Pulse Irrigation

A how-to guide for saving water using pulse irrigation.

What is pulse irrigation?

Pulse irrigation is the action of watering little and often, typically using a drip irrigation system. Instead of watering each bed once per day or per week, a timer or controller is set up to deliver a schedule of 3-6 shorter waterings per day. By utilising a pulse irrigation program you have the potential to cut water usage by an amazing 50% - 80%! The frequency and duration of the pulses required will depend on factors such as local climate, rainfall, soil type and temperature.

But isn't deep watering best?

Often the advice we hear is to provide less frequent and longer soaking applications to ensure water reaches deep down into a plant's root zone. This may be true for trees and established perennials, but not for short season annual flowers and vegetables. The best way we've found to provide water to these shallow rooted crops is in small doses and at regular intervals to maintain a consistent moisture level in the soil.

Benefits of pulse irrigation

- Reduce water usage by 50% - 80%.
- Decrease runoff, water waste and over-watering.
- Minimise leaching of nutrients.
- Eliminate plant stress caused by a dry/wet soil cycle.
- Maintain consistent moisture levels for optimal growth and a healthy soil biome.

In our warming climate, it is now more important than ever to discover ways to reduce the amount of water required for effective farming and growing.

How exactly does it work?

Pulse irrigation uses 'capillary action' to slowly and effectively disperse water laterally and evenly across the bed.

Capillary action, also known as capillary flow, is the phenomenon of water molecules no longer 'sticking' to each other but instead sticking to the walls of the tiny channels and spaces in between the soil particles. The molecules then have enough force to defy gravity and are able to travel horizontally or vertically throughout the soil profile. When water molecules behave like this it is known as 'adhesion'.

The smaller the channels and spaces are within the soil...the more effective this capillary action is [Fig. 1]. Larger channels and spaces will lower the adhesion force required to cling to the walls.
If the gaps becomes too wide the water molecules will revert back to clinging to each other, known as 'cohesion' [Fig. 2], and travel downwards again with gravity.

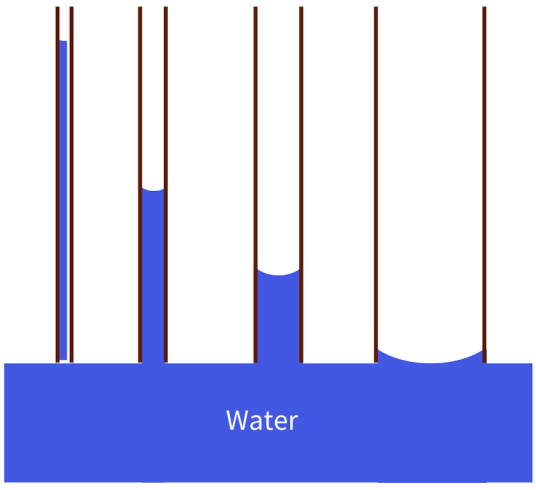


Fig. 1 - Wall size vs capillary action & vertical lift.

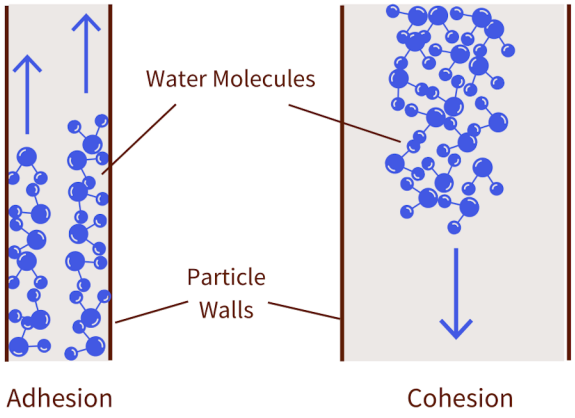
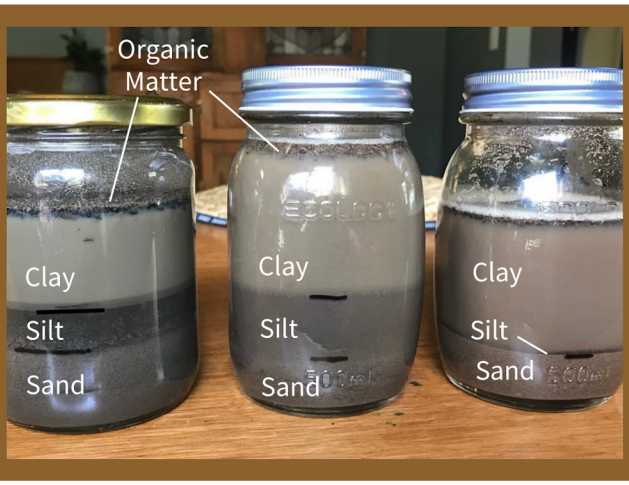


Fig. 2 - Adhesion vs Cohesion

Understanding your soil type

Each soil is comprised of varying percentages of clay, silt or sand, along with other things like decaying organic matter, minerals, nutrients and organisms. You can determine these percentages in your soil by performing an easy soil 'jar test' (see below) otherwise known as a soil texture anaylsis. 'Loam' is a term used to describe soils with roughly equal parts of clay, silt and sand.

