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ASSESSMENT OF GENETIC VARIABILITY AND YIELD POTENTIAL IN SORGHUM (*SORGHUM BICOLOR* L. MOENCH): A DUS-BASED APPROACH

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ABSTRACT

A field experiment was conducted during *kharif* 2019 at AICRP on Sorghum, Haradanahalli Farm, Chamarajanagara, Karnataka to evaluate sixteen sorghum genotypes (CSV 15, CSV 17, CSV 20, CSV 22, CSV 23, CSV 26, CSV 27, CSV 29, SPV 462, SPV 2366, DSV 6, SSV 74, SSV 84, Phule Suchitra, Phule Revati and Gundlupet Local) following DUS guidelines (PPV& FR Act, 2001). The randomized complete block design (RCBD) with three replications showed significant genotypic variation in growth and yield parameters. The result revealed that, the genotype SSV 84 recorded the highest days to 50 % flowering (75), while CSV 17 was the earliest (52) with a mean of 64 days. Plant height ranged from 133.47 to 319.47 cm with Phule Revati being the tallest and CSV 17 the shortest among all the genotypes. Wide differences were witnessed among the genotypes to complete maturation varied from 91 to 117 days with CSV 29 taking the longest and CSV 17 maturing earliest. Considerable variation was also observed in peduncle length, ear head length and ear head width, which were ranged from 28.93 to 38.33 cm, 17.80 to 26.60 cm and 4.63 to 6.77 cm respectively. Test weight varied from 26.67 g to 38.67 g with the highest in SPV 462 and lowest in CSV 15. Among sixteen genotypes, highest seed yield/ plant and seed yield (kg/ ha) was noticed with SPV 462 (28.93 g and 4285 kg/ ha), whereas, lowest by CSV 20 (13.04 g and 1933 kg/ ha) respectively. These findings identify SPV 462, CSV 15 and CSV 27 as superior genotypes for yield potential in drought-prone areas supporting breeding for climate-resilient varieties and their suitability for seed yield and quality traits under the Southern Dry Zone of Karnataka.

***Keywords* :** Sorghum genotypes, DUS, Test weight, Plant height, Seed yield.

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench; family *Poaceae*] is one of the most important millets occupying largest area among the grain crop in the world. It is the fifth most growing cereal crop in the world after wheat, maize, rice and barley. It is an important food crop of Africa and India, also major source of staple food for humans and serve as an important source of cattle feed and fodder besides production of bioethanol and bioplastic. Sorghum crop originated and domesticated in Africa about 5,000-8,000 years ago. Indian subcontinent is the secondary centre of origin of this important cereal (De Candolle, 1885).

The crop is a C_4 photosynthetic plant which increases efficiency of carbon dioxide fixation in plants. Such plants are well adapted to regions of lower latitude that have higher temperatures and are prone to drought (Carpita and McCann 2008). Its easy adaptability to hot and dry agro ecology makes it a climate change-compliant crop. The crop is mainly grown in tropical and subtropical areas where agro climatic conditions such as rainfall, soil and temperature are variable (Sardar Ali *et al*., 2006). Much of the crop is produced in the marginal and stress-prone areas of the semi-arid tropics, mainly on small holdings as it has potential to compete effectively with crops like maize under good environmental and management conditions (Dogget and Rao, 1995).

Sorghum (*Sorghum bicolor* L.) is a major staple food crop for more than 500 million people across Asia and Africa, particularly in semi-arid regions due to its resilience to drought and marginal soils. India continues to be one of the leading sorghum-growing countries contributing a significant share to the global area. However, in recent years, the cultivated area has declined due to cropping pattern shifts, while productivity has shown moderate improvement. Currently, sorghum is cultivated in approximately 4.5-5.0 million hectares in India with an annual production of around 4.5- 4.8 million tonnes and an average productivity of about 950–1100 kg/ ha (Anon, 2023).

Among the states, Maharashtra remains the leading producer, followed by Karnataka, Rajasthan, Madhya Pradesh and Telangana. Karnataka is one of the major sorghum-growing states ranking second in both area and production with cultivation spread over approximately 0.9–1.1 million hectares and productivity ranging from 1100–1300 kg/ ha (Anon, 2022). It serves as a staple food for a substantial population in northern Karnataka, particularly in districts such as Vijayapura, Dharwad, Belagavi, Raichur, Kalaburagi, Ballari, Mysuru and Chamarajanagar where it plays a crucial role in food and nutritional security.

