ANALYSIS:
Irrigation Methodology Effectiveness

MAIT industries


# Generic ET control vs specific soil-moisture control

*Soil-moisture monitoring uses precise, on-site data taken from 'where it matters' — below the ground — to schedule irrigation events, making the guesswork needed for generic ET monitoring no longer necessary. This means water use with soil-moisture monitoring is both efficient and effective for the crop. That, added to good pay-back periods, and the fact it's simple to use, make it an excellent watering method to maintain optimum crop growth. Here's why…*

## Key facts

- soil moisture monitoring is site specific because measurements are taken where it matters — below the ground
- ET uses above-ground measurements, applying formulas to assume a value of theoretical water use below the ground
- differences are inevitable between the ET co-efficient selected and actual soil type and crop it will be applied to
- ET calculations include assumptions, so some guesswork is involved
- soil moisture monitoring is precise (so no assumptions and no guesswork)

## About the methods

**a) Evapotranspiration (ET)**

i) *What:* ET is how much water a crop consumes — water that evaporates from the soil surface and water transpired through plant tissue to the air. ET is affected by:

- the weather: solar radiation, air temperature, relative humidity and wind speed, and
- the crop: type, variety and development stage

ii) *How:* growers can use a theoretical ET for their particular crop (called a "reference ET", represented as "ETo"), or measure it specifically (represented as ETc).

- actual (ETc): sensors (either read manually or automated) are available that directly measure ET (such as an ET gauge). Weather information can also be sought from a local (or regional) weather station, from which growers will also need to get rainfall figures.
- theoretical (ETo): the weather-derived ET value needs to be multiplied by a specific crop "factor" or co-efficient to convert it to an estimate of ETc. This value's accuracy depends on 3 major factors: the weather station's proximity to the site where the data is used, the crop factor's accuracy to the actual crop being grown, and the crop's stage of growth.

**b) Soil moisture monitoring (the MAIT way)**

i) *What*: a range of data is recorded via probes permanently fitted into the ground. The information is recorded automatically, and growers then access it as simple-to-read graphs, via radio telemetry, uploading in the field or via a web portal.

ii) *How:* along with measuring how wet (or dry) the soil is, soil moisture monitoring provides accurate information on the

effectiveness of the last irrigation, the effectiveness of a rain event, the amount of water the plant is using, the depth of water extraction, the rate and extent of through drainage, how long watering needs to be, and how often it must occur. (Without some form of soil moisture monitoring, these aspects cannot be determined.)

## How do you use it?

**a) ET**

Growers need to take several factors into consideration when developing an irrigation-scheduling program using ET:

- estimated crop root-zone depth
- soil texture within the estimated root-zone depth
- soil water-holding capacity
- soil infiltration rate
- estimated effectiveness of rain and irrigation

With all that in mind, growers then measure or record ET values, apply the correct crop factor and irrigate after a specified amount of accumulated ET, which will be based on the readily available water (RAW) in the crop's root zone and the acceptable depletion amount.

While straightforward enough, when using ET data alone to schedule irrigation events, growers have to make many assumptions in their calculations, including:

- that the soil is at field capacity when they begin to calculate ET, to estimate the calculated soil moisture deficit when an irrigation is due
- that the soil profile within the crop's root zone is filled after each irrigation event
- that they can estimate how effective rain events are (eg: any rain measured <10mm is ineffective)
- that the estimated effective irrigation or rain is correct, allowing for some run off, some possible loss through water draining past the root zone, and some evaporation if irrigating during the day
- that the depth of water use or estimated root zone depth is correct

The last point is important because as a crop grows, watering will take longer to properly wet the root zone. In annual crops, root-zone depth increases as the crop matures. As the plant begins to run out of water, there is often a change in the depth of water extraction as the plants search deeper into the profile for moisture. It may take a few days or more (depending on soil type) after this event before the plant shows visible signs of water stress — unfortunately that is too late if growers are aiming to maintain optimum plant growth.

Any of the above factors will have a major impact on the success of an ET-based irrigation scheduling program.

**b) Soil moisture monitoring (the MAIT way)**

MAIT works in conjunction with growers to choose and install soil moisture sensors specifically suited to the site (taking into consideration soil types, crop grown, average plant selection, ***etc.***). While particular operation methods and prices vary, in essence, probes measure the soil profile within and below the crop's root zone, to determine when and how much water to apply.

Because sensors are installed in representative locations, soil moisture monitoring gives growers a powerful management tool to help with irrigation scheduling and management decisions, giving them valuable information on the:

- actual amount of water the crop is using, as affected by the weather and plant growth stage
- depth of the crop's active root zone
- amount of water infiltrating the soil during and after irrigation and rain events
- depth of the wetting event into the soil profile (within or below the crop's active root zone)

Growers view the information they have downloaded onto their computers through a data management and graphing program.

## Some further thoughts

Along with crop type, variety and crop development stage, other factors that affect actual crop ETc are: pests and diseases, soil salinity, poor plant nutrition, soil compaction, windbreaks (these can reduce wind speed over adjoining paddocks, so change their ETc), and watering crops directly into the root zone (this limits evaporation).

Growers will have to adapt their ETc calculations where any of these are considered "significant".

## Wrap up

Sometimes, it's argued that ET-based irrigation scheduling is more representative and can be applied to larger areas. However, a little further knowledge shows this is not the case, simply because:

- the representativeness of calculated ET data is based upon the weather station's location (good if it's on site, not so good if it's several kilometres away)
- ET is a broad-based, universal calculation, but it does not take into account variations across a property (particularly soil)
- before you even begin any calculations, you need to assume field capacity — in other words, how do you predict timing for your first irrigation of the season when using ET? Getting that timing right can be the difference between maintaining your crop at full potential, or "playing catch up" with irrigation all season
- ET-based scheduling requires many more presumptions (see 'How do you use it' section above); successfully irrigating using ET scheduling relies heavily on accurate presumptions
- ET doesn't actually measure soil moisture

Several probes, at deliberately chosen sites, will give growers accurate, specific, individual-to-them data for no-guesswork irrigation scheduling. The methodology is well suited to commercial irrigation enterprises.

Growers can also use the 2 methodologies together for a powerful management tool: localised ET data can be used to develop and build water budget and scheduling programs, and the soil moisture probes can then be used to finetune irrigation-management decisions. This uses both methodologies to their strengths.


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