodder yield per plant.

Table 1: Analysis of Variance for thirteen characters of colored pericarp sorghum

Sr. No	Sources of variation	d.f	Daysto50 % Flowering	Plant height (cm)	Number of primaries per panicle	Panicle Type (1-9 score)	Panicle length (cm)	Panicle width (cm)	Physiological maturity	Grain color (1-5 score)	Glume color (1-6 score)	100 seed weight (gm)	Threshability (%)	Grain yield/plant (g)	Fodder yield/ plant (g)
1	Replication	1	0.02	40.85	1.97	0.09	0.15	0.21	52.24	0.00	0.05	1.05	2.72	7.89	41.50
2	Treatments	80	35.97**	1166.19**	301.97**	9.08**	27.84**	2.32*	45.31**	3.79**	4.69**	0.99	24.60**	98.98**	1977.08**
3	Error	80	6.77	15.24	4.48	0.24	6.20	0.38	12.44	0.01	0.01	0.43	4.63	9.56	85.83

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

Genetic and Phenotypic coefficient of variation, Heritability and Genetic advance

The range of variation and the estimates of genetic parameters which include heritability in broad sense, coefficient of variation (GCV and PCV) and genetic advance are presented in (Table 2). The PCV was higher than GCV for all the characters studied showing that there is relative resistance to environmental changes. The 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 output of phenotypes. However difference between them was not of high magnitude. The range was highest for plant height (131.99-242.49) followed by days to physiological maturity (110.50-134.50), threshability (76.25-92.25), days to 50% flowering (67.00-84.50), number of primaries per panicle (32.49-84.33), panicle length (20.00-39.00), grain yield per plant (15.35-48.55), panicle width (3.83-9.16), 100-seed weight (2.98-7.05), fodder yield per plant (1.50-3.35) and lowest range was for grain color (1-5), glume color (1-6), panicle type (1-9). High estimates of GCV and PCV were observed for glume color (46.49), grain color (41.78), panicle type (34.45), grain yield per plant (24.18, 25.44), number of primaries per panicle (21.37, 21.53). The high values of PCV and GCV indicates that there was a chance of improvement of these traits through direct selection. While moderate to low estimates of GCV were observed for panicle width (17.63, 19.30), plant height (13.21, 13.31), 100-seed weight (12.43, 16.56), fodder yield per plant (12.36, 13.73), panicle length (11.92, 13.52), and days to 50% flowering (5.06, 5.62), days to physiological maturity (3.32, 3.90), threshability (3.79, 4.20). Similar results were reported in Inamdar (2001) [6], Arunkumar *et al.* (2004) [2], Kusalkar *et al.* (2009), Godbharle *et al.* (2010) [5], Sonone *et al.* (2015) [12], Rekha and Biradar *et al.* (2015) [11], Jimmy *et al.* (2017) [7], Taferemalualem *et al.* (2018) [13], Gebregergs *et al.* (2020) [4]. The effectiveness of selection for any character depend not only the extent of genetic variability but also in the extent to which it will be transferred from one generation to the other generation. The genotypic and phenotypic coefficient of variation alone does not show the proportion of total heritable variation. The heritability and genetic advance as percent of mean estimates are better indicators in this respect. High estimates of heritability were observed for days to 50 percent flowering (81.2), plant height (98.7), number of primaries per panicle (98.5), panicle type (97.3), panicle length (77.7), panicle width (83.4), grain color (99.5), glume color (99.6), threshability (81.2),grain yield per plant (90.3), fodder yield plant (81.0), days to physiological maturity (72.5) whereas, medium estimates of heritability was observed for 100-seed weight (56.4).The estimates of high genetic advance were observed for plant height (27.07), number of primaries per panicle (43.70), panicle type (69.99), panicle length (21.64), panicle width 933.18), grain color (85.86), glume color (95.59), grain yield per plant (47.35), fodder yield per plant (22.92) while the values were medium for the character 100-seed weight (19.24), low value estimates were observed for days to 50 percent flowering (9.39) and threshability (7.03). Similar results were reported by Arunkumar *et al.* (2004) [2], Kusalkar *et al.* (2009), Godbharle *et al.* (2010) [5], Sonone *et al.* (2015) [12], Kandelwal *et al.* (2015) [9], Rekha and Biradar *et al.* (2015) [11], Jimmy *et al.* (2017) [7], Taferemalualem *et al.* (2018) [13], Gebregergs *et al.* (2020) [4]. 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) [8]. 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 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. 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. Similar results were reported by Arunkumar *et al.* (2004) [2], Gebregergs *et al.* (2020) [4], Sonone *et al.* (2015) [12], Rekha and Biradar *et al.* (2015) [11]. 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 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 sorghum.

Table 2: Genetic variability parameters for grain yield & its related traits in colored pericarp

Sr. No.	Characters	Range		Mean	σ^2(g) (Genotypic variance)	σ^2(p) (Phenotypic variance)	GCV (%)	PCV (%)	h2 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	32.49	84.33	57.06	148.74	150.92	21.37	21.53	98.5	24.93	43.70

	panicle										
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

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