Material and Methods

The field experiment was conducted during *kharif 2019* at the AICRP on Sorghum, Haradanahalli Farm, Chamarajanagara, Karnataka under medium black soil condition. Sixteen sorghum genotypes (CSV 15, CSV 17, CSV 20, CSV 22, CSV 23, CSV 26, CSV 27, CSV 29, SPV 462, SPV 2366, DSV 6, SSV 74, SSV 84, Phule Suchitra, Phule Revati and Gundlupet Local) were evaluated to assess the genetic variability and yield potential in Randomized Complete Block Design (RCBD) with three replications.

Standard agronomic practices were followed throughout the crop growth period. Each genotype was grown in six rows of three-meter length with a spacing of 45 cm between rows and 15 cm between plants with plot size of 3 m × 2.7 m.

Observations were recorded on growth parameters including days to 50 % flowering, plant height (cm), days to maturity, peduncle length (cm), ear head length (cm), ear head width (cm) as well as yield parameters such as 1000 seed weight (g), seed yield per plant (g) and seed yield (kg/ha) to assess the performance of sorghum genotypes. Seed yield per hectare was calculated using standard conversion formula. The data were subjected to analysis of variance (ANOVA) appropriate for RCBD and the significance of differences among genotypes was tested at the 5% probability level.

Results and Discussion

Days to 50 % flowering

Each genotype studied, took different days to 50 per cent flowering which ranged from 52 to 75 days with a mean of 64 days. Genotype SSV 84 exhibited the earliest flowering (52 days) whereas SSV 84 recorded the maximum duration of 75 days (Table 1). Based on flowering duration, the genotypes were categorized into following three groups (Anon, 2007).

Very early (< 56 days)	Early (56-65 days)	Medium (66-75 days)
CSV 17	SPV 462, CSV 15, CSV 20, SPV 2366, CSV 26, *Gundlupet Local*	CSV 23, CSV 27, DSV 6, SSV 74, SSV 84, CSV 22, CSV 29, *Phule Suchitra, Phule Revati*

The variation in flowering time is mainly attributed to genetic differences among genotypes and their interaction with prevailing environmental conditions (photoperiod and temperature) during crop growth (Elangovan, 2006 and Reddy *et al.* 2007). It is controlled by Maturity Gene Complex (six maturity loci, Ma_1–Ma_6) which determines the sensitivity to photoperiod (Mangal *et al.* 2025).

Table 1 : Performance of sorghum (*Sorghum bicolor* (L.) Moench) genotypes for phenological, growth and panicle traits.

Genotypes	Days to 50 % flowering\ (Days)	Plant height at harvest (cm)	Days to maturity (Days)	Peduncle length (cm)	Ear head length (cm)	Ear head width (cm)
SPV 462	59	230.60	106	36.40	26.60	6.03
CSV 15	59	232.20	104	34.73	25.73	6.77
CSV 20	59	236.47	105	36.00	24.40	5.90
CSV 23	69	232.73	109	35.80	23.00	5.57

CSV 27	71	272.13	110	35.20	21.47	5.97
CSV 17	52	133.47	91	33.07	24.13	5.47
DSV 6	68	213.20	105	35.33	19.53	5.70
SPV 2366	59	217.20	99	34.00	24.67	5.93
SSV 74	66	292.07	114	30.60	19.33	5.50
SSV 84	75	267.20	115	31.93	17.80	5.68
CSV 22	67	290.27	116	32.73	19.63	5.27
CSV 26	58	289.87	110	33.53	20.17	5.62
CSV 29	66	273.20	117	28.93	18.00	4.64
Phule Suchitra	67	311.40	115	32.67	19.07	5.81
Phule Revati	67	319.47	115	35.20	20.87	5.32
Gundlupet Local	60	281.20	106	38.33	18.63	6.80
Mean	64	255.79	106	34.03	21.44	5.75
S. Em±	0.45	6.48	2.85	0.64	0.85	0.24
CD at 5 %	1.31	18.71	10.6	1.84	2.45	0.70
CV (%)	1.23	4.39	8.22	3.25	6.85	7.33

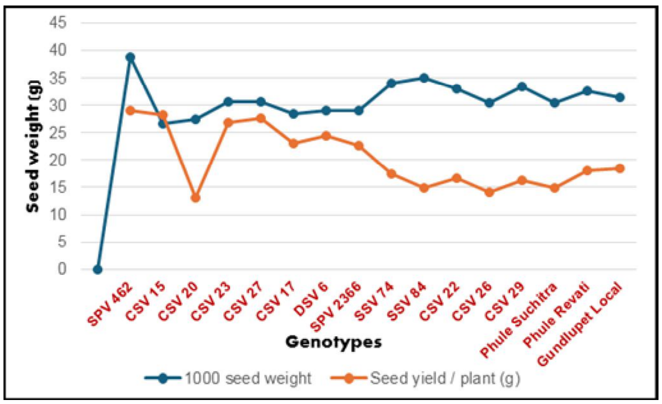

Fig. 1 : Integrated evaluation of 1000 seed weight and seed yield per plant in sorghum genotypes.

