Effect of Drought Stress on Morpho -Phenological and Yield Parameters in Sorghum Genotypes

Abstract: Drought stress is a major challenge for sorghum production, particularly during the reproductive stage. This study investigated the effects of drought stress on sorghum genotypes, focusing on their morpho-phenological characteristics and yield parameters. A field experiment was conducted over two *rabi* seasons (2021-22 and 2022-23) at the University of Agricultural Science, Dharwad, India. Twenty sorghum genotypes were evaluated under both irrigated and rainfed conditions using a split-plot design with two replications. Water stress reduced sorghum plant height, with a mean height of 190.41 cm under irrigated conditions and 176.50cm under rainfed conditions at 90 days after sowing. Water stress advanced the physiological maturity by 10 days compared to irrigated condition. Yield parameters revealed significant differences, the mean grain yield was 70.23 g/plant for irrigated conditions and 54.54 g/plant for rainfed conditions. Water stress also had an impact on harvest index, with irrigated conditions having a mean harvest index of 30.91% and rainfed conditions having a mean harvest index of 28.13%. Genotypes by overall performance Phule Anuradha, BJV 44, and M-35-1 tolerated water stress, by minimizing yield reduction by drought.

Keywords: Sorghum, drought, genotypes, rainfed, plant height and grain yield

1. INTRODUCTION

Drought is a major abiotic stress that limits sorghum production in arid and semi-arid regions of the world. Drought stress can occur at any stage of crop growth and development, but it is particularly damaging during the reproductive stage, when it can lead to significant yield losses. Sorghum genotypes vary in their tolerance to drought stress[14]. Some genotypes have evolved mechanisms to avoid drought stress, such as deep roots or the ability to close their stomata quickly to reduce water loss. Other genotypes have evolved mechanisms to tolerate drought stress, such as the ability to accumulate osmoprotectants or maintain photosynthesis under low water conditions[13]. Understanding the impact of drought stress on different sorghum genotypes is essential for developing breeding strategies to improve drought tolerance. This research article investigates the intricate relationship between drought stress and sorghum genotypes, focusing on their morpho-phenological characteristics and yield parameters. Morpho-phenological traits, such as plant height,

flowering time, and leaf structure, play a vital role in a plant's ability to withstand and adapt to water scarcity. Yield parameters, including grain yield and water use efficiency, are critical for determining a crop's productivity under challenging environmental conditions[6]. By examining how various sorghum genotypes cope with drought stress, this study aims to unravel the genetic and physiological mechanisms underlying their adaptability[10]. Such insights can inform breeding programs, helping develop drought-resistant sorghum varieties that thrive in water-limited environments[5]. Additionally, this research contributes to our broader understanding of how crops respond to changing climate patterns, ultimately facilitating the sustainable cultivation of sorghum and the maintenance of food security in a world increasingly affected by drought stress.

2. MATERIALS AND METHODS:

2.1 Experimental site:

The field experiment was conducted in plot No. 126 of E-block, Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad. The MARS is situated at 15°12’ N latitude and 76°34’ E longitude with an altitude of 678 meters above the mean sea level (MSL).

2.2 Experimental setup:

An experiment was conducted in medium black soil classified as verticinceptisols, with a depth of 2-3 meters. Twenty rabi sorghum genotypes (Table 1) were sourced from the AICRP sorghum, Dharwad, India. The first season's sowing took place on October 24, 2021, followed by the second season's sowing on November 11, 2022. High-quality seeds were utilized for row sowing. Each plot consisted of 6 rows with a 45 cm gap between them, and the spacing between individual plants within a row was set at 15 centimeters. The experiment encompassed two moisture levels: rainfed and irrigated. In the rainfed condition, no irrigation was provided after sowing, whereas in the irrigated condition, two additional irrigations were conducted: the first one 35 days after sowing, and the second one 65 days after sowing.

