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SHORT COMMUNICATION

PHYSIOLOGICAL TRAITS ASSOCIATED WITH DROUGHT TOLERANCE OF SYRIAN DURUM WHEAT VARIETIES UNDER RAINFED CONDITION

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A field experiment was conducted under rainfed condition using drought tolerant and susceptible durum wheat varieties to determine the effect of water deficit on various physiological traits. Data revealed significant differences between the three groups of wheat varieties under study (tolerant, moderately tolerant and susceptible). Drought tolerant group was superior in term of membrane stability index, relative water content, chlorophyll content and chlorophyll fluorescence. This group also showed higher yield, total biomass, tillers number m^{-2}, 1000 grain weight and grain number ear^{-1}. The current investigation indicated that the physiological adaptability of this wheat group as a reason to perform reasonably well under water stressed environment.

***Key words*: Chlorophyll, drought, *Fv/Fm*, membrane stability, relative water content, wheat**

Drought is one of the most important factors for yield reduction in the majority of cultivated areas, affected 40 to 60% of the world's agriculture lands (Mollasadeghi *et al*. 2011). Cereal plants respond to drought through alteration in morphological, physiological and metabolic traits. Hence, traits associated with improved performance under water limited conditions or improved survival to extremely low water availability are diverse (Slafer *et al*. 2005). Drought impacts include growth, yield, membrane integrity, pigment content, osmotic adjustment, water relations, and photosynthetic activity (Praba *et al*. 2009). Understanding of physiological mechanisms that enable plants to adapt to water deficit and maintain growth and productivity during stress period could help in screening and selection of tolerant genotypes and using this trait in breeding programs (Zaharieva *et al*. 2001). The present study was conducted to identify the effect of drought stress experienced naturally under rainfed condition on different physiological traits in the field.

Nine durum wheat varieties representing a range of genetic diversity within Syrian wheat varieties, viz., Sham 3, Sham 5 and Doma 3 (drought tolerant), Bohouth 7, Bohouth 11 and Sham 9 (moderately drought tolerant), Bohouth 5 Bohouth 9 and Sham 7 (drought susceptible) were used in this study. Seeds were obtained from Crop Research Directorate, GCSAR, and sown under rainfed conditions in the field on 20th Nov. 2010 in the second settlement zone (Izra research station, annual rainfall 299 mm) at an adjusted rate of 300 viable seeds/m^2 in randomized block design with three replications. Normal agronomic practices were performed and relevant metrological parameters were obtained from the observatory at each research station. Only 48 mm of rainfall was received by plants during anthesis and post

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anthesis stages indicating exposure of plant to terminal drought stress. However, 328 mm rainfall was received during the growing season (Fig. 1). All physiological observations were estimated on the fully developed leaf at vegetative stage and flag leaf at anthesis stage. SPAD meter was used to measure chlorophyll index. Membrane stability index (MSI) was estimated as described by (Deshmukh *et al.* 1991). Relative water content was determined as described by (Barrs and Weatherley 1962). The polyphasic rise of fluorescence transients of intact leaves was measured by a Plant Efficiency Analyzer (PEA, Handsatech Instruments Ltd., King's Lynn, UK) according to Strasser *et al*. (1995). On mid June plants were harvested from one m^2 and used for recording number of tillers, grain number per ear, 1000 grain weight, total biomass and grain yield.

Significant differences in MSI between drought tolerant, moderately tolerant and susceptible wheat varieties at vegetative stage were observed (Fig. 2). Moderately tolerant varieties showed highest MSI value compared to tolerant followed by susceptibles varieties i.e., 75.8, 74 and 73.3% respectively. While at anthesis stage drought tolerant wheat varieties showed highest MSI values i.e., 74.7% and the lowest value were recorded in drought susceptible varieties i.e., 72.6%. MSI decreased in moderately tolerant and susceptible varieties at anthesis compared to vegetative stage. MSI data indicated membrane structure and function. The results from electrolyte leakage measurements showed that membrane integrity was conserved for tolerant compared to susceptible varieties, this is in agreement with the conclusion of Almeselmani *et al*. (2011).