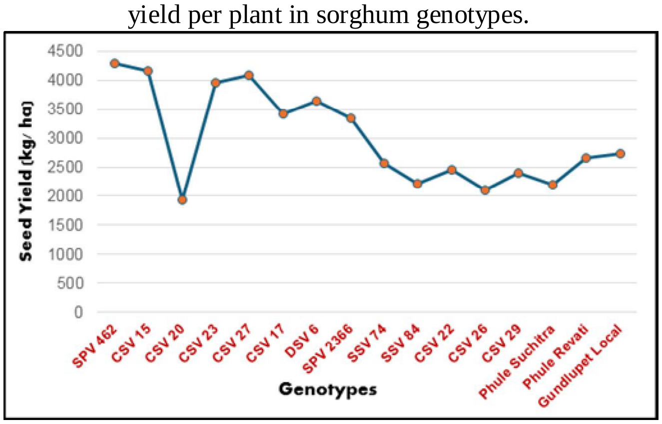

Fig. 2 : Evaluation of seed yield per hectare trait in sorghum genotypes.

Plant height (cm)

Significant variation in plant height was observed among the sixteen genotypes ranging from 133.47 cm to 319.47 cm with a mean of 255.79 cm. The genotype *Phule Revati* recorded the maximum plant height (319.47 cm) while CSV 17 exhibited the minimum plant height of 133.47 cm (Table 1). Based on plant height, genotypes were classified into following four groups (Anon, 2007).

Short (< 150 cm)	**Medium (151-225 cm)**	**Tall (226-300 cm)**	**Very tall (>300 cm)**
CSV 17	DSV 6, SPV 2366	SPV 462, CSV 15, CSV 20, CSV 23, CSV 27, SSV 74, SSV 84, CSV 22, CSV 26, CSV 29, *Gundlupet Local*	*Phule Suchitra*, *Phule Revati*

Plant height exhibited high heritability and the observed variation among genotypes could be attributed primarily to genetic differences. The results are in accordance with Ghosh *et al.* 2015 and Mamta *et al.* 2016. It is an important determinant of yield potential and lodging resistance and its expression is influenced by genotype-specific growth dynamics (Miao *et al.*, 2024)

Days to Maturity

Significant variation in days to maturity was observed among the sixteen genotypes, ranging from 91 to 117 days. The genotype CSV 29 recorded the maximum duration to maturity (117 days) followed by CSV 22 (116 days), SSV 84, Phule Suchitra and Phule Revati (115 days each). In contrast, CSV 17 matured earliest (91 days) among all the genotypes (Table 1).

High heritability combined with higher genetic advance suggests that additive gene action plays a role in both the expression and transmission of any trait (Ammaiyappan *et al.*, 2023 and Zabuloni *et al.*, 2026). The variation in days to maturity is largely governed by genetic makeup although environmental factors also influence quantitative traits. The consistent differences observed under similar conditions indicate the predominance of genotypic effects. Similar findings have been reported in sorghum by El Naim *et al.* (2012) and Verma *et al.* (2017).

Peduncle Length (cm)

Significant variation in peduncle length was observed among the sixteen genotypes, ranging from 28.93 cm to 38.33 cm, with a mean of 34.03 cm. The genotype Gundlupet Local recorded the maximum peduncle length (38.33 cm) followed by SPV 462 (36.40 cm), CSV 20 (36.00 cm) and CSV 23 (35.80 cm). In contrast, the minimum peduncle length was observed in CSV 29 (28.93 cm).

Peduncle length is a key contributor to overall genetic divergence among sorghum lines as it is a highly heritable, genetically determined and ecologically sensitive trait which plays a key role in adapting to adverse environmental conditions (such as drought) and optimizing panicle display for grain yield (Naoura *et al.*, 2019 and Sawadogo *et al.*, 2023).

Ear Head Length (cm)

Among the different genotypes, significant difference was observed for ear head length (Table 1). The ear head length ranged from 17.80 cm to 26.60 cm with a mean of 21.44 cm. Significantly the highest ear head length (26.60 cm) was noticed in SPV 462 and lowest (17.80 cm) was observed in SSV 84 (Fig. 3). Based on the length of ear head, the genotypes were grouped into two categories (Anon, 2007).