Table 1: List of sorghum genotypes used in the experiment

Names of sorghum genotypes							
1	SVD-1272R	**6**	SPV-2217	**11**	Tandur L	**16**	M 148-138
2	SVD-1358R	**7**	CSV-216R	**12**	Phuleannuradha	**17**	Basavanmotti
3	SVD-1528R	**8**	CSV-29R	**13**	Chitapur – L	**18**	Phulevasudha

4	SVD-1403R	**9**	ICSR-15001	**14**	DKS- 35	**19**	BJV-44
5	SPV-486	**10**	Basavan pad	**15**	M-35-1	**20**	ICSR- 13025

2.3 Parameters determined:

This study assessed water stress effects on sorghum genotypes, considering morphology, phenology and yield-related traits.

2.3.1 Morphological characters: Morphological traits were assessed, including plant height, leaf area, and leaf area index at 30, 60, and 90 DAS. Plant height was measured from stem base to tip. Leaf area was determined using Stickler *et al*.[12] method, and leaf area index was computed as the ratio of leaf area to land area per plant.

2.3.2 Phenological characters: We also recorded phenological characteristics such as days to 50% flowering and days to physiological maturity. Days to 50% flowering represented the time when half of the plants in each treatment bloomed, expressed in days. Days to physiological maturity signified the duration for a genotype to reach a stage where seeds developed a dark spot, marking the end of photosynthate supply [9].

2.3.3 Yield parameter: Yield parameters were assessed through panicle weight per plant, grain yield per plant, stover yield, harvest index, and grain yield per hectare.

2.3.3.1 Grain yield per plant (g):The panicle heads were threshed, and the resulting cleaned average grain weight per head was quantified and expressed in grams.

2.3.3.2 Harvest index (%):The Harvest Index (HI) was calculated using the formula, which involves dividing the economic yield by the biological yield and then multiplying by 100 to express it as a percentage.

$$\text{HI (\%)} = \frac{\text{Economic yield (t/ha)}}{\text{Biological yield (t/ ha)}} \times 100$$

2.3.3.3 Grain yield (kg ha^{-1}): The weight of properly dried and cleaned seeds collected from the specific plot was measured in kilograms per plot and then converted to kilograms per hectare.

2.3.3.4 Stover yield (t ha^{-1}): After harvesting the panicles, the plants within each net plot area were cut at ground level and left in the field for sun drying. Once the drying process was

finished, the weight of the dried plants was measured in kilograms per plot and then converted to kilograms per hectare.

2.4 Statistical analysis and interpretation of data

The analysis and interpretation of data was done using the Fisher's method of analysis and variance technique as given by Panse and Sukhatme (8). The level of significance used in "F" and "t" test was at 5% probability level and wherever "F" test was found significant, the "t" test was performed to estimate critical differences among various treatments. Two factorial CRD (complete randomized design) was used to analyze data of experiment I and experiment II was analyzed by split plot design.

3. RESULT AND DISCUSSION

3.1 Morpho-phenological characteristics

3.1.1 Plant height:

Under water stress condition, sorghum plants tend to be shorter compared to their well-watered counterparts. The primary reason behind this reduction in plant height is the diminished cell division in sorghum plants, which restricts their overall growth potential [2]. From 30 days after sowing (DAS) to 90 DAS, the increase in plant height exhibited a gradual pattern, but afterward, the rate of growth decreased until harvest (Table 2). Notably, significant differences in plant height were observed among the *Rabi* sorghum genotypes at various growth stages. At 60 DAS, irrigated plants showed greater mean plant height (129.14 cm), followed by rainfed plants (115.37 cm), and a similar trend followed at 90 DAS. Genotype DKS-35 showed considerably greater mean plant height at 90 DAS (216.46 cm), whereas genotype Basavanapada had a significantly lower mean plant height (147.40 cm).

