International Journal of Agricultural Sciences
Volume **9** | Issue 2| June, 2013 | 799-801

RESEARCH PAPER

Phule Anuradha: New drought tolerant *Rabi* sorghum variety for shallow soil

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Abstract : A new *Rabi* sorghum [*Sorghum bicolor* (L.) Moench] variety Phule Anuradha identified as drought tolerant because of its superior physiological traits under receding soil moisture condition during *Rabi* season on shallow soil type of Maharashtra. An experiment was conducted to screen sixteen genotypes for drought tolerance under receding soil moisture condition during *Rabi* season on shallow type of soil. The grain yield was positively correlated with photosynthesis rate, stomatal resistance, photo-synthetically active radiation, relative water content of leaves (RLWC), leaf area index (LAI), biomass at harvest, grain number per panicle, test weight, ear head exertion, stay green at physiological maturity, per day production of grain with fodder and fodder yield and negatively correlated with leaf temperature difference (^{o}C) , chlorophyll stability index (CSI), stomatal conductance, transpiration rate and stomata frequency under drought stress. Grain yield decreased in all the genotypes as the crop was subjected to progressive drought stress under receding soil moisture situation. Among the genotypes studied Phule Anuradha performed well under drought stress conditions maintaining leaf area, leaf relative water content, biomass at harvest, test weight, ear head exertion(%), leaf temperature, chlorophyll stability index and stomatal frequency.

Key Words : Sorghum, RLWC, CSI, Photosynthesis, Transpiration, Stomatal conductance, Resistance, Stomatal frequency, Correlation

View Point Article : Nirmal, S.V., Gadakh, S.R., Gaikawad, A.R. and Patil, V.R. (2013). Phule Anuradha: New drought tolerant *Rabi* sorghum variety for shallow soil. *Internat. J. agric. Sci.*, **9**(2): 799-801.

Article History : Received : 13.08.2012**; Revised :** 26.04.2013**; Accepted :** 27.05.2013

INTRODUCTION

Rabi sorghum is the most important crop of Maharashtra state occupying an area of 31 lakh ha (Anonymous, 2010). Area under *Rabi* sorghum has remained stable and is grown predominantly in six districts of Maharashtra (Solapur, Ahmednagar, Pune, Beed, Osmanabad and Aurangabad). Although assured market is available, tremendous opportunities exist in food processing and nutritious food by popularizing product as sorghum pop, sorghum flakes.

The productivity of this crop is dependant upon the rain and residual moisture in the soil. There is a tremendous demand in the market for pearly white grain and quality fodder. Keeping all this factors in mind, to find out suitable donors for drought tolerance having good physiological parameters under rainfed conditions especially for shallow type of soil of Maharashtra state an experiment was conducted. The old variety RSLG-262 (Phule Maulee) has although drought tolerant for shallow soil but it is low yielder.

MATERIAL AND METHODS

A field study was done at Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 2008-09, 2009-10 and 2010-11 in *Rabi* season on shallow soils with sixteen *Rabi* sorghum genotypes. The seeds were sown manually with a spacing of 45x15 cm. The gross plot size was 13.5 m^2 and net plot size 7.92 m^2. A basal dose of 25 kg N was applied at the time of sowing. The soil moisture content was measured gravimetrically at planting, panicle initiation, 50 % flowering and at physiological maturity on 0-15 cm, 15-30 cm and 30-45 cm soil depth . All physiological observations were recorded at 50 % flowering and at physiological maturity yield and yield components were recorded at harvest. Plant water status was monitored by measuring relative water content by leaves

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(RLWC), leaf area was measured by using formula (LxWxF) dm^2 and leaf temperature was recorded by infra red thermometer. Rate of photosynthesis, stomatal conductance, transpiration rate and PAR were recorded by portable photosynthesis meter *i.e.* IRGA (Infrared gas analyzer). The yield parameters were recorded and the data were statically analysed as per methods given by Panse and Sukhatme (1985). Correlation was worked out as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The different varieties were grown on exclusively on receding soil moisture on shallow soil. The soil moisture content was gradually decreased (Table 1) from time of sowing till the harvest of crop. This implies that in drought stress condition the crop was grown only under receding soil moisture. The soil moisture was more at deeper depths under stress conditions. Hence, a genotype possessing deep penetrating roots is more suitable under receding soil moisture conditions (Chapman *et al.*, 1993 and Naidu *et al.*, 2001).

