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Evaluation of Crop Water Stress Index, Canopy Temperature and Grain Yield of Five Iranian Wheat Cultivars Under Late Season Drought Stress

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Abstract
In order to evaluate crop water stress index (CWSI) and canopy temperature of wheat cultivars under terminal drought stress, a field experiment was conducted at the Agricultural Research Station of Shiraz University, Shiraz, during 2009 growing season. Five wheat cultivars including Shiraz, Bahar, Pishtaz, Sistan and Yavaros and four levels of water regime including well watering [Irrigation according to 100% field capacity (FC)], excess watering (125% FC), and mild (75% FC) and severe drought (50% FC) stress were used in a split plot design experiment with three replicates. Results showed that Yavaros and Shiraz cultivars with 7.36 and 6.81°C had the highest canopy-air temperature differences (T*c*-T*a*), respectively, while in Bahar this difference was 3.9°C. In all cultivars, slope (*a*) and intercept (*b*) of lower base line equation between T*c*-T*a* and vapour pressure deficit (VPD) were increased significantly due to more limitation in water and increasing VPD. Yavaros and Shiraz cultivars with higher *a* value were found to be more sensitive to increasing VPD. Shiraz and Yavaros cultivars with 0.73 and 0.71 had the highest seasonal mean CWSI, respectively, while CWSI in Bahar, Pishtaz and Sistan ranged from 0.61 to 0.64 under severe drought. A negative relationship was found between CWSI and amount of water supply and net photosynthesis of flag leaf. Maximum grain yield was obtained in Shiraz and Yavaros under well and excess watering and CWSI in these cultivars ranged from 0.31 to 0.36, whereas by decreasing water supply and increasing CWSI, grain yield in these cultivars decreased significantly. Bahar, Pishtaz and Sistan cultivars with lower T*c*-T*a*, water supply and CWSI had better performance than Shiraz and Yavaros cultivars, especially when exposed to water stress conditions. The role of these traits should be further investigated as potential indirect selection criteria for grain yield of wheat cultivars in semi-arid conditions.

Keywords: Canopy temperature, CWSI, Net photosynthesis, Water supply

Introduction
Wheat is an important cereal crop and is adapted to a wide range of climatic conditions (Emam 2007). The success of sustained wheat production in arid and semi-arid regions of the world depends entirely on water availability (Alderfarsi and Nielsen 2001). Efficient use of water in the Mediterranean region is becoming an important issue due to increasing irrigation water requirements as well as environmental sustainability (Emekli *et al.* 2007).

Canopy temperature is a part of the canopy energy balance. As solar radiation is absorbed by leaves, leaf temperatures increase (Panda *et al.* 2003). Leaf cooling takes place as some of the thermal energy drives transpirational water loss. Under water deficit conditions, stomata close in response to loss of turgor pressure, causing a lowering of transpiration rate and hence, an increase in canopy temperature (Kramer 1983). This is the basis for the use of canopy temperature to determine plant water status (Jackson *et al.* 1981).

The crop water stress index (CWSI) calculation is based on three main environmental variables: plant canopy temperature (T*c*), air temperature (T*a*) and atmospheric vapor pressure deficiency (VPD). All these three variables have much influence on water used by plants (Braunworth 1989). An infrared thermometer