3.1.2 Leaf area and Leaf number:

Under well-watered (irrigated) conditions, sorghum genotypes showed a highest mean leaf count (12) and larger leaf area (1219.5 cm^2) compared to rainfed conditions (10 and 1183.8 cm^2, respectively) at the 60 DAS (Table 3 and 5). Osakabe*et al.* [7] found that drought stress reduced leaf area due to water scarcity. SPV 486 exhibited the highest leaf area under both rainfed (1425 cm^2) and irrigated (1382 cm^2) conditions. Conversely, Phule Anuradha showed the least reduction in leaf area, with 1350.5 cm^2 under irrigated conditions and 1316.5 cm^2 under rainfed conditions at 90 DAS. Thus, adequate water availability increases sorghum genotype leaf numbers and areas, but drought stress reduces leaf development and size.

3.1.3 Days to 50% flowering and physiological maturity:

In response to drought stress, sorghum plants often adopt a survival strategy of early flowering. This allows them to complete their reproductive cycle before severe water scarcity sets in, ensuring their survival. Among the twenty sorghum genotypes tested, Phule Anuradha showed early flowering, reaching 50% flowering in only 63 days, demonstrating its drought tolerance (Table 6). This early flowering behavior in tolerant genotypes enables them to reach physiological maturity sooner under stress conditions, ensuring seed production before conditions become too severe [4]. Under non-stress conditions, Phule Anuradha reaches physiological maturity in 108 days, while CSV-216R takes 114 days. However, under rainfed conditions, these genotypes achieve physiological maturity at 103 and 105 days, respectively.

3.2 Yield parameters:

3.2.1 Grain yield per plant:

Significant variations were observed in yield parameters due to irrigation, genotypes, and their interactions (Table 7). In irrigated conditions, the mean grain yield was 70.23 g/plant, while in rainfed conditions, it was 54.54 g/plant. Among the genotypes, BJV-44 displayed the highest grain yield at 78.13 g/plant, while SVD-1272R (43.66 g/plant) and Chitapur - L (48.59 g/plant) recorded notably lower grain yield per plant. Genotypes M 148-138 and Tandur L showed the most significant reduction in grain yield per plant under rainfed conditions, with decreases of 34.3 grams and 30.9 grams, respectively, compared to irrigated conditions, indicating their susceptibility to induced water stress. According to Abderhim*et al*. [1], water scarcity can reduce stomatal conductance, reducing photosynthesis carbon dioxide uptake and assimilate production, which is necessary for grain filling and yield formation.

3.2.2 Stover yield:

Moisture stress significantly affects the stover yield of sorghum genotypes. Limited water availability during critical growth stages negatively impacts plant growth and development, resulting in a decrease in stover yield [3]. Stover yield was notably higher under irrigated conditions at 5413 kg/ha, while rainfed conditions resulted in a significant reduction to an average of 3761 kg/ha. M-35-1 had the highest mean stover yield at 5627 kg/ha, while SVD-1272R showed a decrease of approximately 1685 kg/ha in stover yield under stress conditions compared to non-stress conditions.

3.2.3 Harvest index (HI):

The harvest index was higher under irrigated conditions at 30.91%, while rainfed conditions had a lower mean harvest index of 28.13%. Basavanapada had the highest harvest index at 36.23% under non-stress conditions, followed by Tandur L, while in the stress regime, Basavanapada and PhuleVasudha had the highest harvest indices. Souza *et al*. [11] observed that under drought conditions, limited water availability affects various physiological processes in sorghum plants, resulting in changes in resource allocation and a decrease in the harvest index.

4. CONCLUSION

Water stress is a major challenge for sorghum cultivation, which significantly influences morpho-phenological and yield parameters. Under drought conditions, sorghum plants adapt by reducing their size, leaf area, and flowering time. This allows some genotypes to maintain grain yield, while others are more vulnerable. Grain and stover yields are generally reduced by water stress. The genotypes Phule Anuradha,BJV 44, Phule Vasudha and M-35-1 performed well under both irrigated and rainfed conditions, demonstrating their tolerance to water stress. Efficient water management is essential for mitigating the adverse effects of water stress on sorghum yield and resource allocation.

