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IDENTIFICATION OF HIGH WATER USE EFFICIENCY AND HIGH YIELDING RAGI GENOTYPES FOR RAINFED CONDITIONS

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ABSTRACT

The work was conducted with the purpose of to evaluate the effect of moisture stress on water use efficiency traits *viz* Specific leaf area (SLA), SPAD chlorophyll meter readings (SCMR), Relative water content (RWC)and yield parameters in ten ragi genotypes viz. (GP-3, GP-23, GP-24, GP-25, GP-104, GP-111, GP-149, GP-153 and GP-160). The experiment was conducted in factorial randomized block design with three replications. Moisture stress was imposed from panicle initiation to grain filling stage i.e. (35-60 DAT). Moisture stress has reduced all the yield parameters. The genotypes GP-153performed better than other genotypes, it recorded higher SCMR (32.81), low SLA (125.73),higher RWC (85.51%), and higher grain yield (2560.0 Kg ha-1), higher straw yield (6966.67 Kg ha-1) and higher harvest index (26.80) followed by GP-111. Hence these genotypes have high water use efficiency traits and can perform better under moisture stress conditions and are suitable for rain fed situations

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INTRODUCTION

Finger millet or Ragi (*Eleusinecoracana G.*) is the third most important millet crop of India. It is also an important food crop in South Asia and Africa. Its wide adaptability to diverse environments and cultural conditions makes it a potential food crop. High temperature or heat stress is often accompanied by drought stress under field conditions. Moisture stress during crop growth period especially in kharif growing season accounts for 70 per cent loss in productivity. Any effort to mitigate the loss due to drought could be useful to enhance the food production in the country. It has been suggested that crop improvement in yield could be achieved more efficiently by identifying characteristics that allow a plant to escape, avoid or tolerate water stress. So plants possess various morphological and physiological adaptations in order to survive under moisture stress and complete its life cycle. Screening and selection of plants of different crops with considerable water stress tolerance has been considered an economic and efficient means of utilizing drought-prone areas when combined with appropriate management practices to reduce water loss (Rehman *et al*., 2005). As ragi crop is mostly cultivated in sub marginal lands and limited moisture conditions, it is prone for recurrent drought, which affects crop growth due to moisture as well as temperature stress. Hence thewater use efficiency traits (SLA, SCMR, and RWC) and yield traits are the reliable drought tolerance traits for evaluating the genotypes.

Similar work was done by Muhammad maqsood *et al*., (2007) in two finger millet(*Eleucinecoracana*) landraces viz., TZA-01 and TZM-01 to investigate the effects of environmental stress on the growth, development, radiation use efficiency and yieldunder two moisture regimes (fully irrigated and subjected to drought). Another similar work was done in rice by Renuka Devi *et al.,* (2013) on Physiological and molecular characterization of rice genotypes for intrinsic tolerance to drought suitable for aerobic cultivation.

Therefore information on water use efficiency traits of ragi genotypes is more important in the crop improvement programme to evolve varieties suitable for rainfed situations. Hence the present work was formulated with an objective toevaluate the WUE traits under imposed moisture stress conditions among selected lines under field conditions.

MATERIALS AND METHODS

The experiment was conducted in wetland farm of College of agriculture, Tirupati during late rabi, 2012-13 in a Factorial Randomized Block Design (FRBD) replicated thrice. Major treatments were irrigated and moisture stress and sub treatments were ten ragi genotypes. In case of irrigated treatments, irrigations were applied at critical growth stages, whereas in moisture stress treatment irrigation was withheld from panicle initiation to grain filling stage (35-60 DAT) and no rainfall was received during this period. Prophylactic measures were taken for protecting the crop from pest and diseases. Water Use Efficiency (WUE) was measured using surrogate measure i.e. SPAD Chlorophyll Meter Reading (SCMR).The SPAD-502 (Soil Plant