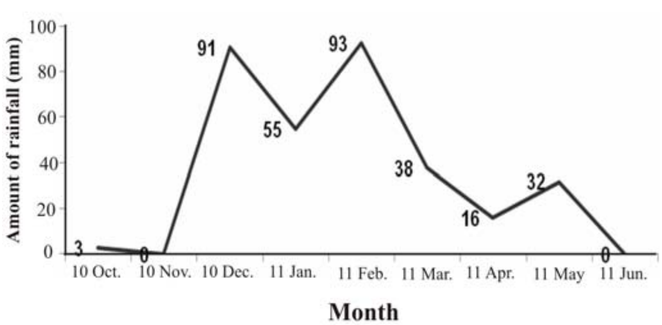

Fig. 1. Total amount of rainfall (mm) in Izra research station during the growing season.

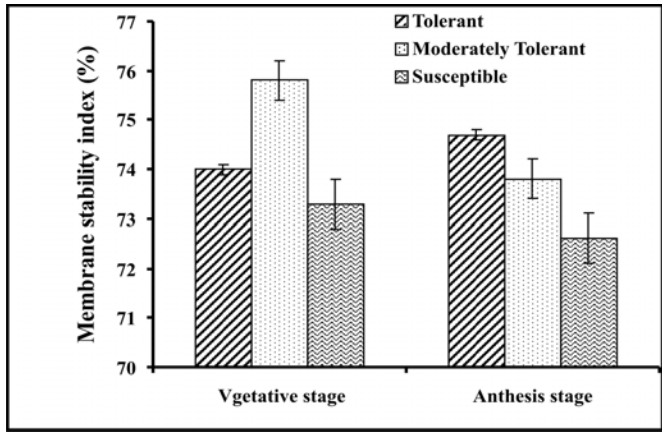

Fig. 2. Effect of water deficit on membrane stability index (%) of durum wheat varieties. LSD values at P≤5%: vegetative and anthesis stage: 1.2 and 1.5, respectively.

Significant differences in RWC were recorded among durum groups. Highest value of RWC was recorded in drought tolerant varieties compared to the other group, at vegetative and anthesis stage, however no differences between the moderately tolerant and susceptible varieties at anthesis stage, and RWC decreased as plant advanced in age as shown in (Fig. 3). A decrease in the relative water content (RWC) in response to drought stress has been documented in a wide variety of plants by Nayyar and Gupta (2006).

Lowest chlorophyll index were recorded in susceptible varieties at vegetative stage i.e., 41.3. At

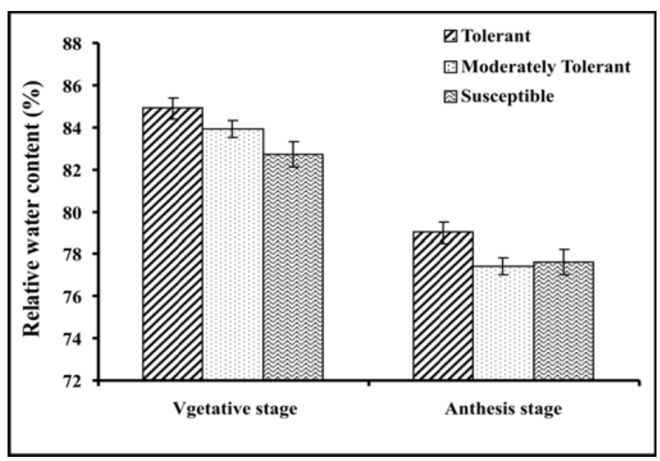

Fig. 3. Effect of water deficit on relative water content (%) of durum wheat varieties. LSD values at P≤5%: vegetative and anthesis stage: 1.1 and 0.8, respectively.

anthesis stage drought tolerant wheat varieties were superior in this character i.e., 54.6 and lowest value were recorded in drought susceptible varieties i.e., 52.6 (Fig. 4). According to Izanloo *et al.* (2008) water deficit leads to an increased depletion of chlorophyll and a decreased concentration of chlorophyll.

Highest values for chlorophyll florescence in drought tolerant varieties at vegetative stage and the values were 0.79, 0.78 and 0.82 for susceptible, moderately tolerant and tolerant wheat varieties respectively (Fig. 5). At anthesis significant differences were recorded among groups and drought susceptible varieties showed lowest *Fv/Fm* values i.e., 0.67. Chlorophyll fluorescence quick variation can be used as a valuable index for evaluation of plants tolerance to environmental stresses (Paknejad *et al.* 2007). Flagella *et al.* (1995) also reported that drought tolerant cultivars showed a smaller decrease in photosynthetic efficiency (*Fv/Fm* ratios).