Table 2. Effect of drought stress on plant height (cm) at 30, 60 and 90 DAS in sorghum genotypes (Pooled 2021-22 and 2022-23)

Genotypes		Plant height (cm)								
		30DAS			60DAS			90DAS		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	41.97	40.79	**41.38**	122.09	110.35	**116.22**	172.50	159.68	**166.09**
2	SVD-1358R	39.20	38.37	**38.78**	126.50	112.37	**119.43**	187.50	174.59	**181.04**
3	SVD-1528R	35.32	37.82	**36.57**	120.54	105.14	**112.84**	173.28	156.88	**165.08**
4	SVD-1403R	40.42	39.38	**39.90**	116.30	101.82	**109.06**	167.00	151.20	**159.10**
5	SPV-486	38.82	43.08	**40.95**	128.39	115.33	**121.86**	187.60	176.88	**182.24**
6	SPV-2217	43.84	45.30	**44.57**	131.30	114.69	**122.99**	190.80	176.13	**183.47**
7	CSV-216R	50.22	41.74	**45.98**	128.50	113.12	**120.81**	185.72	171.20	**178.46**
8	CSV-29R	44.07	46.95	**45.51**	135.82	123.58	**129.70**	201.55	188.60	**195.08**
9	ICSR-15001	41.03	35.52	**38.28**	117.77	105.63	**111.70**	160.00	147.50	**153.75**
10	Basavanapada	45.08	39.85	**41.97**	109.69	98.89	**104.29**	154.20	140.60	**147.40**
11	Tandur L	33.67	33.87	**33.77**	114.13	97.87	**106.00**	161.60	140.49	**151.04**
12	Phule Anuradha	38.25	43.78	**41.02**	138.94	127.54	**133.24**	216.77	206.60	**211.68**
13	Chitapur – L	47.62	41.50	**44.56**	138.92	120.64	**129.78**	210.40	192.70	**201.55**
14	DKS- 35	42.40	46.40	**46.40**	148.73	133.60	**141.17**	222.02	210.90	**216.46**
15	M-35-1	48.23	45.88	**48.56**	147.40	135.79	**141.59**	218.69	209.42	**214.05**
16	M 148-138	47.92	45.82	**46.87**	143.17	122.77	**132.97**	221.50	200.40	**210.95**
17	Basavanmoti	46.62	43.49	**45.05**	130.40	119.07	**124.73**	200.30	188.52	**194.41**
18	Phule Vasudha	46.37	47.57	**46.97**	138.33	127.97	**133.15**	210.60	197.30	**203.95**
19	BJV-44	36.28	37.15	**36.72**	121.52	111.82	**116.67**	181.12	170.42	**175.77**
20	ICSR-13025	36.52	36.17	**36.34**	124.32	109.40	**116.86**	185.10	170.00	**177.55**
Mean		**42.34**	**41.67**	**42.01**	**129.14**	**115.37**	**122.25**	**190.41**	**176.50**	**183.46**
		S.Em. ±		**CD @5%**	**S.Em. ±**		**CD @5%**	**S.Em. ±**		**CD @5%**
Main plot (M)		0.115		1.461	0.955		3.134	3.302		12.962
Sub Plot (P)		3.387		23.035	4.417		16.117	4.835		19.431
Interaction		10.439		29.886	13.613		38.972	14.902		42.662

DAS- Days after sowing, IR- Irrigated, RF- rainfed

Table 3. Effect of drought stress on leaf area (cm^2) at 30, 60 and 90 DAS in sorghum genotypes (Pooled 2021-22 and 2022-23)

