Irrigation scheduling in the Sandveld

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At the request of farmers, practical training in irrigation scheduling was offered from 1 to 3 October 2018 in five Sandveld sub-regions. As at previous occasions Prof Martin Steyn (University of Pretoria) and Chris Barnard (Fertigation Academy) shared their expertise with the farmers and their workers. This time the training primarily took place on farms with the focus on methods to look at the water content of sand at different depths in order to determine when, and how much should be irrigated. This article provides a short overview of the training.

Soil, climate and crop characteristics determine when irrigation is applied, and how much should be irrigated. Of these factors soil, that is to say sand, is surely the biggest challenge for irrigation scheduling in the Sandveld.

Prof Martin Steyn (left) and Chris Barnard (right) with a spade and auger in a field of Theunis Kotzé from Aurora, busy determining the water status of the sand in the upper, middle and bottom layer of the sandy soil.
Soil is the reservoir that must retain water for plants

If taken into account that plant available water (PAW) of sandy soil is only 30 mm m⁻¹, and that not more than 50% of the PAW may be extracted for potatoes, i.e. 15 mm m⁻¹, it is clear that the reservoir in the Sandveld is extremely limited and irrigation scheduling should therefore receive attention daily.

Various aids are available that can be employed to facilitate irrigation scheduling, but any decision on irrigation scheduling is based on the same principles, namely the:
• Water status of the reservoir.
• Growth stage of the crop.
• Prevailing climate.

Soil type determines how much water is available in the reservoir

Loamy soil is like a sponge with numerous, but small cavities/pores whereas sandy soil is like a coarse sponge with less, but large cavities.

If a ‘loamy sponge’ of 10x10x10 cm is submerged in water, and then removed and left to allow the water seep-out (drain), it takes a long time for the water to drain from the sponge. If the sponge is squeezed by hand, a certain amount of water still drains out of the sponge. It can be compared to the water available to plants after the soil has drained, and is known as plant available water. Some water still remains in the sponge that cannot be squeezed out due to adsorption on the sponge surface and is called hygroscopic water which is not available to the plant.

If a ‘sandy sponge’ of 10x10x10 cm is filled with water and then left to drain, a larger volume of water will drain from it much faster as was the case with the ‘loamy sponge’. If the ‘sandy sponge’ is squeezed out, significantly less water would be squeezed from it, and less water will also remain in the sponge because of adsorption of the sponge surface.

Climate determines how much water plants extract from the ground reservoir

Transpiration is the mechanism used by plants to cool down in order to remain functional. Transpiration, therefore, plays a critically important role in irrigation scheduling.

Water is extracted from the ground reservoir by the roots because of transpiration from the leaf surfaces.

Transpiration is at its highest on a sunny, hot day if the wind blows and the air is dry. Extraction of water from the soil is then extremely high.

The lower the temperature, the lesser the wind, the more overcast it is and the higher the relative humidity, the lower the transpiration rate and the lower the water extracted from the soil.

The growth stage of plants determines how much water must be available in the ground reservoir

At the beginning of the growing season the leaf coverage is small and roots are found in the upper level of the soil (about 20 cm). The water needs of plants at this stage is relatively low, but plant available water in the upper level of the reservoir must remain optimum. At the beginning of the season there is a trend to over-irrigate with a consequential leaching of applied nutrients.

As the season progresses the leaf coverage gets bigger and eventually the total soil surface is covered. Simultaneously roots grow deeper into the soil and can reach depths of 50 cm, and even deeper. At the stage when the leaf coverage is 100%, the water need of plants is at its highest and sufficient water must be available in the soil. At this stage over-irrigation must be guarded against.

Towards the end of the season, roots are still present in the upper and deeper ground layers, but the leaf coverage becomes sparse. Water needs then drop and irrigation can be given less frequently.
With any method of irrigation scheduling variation in soil type can impede irrigation. That is why the place(s) where the water status of the soil is determined, is important. If sensors are used, it is important that it be place at representative positions in the field and that they are installed correctly. It remains necessary that the readings obtained from the sensors, be checked by physically entering the field to see what is going on. For more information on sensors and the application thereof in irrigation scheduling, see: Scheduling aids – Ground water content measurements and Ground water potential based scheduling aids by Prof Martin Steyn in the Irrigation of Potatoes (2018) Potatoes South Africa / CHIPS series.

In sandy soil the obvious placing of sensors would probably be in that part of the field that dries-out the quickest, in other words where the risk of water stress is the highest.

The ground water status can also be determined by drawing soil samples from the upper, middle and bottom ground layers with a auger and/or spade and then to squeeze and rub the soil in the hand. The advantage of using an auger is that soil disruption is minimal and that soil samples can be taken at various places in the field in order to be able to take variation into account during decision-making.