Short (11-20 cm)	Medium (21-30 cm)
DSV 6, SSV 74, SSV 84, CSV 22, CSV 29, *Phule Suchitra*, *Gundlupet Local*	SPV 462, CSV 15, CSV 20, CSV 23, CSV 27, CSV 17, SPV 2366, CSV 26, *Phule Revati*

The variation in ear head length among sorghum genotypes is primarily attributed to inherent genetic differences governing panicle architecture and spikelet development (Gebre *et al.*, 2025). The variation in ear head length is mainly attributed to genetic differences among genotypes. Similar variability has been reported in sorghum (Reddy *et al.*, 2007 and Bhusal *et al.*, 2017).

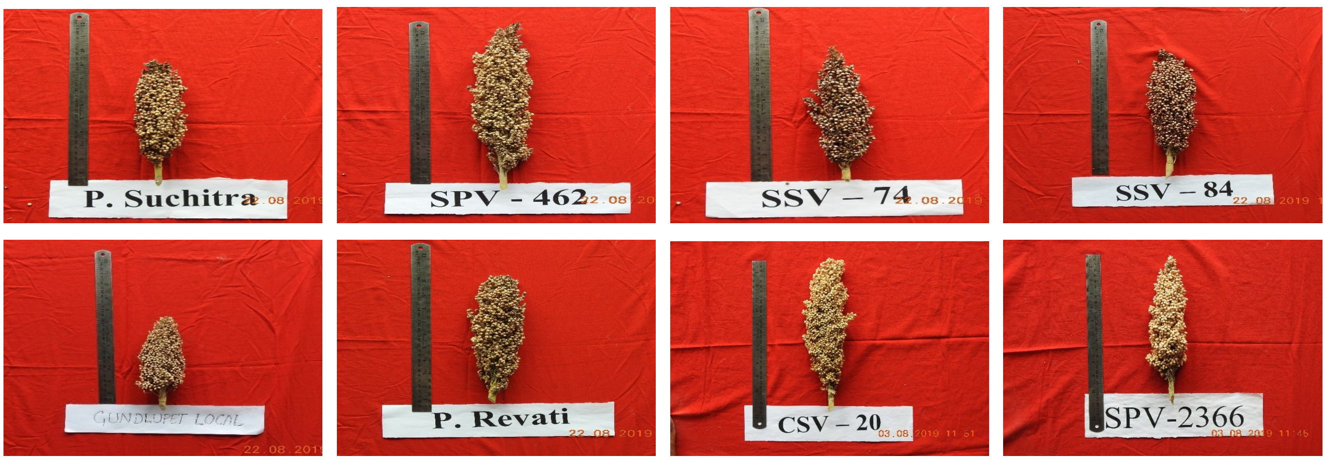

Fig. 3 : Variations in the ear head length of sorghum genotypes

Ear Head Width (cm)

Ear head width differed significantly among the genotypes. The highest ear head width was recorded in CSV 15 (6.77 cm) followed by *Gundlupet Local* (6.73), SPV 462 (6.03) and CSV 27 (5.97) whereas, the lowest ear head width (4.63) was recorded in CSV 29 (Table 1 & Fig. 4).