Genotypes		Leaf area (cm^2)								
		30DAS			60DAS			90DAS		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	342.33	319.63	**330.98**	823.82	791.60	**807.71**	677.00	624.30	**650.65**
2	SVD-1358R	364.86	338.72	**351.79**	1132.50	1118.62	**1125.56**	1115.37	1037.34	**1076.36**
3	SVD-1528R	458.00	458.22	**458.11**	1365.50	1312.50	**1339.00**	1253.57	1194.67	**1224.12**
4	SVD-1403R	475.58	468.85	**472.21**	1345.64	1307.90	**1326.77**	1239.10	1171.61	**1205.35**
5	SPV-486	494.50	512.64	**503.57**	1610.50	1586.90	**1598.70**	1425.10	1382.80	**1403.95**
6	SPV-2217	515.25	502.82	**509.04**	1597.50	1539.40	**1568.45**	1414.40	1352.50	**1383.45**
7	CSV-216R	417.60	414.65	**416.13**	1264.34	1220.33	**1242.34**	1202.60	1142.50	**1172.55**
8	CSV-29R	312.64	324.85	**318.75**	923.33	890.22	**906.78**	819.70	769.50	**794.60**
9	ICSR-15001	367.52	354.68	**361.10**	998.36	952.56	**975.46**	837.54	770.64	**804.09**
10	Basavanapada	405.30	372.85	**389.08**	1142.86	1111.36	**1127.11**	1100.80	1056.50	**1078.65**
11	Tandur L	446.00	426.98	**436.49**	942.33	876.00	**909.17**	728.43	660.63	**694.53**
12	Phule Anuradha	495.16	494.60	**494.88**	1529.60	1506.90	**1518.25**	1350.50	1316.50	**1333.50**
13	Chitapur – L	393.86	404.65	**399.26**	1180.90	1113.80	**1147.35**	1182.97	1140.67	**1161.82**
14	DKS- 35	387.46	368.96	**378.21**	1085.82	1055.44	**1070.63**	1033.60	965.60	**999.60**
15	M-35-1	476.41	479.50	**477.96**	1406.60	1393.80	**1400.20**	1340.15	1296.85	**1318.50**
16	M 148-138	336.72	336.46	**336.59**	1048.27	1003.67	**1025.97**	1022.80	954.50	**988.65**
17	Basavanmoti	392.56	384.33	**388.45**	1229.34	1207.33	**1218.34**	1160.57	1118.67	**1139.62**
18	Phule Vasudha	370.38	364.85	**367.61**	1300.36	1283.56	**1291.96**	1193.60	1150.50	**1172.05**
19	BJV-44	451.81	460.55	**456.18**	1346.64	1324.50	**1335.57**	1257.53	1216.33	**1236.93**
20	ICSR-13025	359.50	304.60	**332.05**	1116.50	1079.54	**1098.02**	1060.67	1001.67	**1031.17**
Mean		**413.17**	**404.67**	**408.92**	**1219.54**	**1183.80**	**1201.67**	**1120.80**	**1066.21**	**1093.51**

	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%
Main plot (M)	0.810	4.292	4.570	20.067	8.453	27.399
Sub Plot (P)	8.863	35.616	25.767	77.396	24.670	73.467
Interaction	27.318	78.209	79.418	227.368	76.039	217.695

Table 4. Effect of drought stress on leaf Area Index at 30, 60 and 90 DAS in sorghum genotypes (Pooled 2021-22 and 2022-23)