Analytical Development) meter was used for measuring the relative chlorophyll content of the leaves. Specific leaf area (SLA) was computed by following formula as SLA = A /WL Where A = Leaf area; WL = Leaf dry weight at time t). Relative water content (RWC %) was calculated following Barrs and Weatherly (1962) as RWC (%) = [fresh weight-dry weight / Turgid weight-Dry weight) x 100].The data on seed yield and yield components were recorded at the time of harvest. The data were statistically analyzed as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

SCMR and SLA values were well established as reliable surrogate traits for WUEin several crops. SCMR obtained under control and moisture stress conditions at 60DAT are given in Table 1. There was significant increase in SCMR values with moisture stress in all genotypes. Significant differences were observed among the genotypes and treatments. Similar significant differences between genotypes under irrigated as well as moisture stress were reported in ragi (MuhammodmaqsoodandAzam Ali2007) and in rice Renuka Devi *et al.* (2013).Chlorophyll content varied significantly within the cultivars at 65 and 90DAS. SPAD values were highest in NLM-80 (45.6) and NPJ-79 (48.3) and Varuna possessed comparable greenness under I0 and I1 respectively at 65DAS.(Sukhmaninder Kaur *et al.*,2015)Sudhakar (2006) observed significantpositive correlation between SCMR and yield under moisture stress in greengram and blackgram. Among the genotypes tested, GP-23 recorded highest mean SCMR (32.81) followed by GP-153(31.28), GP-111 (30.36) and GP-149(29.92).

There is a significant decrease in SLA values with moisture stress in all genotypes Thegenotype GP-23 recorded higher SCMR, however it maintained higher SLA (166.85cm^2) values at 60 DAT. In contrast GP-153 and GP-111 recorded lower SLA and high SCMR values. Since low SLA and high SCMR are the indicators for high WUE, genotypes GP-153 and GP-111 had high WUE. These results are in agreement with (Nageswara Rao *et al.* 1993,Talwar et al.2004 and Latha, 2004). Wright *et al.* (1994) reported an inverse relationship between SLA and WUE, thus indicating that genotypes with thick leaves (low SLA) under moisture stress conditions may be water use efficient.

RWC is an important indicator of water deficit stress in leaves(Sairam*et al.*, 1997) gives a picture of cell membrane stability.RWC indicate the water status of the cells and have significant association with yield and stress tolerance. RWC

Table 1: Evaluation of ragi genotypes for water use efficiency under imposed moisture stress conditions at 60 DAT

Genotype	SLA			SCMR			RWC %		
	T0	T1	Mean	T0	T1	Mean	T0	T1	Mean
GP-3	158.91	140.97	149.94	25.70	26.91	26.30	71.33	90.63	80.98
GP-23	155.87	177.84	166.85	29.97	27.80	28.89	73.29	90.71	82.00
GP-24	162.58	134.68	148.63	24.92	27.90	26.41	70.09	91.31	80.70
GP-25	155.57	164.58	160.07	25.68	27.07	26.38	71.77	91.01	81.39
GP-27	139.69	146.17	142.93	24.71	26.90	25.81	63.56	90.56	77.06
GP-104	145.65	121.10	133.37	30.80	29.92	30.36	77.89	91.21	84.55
GP-111	129.52	129.15	129.33	30.05	32.51	31.28	78.23	91.20	84.71
GP-149	149.68	134.83	142.25	28.73	31.11	29.92	75.41	89.74	82.57
GP-153	121.01	130.44	125.73	31.18	34.44	32.81	79.44	91.59	85.51
GP-160	145.90	134.19	140.04	26.56	28.92	27.74	74.03	91.77	82.90
Mean	146.44	141.39		27.83	29.35		73.50	90.97	
	T	G	T × G	T	G	T × G	T	G	T × G
SE m±	3.38	7.57	10.70	0.50	1.11	1.57	1.78	3.98	5.63
CD (P=0.05)	9.69	21.67	30.65	1.42	3.17	4.48	5.10	11.41	16.14

Table 2: Evaluation of ragi genotypes for Grainyield, Strawyield, Harvest index, and Drymatter under imposed moisture stress conditions at the time of harvest

