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Assessment of some seedling traits associated with drought tolerance in *Triticum* and *Aegilops* species of wheat

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ABSTRACT

Wheat is the most important widely cultivated crops in the world. Its yield is greatly influenced by both biotic and abiotic stresses. Therefore, an evaluation of different species belonging to *Triticum* and *Aegilops* species for seedling traits was attempted. All the traits i.e. root length, shoot length and coleoptile length showed high heritability in broad sense and root length showed significantly positive correlation with coleoptile length under both moisture non- stress (E1) and moisture stress (E2) environments. All the traits showed a decreasing trend under moisture stress conditions in all the species and the reduction for all the traits were more pronounced in wild species than the cultivated species.

Key words: Correlation, Seedlings, Species, Stress, Wheat.

INTRODUCTION

Globally, wheat is one of the most important cereal crop (Briggle and Curtis, 1987). Its importance may vary in different countries and this also depends on the diversity of the species of wheat. Its yield is greatly influenced by both biotic and abiotic factors. Improving abiotic stress resistance is a major challenge for today's breeding programme, especially the drought stress because it is the most important environmental constraint to crop growth. Drought affects many morphological, physiological, biochemical and molecular processes in plants resulting in growth inhibition and thus, yield penalty. The extent of these changes is dependent on time, stage and severity of environmental stress (Cao *et al*., 2011). It is of great importance to assess the effect of stress considering some important traits associated with it. Hence, the search for traits related to drought tolerance is an important step in mitigating the stress damage in wheat breeding for enhanced production.

Among the various growth stages of wheat crop, seedling stage is very important with regards to vigour of the plants. The extent of yield reduction owing to moisture stress depends on the stage of the crop. Moisture stress at initial stage affects germination and other seedling traits. Good early vigour of wheat seedling is related with better yield performance even under water limited environments (Gregory *et al*., 1992, Lopez-Castaneda and Richards, 1994). Incorporation of seedling traits *viz*., germination capacity, longer root, shoot and coleoptile length will certainly benefit the breeding programme that is targeted for drought prone areas and conditions where water availability is limited. Under drought conditions, roots could play an outstanding role to improve yield by effective absorption of water from soil. Although, the plant root system is essential to ensure an efficient water uptake (Blum 2009), it is hardly exploited in plant breeding (Palta *et al*., 2011). Many important agronomical traits including drought tolerance and pathogen resistance present in *Aegilops tauschii* (2n =2x =14, DD), a progenitor of common wheat, have been transferred from related speies and genera into wheat (Villareal *et al*., 2003; Mujeeb- Kazi *et al*., 2004). Wild wheat species are highly tolerant to drought stress (Budak *et al*., 2013.). In the present study also, seven wild species of wheat were used to assess drought tolerance traits under moisture non- stress (E1) and moisture stress (E2) conditions.

MATERIALS AND METHODS

The experimental materials used for the present study consisted of seven wild species of wheat viz., *Triticum boeoticum*, *Triticum triuncialis*, *Triticum monococcum*, *Aegilops comosa*, *Aegilops speltoides*, *Aegilops tauschii* and *Aegilops cylindrica* along with a rainfed bread wheat variety PBW644 (*Triticum aestivum*) which were used to assess different seedling traits for drought tolerance. These genotypes were evaluated under the laboratory conditions during *Rabi* 2013-14. Ten seeds of each species were grown

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in the incubator maintaining 16hrs light and 25ÚC/day. The data on coleoptile length, root length and shoot length under moisture non- stress (E1) and moisture stress (E2) conditions, were recorded separately as follows:

Coleoptile length (cm): Seeds from different species were placed on the wet filter paper in replicated sterilized petri-dishes wetted either with 4 ml of distilled water (E1 = 0 bar water potential) or polyethylene glycol (PEG 6000) (E2 -4 bar water potential) solution for germination. Three ml of water or solution was added to each petri dish after every two days. On 12th day, length of coleoptile of different species was measured under both E1 & E2 conditions.

Root and shoot length (cm): Six days old uniform seedlings grown under normal (0 bar) conditions were transferred in the petri dishes containing PEG solutions of -4 bar water potential. Coleoptile length, root and shoot length of all the seedlings were measured after six days of transfer under water stress conditions and average length was recorded. Root and shoot length were also measured on 12th day under 0 bar water potential. The seedlings used to measure root and shoot length were the same as those used to record data on coleoptile length.

Statistical analysis: The data on above traits were recorded on five random seedlings. Results were based on mean values of at least three replicates from two independent repeats of the experiments. The data were analysed using standard analysis of variance (ANOVA) and comparison among treatment means was made by Duncan's Multiple Range Test (DMRT) using appropriate computer software.

