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Water Uptake and Hydraulic Conductivity of Seminal and Adventitious Roots of Five Wheat Cultivars at Early Growth Stage

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ABSTRACT

To investigate the root anatomy and hydraulic conductivity of wheat cultivars, including Shiraz, Bahar, Pishtaz, Sistan, and Yavaros, a series of controlled environment (growth chamber) experiments were hydroponically conducted at University College of Dublin (UCD), Ireland in 2010. Bahar, Pishtaz and Sistan cultivars were employed as tolerant to drought and Shiraz and Yavaros as sensitive. Twelve plants from each wheat cultivar in three replications were compared in a completely randomized design. Seminal roots had four to five cortical cell layers, and typically one large central metaxylem and 5±1 (in Bahar) to 7±1 (in Yavaros) smaller and circularly arranged peripheral metaxylem vessels. Stellar cells were less lignified in adventitious roots, as compared with seminal roots, and mature xylem vessels of seminal roots of Shiraz and Yavaros cultivars had more lignified walls compared to the other cultivars of the 18 day old plants. Lateral roots of Shiraz cultivar showed the most lignified walls compared to the other cultivars. The highest root hydraulic conductivity in seminal roots was observed in Bahar with the lowest surface area and lignified cell walls. Type of cultivar had also a noticeable effect on flow rate of seminal roots and varied from 2.81 in Shiraz to 3.76×10^{-10} m s^{-1} in Bahar cultivar. With respect to flow rate and osmotic driving force of seminal and adventitious roots, Bahar and Sistan cultivars had the highest hydraulic conductivity. It was concluded that at the early growth stage of wheat cultivars (3rd leaf stage), root anatomical structures of Bahar and Sistan were more efficient in water uptake and this might be attributed to the less lignified cell wall of the peripheral and central metaxylem zones of the roots in these cultivars.

Keywords: Flow rate, Lateral roots, Osmotic driving force, Peripheral metaxylem.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most essential food crop in Iran and many other countries (Emam, 2007). Considering the importance of wheat in Iran, especially in Fars Province, better understanding of the relationship between water uptake and hydraulic conductivity in relation to root anatomy for Iranian wheat cultivars would be a top priority. Cereals appear in all shapes and sizes, yet in physical terms they are variable hydraulic conductors that use a naturally occurring gradient in the energy content of water (water potential) between root and shoot environment (atmosphere) to drive the water uptake and dissolved mineral nutrients (Knipfer and Fricke, 2010b). Hydraulic resistances, as they occur at the root and shoot level, can limit water flow through the plant, analogous to Ohm's Law (Frensch, 1997).

The water movement in roots is often described as an osmotic pressure in which root membranes play an important role (Knipfer and Fricke, 2010b; Kramer, 1983; Kramer and Boyer, 1995). Also, the physical characteristics of roots are related to their

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