Anticipatory irrigation

This is the sound track from the video ‘Anticipatory irrigation’.

Anticipatory irrigation is a simple way of achieving the twin aims of making use of the smaller rainfalls and minimising evaporation losses.

The aim is to get water deep into the soil protected from evaporation.

Just as there is a threshold for run off in our dams there is a threshold of irrigation water which must be applied before the water penetrates into the deeper soil.

There is always an insulating crust which must be wetted out first, and all the water used to wet out this crust will be lost by evaporation in a few hours.

Irrigators know that they have to apply enough water to fill the profile which will extend the time between irrigations and hence reduce these threshold losses.

It is less obvious that the best time to irrigate is just after a rainfall. The surface is then already wet so a smaller volume of water is needed to fill the profile.

There are times when rain is expected but the plants need some water now. The aim then is just to apply enough water to satisfy the immediate plant needs in the short term.

At other times extreme heat may be forecast when it is better to irrigate ahead of time rather than irrigate under high evaporation conditions.

All of this is just common sense, but to apply means knowing how much water is needed to fill the profile.

Probes are widely used to measure soil moisture. But there are two intrinsic problems. They only moisture content just around the probe. There is a wide variation in moisture levels throughout the root zone so the readings vary widely depending on where the probe is positioned. Experts try and position the probe in an average position but this is much more difficult than it appears.

An ever bigger problem is knowing the wetted volume. Irrigation systems never apply water uniformly and only wet out part of the roots zone.

This leaves us with what may appear to be an insurmountable problem, how to calculate the total water in the soil from a few sample points.

But the answer is just so stunningly simple. The best way of explaining this is by considering the problem of working out how much water is needed to fill a jar of stones which is already partially filled with water. This is exactly the problem we face in the soil.

A water expert may be tempted to try use a soil moisture probe to find out the amount of water currently in the soil, work out the empty spaces in between the stones and eventually calculate out the amount of water needed to fill the profile.

The solution is almost child like, simply measure how much water is needed to fill the jar. This tells exactly us how much water was needed to fill it up.

How do we apply the simple idea to irrigation scheduling.

We fill the soil with water and we use our soil moisture probes to measure when the soil is full, more specifically we measure how much water must be applied for the water to reach the bottom of the root zone. We do not care how much water is in the soil, we are just taking this as full.

Now we let the plant use up some water, again we have little idea how much water the plant has used but we can measure this by filling the soil up again,.

Sounds simple but there is a snag. It can take a long time for the water to soak down to the base of the root zone so we cannot just keep on pouring on water until the profile is filled, that would give us big errors.

But there is an easy way of overcoming this snag. Make a guess of how much water has been used, (which we can do by guessing a crop factor and multiplying by the evaporation) and apply that amount of water.

We do not even have to start with the profile full, just guess a crop factor, apply the estimated water and measure the irrigation depth. All we have to do is keep on adjusting the crop factor until after we have applied the estimated amount of water the profile is full. Then at any point in time we know, just by looking at the evaporation how much water is needed to fill (or partially fill) the profile.

Guessing is a bit hit and miss, but we can make the whole process very efficient using a mathematical technique called predictor corrector which is build into a simple software program. So let us see how this works.

BASIC THEORY

We need to know the amount of water the plants are using, and the maximum allowable deficit in the soil.

These are site specific so we have to measure them.

We cannot measure them directly but we can learn them by monitoring the site.

We make the best estimate of the crop factor and allowable deficit, erring on the side of caution.

We measure the evaporation and make a best estimate of current deficit from evaporation and the current crop factor, compare with allowable deficit and decide whether to irrigate or not.

After irrigating we measure either soil moisture or irrigation depth and use this data to adjust the current crop factor.

When the crop factor is stable we can measure onset of plant stress to determine the allowable deficit.

Software overview

This is the home menu and let us imagine we are in mid cycle, we irrigated some time ago and entered all the irrigation, crop factor data etc and are now just watching for the system to tell us when to irrigate next.

We click the weather and irrigation data tab, this column is the actual recorded evaporation data while this is the predicted evaporation which is used to give the total water content anticipated over the next period. The system is waiting for us to enter the measured evaporation for the date shown. Normally this would be yesterday, but some people measure today's evaporation in the evening ready for an overnight irrigation.

The figure in the record evaporation tab is the predicted evaporation, so this has to be over written with the measured evaporation.

If you are working on yesterdays evaporation make sure you do not click the record button for today's date.

If you make a mistake you can right click any value and correct.

If there has been any rainfall you need to enter this now.

You may also want to check that the last irrigation has been entered. Normally this is done automatically but if you missed this step you can enter manually now.

Click block water usage - this form is in two parts, the top form gives details of a specific block while the lower gives a summary of all blocks.

A full profile is taken as zero, the negative numbers show the water needed to refill the profile. The yellow indicates that that block has now reached a threshold, which we have set, indicating that the block is now ready to be irrigated and with the number indicating how much water is needed to refill the profile.

The chart indicates the predicted date when each block needs irrigating, we then consider the weather forecast and take the decision which blocks to irrigate and when.

Click on the irrigation planner button and drag the forms so they are all visible so the transfer can be checked. Double click on the blocks needing irrigation which transfers the data to the irrigation planner. Print a copy of the planner which shows the irrigation time.

After irrigating the soil moisture or irrigation depth should be measured allowing time for the water level to stabilise. Record the irrigations by right clicking each irrigation and then clicking record. This can be viewed by clicking the weather and irrigation button. You should also enter the irrigation depth.

Check that all the weather and irrigation details are entered. It is now time to get to the heart of the program and adjust the crop factor.

This can be based on either soil moisture or irrigation depth, but we recommend using irrigation depth.

Click the crop factor and crop factor data buttons and arrange the screens so they can both be viewed.

Click the calculate revised crop factor button and review the revised crop factor. It is very useful to view the changes in the crop factor graph to see how it is trending. If you are satisfied then click the record crop factor button.

This is the core routine in using the program. If the irrigation water is saline you may also include the soil salinity calculation button. With this method of only applying sufficient water to fill the profile salt will accumulate in the soil - so flushing may be needed.

You may also want to check the annual water use, unfortunately irrigation is not just about applying the right amount of water for the plants, it is a question of juggling the amount of water available.

This is an overview of the basic routine now we have to do this in the real world learning the correct crop factor and water holding capacity of the soil without damaging the plants or wasting water in the process.