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Impact of drought stress on seed germination, growth characters and stress tolerant index of different pearlmillet genotypes

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Abstract
An experiment was conducted in ten pearlmillet genotypes to study the drought stress effect in early developmental stage under laboratory condition. Drought stress was imposed at -3 bars, -4 bars, -5 bars, -6 bars and -7 bars concentration by using PEG. The germination percentage, shoot and root length, vigour index and stress tolerant index were recorded. Under imposed drought stress every genotype behaves differently with respect to drought stress condition. The genotype PT 5748 performed superior under severe stress condition. It recorded highest germination percentage (30%), vigour index (180) and high stress tolerance index (7.86%) in -6 bars. However, the genotype PT 5756 recorded germination percentage (10%), vigour index (132) and low stress tolerance index (9.40%) in -4 bars PEG concentration. It indicates the survival extinct under drought stress. The study was helpful to provide the breeding material for ensuring more drought tolerance potential in pearlmillet.

Keywords: Pearlmillet, drought, genotypes, vigour index, stress tolerance index

Introduction
Water is plays an important role in agriculture which shows the major influence on production and productivity of crop plants. In every crop has a certain water requirement to meet their daily needs. Drought stress highly affects the agriculture productivity and yield. It is most peculiar factor, which affects more than 50 per cent of the crop yields worldwide (Wang *et al.*, 2003) [1]. Harris *et al.*, (2002) [2] stated that the first and foremost cause of drought stress is the impaired germination and poor crop stand establishment. Seed vigour index is a significant factor that can influence plant population and yield (Siddique and Wright, 2004) [3].
Pearlmillet is a coarse grain cereal crop, which also behave differently upon its growth developmental stage. If drought stress occurs at early stage, it causes major impacts on plant population and vigour characters. Hence, the experiment planned to study the germination behaviour of various pearlmillet genotypes. This study will helpful to improve the drought tolerant characters of pearlmillet in breeding characters.

Materials and Methods
The study was conducted in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. The pearlmillet seeds were placed on germination paper in each petridish separately. The germination paper was moistened regular interval with PEG solutions for drought imposition and water for control. The petridishes were kept under room temperature. The experiment was laid out in completely randomized block design with three replications. The salinity was imposed with PEG solution with different level of concentrations *viz.*, -3 bars, -4 bars, -5 bars, -6 bars and -7 bars.
The germination was recorded at every 24 h interval up to 12 days. Seeds were considered germinated when the radicle was at least 2 mm long. Finally germination was recorded on the 12th day and the number of seeds germinated was expressed as per cent. Length of shoot was measured from the collar region to the tip of the longest leaf and expressed as cm. Root length of the seedlings was measured from the base of the stem to the tip of the longest root and expressed as cm. The vigour index of the seedlings was calculated using the following formula (Abdul-Baki and Anderson, 1973) [4]. Vigour index = (Root length + Shoot length) x Germination percentage. Stress tolerance index (STI) was calculated using the following

formula (Dhopte and Livera, 1989) [5] and expressed as per cent. (Vigour index of the treated seedling / Vigour index of the absolute control seedling) x 100.

Results and Discussion

Seed germination is significance in the growth cycle of plants it determines the standard establishment and final crop yield. In the present study, the germination of pearlmillet genotype seeds was highly affected by drought stress. The germination was drastically changed according to the drought severity. Water stress may results in delayed and reduced seed germination or may prevent germination completely (Turk *et al.*, 2004) [6]. According to Taylor *et al.* (1982) [7], the initiation of cell elongation itself during germination is differentially sensitive to water stress. Slow and poor germination under water stress is obviously due to decreased water potential of the germination medium, which restricts the water availability to the seeds (Soltani *et al.*, 2002) [8]. The reduction of germination percentage might be due to reduction of water content in the medium by the addition of PEG. The addition of any solute decreases the water potential of the medium like drought and ultimately affects seed germination.

The genotype PT 5748 was germinated upto -6 bars followed by PT 5742. It shows the capacity of the genotype to stand under drought stress condition. However, the genotype PT 5756 and PT 5707 was showed significant reduction of germination percentage under mild stress conditions itself. Supporting this finding, Bajji *et al.* (2000) [9] and Mohamed *et al.* (2000) [10] correlated the maintenance of decreased osmotic potential with the mechanism of drought resistance as it enables turgor maintenance and growth continuation in tomato lines tested under various PEG concentrations. This reflects an adaptive response involving an increase in root length to reach deeper water in the soil (Radhouane, 2007) [11].

Table 1: Effect of drought stress on germination characteristics of Pearlmillet genotypes

S. No.	Pearlmillet genotypes	Bars	Germination Percentage (%)	Shoot Length (cm)	Root Length (cm)	Vigour Index
1	PT 5697	Control	100	11	9	2000
		-3	70	8	7.5	1085
		-4	40	5.6	6.1	468
		-5	10	1.1	5	61
		-6	-	-	-	-
		-7	-	-	-	-
2	PT 5702	Control	90	8.5	9.4	1611
		-3	50	5.7	6.7	620
		-4	40	5.4	5.1	420
		-5	40	3.4	5	336
		-6	10	-	-	-
		-7	-	-	-	-
3	PT 5707	Control	90	8	5.6	1224
		-3	40	7.1	4.9	480
		-4	10	4.5	4.5	90
		-5	-	-	-	-
		-6	-	-	-	-
		-7	-	-	-	-
4	PT 5721	Control	100	13.1	16	2910
		-3	100	8.5	13.4	2190
		-4	80	6.7	8.1	1184
		-5	80	5	6	880
		-6	-	-	-	-
		-7	-	-	-	-
5	PT 5736	Control	90	12	13	2250
		-3	40	11.6	10.6	888
		-4	20	6.6	8.8	308
		-5	-	-	-	-
		-6	-	-	-	-
		-7	-	-	-	-
6	PT 5748	Control	100	12.8	10.1	2290
		-3	100	8.7	5.1	1380
		-4	70	8.4	4.7	917
		-5	60	8.3	4.6	774
		-6	30	4	2	180
		-7	-	-	-	-
7	PT 5756	Control	90	7.5	8.1	1404
		-3	20	6.7	10.6	346
		-4	10	4.7	8.5	132
		-5	-	-	-	-
		-6	-	-	-	-
		-7	-	-	-	-
8	PT 5762	Control	90	7.5	12	1755
		-3	50	6.1	9.4	775
		-4	20	5.3	9	286
		-5	10	4	7	110

