FACTSHEET

GREATSOILS

Soil health and water supply

Figure 1. Auger showing good soil structure and roots to a depth of 25cm

This factsheet explains the relationship between soil health and soil water supply to crops. Practical measures to monitor and improve the management of soil water through soil health interventions are described.

Action points

- **Manage soil structure to enable retention of readily available water**
- **Ensure soil is at the optimum moisture content at the time of bed formation in order to achieve a good tilth and maintain storage pores**
- **Increasing organic matter content of coarse-textured (light sandy) soils will improve retention of readily available water for crop growth and provide optimum conditions for microbiological processes such as nutrient cycling**
- **Simple in-field measurements using an auger or probe can be used to manually check the soil moisture in beds**
- **Gain useful insights into the health of soils – look out for compacted layers when installing access tubes for soil moisture probes**

Importance of soil water supply to high-value horticulture crops

Soil water supply is critical to managing the yield and quality of high-value crops horticultural crops. Improving soil health, in particular organic matter content, can benefit the supply of water from irrigation and rainfall by increasing infiltration rate and water-holding capacity.

Irrigation scheduling is informed by evapotranspiration measurements in horticultural crop production. However, the need for irrigation can be assessed based on judgement (such as the look and feel of soil removed from a bed using an auger, or resistance offered to a cane or auger) or measurement (such as a neutron probe). This not only provides information on soil moisture status but can also provide clues about soil condition and health. Compacted layers may be detected when installing access tubes for soil moisture probes, while an auger can show the presence of good soil structure and rooting depth (Figure 1).

Soil pores and water availability

Soils consist of solid particles arranged into more or less structured aggregates. However, it is the spaces between the particles (pores) that provide the habitats for soil organisms and plant roots. The size and distribution of these pores determine not only the amount of water and air held in the soil but also how available that water is to plant roots and to soil organisms.

Maintaining good air-filled porosity is an important consideration in soil health management. As soils become compacted, the porosity decreases, and under wet conditions, air-filled porosity can become too small to allow adequate movement of oxygen into the soil, affecting crop growth. As a rough guide, soil should always have at least 10 per cent air-filled porosity.

Example

A pipe of 10cm diameter was driven into a sandy loam soil in spring 24 hours after the last rainfall. In the intact cylinder of soil 25cm deep that was removed:

- If measured in a lab, approximately half the volume of the soil cylinder would be occupied by solid particles and the other half would be space (the porosity of the soil was 50 per cent)
- The soil was at field capacity and we expect that approximately half the volume of spaces were occupied by water (25 per cent of the total volume) and the remaining spaces were occupied with air (25 per cent air-filled porosity)

Devices such as a neutron probes or WET (water content, electrical conductivity and temperature) sensors measure volumetric water content, but not all of that water is readily available to crops. Following a heavy rain event, some water initially drains through the soil. It takes around 24 hours for the water to redistribute, by which time drainage pores greater than 30µm in diameter will have emptied of water. However, not all the water drains through and some is retained in the smaller soil pores.

Roots struggle to use water in pores smaller than 3µm and in the smallest pores (less than 0.2µm) water is held so tightly that it is unavailable to plants (beyond the permanent wilting point). The most readily available water is stored in pores in the range 3–30µm. This is also the optimum range of water availability for soil microbiological processes eg mineralisation of nitrogen, phosphorus and sulphur from organic matter. So, in terms of soil health management, the aim should be to optimise the number of pores in this size range by avoiding compaction and encouraging good aggregate formation.

Figure 2. Using soil matric potential to schedule irrigation in protected salads

Some growers use information on soil matric potential (in the range -10 to -100kPa) to assist with scheduling irrigation (Figure 2). Table 1 summarises the link between pore sizes and plant water availability (expressed as soil matric potential).

Table 1. Pore sizes and plant water availability

Pore size (µm)	Equivalent soil matric potential (-kPa)	Biological significance
3,000	0.1	Earthworm channel
300	1.0	Root channel
30	10	Field capacity
3	100	Limit for readily available water
0.2	1,500	Permanent wilting point

Notes: Readily available water for plant use from -10 to -100kPa (also optimum range for soil microbiological processes)
Water-holding capacity from -10 to -1500kPa

Managing organic matter to improve soil water retention

Increasing the organic matter in soil can improve water retention. It has been found that water retention response to organic matter is greater in coarse-texture (light sandy) soils than in fine-texture (heavy clay) soils. The use of compost applied every three years in a potato rotation over 12 years (barley, red clover, potato) has been shown to increase the volumetric water content at -33kPa and -100kPa in sandy loam soil growing potatoes. This demonstrates that soil organic matter improves the retention in soil of water within the pores that plants can readily use.