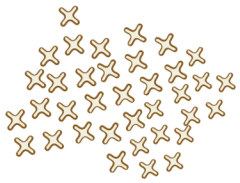


How to do a soil 'Jar Test':

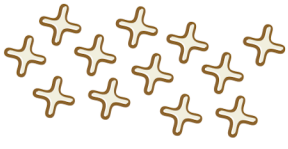
1. Place a small scoop of soil in a jar and fill with water almost to the top.
2. Shake well, then allow to settle so layers can form. Sand has the heaviest particles so will drop to the bottom of the jar. Next is silt, then clay. Organic matter will float on top.

Clay particles are much finer and smaller than sand or silt particles, so soils with a higher clay content will naturally have smaller gaps and pathways between particles.

This is ideal for capillary action and explains why it takes longer for water to drain through clay soils and also why clay soils better retain nutrients. Sandy soils have the largest particles so will drain water quickly but, as a result, are much less effective at retaining nutrients.



Clay particles



Silt particles

Sand particles

Improving soil for good capillary flow

If your soil has a higher **sand** component and is prone to being hydrophobic or leaching nutrients, you can improve it by:

- Adding compost, humates, biochar and animal manures to increase organic matter and soil nutrition.
- Adding powdered clay (Bentonite).
- Growing a cover crop to improve soil structure, microbial populations and nitrogen levels.
- Disturbing the soil (tilling) as little as possible to allow the soil structure to build and protect microbial populations.
- Soil testing can advise if organic amendments are required.

If your soil has a higher **clay** component and is prone to compaction, poor drainage or anaerobic conditions, you can improve it by:

- Adding compost, humates, biochar and animal manures to increase organic matter and soil nutrition.
- Growing a cover crop to improve soil structure, microbial populations and nitrogen levels.
- Tilling or broad-forking the soil initially to loosen compaction and allow organic matter to be worked deeper into the soil profile. After this minimal tillage is best to protect soil biome.
- Soil testing can advise if organic amendments are required.

What part do soil organisms play?

Our soil is teeming with microscopic life and scientists are only just beginning to discover and fully understand the roles that different bacteria and fungi perform, and the symbiotic or pathogenic relationships that can exist between the microbiome and plant roots. Macroscopic organisms, such as worms, also play their part by consuming the organic matter we add, helping to disperse it throughout the soil profile.

We do know that the movements of these micro and macro organisms, along with plant roots growing and stretching throughout the soil, help to form the tiny channels and tunnels that support good capillary action.

Growing cover crops are an excellent way to support these beneficial microbial populations, while also improving soil structure and fertility.

A healthy summer cover crop of Buckwheat

How long and how often?

The amount of pulses you need to run each day will depend on factors such as how many drip lines are installed, soil type, temperature, evaporation and frequency of local rainfall.

The following watering schedule is a good place to start:

5 mins x 6 times p/day (total 30 mins)
eg: 6am / 9am / 12pm / 3pm / 6pm / 9pm

It will take 1-3 weeks of pulse watering like this for capillary action to build up an even width and depth of moisture in the soil. To begin with, a 5 min pulse cycle may disappoint and look like it is hardly watering anything at all [Pic. 1]. But after a few days, you will notice the wet areas starting to join up [Pic. 2] before full saturation is finally reached [Pic. 3].

On our farm, we generally run 2-3 lines of drip tape in each bed with a dripper spacing of 20cm. We have 3 program settings that we alternate between (6, 5 or 4 pulses). Our controller is linked to a phone app so we can easily turn it off when it starts to rain. We also find it safer not to run our pulse system overnight as we are much more likely to be alerted to problems such as leaks or burst pipes during the daytime.

Pic. 1

Pic. 2

Pic. 3

Assess and adjust

As soon as your soil is evenly moist, it's important to start experimenting to try and reduce the amount of pulses used and still maintain good moisture levels. Your soil should feel moist to touch but not sloppy or over-saturated. Too much water will force air out of the soil and your plants will quickly show signs of stress.

You may also find you can eventually remove one or even two drip lines (depending on your soil and planting formations) to further increase water savings. Good luck!

Before

Water pooling on the top of this hydrophobic sandy soil after the first 5 min water pulse.

After

Soil is now evenly moist and ready to plant after 2 weeks of a 6 x pulse p/day program.

Need to know more?

For full details on how we set up our irrigation system here at Earthenry Farm, including system diagrams and parts to purchase, check out our **Irrigation e-Book** at www.earthenry.com.au

Sources and further reading

'Dahlias in Australia "The Winkie Way"' by John Menzel, pages 22-26, ISBN: 978-0-646-95134-8 <http://www.winkiedahlias.com/>

'Capillary Action and Water', Water Science School, USGS, <https://www.usgs.gov/special-topics/water-science-school/science/capillary-action-and-water>

Soil Texture Analysis - 'The Jar Test', HGIC, <https://extension.unl.edu/statewide/lincolnmcpherson/Soil%20Texture%20Analysis%20%E2%80%9CThe%20Jar%20Test%E2%80%9D.pdf>

'Quantifying the impact of microbes on soil structural development and behaviour in wet soils', Helliwell, J.R. et. al, Soil Biology & Biochemistry, Volume 74, July 2014, Pages 138-147, <https://www.sciencedirect.com/science/article/pii/S0038071714000984>