		-6	-		-		-		-	
		-7	-		-		-		-	
9	PT 5773	Control	90		10.1		13.5		2124	
		-3	50		7.6		11		930	
		-4	30		6		10		480	
		-5	10		5.7		9.5		152	
		-6	-		-		-		-	
		-7	-		-		-		-	
10	PT 5783	Control	90		11		16		2430	
		-3	40		8		13		840	
		-4	30		7.8		9		504	
		-5	10		7.5		7.9		154	
		-6	-		-		-		-	
		-7	-		-		-		-	
			SEd	CD (P=0.05)	SEd	CD (P=0.05)	SEd	CD (P=0.05)	SEd	CD (P=0.05)
		G	0.36	0.73	0.04	0.09	0.06	0.13	6.65	13.17
		S	0.28	0.56	0.03	0.07	0.05	0.10	5.15	10.20
		G X S	0.90	1.79	0.11	0.23	0.16	0.32	16.29	32.27

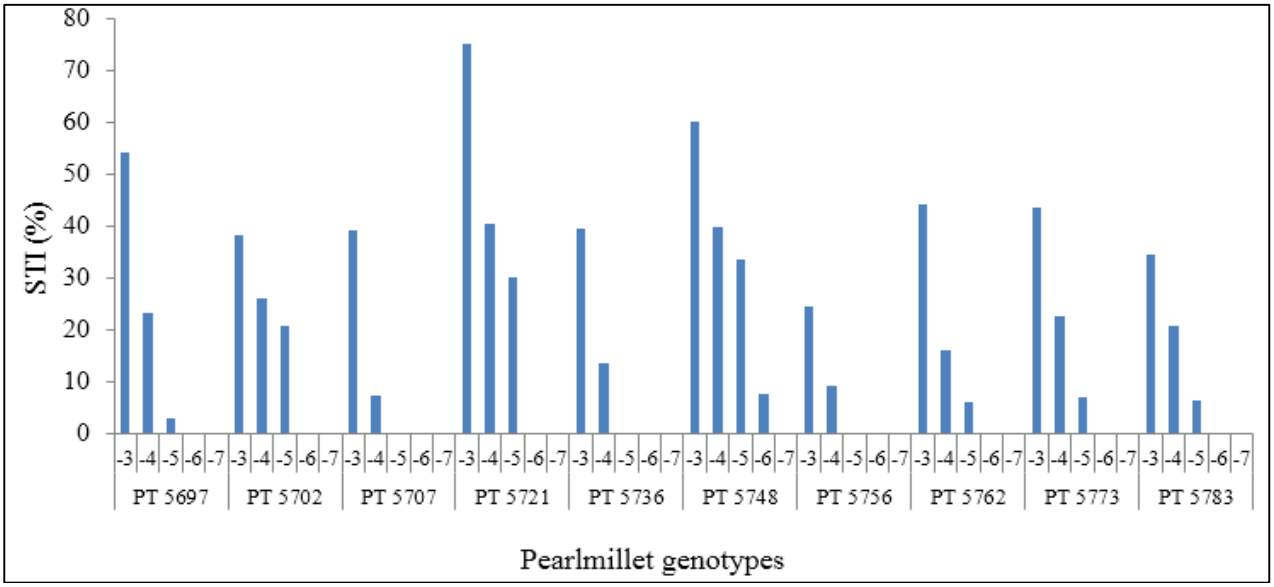

Fig 1: Effect of different levels of drought stress on Pearlmillet genotypes in stress tolerance index (%)

Narayan and Mishra (1989) [12] recorded deeper penetration of root under moisture stress, and concluded that depth of root penetration could serve as an important selection criterion for screening cultivars for drought resistance. Root length was more affected to drought condition than shoot length in tomato genotypes as observed by Kulkarni and Deshpande (2007) [13]. The analysis of vigor index indicated that PT5748 exhibited highest vigour index and the PT 5756 exhibited lowest vigour index. These coincide with the root and shoot length character of the genotypes (Table 1). Sadasivam *et al.* (2000) [14] suggested that, the tolerant cultivar recorded higher vigour index than sensitive cultivar in rice.

STI is a more stable character and can be considered as a useful tool to screen abiotic tolerant genotypes (Dutta and Bera, 2008) [15]. Evaluating the genotypes under stress, PT 5748 showed highest stress tolerant index of 7.86 per cent in -6 bars and -5 bars recorded 33.79 per cent of stress tolerance index. The high STI may be due to the higher germination percentage associated with the increased shoot and root length which lead to superior vigour index. The lowest stress tolerance index was recorded in PT 5756 and PT 5736 (Figure 1).

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