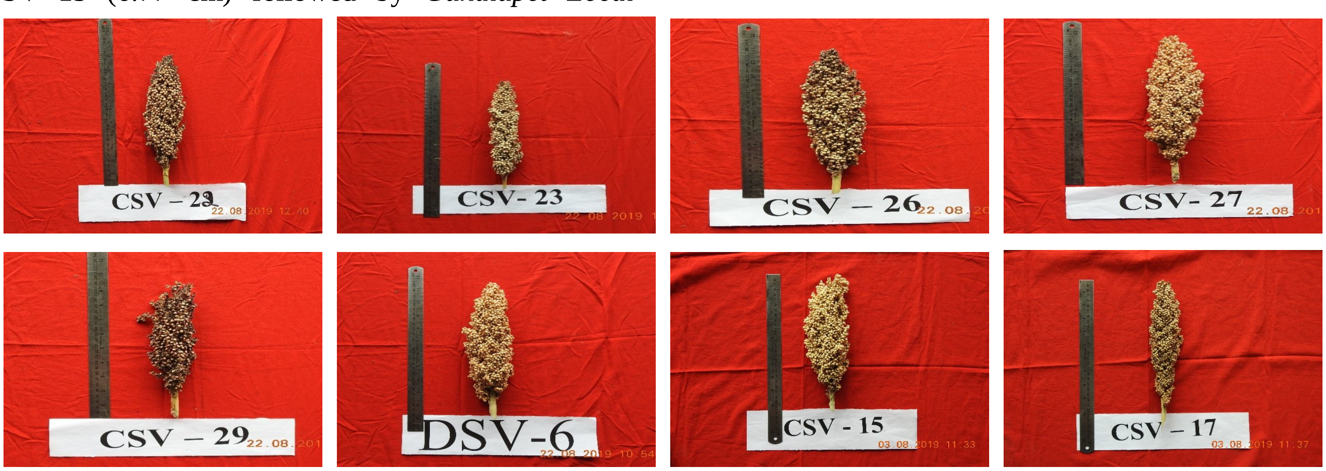

Fig. 4 : Variations in the ear head width of sorghum genotypes

The width of the ear head indicates the compactness or density of ear head of the particular sorghum genotype (Angadi and Somu, 2025). This trait helps in differentiation of genotypes as it influences the shape of the ear head. The similar findings were also noted by Seetharam and Ganesamurthy (2013) and Sujatha and Pushpavalli (2015) in sorghum.

1000 Seed Weight (g)

The 1000 seed weight among the genotypes ranged from 26.67 g to 38.67 g with a mean of 31.27 g. The maximum test weight was recorded in SPV 462 (38.67 g) followed by SSV 84 (35.00 g) and SSV 74 (34.00 g) while the lowest (26.67 g) was observed in CSV 15 (Fig 1). Based on test weight, genotypes were grouped into following three categories (Anon, 2007).

Low (25-30 g)	Medium (31-35 g)	High (36-40)
CSV 15, CSV 20, CSV 26	CSV 23, CSV 27, CSV 17, DSV 6, SPV 2366, SSV 74, SSV 84, CSV 22, CSV 29, *Phule Suchitra*, *Phule Revati*, *Gundlupet Local*	SPV 462

Difference in test weight was mainly due to polygenic inheritance, where no single gene dominates allowing for continuous variation across populations (Cheng *et al.* 2021). It is one of the quantitative traits and the differences in this trait is mainly due to genetical make up or slight influence by the environment. However, very often this trait may be influenced by mother plant nutrition and environmental conditions prevailing during seed development and maturation. Similar observations were also observed by Reddy *et al.* (2009) and Balmuri *et al.* (2018) in sorghum.

Seed Yield per Plant (g)

Seed yield per plant varied significantly among the genotypes ranging from 13.04 g to 28.93 g with a mean of 20.32 g. The highest seed yield per plant was recorded in SPV 462 (28.93 g) followed by CSV 15 (28.13 g), CSV 27 (27.57 g) and CSV 23 (26.74 g) whereas the lowest (13.04 g) was recorded in CSV 20 (Fig. 1).

The quantity of seeds obtained from individual plant depends on the yield contributing characteristics *viz.*, ear head length and width. However, it mainly depends on the genetic constitution of individual genotype besides management practices (Lema, 2016). Ear head length shows positive genotypic association with yield per plant exerting direct positive path effects while ear head width contributes via seed set and row count (Ngidi *et al.* 2024).

Seed yield (kg/ ha)

The seed yield obtained for various genotypes per hectare ranged from 1933 to 4285 kg/ ha with a mean of 3010 kg/ ha (Fig 2). The seed yield per hectare recorded significantly highest in SPV 462 (4285 kg/ ha) followed by CSV 15 (4168 kg/ ha), CSV 27(4083 kg/ ha) and CSV 23 (3961 kg/ ha). The genotype CSV 20 recorded lowest (1933 kg/ ha) seed yield per hectare.

This quantitative trait variation among the genotypes is mainly due to variability in genetic makeup modulated by environmental factors and nutrient availability (Ngidi *et al.*, 2024). Similar findings were also noticed in the study of Jadhav *et al.* (2011) and Mwamahonje and Maseta (2018) in sorghum.

Conclusion

The study demonstrated substantial genetic variability among sorghum genotypes for phenological, morphological and yield-related traits under the Southern Dry Zone of Karnataka. Genotypic effects predominantly governed the trait expression, indicating strong inherent genetic control with limited environmental influence under uniform conditions. Among the sixteen evaluated genotypes, SPV 462 consistently exhibited superior performance for grain yield and key yield-contributing traits including ear head dimensions and test weight, while CSV 15 and CSV 27 also showed high yield potential. In contrast, CSV 17 was identified as an early-maturing genotype indicating its suitability for drought escape and short-duration cropping systems. The results highlight the importance of trait integration and genetic variability in enhancing yield performance and adaptability. The identified superior genotypes can be effectively utilized for direct cultivation as well as in breeding programs aimed at developing high-yielding, climate-resilient sorghum varieties for semi-arid regions.

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