Water Dynamics in Plant Production, 2nd Edition

Questions and Discussion Points

Chapter 7 – The Water Balance of the Plant

Section 7.1
1. What is the general cause for water flow in soil and plants? In which direction is water transported?
2. Please explain what 'turgor' is in a plant cell, how turgor is created and how it develops as water fills a cell.
3. How can turgor trigger cell enlargement?
4. Describe by use of Fig. 7.1, the size and variation of ϕ, P and O with varying cell volume, which changes as water fills the cell. What happens to Ψ?
5. What is 'osmosis' and how do 'aquaporins' make osmosis possible?

Section 7.2
1. Explain the uptake of water by a 'single root' by use of Fig. 7.2 and Eqn 7.7.
2. Clarify how 'specific root water uptake rate' UR would be modified by increasing root length density, either in a somewhat dry soil or in a moist soil.
3. On the basis of Fig. 5.1 show how the term 'air capacity' changes with soil texture. Which soil lacks sufficient aeration?
4. Paddy rice is grown in soils with stagnant water. How does this crop plant manage its aeration need?

Section 7.3
1. What are the three essential climatic pre-conditions for water transpiration by plants?
2. Please discuss the dominant role of stomates with respect to gas exchange with CO_2 and H_2O and their vital role in surviving drought.

Section 7.4
1. Explain how osmoregulation by guard cells influences the aperture of stomates.
2. Opening and closing of stomates are governed by two control circuits. What is their special feature?

Section 7.5
1. Please describe the pathway of water from its entry into the root epidermis and its subsequent movement through various tissues to the stele and through the vessel tube to the leaf, where the liquid water changes to the vapour phase and passes through the stomates to the outside atmosphere.
2. What are the physical processes of water transport and the relevant driving forces moving the water molecules within the soil–plant–atmosphere system?

Section 7.6
1. Explain the ascent of water in the vessel of a tall tree by use of the technical term 'subatmospheric pressure'. How is this negative pressure implemented within the vessel system?

2. Imagine a karri tree (*Eucalyptus diversicolor*) of 100 m height (reference level: soil surface). Outline the magnitude of total water potential ϕ at each of the following points and for each altitude indicate the four component potentials O, Ψ, P and Z that make up ϕ:
(a) in the root system, where water from the soil penetrates the rhizodermis;
(b) in the xylem of the trunk at soil surface;
(c) in the xylem at 1 m height;
(d) in the xylem at 100 m height;
(e) in the parenchyma of the leaf at that altitude;
(f) in the substomatal cavity with 97% relative humidity (RH); and
(g) outside the leaf with 70% RH.
3. How do plants deal with 'cavitation'?
4. Please explain the origin of guttation.

Box 7.2
1. Josef Böhm, a former professor of botany in Vienna, tried to determine the 'suction force' within the xylem of plants by a specific experimental set-up in his laboratory. He was searching for an explanation of water rise in plants up to 200 feet and even higher. In most of his experiments he failed to demonstrate the enormous suction forcing the water up to the height as indicated. The failure occurred because of the formation of a gas bubble (Fig. B7.2). Describe what happened.