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SHORT COMMUNICATION

SCREENING OF GUAR GENOTYPES FOR DROUGHT TOLERANCE

A. CHAKRABORTY[1], P. SUDHAKAR[2], A. SIVASANKAR[3], P. LATHA[4] AND B.G. SINGH[5]

[1,3,5]College of Agriculture, ANGRAU, Rajendranagar - 30, Hyderabad, A.P.
[2,4]Institute of Frontier Technologies, Regional Agricultural Research Station, ANGRAU, Tirupati-517 502, A.P.

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Ten guar genotypes were screened for drought tolerance under field conditions by imposing moisture stress from 35 days after sowing (DAS) to 70 DAS (flowering to pod filling). Different drought tolerant traits viz., specific leaf area (SLA), SPAD Chlorophyll Meter Readings (SCMR), relative water content (RWC) and leaf peroxidase activity were recorded at 30 days after imposition of moisture stress (65 DAS) in simulated mid season moisture stress and irrigated treatment. The genotypes WSP–50, GG–1, RGM–111 recorded lower SLA (92.12 to 97.32 $cm^2 g^{-1}$), higher SCMR (62.67 to 65.17), RWC values (59.80 to 64.70%) with higher peroxidase activity (289 to 301 units $litre^{-1}$) under moisture stress conditions, which establish the drought tolerant nature of these genotypes. These genotypes can be used as good donor source for developing drought tolerant genotypes.

Keywords: **Drought tolerance, guar genotypes, physiological traits**

Drought affects almost all functions in plants. Plants respond to drought by initiating a number of developmental, physiological, biochemical and molecular changes. Guar or cluster bean (*Cyanopsis tetragonoloba* L.) is an arid legume and its endosporium contains 19-43% of galactomannan gum having higher export value. This crop is drought tolerance and sensitive to low temperatures. In the recent past, various morphological (Chaves *et al.* 2003), physiological (Rao and Wright, 1994) and drought tolerant (Sudhakar *et al.* 2006) traits contributing to drought tolerance were reported and substantial genetic variability among genotypes was observed for these traits. Such variability in guar genotypes for these traits is yet to be explored.

Environmental stresses are thought to result in the production of reactive oxygen species (ROS) and hydrogen peroxide in plants, causing oxidative stress (Hernandez *et al.* 2000). The ability of higher plants to scavenge the toxic ROS and hydrogen peroxide using various antioxidant enzymes seems to be a very important determinant of their tolerance to environmental stresses. The various components of this antioxidant system include carotenoids, flavanoids, phenolic compounds as well as antioxidant enzymes such as superoxide dismutase, catalase and peroxidase (Ali and Abbas 2003).

Guar is introduced recently in arid areas of Andhra Pradesh as an alternate crop for groundnut and jowar due to its drought tolerant nature. However, there is no information on varietal adaptability under these conditions. Hence, the present investigation was initiated to identify guar genotypes, which posses higher water use efficiency traits and seed yield under moisture stress conditions for recommendation to these dry land areas of Andhra Pradesh.

*Corresponding author, palagiris@hotmail.com

The present investigation was conducted in the semi arid conditions of Hyderabad in sandy clay loam (College of Agriculture, Rajendranagar) during late rabi season, 2006-07. There were two main treatments i.e., irrigated and simulated mid season moisture stress (35 DAS to 70 DAS). Under adequately irrigated condition, the plots were irrigated replenishing 80 per cent pan evaporation after taking the rainfall, if any, into account. Irrigation was withheld from 35 DAS to 70 DAS and during normal stress period (0 to 30 DAS and 71 to 90 DAS); the crop received regular irrigations based on cumulative pan evaporation under simulated moisture stress condition. The sub treatments consisted of ten guar genotypes viz., WSP-50, VIKAS–35, RGC–1038, GG–1, HGS–884, GUAG–9808, GUAG–003, GUAG–9708, RGC–1078, RGM–111 obtained from Plant Breeding Section of Regional Agricultural Research Station, Tirupati. The treatments were arranged in split plot design and replicated thrice. The seeds were sown on flat beds of 3 × 2 m size plot with 30 cm × 10 cm spacing. Prophylactic measures were taken for protecting the crop from diseases and pests. The total amount of rainfall received was 17.8 mm during experiment period and incidentally during period of imposing moisture stress treatment, no rainfall was recorded. The average maximum and minimum temperature during crop period was 34.16 ^{0}C and 18.90 ^{0}C respectively (Table 1).