Genotype	Grain yield Kg ha^{-1}			Straw yield kg ha^{-1}			Harvest index		
	T0	T1	Mean	T0	T1	Mean	T0	T1	Mean
GP-3	2146.7	986.7	1566.7	5063.33	4306.67	4685	29.77	18.64	24.21
GP-24	1603.3	913.3	1258.3	4546.67	4056.67	4301.67	26.07	18.38	22.22
GP-25	1440	898.3	116 9.2	3500	4253.33	3876.67	29.15	17.44	23.29
GP-27	2240	1423.3	1831.7	4240	3436.67	3838.33	34.57	29.29	31.93
GP-23	2706.7	1674	2358.3	3203.33	2736.67	2970	45.8	42.35	44.07
GP-104	2943.3	2033.3	2488.3	6923.33	4866.67	5895	29.83	29.47	29.65
GP-111	3316.7	2376.7	2846.7	8343.33	7230	7786.67	28.44	24.74	26.59
GP-149	2683.3	1610	2146.7	6455.3	6290	8615	19.7	20.38	20.04
GP-153	2840	2280	2560	7096.67	6836.67	6966.67	28.58	25.01	26.8
GP-160	2863.3	1393.3	2128.3	6850	5556.67	6203.33	29.48	20.05	24.76
Mean	2478.33	1558.9		5622.2	4957		30.14	24.57	
	T	G	T × G	T	G	T × G	T	G	T × G
SE m±	147.47	329.75	466.34	285.14	637.6	901.71	1.97	4.41	6.24
CD(P=0.005)	422.32	944.33	1335.49	816.5916	1825.954	2582.289	5.65	12.63	17.86

values obtained under control and moisture stress conditions at 60DAT were given in (Table 1). There was a significant decrease in RWC values with moisture stress in all genotypes. Similar significant differences between genotypes under irrigated as well as moisture stress was reported in wheat (Moaedalmeselmani*et al.,* 2012) rabi sorghum (Surwenshi*et al*., 2010) and in rice (Renuka*et al*., 2013).Similar results were also reported in Bermuda grass which had relative water content (85.62 %) was found to bemost drought tolerant followed by Zoysia japonica which is best suitable for stress tolerant conditions. (Ubendra*et al*., 2015)

Nadarajan and Kumaravelu, (1993) also reported that relative water content (per cent) in leaf tissue decreased in rice genotypes under moisture deficit conditions. Thus the leaf tissue maintained low water content, indicating these genotypes as susceptible under stress condition. Among the genotypes, GP-153, GP-111 and GP-104 maintained significantly higher RWC values at 60DAT .This indicates that maintenance of higher water status under drought plays an important role in building grain yield

Among the genotypes GP-111 recorded significantly higher grain yield of 2846.7kg ha^{-1} followed by GP-153 2560 kg ha^{-1}(Table 2).The genotypes GP-23, GP-149, GP-160 recorded poor yield under moisture stress conditions, despite of recording higher yields under irrigated conditions. Similar results of decrease in the grain yield due to moisture stress were reported in prosomillet (Seghatoleslami*et al*., 2008).

The genotypes GP-153(8615.0 kg/ha) and GP-111 (7786.67 kg ha^{-1}) recorded significantly high mean straw yield followed by GP-104 (6966.67 kg ha^{-1}). The genotypesGP-23(2220.0kgha^{-1}) and GP-27 (3838.3 kg ha^{-1}) recorded lowest straw yields.

Among the tested genotypes GP-153 recorded highest mean harvest index (44.32%) followed by GP-111 (35.99%) compared to other genotypes. The higher harvest index of these genotypes represents an increased physiological capacity to mobilize photosynthates and translocate them efficiently to organs of economic value, i.e. grain yield as opined by Wallace *et al*. (1972).GP-3 and GP-23 recorded lowest harvest index

This present study concluded that the three genotypes GP-153,

GP-111 and GP-104 maintained significantly higher values regarding SCMR, RWC and lower SLA. These genotypes also maintained high grain yield and its attributes. Hence these genotypes are considered to possess high WUE and other drought tolerance traits and grain yield. Hence these three are best fit for rainfed cultivation.

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