Acta Scientific AGRICULTURE (ISSN: 2581-365X)

Volume 8 Issue 2 February 2024

Editorial

A New method for Computation of Integral Water Capacity (IWC)

Zahra Kazemi*

Department of Soil science, University of Tabriz, Iran

***Corresponding Author:** Zahra Kazemi, Department of Soil science, University of Tabriz, Iran.

Received: November 27, 2023

Published: January 01, 2024

Abstract

The latest concept of soil available water for plants, integral water capacity, (IWC), is routinely computed by developing weighting functions (ωi(h)) for limiting factors for available water to plants, within a particular matric potential range (h) in the root medium. It is almost computed using the presumed ωi(h) created by the inventors of this concept and using soil properties without considering plant attributes. Up to now, no study has been done about using leaf water potential (LWP) of plants as a plant response criterion for the computation of IWC. LWP can consider the effects of soil, plant and atmospheric conditions on water availability for plants. In our last research, due to conducting the experiments in the greenhouse and the destructiveness of LWP measurement method, the number of data points was not enough to create appropriate weighting functions based on this index. We suggest more studies on this criterion for determining IWC in the field condition.

Keywords: Leaf Water Potential; Matric Potential; Weighting Function

Introduction

Integral water capacity (IWC) was introduced by Groenevelt., *et al*. (2001) as a substitution for previous soil available water for plant concepts including classical plant available water (PAW) and least limiting water range (LLWR). So far defining dry and wet soil matric potential limits for a particular limiting factor has seldom been determined using plant response and almost has been computed soil property based. The main purpose of the current study was to compare the various methods for computing IWC and propose a new plant-based method (IWC_p) by creating LWP-based weighting functions (ω_p(h)).

Leaf water potential (LWP)

The water status of the plant can be determined by using physiological indicators such as leaf water potential (LWP). LWP is a measure of the plant's water status and is useful in detecting water stress in plants. The soil, plant and atmosphere chain (SPAC) model, which is the basis of our understanding of soil-plant relationships and the response of plants to water shortage conditions, suggests that plant indicators such as LWP can be the most direct stress indicator for plant water and biological need for irrigation. It is one of the important parameters in determining plant tolerance to drought and salinity because water stress limits transpiration by closing the stomata, limiting evaporation from the leaf surface and affecting plant photosynthesis and crop production (Shirley., *et al*. 1990). In our last study in a sandy clay loam with 3 soil compaction (D_1 to D_3) and 4 root pruning levels (L_1 to L_4) with 3 repeats (R_1 to R_3), we tried to create appropriate ω_p(h) based on LWP. Changes in LWP of sunflower plants under stress treatments with time during two wet and dry cycles, firstly compared with control treatments without any water stress at the same level of soil compaction and root pruning ($D_1L_4R_3$) and secondly with the treatments without compaction limitation in addition to the previously mentioned stresses ($D_1L_4R_3$) for creation a new ω (*h*)) using LWP. The results of that study were not published. For more details of materials and methods refer to Kazemi., *et al*. (2021). The maximum value of LWP (less negative) for treatments under stress (D_1L_1 to D_1L_4) was equal to --1.2 to -1.6 MPa and its minimum value (most negative) was equal to -3 to -3.7 MPa, compared to the maximum and minimum of -1.32 and -1.85 MPa for $D_1L_4R_3$ treatment and the average value of -1.56 MPa for it. The maximum value of LWP (less negative) for the under-stress treatments of D_2L_1 to D_2L_4 was equal to -1.5 to -1.3 MPa and for D_3L_1 to D_3L_4 -1.35 to -1.6 MPa and its minimum value was -0.3 to -3.5 MPa. for D_2 treatments and ranged from -3 to -3.2 for D_3 treatments, compared to the average value of -1.56 MPa

$D_1L_4R_3$ treatment. In the research of Herve et al. (2001), under optimal irrigation conditions, LWP equal to 0.51 MPa was reported. In our last research, the number of data points was not enough to create suitable weighting functions based on this plant index, due to the experiments conducted in greenhouse conditions and the destructiveness of LWP measurement method. Additionally, in the dry range of the soil moisture curve, there was no measurement of LWP with a pressure chamber device.

Integral Water Capacity (IWC)

Kazemi., *et al*. (2021) computed the plant response-based integral water capacity (IWC_P) using leaf stomata conductance (g) in the greenhouse condition. They developed appropriate weighting functions based on relative stomata conductance (g/g_c), as a ($\omega(h)$) and assumed it varies between 0 to 1 and involves effects of all water availability limiting factors in the root medium, as a function of *h*. Then IWC_P was compared with Groenevelt et al (2001) soil properties-based method (IWC_G). The results showed that averaged over the three compaction levels, IWC_P and IWC_G were 0.169 and 0.14 cm^3cm^{-3}, respectively, indicating that water availability determined on the plant response basis is 17% greater than that predicted by IWC_G. At the highly compacted D_3 treatment (D_b= 1.75 $Mg.m^{-3}$), the IWC_G values were 84% less than the D_1 treatment with D_b equal to 1.35 $Mg.m^{-3}$. This reduction was 19% for D_2 treatments with D_b equal to 1.55 $Mg.m^{-3}$and reflects the dominant effect of soil compaction on water availability. This difference and over susceptibility (84%) of IWC_G to soil compaction imply that the soil matric domains proposed for the various soil limitations and the experimental relations employed in Groenevelt., *et al*. (2001) approach to quantify their restricting effects as weighing functions need to be modified according to each particular plant needs or response [1-4].

Conclusion

The presumed weighting functions in IWC_G method led to over or under prediction of IWC. So it has been proposed that it is computed by some plant based criterion weighting functions to consider both soil and plant properties in water availability for plant.

Bibliography

1. Groenevelt PH., *et al.* "A new procedure to determine soil water availability". *Australian Journal of Soil Research* 39 (2001): 577-598.
2. Herve D., *et al.* "QTL Analysis of photosynthetic and water status traits in sunflower (Helianthus Annus L.) under greenhouse condition". *Journal of Experimental Botany* 362 (2001): 1857-1864.
3. Shirle MN., *et al.* "Abscisicacidaccumulation and carotenoid and chlorophyll content in relation to water stress and leaf age of different types of citrus". *Journal of Agricultural and Food Chemistry* 38 (1990): 1326-1334.
4. Z Kazemi., *et al.* "Revisiting integral water capacity on the basis of stomatal conductance at various soil and root length densities in sunflower plant". *Agricultural Water Management* 243 (2021): 106451.