Genotypes		Leaf Area Index								
		30DAS			60DAS			90DAS		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	0.51	0.47	**0.49**	1.22	1.17	**1.20**	1.00	0.92	**0.96**
2	SVD-1358R	0.54	0.50	**0.52**	1.68	1.66	**1.67**	1.65	1.54	**1.59**
3	SVD-1528R	0.68	0.68	**0.68**	2.02	1.94	**1.98**	1.86	1.77	**1.81**
4	SVD-1403R	0.70	0.69	**0.70**	1.99	1.94	**1.97**	1.84	1.74	**1.79**
5	SPV-486	0.73	0.76	**0.75**	2.39	2.35	**2.37**	2.11	2.05	**2.08**
6	SPV-2217	0.76	0.74	**0.75**	2.37	2.28	**2.32**	2.10	2.00	**2.05**
7	CSV-216R	0.62	0.61	**0.62**	1.87	1.81	**1.84**	1.78	1.69	**1.74**
8	CSV-29R	0.46	0.48	**0.47**	1.37	1.32	**1.34**	1.21	1.14	**1.18**
9	ICSR-15001	0.54	0.53	**0.53**	1.48	1.41	**1.45**	1.24	1.14	**1.19**
10	Basavanapada	0.60	0.55	**0.58**	1.69	1.65	**1.67**	1.63	1.57	**1.60**
11	Tandur L	0.66	0.63	**0.65**	1.40	1.30	**1.35**	1.08	0.98	**1.03**
12	Phule Anuradha	0.73	0.73	**0.73**	2.27	2.23	**2.25**	2.00	1.95	**1.98**
13	Chitapur – L	0.58	0.60	**0.59**	1.75	1.65	**1.70**	1.75	1.69	**1.72**
14	DKS- 35	0.57	0.55	**0.56**	1.61	1.56	**1.59**	1.53	1.43	**1.48**
15	M-35-1	0.71	0.71	**0.71**	2.08	2.06	**2.07**	1.99	1.92	**1.95**
16	M 148-138	0.50	0.50	**0.50**	1.55	1.49	**1.52**	1.52	1.41	**1.46**
17	Basavanmoti	0.58	0.57	**0.58**	1.82	1.79	**1.80**	1.72	1.66	**1.69**
18	Phule Vasudha	0.55	0.54	**0.54**	1.93	1.90	**1.91**	1.77	1.70	**1.74**
19	BJV-44	0.67	0.68	**0.68**	2.00	1.96	**1.98**	1.86	1.80	**1.83**
20	ICSR-13025	0.53	0.45	**0.49**	1.65	1.60	**1.63**	1.57	1.48	**1.53**
Mean		**0.61**	**0.60**	**0.61**	**1.81**	**1.75**	**1.78**	**1.66**	**1.58**	**1.62**

	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%
Main plot (M)	0.001	0.005	0.007	0.036	0.013	0.049
Sub Plot (P)	0.013	0.057	0.038	0.135	0.037	0.124
Interaction	0.040	0.116	0.118	0.337	0.113	0.323

DAS- Days after sowing, IR- Irrigated, RF- rainfed

Table 5. Effect of drought stress on number of green leaves per plant at 30, 60 and 90 DAS in sorghum genotypes (Pooled 2021-22 and 2022-23)

Genotypes		Number of green leaves per plant								
		30DAS			60DAS			90DAS		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	5.50	5.50	**5.50**	12.25	10.25	**11.25**	9.75	7.25	**8.50**
2	SVD-1358R	5.50	5.00	**5.25**	12.25	11.25	**11.75**	10.25	7.50	**8.88**
3	SVD-1528R	5.25	4.75	**5.00**	11.75	10.00	**10.88**	10.50	6.75	**8.63**
4	SVD-1403R	5.75	5.50	**5.63**	12.50	11.25	**11.88**	10.75	8.00	**9.38**
5	SPV-486	6.50	5.75	**6.13**	12.75	11.00	**11.88**	11.25	9.00	**10.13**
6	SPV-2217	6.00	5.75	**5.88**	12.75	11.50	**12.13**	9.75	8.50	**9.13**
7	CSV-216R	5.50	4.75	**5.13**	12.00	11.00	**11.50**	9.75	7.50	**8.63**
8	CSV-29R	6.00	6.25	**6.13**	12.00	11.75	**11.88**	11.00	9.00	**10.00**
9	ICSR-15001	5.25	4.75	**5.00**	11.50	9.50	**10.50**	9.75	7.00	**8.38**
10	Basavanapada	5.75	5.75	**5.75**	12.25	11.25	**11.75**	10.00	8.00	**9.00**
11	Tandur L	5.00	4.75	**4.88**	12.25	9.75	**11.00**	9.75	6.25	**8.00**
12	Phule Anuradha	6.00	6.25	**6.13**	12.25	11.00	**11.63**	10.25	9.00	**9.63**
13	Chitapur – L	5.00	4.50	**4.75**	12.00	9.75	**10.88**	10.00	6.25	**8.13**
14	DKS- 35	6.50	6.00	**6.25**	11.75	11.50	**11.63**	10.25	8.50	**9.38**
15	M-35-1	6.75	6.50	**6.63**	12.00	11.25	**11.63**	11.00	9.25	**10.13**
16	M 148-138	5.00	5.25	**5.13**	12.00	10.50	**11.25**	10.00	8.00	**9.00**
17	Basavanmoti	5.50	5.50	**5.50**	12.00	11.75	**11.88**	11.00	9.50	**10.25**
18	Phule Vasudha	5.50	5.00	**5.25**	12.00	11.25	**11.63**	11.00	9.00	**10.00**
19	BJV-44	6.75	6.00	**6.38**	12.75	11.25	**12.00**	11.00	10.25	**10.63**
20	ICSR-13025	5.25	4.25	**4.75**	11.75	10.00	**10.88**	9.50	7.25	**8.38**
Mean		**5.71**	**5.39**	**5.55**	**12.14**	**10.84**	**11.49**	**10.33**	**8.09**	**9.21**

