

EVALUATION OF DIVERSE GERMPLASM FOR RABI ADAPTION ON MEDIUM SOIL

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Abstract: Forty eight landraces rabi sorghum (*Sorghum bicolor* (L.), germplasm including M-35-1, CSV 22R and Phule Chitra as a checks were evaluated in medium soil under rainfed condition. The variations in grain and fodder yield due to genotypes were statistically significant. Considering the mean performance for three years the genotype Gondavale Local produced numerically higher grain yield (66.50 g/plant) followed by RSV 1426 (66.0 g/plant) than the high yielding check Phule Chitra (47.50g/plant). High yield of Gondavale Local and RSV 1426 is correlated with its superior physiological parameters. The grain yield is positively correlated with SPAD value, Leaf area, heat unit, heat unit efficiency, higher biomass, Harvest Index (%), Earhead Exertion (EE%), stomatal conductance, photosynthesis and negatively correlated with leaf temperature difference and transpiration rate.

Keywords: Evaluation, Medium soil, Rabi adaption, *Sorghum bicolor* (L.)

Introduction

Sorghum (*Sorghum bicolor* L. moench) is an important food and fodder crop of the world. Rabi sorghum in the Deccan plateau is normally grown under stored and receding soil moisture condition, where it experiences both soil and atmospheric drought. Identifying the morphological or physiological traits imparting tolerance to drought stress has been given high priority in crop plants. Although, sorghum is said to be drought tolerant yet at certain critical stages, moisture stress causes considerable reduction in growth and yield. (Griffin, 1996). Variations in drought tolerance both among and within crop species are known and some genotypes of sorghum are known to be better adapted to dry conditions. (Bapat,1995). Hence present study was undertaken to evaluate the relative performance of some sorghum germplasm for rabi adoption on medium soil and to identify potential donors for rabi adaption traits such as phenology, physiological traits components of biomass and grain yield.

Materials and Methods

Field experiment was conducted for three consecutive years 2011-12, 2012-13 and 2013-14 in Rabi season at All India Co-ordinated Sorghum Improvement Project, Mahatma Phule

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Krishi Vidyapeeth, Rahuri. Forty eight sorghum genotypes of diverse origin including three checks

M-35-1, CSV 22R and Phule Chitra were evaluated on medium soil. The experiment was laid out in randomized block design with three replications. Fertilizer inputs were 40 kg N and 20 kg P₂O₂ as basal application. Plant protection included hand weeding as required, as well as insecticide treatment following standard recommendations. The seeds were sown manually with spacing of 45 cm between rows and 15 cm between plants in a row with more than two seeds per hill and thinned to one per hill at 15 days after sowing. The gross plot size was 4.50X1.80 m and net plot size was 4.20 x 0.90m. Crop was grown on receding soil moisture condition.

All physiological observations were recorded at 50% flowering and at physiological maturity, where as yield and yield components were recorded at harvest. Leaf temperature was recorded using an infrared thermometer. The photosynthetic rate, transpiration and stomatal conductance were recorded at flowering by using portable infrared gas analyzer (IRGA).

The panicles were sundried, threshed, cleaned and weight of the grains was recorded and expressed as grain yield grams per plant. Plants were dried in sunlight and weight of fodder was measured as fodder yield per plant. Thousand grains from the seeds collected from five randomly selected plants were taken for 1000 grains count. The weight of 1000 grains was recorded separately and expressed in grams. Biological yield was calculated as the sum of panicle dry weight and dry straw weight. Percentage of grain yield of a plant to the biological yield gave harvest index. Stay green score was recorded at harvest at 1-9 scale. The soil moisture content was measured gravimetrically at planting, at panicle initiation, 50 % flowering and physiological maturity on 0-15cms, 15-30 cms, 30-45 cms and 45-60 cms soil depth. The average data of three years were subjected to basic statistics and correlation analysis using statistical software packages of SPSS Version12.

Results and Discussion

Plant height is basically genetically controlled character influenced by environmental condition and genotypes. The data revealed significant differences in plant height among genotypes in medium soil. The data is presented in table 1. Plant height varied from 182 cm to 221 cm. Highest plant height was recorded by Gondavale local (221 cm) followed by CSV 22 R (220 cms). Days to 50 % flowering ranged from 69 to 76 days. Two entries flowered earlier than check M-35-1 (71 days) which include RSV 1478 and Tansoli halli local (69 days). Days to physiological maturity ranged from 109 to 119 days. Entry RSV 1426, RSV

1449, RSV 1460 and RSV 1462 required maximum (119 days) for physiological maturity while genotype Halyal local matured earlier (109 days) than checks. Earhead exertion in the germplasm ranged from 48.00 % to 71.67 %. Highest Earhead Exertion was recorded in check Phule Chitra (71.67 %) followed by Jamkhed local- 2 (70.67), RSV 1426 (70.33) and Gondavale local (70.00 %).