Table 1 : Soil moistures status (%) during crop growth

Crop age	Soil moisture (%) at different soil depth		
Soil Depth	0-15 cm	15-30 cm	30-45 cm
At planting	24.07	24.33	25.47
At panicle initiation	20.60	19.97	23.23
At 50 percent flowering	21.17	20.17	22.07
At physiological maturity	16.30	17.17	18.60

The variety differed in RLWC in shallow soil due to drought stress conditions (Rodriguiz *et al.*, 1992). Among the genotype studied Phule Anuradha maintained higher RLWC (Table 2a).This difference in RLWC among the genotypes brings differences in their survival under drought stress conditions (Sinclair and Ludlow, 1986).

Leaf area is a function of cell expression, which is again depend upon turgidity of cell. The variety Phule Anuradha (3.30) recorded maximum leaf area index than the other varieties M 35-1 (3.02) Phule Maulee (3.16) and Phule Chitra (3.27) (Table 2a). The decreases in leaf area are due to less elongation and enlargement of cell, coupled with lower the photosynthetic rate (Boyer, 1983). Leaf area is the main yield determining factor under receding soil moisture environment (Fischer and Turner, 1978). The mean leaf area index showed highly positive significant correlation with the average grain and fodder yield. Nirmal and Patil (2008) and Hiremath and Parvatikar (1985) noted the similar results.

Physiological parameters like leaf area index, relative leaf water content, leaf temperature, chlorophyll stability index, stomatal frequency, earhead exertion (%) and harvest

Table 2a : Physiological traits associated with grain and fodder yield (shallow soil)

Sr. No.	Entry	LAI	RLWC (%)	CSI at flow.	HI	Photosynthesis rate (µ mol/m² / sec.)	Stomatal cond. (mol/m² / sec.)	Stomatal resis. (s/cm²)	Transpi rate (m/mol)	PAR (nm) (*)	Stomatal frequency mm² Adax	Stomatal frequency mm² Abax	Stay green at phy. maturity (1-9 scale)	EE (%)	Leaf temp. Diff. (°C)	Yield (kg ha⁻¹) Grain	Yield (kg ha⁻¹) Fodder
1.	P.Maulee	3.16	45.6	0.33	26	26.4	23.9	4.90	1.38	560	128	155	7-8	74	-3.5	871	6048
2.	M 35-1	3.02	44.2	0.47	28	24.9	23.5	4.95	1.56	489	134	155	7-8	76	-3.4	795	5079
3.	P.Anuradha	3.30	47.6	0.25	32	32.6	23.1	5.10	1.25	507	123	144	5-6	89	-4.04	1303	5590
4.	P. Chitra	3.27	40.6	0.34	28	29.8	23.5	5.08	1.62	536	128	154	7-8	74	-3.7	964	5014
	Correlaion	+0.37	+0.31	-0.20	-0.30	+0.30	-0.44	+0.35	-0.33	+0.34	-0.41	-0.54	-	-0.38	-0.06	-	+0.56

Table 2b : Physiological traits associated with grain and fodder yield (shallow soil)

Sr. No.	Entry	Plant height (cm)	Biomass (kg/ha) at 50 % flow.	Biomass (kg/ha) at Harvest	Days to 50 % flow.	Days to Phy. maturity	Per days production kg/ha/day Grain	Per days production kg/ha/day Fodder	Dry matter at harvest (g/m²) Leaves	Dry matter at harvest (g/m²) Stem	Dry matter at harvest (g/m²) Panicle	Grain No. per earhead	1000 grain weight (g)	ROWL (mg/ min.)
1.	P.Maulee	182	1868	3195	70	113	7.86	54.7	49.2	230	115.3	1133	30.3	1.9
2.	M 35-1	189	1895	3216	75	118	6.89	44.1	54.3	283	146.9	1225	33.7	2.1
3.	P.Anuradha	183	1931	2861	67	112	10.58	52.0	45.0	237	110.0	1245	32.3	1.4
4.	P. Chitra	210	1862	3240	76	120	6.75	42.2	60.3	361	144.0	1168	30.3	1.7
	Correlation	-0.3	+0.3	+0.2	+0.5	-0.1	+0.2	+0.3	+0.4	+0.2	+0.5	-0.1	+0.4	-0.3

index of variety Phule Anuradha, did perform well with less reduction in yield under drought stress. Sanjana Reddy *et al.* (2012) noted the similar result. Phule Anuradha was found drought tolerant especially under stress condition on shallow soil due to its higher biological and grain yield. It had also high photosynthesis rate , stomatal resistance, RLWC, lower chlorophyll stability index, leaf temperature difference, stomatal frequency, transpiration rate (Table 2a) and biomass production at harvest test weight, per day production of grain and fodder and ROWL (Table 2b).

It can be concluded from study that the variety Phule Anuradha is suitable for growing under receding soil moisture conditions in shallow soil of Maharashtra in *Rabi* season.

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