	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%
Main plot (M)	1.000	5.706	0.500	2.353	3.250	11.295
Sub Plot (P)	0.656	4.341	0.959	4.190	1.202	5.278
Interaction	2.023	5.793	2.957	8.466	3.706	10.610

DAS- Days after sowing, IR- Irrigated, RF- rainfed

Table 6. Effect of drought stress on days to first flowering, 50 % flowering and physiological maturity in sorghum genotypes (Pooled 2021-22 and 2022-23)

Genotypes		Days to first flowering			Days to 50 % flowering			Days to physiological maturity		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	67	61	**64**	75	68	**71**	115	104	**109**
2	SVD-1358R	77	72	**75**	82	77	**80**	130	119	**125**
3	SVD-1528R	79	71	**75**	86	78	**82**	131	120	**126**
4	SVD-1403R	77	69	**73**	82	73	**77**	123	114	**118**
5	SPV-486	74	70	**72**	77	74	**76**	125	117	**121**
6	SPV-2217	79	73	**76**	86	78	**82**	129	120	**124**
7	CSV-216R	68	63	**66**	73	68	**70**	114	105	**109**
8	CSV-29R	72	68	**70**	77	70	**74**	117	109	**113**
9	ICSR-15001	79	72	**76**	86	77	**81**	135	123	**129**
10	Basavanapada	72	68	**70**	76	71	**74**	123	115	**119**
11	Tandur L	79	70	**75**	88	79	**83**	128	114	**121**
12	Phule Anuradha	62	58	**60**	65	61	**63**	108	103	**105**
13	Chitapur – L	88	79	**84**	94	85	**89**	137	123	**130**
14	DKS- 35	64	59	**61**	68	62	**65**	115	106	**111**
15	M-35-1	68	65	**67**	71	68	**69**	115	107	**111**
16	M 148-138	77	70	**73**	82	76	**79**	127	115	**121**
17	Basavanmoti	75	72	**73**	79	74	**77**	126	119	**122**
18	Phule Vasudha	74	72	**73**	79	75	**77**	131	120	**125**
19	BJV-44	81	78	**80**	85	80	**82**	129	121	**125**
20	ICSR-13025	86	80	**83**	91	86	**88**	137	126	**132**
Mean		**75**	**69**	**72**	**80**	**74**	**77**	**125**	**115**	**120**

	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%
Main plot (M)	0.500	3.706	0.333	2.235	0.001	0.003
Sub Plot (P)	1.419	6.028	1.721	5.872	2.652	7.701
Interaction	4.373	12.520	5.306	15.190	8.175	23.404