Leaf temperature difference varied from -3.93 to -5.47. RSV 1426 and Halyal local recorded leaf temperature difference -5.47 followed by Bidar Local (-5.37). High yielding check P.Chitra recorded Leaf temperature difference of -5.43 and M-35-1 (-5.0). Relative chlorophyll content (SPAD units) at flowering differed significantly and varied from 40.87 to 56.53. Entries RSV 1426 (56.53) and Gondavale local (56.37) had shown highest SPAD values than check P.Chitra (51.47).

Photosynthesis rate, transpiration rate, stomatal conductance were recorded at flowering and varied significantly. Photosynthesis rate ranged from $24.23 \mu \text{ m mol Co}_2 \text{ m}^{-1} \text{ S}^{-1}$ to $30.60 \mu \text{ m mol Co}_2 \text{ m}^{-1} \text{ S}^{-1}$. Highest photosynthesis rate was recorded by entries RSV 1426 ($30.60 \mu \text{ m mol Co}_2 \text{ m}^{-1} \text{ S}^{-1}$) and Gondavale Local ($30.50 \mu \text{ m mol Co}_2 \text{ m}^{-1} \text{ S}^{-1}$). Transpiration rate ranged from $1.14 \text{ m/mol H}_2\text{O m}^{-1} \text{ S}^{-1}$ to $1.42 \text{ m/mol H}_2\text{O m}^{-1} \text{ S}^{-1}$. Entry Gondavale local recorded lowest transpiration rate ($1.14 \text{ m/mol H}_2\text{O m}^{-1} \text{ S}^{-1}$) followed by RSV 1426 ($1.15 \text{ m/mol H}_2\text{O m}^{-1} \text{ S}^{-1}$) as against check P. Chitra ($1.14 \text{ m/mol H}_2\text{O m}^{-1} \text{ S}^{-1}$). Stomatal conductance varied from $22.20 \text{ m mol/m}^2 / \text{ sec}$ to $28.00 \text{ m mol/m}^2 / \text{ sec}$. Entry Gondavale local recorded highest ($27.87 \text{ m mol/m}^2 / \text{ sec}$) stomatal conductance followed by RSV 1426 ($27.47 \text{ m mol/m}^2 / \text{ sec}$). Check P.Chitra had $28.00 \text{ m mol/m}^2 / \text{ sec}$ stomatal conductance. Genotype having higher rate of photosynthesis had lower rate of transpiration and higher stomatal conductance results into higher water use efficiencies. These results are in conformity with Nirmal *et al* 2013.

Stay green plants exhibit greener leaves and stems during the grain filling period under water limited conditions compared with their senescent counter parts, resulting in increased grain yield, grain mass and lodging resistance. Entry RSV 1426 and Gondavale local recorded stay green score of 5-6 same as check P.Chitra (5-6 stay green score). In case of biological yield at maturity, the range of variation observed was 117 g/plant to 196.50 g/plant. Gondavale local recorded highest biological yield 196.50 g/plant followed by RSV 1426 (184.00 g/plant). High yielding check P. Chitra recorded biological yield of 159.00 g/plant.

There were differences among entries for Harvest Index. Harvest Index in these entries ranged from 19.67 to 33.33 %. Significantly highest Harvest Index was recorded by entry

RSV 1426 (33.33 %) followed by Gondavale Local (31.00 %) and Check P. Chitra (31.00). Mean grain yield varied between 29.00 g/plant to 66.50 g/plant. Four entries viz; Gondavale Local (66.50 g/plant), RSV 1426 (66.00 g/plant), Tansoli halli local (62.50 g/plant) and Jamkhed local- 2 (60.50 g/plant) recorded highest grain yield than check P.Chitra (56.50 g/plant). Mean fodder yield in these entries varied from 81.00 g/plant to 130.20 g/plant. Highest fodder yield was recorded by entry Gondavale local (130.20 g/plant) followed by RSV 1426 (118.40 g/plant) than check P. Chitra (114.40 g/plant).

The grain yield was positively correlated with Harvest Index, 1000 grain weight, Earhead Exertion %, Stay green at physiological maturity, SPAD at 50 % flowering, photosynthesis rate and negatively correlated with leaf temperature differences, transpiration rate and stomatal conductance. Results are in conformity with Reddy *et al* 2012. Based on the morphological, physiological parameters studied and compared with checks, the following entries have been found promising and they may be utilized by breeders in the breeding programme to evolve new rabi sorghum variety. They are RSV 1426, Gondavale Local Tansole halli local and Jamkhed local- 2.