RESULTS AND DISCUSSION

Analysis of variance showed highly significant differences among different species for all the traits indicating that there was considerable variation among different species (Table1) whose post-hoc comparisons for all the traits were presented in Table 2. All the traits showed relatively higher heritability. Root length had the highest heritability (H^2) = 92.44 under E1 & 93.81 under E2) whereas, coleoptile length had lowest E2 (59.09) value. Shoot length also showed relatively high heritability values (E1 = 79.79 and E2 = 74.29). Therefore, selecting for the traits measured should be practicable.

The simple correlation analysis showed that there were highly positive correlations among variables used in the study (Table 3). Root length exhibited highly positive and significant association with coleoptile length under both the environments. Similarly, shoot length also showed significant positive correlation with coleoptile length under moisture stress environment. These findings led to conclusion that the traits under study if possessed by different genotypes may be used to develop drought tolerant wheat genotypes. Blum *et al* (1980) and Ashraf *et al*. (1992) studied the effects of polyethylene glycol (PEG) in screening of drought tolerance of wheat seedlings. Lopes and Reynolds (2010) also observed differences in expression of rooting depth among near isogenic lines under drought. Present study showed genotype variation in root length, shoot length and coleoptiles length under both the environments (E1 & E2). The decreasing trend was observed in length of root, shoot

TABLE 1: Mean squares from ANOVA for seedling traits.

	Df	Root length		Shoot length		Coleoptile length	
		E1	E2	E1	E2	E1	E2
Genotypes	7	15.46*	8.39*	20.04*	4.09*	2.37*	0.96*
Error	16	0.41	0.18	1.56	0.42	0.22	0.18
g2(Vg)		5.02	2.73	6.16	1.22	0.72	0.26
p2(VP)		5.43	2.91	7.72	1.64	0.94	0.44
H^2(%)		92.44	93.81	79.79	74.39	76.59	59.09

TABLE 2: The mean of seedling traits under Moisture non-stress (E1) and Moisture stress (E2) conditions.

Species	Root length		Shoot length		Coleoptile length	
	E1	E2	E1	E2	E1	E2
Aegilops cylindrica	5.96^{b*}	1.67^{d}	4.63^{cd}	3.42^{cd}	2.79^{bc}	1.52^{b}
Triticum boeoticum	4.10^{c}	3.17^{c}	6.97^{bc}	5.5^{ab}	3.42^{ab}	2.17^{b}
Triticum triuncialis	4.25^{c}	4.0^{b}	7.0^{bc}	5.67^{a}	2.5^{bc}	2.25^{b}
Triticum monococcum	2.0^{d}	1.83^{d}	6.17^{bcd}	4.5^{abc}	2.03^{c}	1.67^{b}
Triticum boeoticum	2.20^{d}	1.67^{d}	4.07^{d}	2.43^{d}	2.17^{c}	1.67^{b}
Aegilops tauschii	2.83^{d}	1.85^{d}	7.58^{b}	5.17^{ab}	2.3^{bc}	1.83^{b}
Aegilops comosa	5.93^{b}	2.33^{d}	10.07^{a}	4^{bc}	4.21^{a}	1.5^{b}
Triticum aestivum	8.67^{a}	6.47^{a}	11.77^{a}	5.53^{ab}	4.23^{a}	3.2^{a}

*Means with same letter are not significantly different (Duncan's multiple range test, 0.05)

TABLE 3: Correlation for seedling traits under moisture non stress (E1) and moisture stress (E2) environments.

Variables	Root Length		Shoot length	
Shoot length	0.69	0.63		
Coleoptile length	0.84*	0.96*	0.80*	0.65

and coleoptile of different wheat species in the moisture stress conditions. However, *Aegilops cylindrica* and *Triticum boeoticum* showed the maximum reduction of root length under moisture stress conditions while the minimum reduction under moisture stress condition was shown by *Triticum triuncialis*. In case of shoot length, *Triticum triuncialis* and first accession of *Triticum boeoticum* showed minimum reduction however, second accession of *Triticum boeoticum* showed maximum reduction. These seedling traits can be useful to improve wheat stand establishment. Coleoptile length is of great importance under variable seeding depth, soil surface temperature and moisture, which affect the coleoptile development and in turn seedling emergence and crop stand establishment. Coleoptile length is a highly heritable character and could be efficiently used in selection programmes in early segregating generations (Hakizimana *et al*., 2000). Although the main variation in the coleoptile length is genetic (ICARDA, 1987) however, in the present study coleoptile length of all the wild species were at par with each other. The present study inferred that all the traits showed a decreasing trend under moisture stress conditions in all the species and the reduction for all the traits are more pronounced in wild species than the cultivated species *(Triticum aestivum).*

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