Drought tolerance traits viz., specific leaf area (SLA), SPAD Chlorophyll Meter Reading (SCMR), relative water content (RWC) and peroxidase activity were measured during imposition of moisture stress and seed yields were recorded at harvest. SLA and SCMR were recorded on third leaf from the apex. SLA was calculated from the measured values of leaf area (using leaf area meter LI–COR Model–3100) and leaf dry weight. SCMR was measured using Minolta SPAD–502 Chlorophyll meter. The relative water content (RWC) of leaf samples was calculated based on fresh weight, turgid weight and dry weight of leaf samples using the following formula (Gonzalez and Gonzalez-Vilar 2001).

Table 1. Meteorological data during crop growth period (January, 2007 to April, 2007).

Standard week	Period	Temperature (^{0}C)		RH (%)		Rainfall (mm)	Rainy days	Mean temp. (^{0}C)
		Max.	Min.	I	II			
4	22-28 Jan	30.7	15.5	85	34	0.0	0	23.1
5	29-04 Feb	31.4	15.5	84	26	0.0	0	23.5
6	05-11	31.9	16.5	83	31	0.0	0	24.2
7	12-18	30.6	16.1	82	34	0.0	0	23.4
8	19-25	30.5	14.3	82	26	0.0	0	22.4
9	20-04 Mar	33.9	16.6	67	22	0.0	0	25.2
10	05-11	34.6	21.4	80	29	0.0	0	28.0
11	12-16	34.4	19.3	70	25	0.0	0	26.8
12	19-25	37.6	22.4	61	19	0.0	0	30.0
13	26-01 Apr	37.4	20.6	70	19	0.0	0	29.0
14	02-08	38.8	22.0	75	20	0.0	0	30.4
15	09-15	37.6	23.4	74	27	2.6	0	30.5
16	16-22	34.8	22.2	76	36	15.2	2	28.5
	Mean	34.2	18.9	76.1	26.8	17.8		

$$RWC = \frac{\text{Fresh weight–dry weight}}{\text{Turgid weight–dry weight}} \times 100$$

The peroxidase activity was measured using guaiacol as substrate (Sadasivam and Manickam 1997) and expressed as enzyme activity units per litre. Soil moisture data shows that after stress imposition mean soil moisture gradually reduced from 8.02 per cent to 1.76 per cent in stress imposed plots (Table 2) confirming the depletion of soil moisture. The mean relative water content of leaves was lowered by 35 per cent in moisture stress imposed treatments compared to irrigated treatments. GG–1 (64.7 %), WSP–50 (62.1 %), GUAG–9708 (60.0 %) and RGM–111 (59.8 %) maintained higher RWC compared to other genotypes conferring higher drought tolerance (Table 3). Maintenance of higher RWC under moisture stress conditions, maintain leaf temperature, leaf diffusive resistance and net photosynthetic rate through stomatal regulation and mesophyll resistance (Sandhu and Horton 1978). Higher SPAD chlorophyll meter reading (SCMR) in moisture stress condition is indication of genotypes capability for higher carbon assimilation. WSP–50 recorded significantly high SCMR (65.17) followed by GG–1 (63.13) and RGM–111 (62.67) compared to other genotypes under simulated moisture stress conditions (Table 3). In contrast, specific leaf area (SLA) values were significantly lower for these three genotypes viz., WSP–50 (93.6 cm^2g^{-1}), GG–1 (91.3 $cm^2 g^{-1}$) and RGM–111 (97.3 cm^2g^{-1}) compared to other genotypes (Table 3) and SLA recorded a negative correlation with SCMR (R^2 = 0.3835) (Fig. 1). Wright *et al.* 1994 also reported an inverse relationship between SLA and water use efficiency**.** Similar results were also reported in groundnut (Latha 2004) and in blackgram, greengram (Sudhakar *et al.* 2006).

Table 2. Soil moisture per cent during impostion of moisture stress period (35 - 70 DAS).

S.No.	Days after sowing (DAS)	Mean soil moisture per cent in irrigated plots	Mean soil moisture per cent in simulated moisture stress plots
1	30	8.02	8.02
2	40	8.06	7.15
3	50	7.96	5.32
4	60	8.03	3.16
5	70	7.98	1.76

Leaf peroxidase activity recorded at 60 DAS significantly varied between irrigated and moisture stress treatments. WSP–50 (301 units $litre^{-1}$), GG–1 (298 units $litre^{-1}$), and RGM -111 (289 units $litre^{-1}$) also recorded higher peroxidase activity under moisture stress conditions which further establish drought tolerant nature of these genotypes (Table 3). Increase in peroxidase activity under stress conditions have been linked with protection from oxidative damage, lignification and cross linking of cell wall to prevent from such adverse conditions (Dalal and Khanna-Chopra 2001).