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Table 1. Soil moisture status (%) during crop growth for rabi season
(During 2011-12 to 2013-14)

Crop Age	Soil depth (cm)			
	0-15	15-30	30-45	45-60
At planting	37.60	38.30	40.0	40.50
At panicle initiation	35.30	36.30	39.60	40.30
At 50% flowering	30.30	33.00	34.40	35.10
At physiological maturity	24.30	27.20	30.30	33.20

Table 2. Evaluation of diverse germplasm for *rabi* adaptation (Pooled mean of three years data 2011-12,2012-13,2013-14)

Sr.No.	Entry Name	Plant height (cm)	1000 grain weight (g)	Days to phy. maturity	Days to 50 % flow.	EE%	Leaf temp. Diff. ($^{\circ}$ C)..	SPAD at 50% flow	Photosynthesis rate (μ m mol CO_2 $\text{m}^{-1}\text{S}^{-1}$)	Stomatal cond. (m mol/ m^2 / sec.)	Transpi rate (m/mol H_2O $\text{m}^{-1}\text{S}^{-1}$)	Staygreen score at phy. Maturity	Biological Yield g/plant	HI(%)	Grain yield g/plant	Fodder yield g/plant
1	RSV-1425	193.0	29.75	114.67	71.5	56.67	-4.57	46.73	26.1	24.00	1.42	7-8	143	26.00	43.50	99.70
2	RSV-1426	212.0	34.13	119.67	74.5	70.33	-5.47	56.53	30.60	27.47	1.15	5-6	184	33.33	66.00	118.40
3	RSV-1449	201.0	30.60	119.33	76	56.33	-4.40	44.00	24.67	25.60	1.37	7--8	162.5	26.00	55.50	107.00
4	RSV-1458	184.0	28.29	115.00	73	63.67	-4.90	44.63	26.33	24.07	1.40	8--9	137.5	26.00	47.50	90.00
5	RSV-1460	207.0	29.21	119.00	73.5	57.33	-4.40	44.67	28.53	24.13	1.38	7--8	129.5	25.00	42.00	87.50
6	RSV-1461	207.0	30.38	115.33	74.5	60.00	-5.07	44.50	27.87	24.17	1.37	7--8	143	27.67	49.00	94.00
7	RSV-1462	186.0	33.11	119.67	76.5	62.00	-4.90	41.60	28.17	24.67	1.37	8--9	157	21.00	35.00	121.90
8	RSV-1468	220.0	40.51	116.00	73	48.00	-4.90	49.77	26.90	24.53	1.36	7--8	145	27.67	55.00	90.40
9	RSV-1478	205.0	29.60	113.00	69.5	68.00	-4.90	45.70	29.07	25.67	1.36	7--8	125.5	26.00	38.50	87.00
10	RSV-1479	205.0	28.20	115.00	73.5	59.67	-5.13	49.17	29.87	25.57	1.35	7--8	141	24.00	50.00	91.00
11	Tansoli halli local	206.33	30.75	111.67	69	69.00	-4.07	44.17	29.20	24.03	1.35	5--6	181	24.33	62.50	123.70
12	Yadgir local	208.67	27.05	116.33	75.5	56.00	-4.97	45.67	29.00	27.03	1.34	8--9	156	22.67	46.50	109.20
13	Dharampur local	217.67	28.65	112.67	73	60.00	-5.33	49.23	26.53	23.80	1.33	7--8	140	24.00	48.50	91.70
14	Tillehal local	201.33	34.89	115.33	72	57.67	-4.27	46.07	25.33	25.53	1.33	8--9	155.5	19.67	37.50	118.00
15	Halyal local	217.33	29.66	109.00	71.5	52.67	-5.47	47.43	29.67	27.03	1.32	8--9	138.5	28.00	45.00	93.40
16	Jamkhed local-1	171.00	31.74	113.33	72.5	65.00	-4.43	44.40	28.87	26.20	1.32	8--9	117	23.33	29.00	87.90
17	Mundewadi local	205.00	28.07	118.67	74.5	58.67	-5.03	41.80	25.47	25.23	1.31	7--8	125	26.33	43.50	81.50
18	Khadkat local	201.67	36.68	116.00	72	45.33	-4.30	49.97	24.90	24.20	1.31	7--8	179	24.33	56.50	117.90
19	Patoda local	197.67	35.75	115.00	72.5	56.67	-4.40	40.87	28.40	23.23	1.30	7--8	140.5	23.67	35.50	105.00
20	Nimbodi local	210.00	27.89	116.00	75	53.00	-4.60	46.17	27.47	26.13	1.30	8--9	123.5	28.33	41.50	82.00
21	Jamkhed local-2	205.67	31.99	118.67	75	70.67	-5.07	41.10	26.00	22.20	1.29	7--8	167.5	25.33	60.50	107.00
22	Bidar local	207.00	37.19	118.33	76.5	53.00	-5.37	49.07	28.63	25.03	1.28	7--8	163.5	25.33	51.50	106.70
23	Pathari local	200.67	34.67	116.00	74.5	63.00	-3.93	49.90	26.43	26.80	1.28	8--9	143	27.33	43.50	99.70