DAS- Days after sowing, IR- Irrigated, RF- rainfed

Table 7. Effect of drought stress on grain yield/plant,grain yield/ha, stover yield and harvest index in sorghumgenotypes (Pooled 2021-22 and 2022-23)

	Genotypes	Grain yield (kg/ha)			Grain yield/plant (g)			Stover Yield (kg/ha)			Harvest Index (%)		
		IR	RF	Mean	IR	RF	Mean	IR	RF	Mean	IR	RF	Mean
1	SVD-1272R	952	852	**902**	51.18	36.15	**43.66**	5007	3186	**4096**	27.76	23.48	**25.62**
2	SVD-1358R	1169	1037	**1103**	68.02	55.54	**61.78**	5110	3457	**4284**	31.32	30.32	**30.82**
3	SVD-1528R	1012	828	**920**	65.03	44.51	**54.77**	5234	3525	**4380**	30.44	26.60	**28.52**
4	SVD-1403R	1444	1123	**1283**	69.49	55.73	**62.61**	5342	3601	**4471**	32.34	30.58	**31.46**
5	SPV-486	1260	1171	**1215**	75.74	62.42	**69.08**	4975	3321	**4148**	31.53	29.24	**30.38**
6	SPV-2217	1129	982	**1055**	68.56	52.90	**60.73**	5880	4091	**4985**	29.70	27.38	**28.54**
7	CSV-216R	890	812	**851**	56.77	46.71	**51.74**	5306	3569	**4437**	27.93	26.76	**27.35**
8	CSV-29R	1163	1075	**1119**	73.05	62.65	**67.85**	5728	4051	**4890**	31.12	30.10	**30.61**
9	ICSR-15001	872	619	**745**	59.01	39.29	**49.15**	4512	2907	**3710**	31.30	27.33	**29.32**
10	Basavanapada	1302	1207	**1255**	76.03	59.18	**67.61**	4656	3042	**3849**	36.23	34.27	**35.25**
11	Tandur L	738	573	**656**	70.96	40.04	**55.50**	4544	2803	**3674**	36.19	30.32	**33.26**
12	PhuleAnuradha	1156	1063	**1109**	80.58	70.36	**75.47**	6235	4701	**5468**	28.23	26.97	**27.60**
13	Chitapur – L	493	316	**405**	61.90	35.28	**48.59**	4777	3027	**3902**	30.35	23.00	**26.67**
14	DKS- 35	1539	1348	**1444**	80.82	70.86	**75.84**	6075	4422	**5249**	28.41	28.29	**28.35**
15	M-35-1	1350	1271	**1310**	79.88	73.50	**76.69**	6394	4860	**5627**	30.21	29.54	**29.88**
16	M 148-138	1350	1095	**1222**	78.67	44.36	**61.51**	5517	3824	**4671**	31.51	24.18	**27.85**
17	Basavanmoti	1306	1258	**1282**	63.69	52.73	**58.21**	5900	4461	**5180**	28.49	25.90	**27.20**
18	PhuleVasudha	1426	1362	**1394**	75.52	68.73	**72.12**	5983	4454	**5219**	31.57	31.83	**31.70**
19	BJV-44	1332	1269	**1300**	80.08	76.17	**78.13**	6115	4621	**5368**	30.00	30.25	**30.12**
20	ICSR- 13025	983	780	**882**	69.52	43.75	**56.64**	4975	3289	**4132**	33.49	26.18	**29.84**
Mean		**1143**	**1002**	**1073**	**70.23**	**54.54**	**62.38**	**5413**	**3761**	**4587**	**30.91**	**28.13**	**29.52**

	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%	S.Em. ±	CD @5%
Main plot (M)	265.635	775.212	13.520	51.788	547.603	1757.958	5.020	14.784
Sub Plot (P)	111.026	410.725	4.982	13.297	229.772	619.526	2.836	7.037
Interaction	342.207	979.712	15.354	43.958	708.204	2027.535	8.742	25.027

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