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Correlation analysis for shoot/root parameters under polyethylene glycol (PEG) induced water stress in sorghum (*Sorghum bicolor* (L.) Moench) genotypes

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Abstract
The genetic potential was evaluated for thirty sorghum genotypes for drought tolerance based on shoot/root parameters. The traits considered as shoot length, root length, fresh root weight and dry root weight under polyethylene glycol (PEG) induced water stress. These genotypes exhibits significant variation for the traits under considered based on analysis of variance estimation. In addition to this, the traits exhibit highly significant association between one another. The traits like fresh root weight (rg= 0.84 and rp=0.85) had highest genotypic and phenotypic association with dry root weight, followed by shoot length with root length (rg= 0.75 and rp=0.78), root length with fresh root weight (rg= 0.76 and rp=0.75), root length with dry root weight (rg=0.64 and rp=0.65), shoot length with fresh root weight (rg= 0.61 and rp=0.65) and shoot length with dry root weight (rg=0.58 and rp=0.62). This suggests the possibilities of improvement of these characters through selection for drought tolerance breeding programme.

Keywords: sorghum, correlation analysis, seedling, shoot, root parameters, drought tolerance, polyethylene glycol

Introduction

Sorghum is an important food crop in the semi-arid region of the world. In addition to this, it is being considered as fodder and many industrial purposes. Unfortunately, the production and productivity is severely limited by drought. Crop improvement practices such as evaluation and selection of sorghum genotypes at large scale can help under this circumstance. However, it requires large resource consumption and little complex too. In this scenario, screening genotypes at seedling stage had the advantage of low cost, less laborious, rapid screening and ease of handling (Rauf, 2008) [1]. Germination and seedling stages are the critical stages; water stress induced during these stages has been exploited in sorghum (Gill *et al*., 2002) [2] used for discriminate genotypes.

In this purpose, polyethylene glycol (PEG) a polymer compound will greatly induce dehydration in plants with molecular mass of 6000 and above are non-ionic, water-soluble polymers which are not expected to penetrate intact plant tissues rapidly. This solution interferes with the roots to absorb water due to reduction of osmotic potential (Dodd and Donovan, 1999; Sidari*et al*. 2008) [3, 4]. Hence, PEG based screening become an alternate approach to screening genotypes for drought tolerance (Khodarahmpour, 2011) [5].

Materials and methods

The experiment was carried out at Tamil Nadu Agricultural University, Coimbatore. Thirty sorghum genotypes were used in this study for shoot/root parameters (Table 1). The experiment was laid out under factorial completely randomized block design (FCRBD) with two replications. The genotypes and moisture levels were considered as factors *viz.*, control and stress. In control seeds were germinated under normal condition (irrigated) and stress (drought) were maintained at -0.8MPa created using a polyethylene glycol solution (PEG-6000) as suggested byMichel and Kaufmann (1973) [6]. The germination test was conducted by following the procedure prescribed by ISTA (2011) using paper medium at step-in germinator (28 ± 2^0 C and 90 ±3 % RH) for ten days.

Five plants from each genotype from each replication were evaluated for shoot and root length, fresh root weight and dry root weight. The root and shoot length were measured using measuring scale. Fresh and dry root weight was measured using digital balance. Drying of root sample by using hot air oven at 70ºC for 24 hrs (Kaydan and Yagmur, 2008) [7].