Tolerant wheat varieties were superior in yield and its components (Table 1). Drought susceptible varieties had the lowest total biomass i.e., 703 g/m^2, while highest value was recorded in drought tolerant varieties i.e., 799 g/m^2. The differences were highly significant among the three groups and tolerant and moderately tolerant wheat varieties were superior by 14 and 10%, respectively compared to susceptible one. Significant differences were recorded in yield among drought tolerant, moderately tolerant and susceptible varieties i.e., 198, 220 and 195.3 g/m^2, respectively (Table 1). Highest values for grain yield were recorded in the moderately tolerant varieties and the grain yield of moderately tolerant varieties significantly exceeded those of tolerant and susceptible one. Blum and Pnuel (1990) reported that yield and yield components of wheat varieties significantly decreased under minimum annual precipitation.

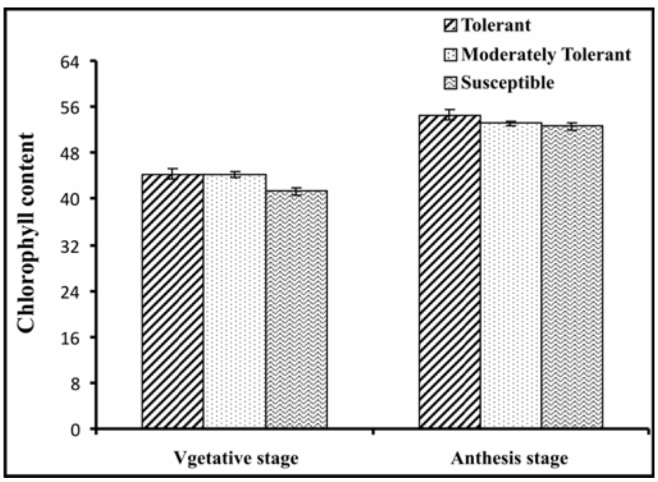

Fig. 4. Effect of water deficit on chlorophyll content of durum wheat varieties. LSD values at P≤5%: vegetative and anthesis stage: 0.6 and 0.8, respectively.

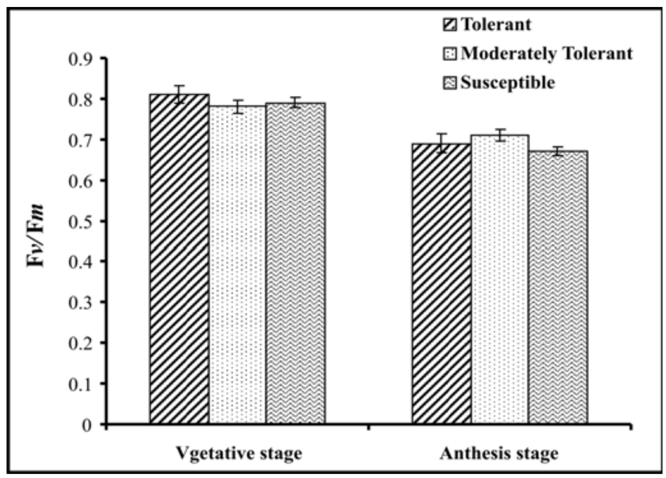

Fig. 5. Effect of drought stress on chlorophyll fluorescence of durum wheat varieties. LSD values at P≤5%: vegetative and anthesis stage: 0.06 and 0.03, respectively.

Table 1. Effect of water deficit on wheat yield and yield components in drought tolerant, moderately tolerant and susceptible group.

	Grain number ear^{-1}	Tillers number m^{-2}	Grain yield (g m^{-2})	Total biomass (g)	1000 grain weight (g)
Tolerant	39.2	275	198	799	43.5
Moderately tolerant	37.4	263	220	776	43.6
susceptible	36	240	195	703	42.7
LSD at 5%	1.1	12	1.7	21	0.49

Significant differences were recorded for tiller/m^2 among the three groups and tolerant and moderately tolerant varieties were superior by 15 and 10% compared to susceptible varieties (Table 1). Susceptible and moderately tolerant varieties have no difference in grain number per ear and drought tolerance varieties had highest grain number per ear i.e., 39.2 and it was superior by 8% compared by susceptible one. Highest 1000 grain weight was observed in moderately tolerant varieties i.e., 43.6 g and no significant differences between tolerant and moderately tolerant varieties. However lowest 1000 grain yield were recorded in drought susceptible varieties i.e., 42.7 g. Similar, observations were recorded earlier (Chandler and Singh 2008).

Based on the present study it is concluded that all the studied traits have direct or indirect impact on yield which influencing photosynthetic rate and associated parameters like chlorophyll content and chlorophyll fluorescence.

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