SOIL WATER—TASMANIA

Key points

- Available water is the difference between field capacity, which is the maximum amount of water the soil can hold, and wilting point where the plant can no longer extract water from the soil.
- Not all water held in soil is available to plants.
- Sandy soils store less water than clay soils.
- The root zone depth, together with soil texture and structure, determine the readily available water available for plant growth.

Background

Efficient irrigators should aim to minimise the time soil is in a saturated or dry state, and maximise the time when water is readily available to the plant. Soil is like a big sponge—it can only soak up a certain amount of water and it can only do it at a certain rate (infiltration rate). When soil is saturated there is no benefit in applying more water. Excess water only produces plant stress, waterlogging, drainage to watertable below the root zone, run-off and leaching of fertilisers.

Soil water is held in soil pores (the spaces between soil particles). There are two forms of soil water:

- water held tightly to the soil particles (adsorbed water)
- water held in the pores between the soil particles (capillary water).

Roots remove water from the soil pores by creating suction. Plants use water from large soil pores first because it is more difficult for the roots to remove water held by the small soil pores. Some plants can extract water from drier soil more easily than others.

Soil water content

How 'tightly' the soil holds onto its water, and how much effort the plant has to exert to extract this water, can be described as 'soil moisture tension'. We use a negative pressure in kPa to measure this tension. By measuring soil water, we can describe the condition of the soil at each stage of irrigation and crop water use: from 'saturation' to 'permanent wilting point', and the stages in between, 'field capacity' and 'refill point'.

Once rain or irrigation stops, large soil pores (macropores) drain due to gravity. Depending on the type of soil, this drainage may take 1–4 days. When the large pores have drained, the soil is still wet, but not saturated. The soil is at ***field capacity***. Field capacity in most soils is at a soil-water tension of about - 8 to -10 kPa.

The small pores resist gravity and hold onto their water through capillary force. The water they provide is the main source of readily available water for the plant. It is easy for plants to extract water when the soil is at or near field capacity. As water is used by a plant, and evaporation also takes place, the plant has to work harder to extract water from the soil. The harder the plant has to work, the higher the soil water tension. If a plant has to work too hard, it will start to wilt, reducing growth and yield. Eventually the soil reaches a point when the plant can no longer extract any water. This is called the ***permanent wilting point***. Once the soil has passed this point, water is held by the soil so tightly that the plant will die due to a lack of water.

After heavy rain or over-irrigation, soil may become ***saturated***. This is when even the largest pores are filled with water. Applying more water causes ponding, run-off or deep drainage. When the soil is saturated there is no air for the plant roots. This will stress most actively growing plants.

Water-holding capacity of soil

The water-holding capacity of saturated soils is generally 400–600 mm of water per metre of soil depth, but this depends very greatly on the clay content or soil texture (figure 1) (refer to 'Soil Texture' fact sheet).

- At saturation, sand holds about 400 mm of water per metre of soil depth. About 70 mm of this is below permanent wilting point (unavailable to plants). 60 mm (the blue section) is the total water available to plants (***available water***), and the remaining 270 mm is the ***free-draining water*** (not held in the soil) between field capacity and saturation.
- Medium to heavy clay holds slightly more water, but 250 mm is held below permanent wilting point, which means they need to be much wetter before any water is available to plants. 140 mm is available to plants, and only about 20 mm is free-draining above field capacity.
- Sandy loams, loams, clay loams and self-mulching clays hold a similar total volume of water. Self-mulching clays have the most available water, which plants can use, followed by the loams, clay loams and light clays.