Table 1: The list of 30 sorghum genotypes used in this study

S. No.	Genotypes	Source	S. No.	Genotypes	Source
1	ICSR93001	ICRISAT	16	KO5SS38	IIMR
2	DRT1026	ICRISAT	17	KO5SS186	IIMR
3	ICSR24001	ICRISAT	18	KO3SS127	IIMR
4	DRT1030	ICRISAT	19	B35	ICRISAT
5	IS23399	ICRISAT	20	ICSV587	ICRISAT
6	MS7735	Unknown	21	DRT1019	ICRISAT
7	RS14432	ICRISAT	22	IS5005	ICRISAT
8	ICSV202	ICRISAT	23	IS1130	ICRISAT
9	KO5SS202	IIMR	24	IS3552	ICRISAT
10	KO5SS150	IIMR	25	AS5160	Unknown
11	KO5SS25	IIMR	26	MS8444	Unknown
12	KO5SS53	IIMR	27	VS1565	Unknown
13	KO5SS302	IIMR	28	KO5SS244	IIMR
14	KO5SS267	IIMR	29	CO26	TNAU
15	KO5SS450	IIMR	30	ICSV95022	ICRISAT

Statistical analysis

Differences between genotypes for different characters were tested for significance by using analysis of variance technique (Panse and Sukhatme, 1954) [8]. Phenotypic and genotypic correlation were calculated by the formula suggested by Al-Jibouri *et al.*, (1958) [9].

Results and Discussion

Significant differences were observed among the genotypes for root length, shoot length, fresh and dry root weight under drought stress has justified the relative contributions of these traits to the variability, hence are amenable to selection (Table 2). In this study, the genotypic and phenotypic correlations were estimated for shoot/root parameters of 30 sorghum genotypes. The Phenotypic and genotypic correlations for traits considered with each other as root length, shoot length, fresh root weight and dry root weight were found positive and highly significant (Table 3). The traits like fresh root weight (rg= 0.84 and rp=0.85) had highest genotypic and phenotypic association with dry root weight, followed by shoot length with root length (rg= 0.75 and rp=0.78), root length with fresh root weight (rg= 0.76 and rp=0.75), root length with dry root weight (rg=0.64 and rp=0.65), shoot length with fresh root weight (rg= 0.61 and rp=0.65) and shoot length with dry root weight (rg=0.58 and rp=0.62). This reveals that all these parameters are highly bundled in respect with whole plant water relationship. The traits like root length, root fresh weight and root dry weight were significant and positive correlated with shoot length under drought stress condition. These results were substantiates with Riaz *et al*., 2013 [10].

These seedling parameters may be strongly associated with yield. Similarly, Natarajan, 1992 and Abbas *et al.*, 2007 [11, 12] showed that yield was positively and significantly correlated with root length, and dry root weight in tomato.

The results exhibited as pervasive root system of genotypes can be combined with the effectiveness of maintaining high level of internal plant water status, the resulting genotype may have superior adaptation to drought environment. These implications were substantiates with Hurd and Spratt (1975) [13].

This association study reveals the relativeness on internal plant water status between shoot/root parameters as plant developmental stages. This could allow us to predict that drought tolerance of genotypes at early stages as scope of selection Sandhu and Kang (1998) [14]. Therefore, these correlation coefficient estimates may be used for indirect selection at seedling stages as drought tolerance of sorghum genotypes. Identification of most reliable drought tolerance parameters can facilitate efficient identification of drought tolerant genotypes. The genetic variability and correlation coefficient with these potential traits can evaluate at seedling stage will highly useful in efficient breeding programmes for drought tolerance.

Table 2: Analysis of variance (ANOVA) for four characters under drought stress condition

Sources of variations	d.f.	Shoot length	Root length	Fresh root weight	Dry root weight
Replication	1	0.0482	0.0240	0.0015	0.0001
Treatment	29	5.1359**	2.5809**	0.1598**	0.0062**
Error	29	0.4513	0.6171	0.0081	0.0003

d.f. Degrees of freedom, **significant at 1 %

Table 3: Genotypic and phenotypic correlations for shoot/root parameters under PEG induced drought stress condition

Characters	Root length		Fresh root weight		Dry root weight	
	rg	rp	rg	rp	rg	rp
Shoot length	0.75**	0.78**	0.61**	0.65**	0.58**	0.62**
Root length			0.76**	0.75**	0.64**	0.65**
Fresh root weight					0.84**	0.85**

** Significant at 1 %

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