Soil texture and water

Soil profiles and horizons

A soil profile is a 'cross section down through the soil'. It normally consists of a number of soil horizons (layers) each with different characteristics (texture and/or stone content).

Figure 1 shows a soil profile with three distinct soil horizons. For irrigation you need to know information about the hydraulic (water) properties of each soil horizon within the soil profile to determine the amount of water available to the plant (how big the bucket is for storing and accessing water). The size of 'the bucket' determines how frequently you need to irrigate (return period) and the maximum irrigation you can apply in one application.

Figure 1. Soil profile with different horizons.

Soil texture

Soil texture describes the particle sizes in soil. Particles are grouped according to their size. These are named **clay** (< 0.002mm), **silt** (0.002–0.05mm), and **sand** (> 0.05mm).

Soil texture description is based on the fractions of each texture present. The soil texture triangle (Figure 2) is often used to determine soil textures.

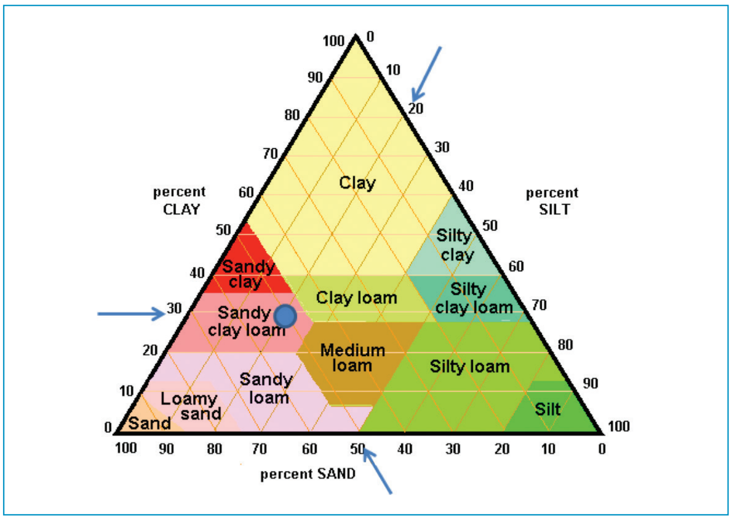


Figure 2: This soil texture triangle labels soil textures according to proportions of sand, silt and clay.

Soil water holding capacity and texture

Figure 3 shows typical soil water holding capacities (WHC) for different soil textures in mm of water per 100mm of soil depth. It also shows their typical permanent wilting points (WP) and field capacities (FC).

Sands have low water storage (FC 12mm) but most of the water can be abstracted by the plant (WP 2mm) resulting in low WHC = 10mm.

Loams have high water storage (FC 33mm) and most of the water can be abstracted by the plant (WP 13mm) resulting in high WHC = 20mm.

Clays have high water storage (FC 38mm) but they retain much of the water - do not make it available to the plant (WP 24mm) resulting in low WHC = 14mm.

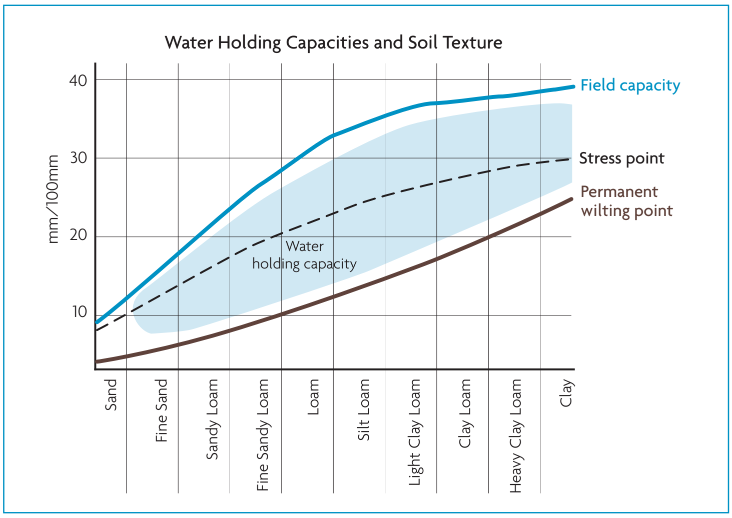
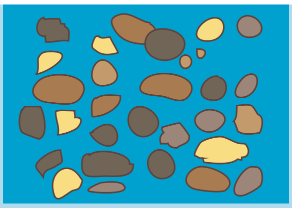


Figure 3. Water holding capacity is largely dependent on soil texture.

Understanding soil water terminology

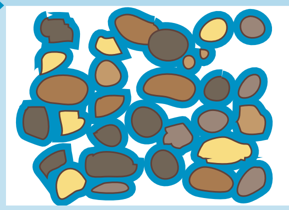
SATURATED SOIL
All pores filled with water. Plant roots short of air for oxygen and gas exchange.



Larger macro-pores drain by gravity, air enters soil.

DRAINAGE WATER (UNAVAILABLE)

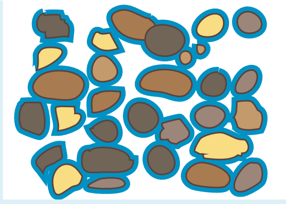
FIELD CAPACITY
Macro-pores provide air spaces and oxygen.
Micro-pores filled with water held by capillary forces.
Plant roots easily take up water.



Plants and soil surface evaporation remove soil water from micro-pore reservoir.

READILY AVAILABLE WATER (RAW)

STRESS POINT (TRIGGER POINT)
Finest pores retain water held by strong capillary forces. Plant roots take up water with increasing difficulty. May wilt during the day, recover at night. Soil well aerated.

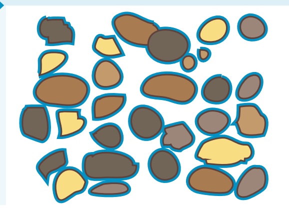


Plants and surface evaporation continue to remove water from smallest micro-pores.

SURVIVAL WATER

PLANT AVAILABLE WATER

PERMANENT WILTING POINT
Only 'hygroscopic' water remains in soil, bound very strongly to the soil particles. Plant roots unable to take up water, plants wilt and do not recover.



HYGROSCOPIC WATER (UNAVAILABLE)

Available Water Holding Capacity

Why – This is a fundamental piece of information needed to design an irrigation system and manage irrigation.

To determine AWHC four pieces of information are required;

1. A soil profile split into each horizon.
2. The depth of each horizon.
3. The soil texture of each horizon.
4. Information on WHC for each texture.

To obtain the information for 1, 2 and 3 . . . find a spade, a ruler and dig a hole!

Soil WHC information for 4, can be obtained from regional council websites and Landcare Research online data base 'S-Map Online'. Site specific AWHC can be determined on-site using soil moisture measuring tools such as neutron probes.

Table 1 gives an indication of Available Water Holding Capacity for the various soil classes.

Table 1: Typical total available water capacities.

Class	Millimetres per 100 mm of soil depth: Down to 300 mm	Below 300 mm
Sand	15	5
Loamy sand	18	11
Sandy loam	23	15
Fine sandy loam	22	15
Silt loam	22	15
Clay loam	18	11
Clay	17.5	11
Peat	20–25	> 20–25

Source: Adapted from NZS5103:1973

STONES
If stones are present, the WHC value should be reduced by the same percentage, i.e. if stones make up 30% of the soil volume, reduce the soil WHC by 30%.