Case Study – Field-grown strawberry trials at EMR

A WRAP-funded study (WRAP Project OAV023-006) at East Malling Research has shown that the incorporation of green compost into strawberry beds prior to planting replaced the need for fertigation and increased the water-holding capacity (also known as the full-point for irrigation scheduling) of the soil. There was no difference in crop yield or quality, as measured by taste tests, berry firmness and shelf life. Profit was increased by £605/ha as a result of using green compost.

Soil moisture and soil strength

There is a fairly small range of water content when soil clods are weaker than the bulk soil and yet not plastic – this is when the soil clods are most readily broken, and the conditions are ideal for creating a good tilth. If the water content is too high, the soil becomes plastic and cultivation causes smearing and loss of structure and destroys the all-important storage pores (spaces for storing readily available water). So, timeliness of cultivation (cultivating at the appropriate water content) is essential for maintaining good soil structure, for example, when forming beds. The energy used for cultivation can be a good indicator of soil strength.

One way to estimate the water content of lighter soils is to push an auger or a cane into the ground – the wetter the soil, the lower the strength of the soil and the easier it is to push in.

A video demonstrating this technique can be found at: **ahdb.org.uk/greatsoils**

An alternative for measuring soil strength is to use a penetrometer (DICKEY-john or similar), which gives a measure of the force used to push into the soil (Figure 3). To get the best out of this device you need to know the typical readings for the soils in each field. Once you have built up a good knowledge base then the measurements made following different management interventions can be assessed with confidence.

The combination of simple in-field assessments of soil physical condition together with timeliness of cultivation and management of soil organic matter will lead to improvements in soil health.

Figure 3. Martin Brittain (Fresh Growers) testing strength of soil in a carrot crop using a penetrometer

"We must treat soil as a living system. Nurturing that system is especially important for intensive cropping; we must give back, not just take from the soil.

At Valefresco, we recognise the need to increase soil organic matter, but doing so is not straightforward. We have been increasing our use of cover crops over the last few years for our outdoor cropping (Figure 4A).

For protected cropping (Figure 4B), very little work seems to have been done with cover crops, so doing our own small trials is a necessity prior to potentially rolling it out large scale."

Steve Nickells, Valefresco

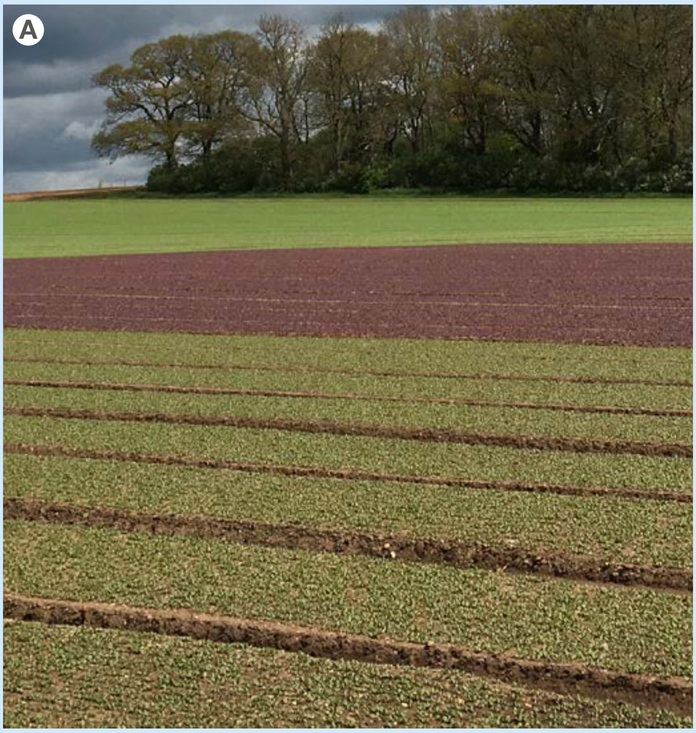

Figure 4 Outdoor (A) and protected (B) leafy salad crops grown in sandy loam soils at Valefresco

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Further information

A range of resources to help you with soil health assessment and soil management are available at: **ahdb.org.uk/greatsoils**

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