SOILS

SOIL WATER

CALU FACTSHEET

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Understanding the behaviour of water in soils helps growers to improve their water efficiency. There is a complex interaction between the soil's physical properties and the physiological activity of plants. Nevertheless, some common principles apply, and understanding these should improve water management.

Water in soils can be split into three categories:

- **Hygroscopic or chemical water**: this is water that is bound tightly to the surface of the soil particles. It is not available to plants.
- **Capillary water**: is water that is held in the soil by the forces of cohesion (water molecules sticking to each other) and adhesion (water molecules sticking to the soil particle surfaces). Most capillary water is available to plants. However, as the soil dries out, and there is less capillary water, it is held more and more tightly in the soil and becomes increasingly difficult for the plants to obtain.
- **Gravitational water**: is water that drains freely from the soil simply due to the force of gravity pulling it downwards.

Some plants are better able to obtain water from soils, but as a general rule of thumb, it is assumed that water that is held in the soil with a pressure of less than 15bars will be available to plants. When water is held more tightly than this, plants will begin to show physical damage (wilting) which quickly becomes irreversible. This is known as the **permanent wilting point**.

A soil is described as **saturated** when all its pores are filled with water. Once the gravitational water has drained from a saturated soil, it is said to be at **field capacity**. The water volume that makes up the difference between field capacity and permanent wilting point is what is known as **available water.** This is usually expressed as cm (or mm) of available water per cm depth of soil.

The absolute volume of water in a soil is not the most important characteristic in assessing water availability. What is important is the physical texture of the soil. For example, clayey soils have a large proportion of small particles with large surface areas. The soil water adheres to these very strongly. If a bone dry clay soil and a bone dry sandy soil are wetted with the same volume of water, the sandy soil will have a higher volume of plant available water. This is because the particles are larger, with smaller surface areas, and therefore the water sticks less strongly to them.

Table 1, below, provides some representative examples of the relationship between particle size, field capacity, permanent wilting point and available water.

Table 1: relative water holding capacities of different soil textures

	Field capacity (mm/cm)	Wilting point (mm/cm)	Available water (mm/cm)
Coarse sand	0.6	0.2	0.4
Fine sand	1.0	0.4	0.6
Loamy sand	1.4	0.6	0.8
Sandy loam	2.0	0.8	1.2
Light sandy clay loam	2.3	1.0	1.3
Loam	2.7	1.2	1.5
Sandy clay loam	2.8	1.3	1.5
Clay loam	3.2	1.4	1.8
Clay	4.0	2.5	1.5

This demonstrates clearly that although a fine particled clay soil is able to hold twice as much water as a sandy loam soil, only a small proportion of this additional water is actually available to plants.

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PRIDD
DŴR PRIDD

TAFLEN FFEITHIAU CALU
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Mae deall ymddygiad dŵr mewn pridd yn helpu tyfwyr i wella'i heffeithlonrwydd dŵr. Ceir rhyngweithio cymhleth rhwng nodweddion ffisegol y pridd a gweithgarwch ffisiolegol planhigion. Er hynny, mae rhai egwyddorion cyffredin yn berthnasol, a dylid gwella rheolaeth dŵr drwy ddeall y rhain.

Gellir rhannu dŵr mewn pridd yn dri chategori:

- **Dŵr hygrosgopig neu gemegol**: dŵr yw hwn sydd wedi'i rwymo'n dynn i arwyneb y gronynnau pridd. Nid yw ar gael i blanhigion.
- **Dŵr capilarïaidd:** yw dŵr a gedwir yn y pridd gan rymoedd cydlyniad (moleciwlau dŵr yn glynu at y naill a'r llall) ac ymlyniad (moleciwlau dŵr yn glynu at arwynebau'r gronynnau dŵr). Mae'r rhan fwyaf o ddŵr capilarïaidd ar gael i blanhigion. Fodd bynnag, fel mae'r pridd yn sychu allan, a cheir llai o ddŵr capilarïaidd, caiff ei ddal yn dynnach ac yn dynnach yn y pridd a daw'n fwyfwy anodd i blanhigion ei gael.
- **Dŵr disgyrchol:** yw dŵr sy'n draenio'n rhydd o'r pridd dim ond oherwydd bod grym disgyrchiant yn ei dynnu i lawr.

Mae rhai planhigion yn gallu cael dŵr o bridd, ond fel rheol gyffredinol, tybir y bydd dŵr sy'n cael ei ddal yn y pridd gyda phwysedd o lai na 15bar ar gael i blanhigion. Pan ddelir dŵr yn dynnach na hyn, bydd planhigion yn dechrau dangos niwed corfforol (gwywo) na ellir ei ddadwneud. Gelwir hyn yn **bwynt gwywo parhaol**.

Dywedir bod pridd yn **ddirlawn** pan fydd ei holl fandyllau'n llawn dŵr. Ar ôl draenio'r dŵr disgyrchol o bridd dirlawn, dywedir ei fod wedi cyrraedd **cynhwysedd maes (*field capacity*)**. Yr enw a roddir ar gyfaint dŵr sy'n gwneud yn iawn am y gwahaniaeth rhwng cynhwysedd maes a gwywo parhaol yw **dŵr rhydd (*available water*).** Mynegir hyn fel rheol fel cm (neu mm) o ddŵr rhydd fesul cm o ddyfnder pridd.

Nid cyfaint absoliwt dŵr mewn pridd yw'r nodwedd bwysicaf wrth asesu faint o ddŵr sydd ar gael. Yr hyn sy'n bwysig yw ansawdd ffisegol y pridd. Er enghraifft, mae gan bridd cleiog gyfran fawr o ronynnau bychain gydag arwynebau mawr. Mae'r dŵr pridd yn glynu'n gryf iawn at y rhain. Pe bai pridd cleiog sych grimp a phridd tywodlyd sych grimp yn cael eu gwlychu gyda'r un faint o ddŵr, bydd gan y pridd tywodlyd gyfaint uwch o ddŵr ar gael i blanhigion. Y mae hyn oherwydd bod y gronynnau'n fwy, gydag arwynebau llai, ac felly mae'r dŵr yn glynu'n llai cryf atynt.

Mae Tabl 1, isod, yn rhoi ychydig o enghreifftiau cynrychioladol o'r berthynas rhwng maint gronynnau, cynhwysedd maes, pwnt gwywo parhaol a'r dŵr rhydd.

Tabl 1: cymharu gallu gwahanol bridd i ddal dŵr

	Cynhwysedd maes (mm/cm)	Pwynt gwywo (mm/cm)	Dŵr rhydd (mm/cm)
Tywod bras	0.6	0.2	0.4
Tywod mân	1.0	0.4	0.6
Tywod lomog	1.4	0.6	0.8
Lom tywodlyd	2.0	0.8	1.2
Lom clai tywodlyd ysgafn	2.3	1.0	1.3
Lom	2.7	1.2	1.5
Lom clai tywodlyd	2.8	1.3	1.5
Lom clai	3.2	1.4	1.8
Clai	4.0	2.5	1.5

Mae hyn yn dangos yn glir er bod pridd clai gyda gronynnau mân yn gallu dal ddwywaith yn fwy o ddŵr â phridd lom tywodlyd, dim ond cyfran fechan o'r dŵr ychwanegol hwn sydd ar gael mewn gwirionedd i blanhigion.

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