24	Katarkhatav	195.33	36.19	114.33	74	63.00	-4.37	46.10	28.37	26.27	1.27	8--9	167	28.00	4.50	109.40
25	Aurad local	216.00	34.49	116.00	74	58.67	-4.93	46.77	27.87	27.00	1.27	8--9	131.5	24.33	38.00	93.70
26	Mardi local	202.67	36.25	116.67	74.5	64.33	-5.17	43.90	24.43	25.67	1.26	7--8	126	27.67	45.00	81.00
27	Gondavale local	221.67	34.12	114.00	75	70.00	-5.27	56.37	30.50	27.87	1.14	5--6	196.5	31.00	66.50	130.20
28	Mangalwedha local	212.00	29.78	117.33	73	58.00	-4.10	47.70	28.30	23.37	1.25	8--9	128	20.00	31.00	96.90
29	Honsal local	219.00	38.04	117.67	74.5	60.00	-4.53	47.37	24.23	25.27	1.24	8--9	142	23.33	44.50	97.20
30	Pusegaon local	197.33	29.53	113.33	72	49.00	-4.20	48.47	27.60	24.67	1.24	7--8	183.5	28.67	56.00	125.20
31	Kavalagudda mungaru	182.33	30.80	117.67	75	65.67	-4.77	47.40	27.10	25.40	1.23	8--9	175	27.67	50.50	118.40
32	Tikota	194.67	30.90	115.33	75	60.67	-5.17	47.60	25.77	24.17	1.23	8--9	158	26.67	47.00	111.40
33	Bairodagi	196.67	30.13	117.00	74.5	58.00	-4.67	48.70	26.23	23.90	1.22	8--9	129	26.67	41.00	88.20
34	Honawad-2	193.0	23.47	115.00	71.5	53.33	-4.83	44.80	29.27	24.10	1.22	7--8	127.5	29.33	52.00	75.40
35	Honawad	185.00	33.33	133.33	71.5	46.33	-5.03	50.00	28.10	27.00	1.21	5--6	176.5	24.33	59.00	117.70
36	SSRG164	207.00	31.37	116.67	71.5	63.67	-4.10	40.87	26.83	26.83	1.20	7--8	142	28.00	43.50	98.50
37	SSRG200	196.67	33.07	113.67	75	60.33	-4.77	46.73	28.27	26.13	1.20	7--8	167.5	23.67	32.00	94.70
38	SSRG147	205.00	30.15	117.33	74.5	53.00	-4.27	47.23	27.93	24.67	1.19	8--9	120	24.00	40.00	90.40
39	SSRG170	211.00	27.20	115.00	71.5	59.67	-4.93	49.47	26.37	24.93	1.19	7--8	119.5	30.33	42.00	84.90
40	SSRG201	206.33	33.07	115.33	73.5	63.67	-4.80	44.83	26.57	26.23	1.18	7--8	138	28.00	55.50	81.00
41	SSRG204	219.67	27.97	113.00	71.5	59.67	-4.40	49.40	26.60	26.73	1.18	8--9	129.5	25.33	48.50	77.40
42	SSRG202	203.00	31.23	113.33	71.5	68.33	-4.63	49.87	27.20	26.67	1.17	7--8	135	29.67	50.50	90.90
43	SSRG206	205.33	33.73	116.67	74	65.00	-5.10	47.77	26.63	26.80	1.16	7--8	121	27.00	45.50	92.00
44	SSRG203	183.00	35.50	114.33	72.5	57.33	-3.97	46.50	28.03	25.87	1.16	8--9	154.5	24.67	47.50	114.40
45	SSRG236	199.67	31.43	118.67	73	60.33	-5.13	46.53	26.77	26.30	1.15	8--9	163	26.33	40.50	113.90
46	M35-1(C)	201.33	31.13	113.67	71	67.67	-5.00	44.83	25.47	27.23	1.15	8--9	139.5	25.00	46.00	88.40
47	CSV 22R(C)	220.00	36.70	119.33	75	69.67	-4.90	46.53	25.97	26.17	1.14	7--8	130.5	25.67	47.50	82.50
48	P. Chitra (C)	193.67	36.13	116.67	73	71.67	-5.43	51.47	30.03	28.00	1.14	5--6	159	31.00	56.50	114.40
	Correlation	+0.32	+0.45	+0.12	+0.11	+0.46	-0.25	+0.43	+0.23	+0.15	-1.13		+0.25	+0.68		