**How does one feel how dry/wet the soil is?**

1. Choose representative positions in the field:
   - uniform plant stand;
   - not too close to the side of the field / sprayer paths;
   - between first and second or between second and third centre pivot wheel (from the side of the field); and
   - in the row, on the ridge, between two plants.
2. Draw a soil sample from the upper 20 cm of the soil with the auger.
3. Take a handful of soil from the upper 20 cm of the soil.
4. Squeeze the soil and open hand. Then rub some of the soil between finger and palm:
   - If the soil ball breaks-up easily, the soil is dry;
   - If the soil in the ball sticks together and the soil smears in the palm after being rubbed, it is wet; and
   - Something in between is moderately dry/wet (or moist).
5. Do the same with the middle soil layer (20 – 40 cm) and the bottom soil layer (40 – 60 cm).
6. Take more than one similar sample at different positions in the centre pivot circle.
7. Take a decision on irrigation taking with due cognisance to the soil water status according to the observations of the different samples from the circle.

**Irrigation scheduling**

The growth stage of the planting, the expected weather conditions and water status of the soil must all be taken into account. The upper layer must be managed slightly wetter than the bottom layer, merely because leaching of water and nutrients must be limited.

**Scenario 1**

1. A young planting where about 25% of the soil surface is covered with leaves.
2. Sunny days with extremely high temperatures, no rain and/or wind, are forecasted for the next few days.
3. The upper and middle soil layers is moist, whereas the bottom soil layer is wet.

Because the plants are still young with a small soil cover, the water usage is relatively low (in comparison with a crop with a 100% leaf cover). At this stage the root system is shallow and water is extracted from the upper soil layer. In this instance the aim is make provision for enough water in the upper and middle soil layers. A very light cooling irrigation during the day “to keep the climate soft” may also be necessary. A cooling irrigation of less than 4 mm can be applied as it will make little difference to the ground water status. Because the middle soil layer is wet after the first irrigation, the next irrigation can be light to keep the upper soil layer moist. However, but because it is so hot, it must be ensured that he middle and bottom soil layers do not dry-out. It will almost be impossible to catch-up with the backlog in the ground water status because as the plants require more water as they grow bigger. It is therefore critically important to watch the water status of the bottom layer (reservoir) and to ensure that no drying-out takes place.

**Scenario 2**

1. About 100% of the soil surface is covered with leaves.
2. Sunny days with high temperatures, no rain and moderate winds, is forecasted for the next few days.
3. The upper and middle ground layers are moist, whereas the bottom soil layer is wet.

The water needs of the planting is maximal because
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the leaf cover is 100%. The root systems is present in the upper, middle and possibly the bottom ground layers. The purpose is to keep the upper and middle ground layers moist, whilst the bottom ground layer must never dry out. Daily irrigation of about 10 mm is probably necessary and the ground water status must be determined every second day. If the bottom ground layer starts to become dry, more irrigation should be applied to replenish the water there.

Scenario 3
1. About 100% of the soil surface is covered with leaves.
2. Cloudy days with low temperatures (15-20°C), no wind or rain, is forecasted for the next few days.
3. The upper ground layer is wet, the middle ground layer is moist, whereas the bottom ground layer is dry.

For as long as the cloudy, cool, windless conditions prevail the water consumption of the planting will remain relatively low (in comparison with a young planting). If the underground was moist, irrigation in the next day or two would have been unnecessary. However, should conditions return to normal (in other words hot, sunny days), water usage will increase and it will be difficult get the underground moist. Irrigation is necessary to ensure water in the bottom ground layer, and the weather forecast should be watched so that adjustments can be made timeously.

Scenario 4
1. About 100% of the soil surface is cover with leaves.
2. Sunny days with moderate temperatures and downfalls in the afternoons, are forecasted for the next few days.
3. A slight wind is forecasted for the next few days.
4. The upper and middle ground layers are moist, whereas the bottom ground layer is wet.

Under the forecasted conditions, and with a leaf cover of 100%, the water usage of the planting is high. However, conditions look very good because roots are present throughout the ground profile and sufficient water is available in all three ground layers. If rain is received as forecasted, it will probably not be necessary to irrigate. If it does not rain, the ground water must be monitored and replenished as necessary.

Scenario 5
1. The planting is busy dying-off and problems were experienced with early blight which means leaf cover is about 50%.
2. Cloudy days with average temperatures, no rain and a moderate wind, are forecasted for the next few days.
3. The upper and middle ground layers are moist, whereas the bottom ground layer is wet.

Water usage in the next few days will be relatively low. No immediate irrigation is necessary because the ground profile has sufficient water. A light irrigation will probably be necessary in a day or two to prevent the upper ground layer from drying out. If the plants recover, new leaves form and the leaf cover increases, water usage will increase in the next few of weeks. If the leaf cover remains slight or relatively low, the water requirement will be low. Stop irrigation two weeks prior to the expected die-off date to ensure proper skin set.

The training started with a refresher session in the hall at Goergap, and was followed by practical sessions in five sub-regions of the Sandveld.