Mean seed yields were significantly affected due to imposed moisture stress compared to irrigation control. Among the genotypes, RGM-111, GG-1 and WSP-50 (16.0 q ha^{-1}) recorded highest seed yield compared to other genotypes. Guar seed yield under moisture stress positively correlated with peroxidase activity (R^2=0.816) and SCMR (R^2=0.8523) and negatively correlated with SLA (R^2=0.2192). Such variability due to moisture stress also observed in soyabean (Smiciklas *et al.* 1989), groundnut (Latha 2004) and blackgram, greengram (Sudhakar *et al.* 2006).

The present study revealed that the genotypes WSP–50, GG -1 and RGM–111 recorded higher seed yields and also depicted drought tolerance in terms of higher RWC, SCMR and leaf peroxidase activity and

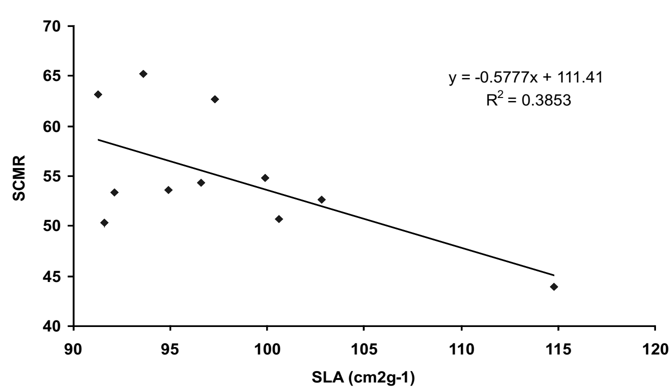

Fig. 1. Correlation between SLA and SCMR

Table 3. SPAD chlorophyll meter readings (SCMR), specific leaf area (SLA), relative water content (RWC) and peroxidase activity of guar genotypes at 30 days after imposing moisture stress (DAIS).

Genotypes	SCMR			SLA ($cm^2 g^{-1}$)			RWC (%)			Peroxidase activity (units $litre^{-1}$)			Seed yield ($q ha^{-1}$)		
	Irrigated	**Stress**	**Mean**	**Irrigated**	**Stress**	**Mean**	**Irrigated**	**Stress**	**Mean**	**Irrigated**	**Stress**	**Mean**	**Irrigated**	**Stress**	**Mean**
WSP-50	74.13	65.17	69.95	67.64	93.60	80.66	90.79	62.11	76.45	245	301	273	12.4	16.0	14.2
VIKAS–35	62.34	53.55	57.95	99.40	94.92	97.18	90.78	58.84	74.81	227	281	254	8.9	12.0	10.5
RGC–1038	66.27	50.70	58.48	122.40	100.60	115.30	88.26	57.80	73.03	222	287	254	9.4	14.2	11.8
GG-1	71.73	63.13	67.43	78.60	91.30	84.98	87.14	64.70	75.92	240	298	269	12.6	16.0	14.3
HGS–884	68.50	54.70	61.60	117.00	99.90	108.48	90.21	57.50	73.86	237	286	262	10.8	15.8	13.3
GUAG -9808	68.73	43.86	56.30	128.30	114.80	121.58	88.74	56.10	72.42	227	275	251	7.5	11.1	9.3
GUAG-003	66.33	52.57	59.45	128.80	102.80	114.33	91.86	58.40	75.13	232	282	257	9.9	14.6	12.3
GUAG-9708	54.40	50.33	52.36	105.00	91.60	98.33	90.31	60.0	75.16	219	279	249	9.0	10.7	9.9
RGC-1078	66.47	53.27	59.86	113.20	92.12	102.68	89.15	55.06	72.11	221	284	253	8.5	11.5	10.0
RGM-111	71.07	62.67	66.87	78.00	97.32	87.68	90.0	59.80	74.90	232	289	261	11.8	16.3	14.1
MEAN	66.20	54.29		111.25	96.60		81.37	60.27		228.5	285.8		10.1	13.8	
	SEm	CD at 5%		SEm	CD at 5%		SEm	CD at 5%		SEm	CD at 5%		SEm	CD at 5%	
Irrigation treatments	0.47	1.35		0.53	1.54		0.49	1.41		0.75	2.13		0.77	2.20	
Genotype	1.05	3.03		1.20	3.44		1.10	3.17		1.66	4.77		1.72	NS	
Interaction	1.50	4.3		1.70	4.87		1.56	4.48		2.36	6.75		2.43	NS	

lower SLA values compared to other genotypes. Hence these varieties are suitable to grow in dryland areas of Andhra Pradesh. This study concludes that genotypic differences in water use efficiency traits and seed yields in the identified genotypes can also be used as potent donor source for breeding drought tolerant genotypes.

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