A plant cannot easily use all of the available water held in the soil. For practical irrigation planning, irrigators must work with the water that can be readily removed from the

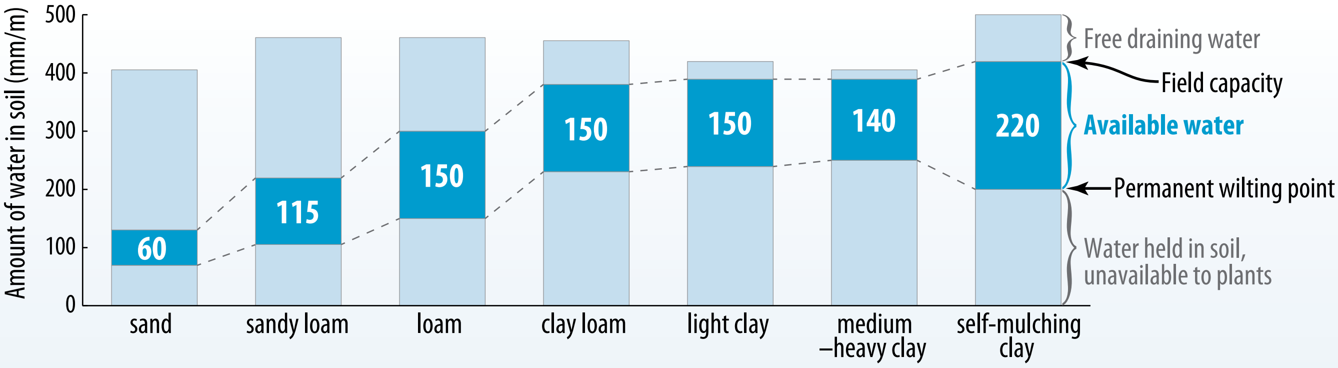

Figure 1: *Available water stored in soils of different textures (Armstrong et al. 2008).*

soil by the plant, the ***readily available water*** (RAW). RAW is expressed in millimetres per metre (mm/m) and indicates the depth of water (mm) held in every metre (m) of soil depth that can be readily removed by the plant. RAW should be calculated for the plant's effective root zone. To achieve high yields without creating excess drainage, you need to know the RAW for each crop. Only 25 to 60% of the available water is 'readily available water' (table 1). When RAW is used up, irrigation should be applied.

Table 1: *Readily available water for a range of soil textures.*

SOIL TEXTURE	READILY AVAILABLE WATER (RAW) (mm/m)
Sand	30
Loamy sand	50
Sandy loam	70
Loam	90
Clay	50
Clay loam (Ferrosol)	80
Well structured clay	60

Effective root zone

The effective root zone is that part of the plant's root zone where the main mass of a plant's roots that contribute to crop growth are found. Below the effective root zone there may be a few roots, but any water they extract is unlikely to be significant for the plant's growth. The effective root zone is typically two-thirds the depth of the deepest roots (table 2). For annual crops, the root zone increases during the irrigation season.

Table 2: *Root zone depths for a range of Tasmanian crops when fully developed.*

CROP	ROOT ZONE DEPTH (m)
Potatoes	0.6
Poppies	0.5
Peas	0.5
Green beans	0.5
Pyrethrum	0.8
Buckwheat	0.4
Carrots	0.5
Onions	0.3
Broccoli	0.5
Squash	0.5
Lucerne	1.2
Pasture	0.3
Stone/pomme fruit	1.0
Vines	0.7

When to irrigate

After readily available water has been used, plant roots cannot as easily extract water from the soil. This point is referred to as the refill point. As its name suggests, refill point is the time to irrigate. The drier the soil is, the more water it needs to return to field capacity. Field capacity and refill point are critical values for the correct use of many of the soil water monitoring technologies currently in use in Tasmania. These values vary according to soil type and crop grown and professional guidance should be sought.

Further reading and references

Armstrong D, Cotching WE, Bastick C (2001) Assessing your soil resources for irrigation, Wise Watering Irrigation Management Course notes. http://www.dpipwe.tas.gov.au/inter.nsf/WebPages/JMUY-5FJVP7?open#CourseMaterial

Author: **Bill Cotching** (Tasmanian Institute of Agriculture)

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