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Editorial: Highlighting Some Opinions for Studying Soil Water and Plant Relationships in Arid Lands

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After successful one year of publication, covering the soil, water and plant disciplines in Journal of Soil and Plant Interactions, the editorial board desire to emphasize some aspects of future studies, which seem essential for the agricultural practices in arid and semi-arid regions:

1- Rainfed agriculture. Due to rise in population, changing diets that include more animal products (UNESCO, 2012) and global warming (Abbaspour et al., 2009) as well, there is increased pressure on ground water or surface (blue) water bodies to produce more food and fibers (Peterson et al., 2012). Since blue water is limited and is even consumed more than allowable level (FAO, 2008), it will be difficult to extend irrigated areas especially in Iran. Therefore, it is a priority to increase the efficiency of green water (water located in the soil) resources (Rockström, et al. 2003). More than half the area is devoted to rainfed farming (green water dependent agriculture) in Iran (Statistical Center of Iran, 2019), but less researches have been performed on the large untapped potential for upgrading rainfed agriculture (Mohammadi, 2015). Some practices have been advised by Joint (2001) to enhance soil water availability and hence productivity in rainfed fields such as; improving overall soil water storage by avoiding deep drainage, mulching and compost use, conservation tillage/farming systems (Serraj and Siddique 2012) and in-field water conservation. However, it should be investigated which approach is applicable and compatible for each soil and region.

2- Actual plant available water. In many water management practices or even research efforts, the plant available water (PAW) is determined from laboratory soil samples as the water content difference between field capacity (FC) and permanent wilting point (PWP). Notwithstanding, many concerns should be considered in the application of the PAW to envisage soil, water and plant interactions: i) PAW does not give an appropriate estimate of the actual available water especially in a layered soil profile and within the rhizosphere as well (Evett et al., 2019), ii) the concept of FC at a particular cutoff matric potential is not the suitable upper limit of plant available water (van Lier, 2017; Logsdon, 2019). However, some dynamic concepts for FC have also been proposed (e.g., Twarakavi, et al. 2009, Assouline and Or 2014, Reynolds 2018) but, these concepts are not still examined for manner of water uptake by plant in the natural conditions, iii) actual wilting point as a lower limit of PAW is dependent on the plant type (Terros et al., 2021), climatic condition (Passioura and Angus, 2010), soil nitrogen content (Angus and Van Herwaarden 2001), plant-soil interactions (Wiecheteck et al., 2020) and plant-microorganism symbiosis (Hosseini et al., 2016), rather than being a fixed point (i.e., constant matric potential). Subsequently, these limitations would also be embedded in i) the least limiting water range (LLWR) concept (Da Silva et al., 1994) that, in addition of FC and PWP, takes into account soil aeration and mechanical resistance restrictions in cut-off form or, ii) the integral water capacity, IWC, concept (Groenevelt et al., 2001) which uses continuous weighting functions corresponding to various soil limiting factors. Moreover, the appropriateness of limits of the LLWR concept (de Lima, et al. 2020) and IWC concept (Meskini-Vishkaee, et al. 2018) are disputable because these concepts do not consider specific soil and plant properties (Mohammadi, et al. 2010,Kazemi, et al. 2020). The insufficiency in traditional concepts of available water can inspire farther efforts on i) more reliable albeit more difficult, measurements or prediction of the actual available water for plant uptake and, ii) the role of "management on soil water extraction which is probably the least well understood part of the crop water balance" (Passioura and Angus, 2010).

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3- Circumspection in upscaling of the pot experiments.

Applying of laboratory experimental results to natural field systems is one of the biggest challenges for vadose zone modeling (Arora et al., 2019). Therefore, reasonable upscaling methods are required to extrapolate the soil hydraulic properties, root water uptake, chemical and biological properties to the field scale and beyond (Vereecken et al., 2016). This challenge is remained, and even more, critical for the rhizosphere researches (Vetterlein et al., 2020) or studies carried out under controlled-environment conditions (e.g., see Passioura, 2006). However, some advantages have been attributed to laboratory scale (Vetterlein et al., 2020) or pot-based experiments in greenhouse circumstance (Limpens et al., 2012), but these types of experiments should be given less priority in comparison with field-based experiments particularly for drought stress researches. Drought stress in crop is, indeed, an imbalance between water uptake by roots and water loss by stomata that induced by evaporation demand (Vicente‐Serrano et al., 2020). Atmospheric evaporation demand has paramount role to impose drought stress in arid and semi-arid regions (Vicente-Serrano et al., 2017). Reference evapotranspiration, ET_0, as a measure of atmospheric evaporation demand (Seneviratne and Ciais, 2017) reveals a large difference between the greenhouse conditions and field environments. This discrepancy confirms the circumspection that should be observed in generalizing results of pot experiments to field scale for drought studies and, highlights the need of large scale experiments. Nevertheless, importance of greenhouse based studies on the vegetables and crops growing in the glasshouse remains strong.

4- Effective use of water in drylands. The concept of effective use of water (EUW) was proposed by (Blum, 2009) to imply primarily maximal soil water capture for transpiration and minimal water loss by soil evaporation for yield improvement under drought stress. It is beyond the water use efficiency, WUE, concept and creates new standpoint to address the crop and water management issues in the rainfed agriculture (Sinclair, 2018; Kalamartzis et al., 2020; Thapa et al., 2020). This concept compiles several approaches, which are regional and crop dependent consequently, further attempts are required to quantitative analysis the approaches efficacy for the regional circumstance.

In conclusion, more researches should be redirected to the rainfed agriculture to increase water productivity and crop yield through the large scale experiments. Moreover, the soil water extraction by plant should be considered as of paramount importance in the drought stress researches.

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