



HORTGRO SCIENCE  
IRRIGATION SEMINAR 2017  
SUMMARY REPORT

**HORTGRO**

Growing Fruit IQ

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## FUNCTION OF WATER DURING DIFFERENT PHENOLOGICAL STAGES

# PHENOLOGY AND WATER IN THE FRUIT TREE

Professor Stephanie Midgley of the department of horticultural science at Stellenbosch University discussed the role of water at different phenological stages. She showed how drought stress impacts on plant performance during the production cycle.

**"EVERYTHING** starts at the leaf surface, the stomata," Midgley began. She explained that the air outside the stomata contains less water vapor than the air inside the stomata. As a result, when the stomata are open, the leaf loses water. The tree replaces this water by drawing more water up from its roots. It becomes part of "a continuous column of water from the soil into the atmosphere."

Light is the most important factor initiating transpiration. The trees open their stomata in response to light, so that they can take up carbon dioxide for photosynthesis. High temperatures, low relative humidity and wind increase transpiration rates, as do a large canopy and heavy crop load.

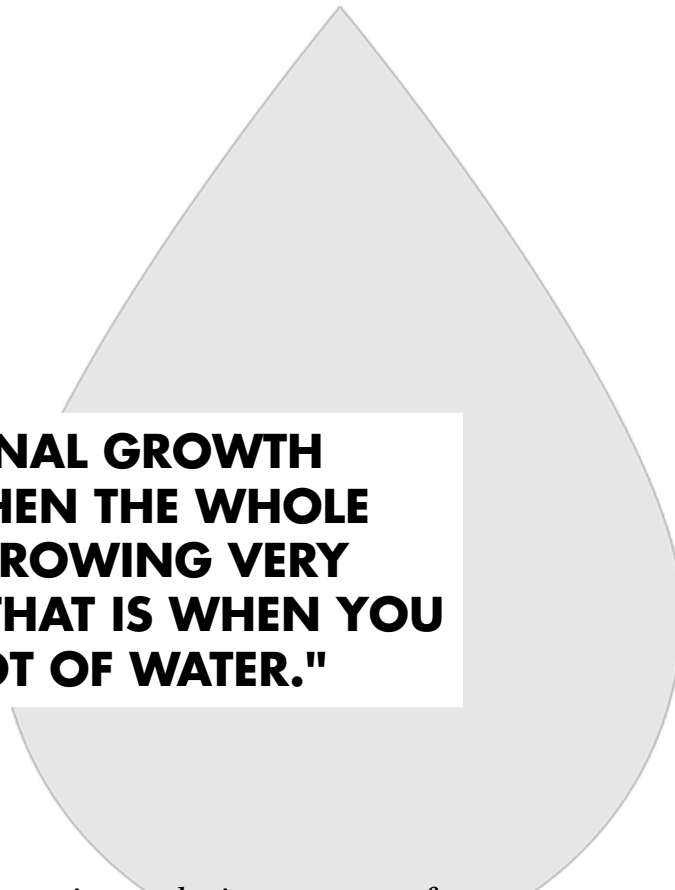
Apple trees need large amounts of carbon dioxide. They keep their stomata open for as long as possible, even in the face of a water deficit. "Apple trees are unusual in that they are quite tolerant of a daily water stress developing, even if the tree is well-watered," Midgley clarified. When the vapor pressure deficit becomes insupportable, trees start to close their stomata. This typically occurs around noon for a mature tree on a hot day. It leads to a depression of photosynthesis that continues throughout the afternoon.

Midgley noted that "it is very important to define what we mean by stress in apples." She considers a water potential below minus 2.5 megapascal in the xylem in the middle of the day as the starting point of stress.

Midgley also discussed seasonal changes in transpiration. Transpiration increases from spring onward and peaks in December. Thereafter, it decreases, stopping when leaves fall in autumn. A tree with a full canopy transpires most during warm months with high light levels.

The second part of the presentation dealt with the impact of water stress on different phenological processes. The focus was on pome fruit.

"The first 40 to 50 days after full bloom is an absolutely critical period," Midgley emphasized. "Any water deficit in that period has a direct impact on not only fertilization and fruit set, but very particularly



**"IN THE FINAL GROWTH PHASE WHEN THE WHOLE FRUIT IS GROWING VERY RAPIDLY, THAT IS WHEN YOU NEED A LOT OF WATER."**

the process of cell division." Cell division can only occur when cells are fully hydrated. **Water stress will lead to poor fertilization and insufficient numbers of cells in fruit. Fruits that have low cell numbers cannot recover to become large fruit at harvest.** Midgley added that this period is also critical because transpiration drives sap flow. Sap flow brings nutrients from the roots to the sprouts.

However, as stated by Mico Stander of Agrimotion in his talk, the cell division stage is when growers can sometimes save water. This is because the tree has a relatively low water requirement at this stage due to the canopy still developing. Also, the soil may still be wet in the Western Cape due to winter and early spring rain. Hence, growers may potentially supply water in excess of what is required during this stage. However, as stated by Midgley, drought stress at this critical stage is very detrimental to fruit size so water saving is only possible if the needs of the trees are met.

Flower bud initiation is the next important period that is sensitive to drought. It occurs in the middle of summer. Bud development, in late winter and spring, is less affected by water stress.

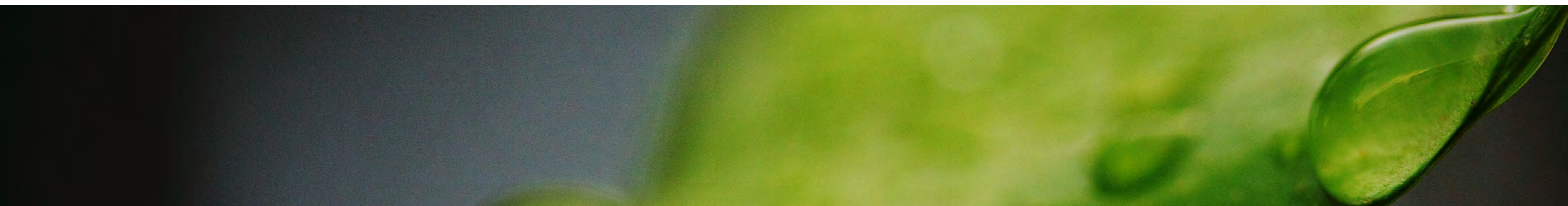
Midgley identifies the last stages of fruit enlargement as the third sensitive period. "In the final growth phase where the cells are swelling out and the whole fruit is growing very rapidly in terms of volume, that is when you need a lot of water."

Midgley draws attention to the importance of processes that occur after harvest. "Just a warning note, that the post harvest processes are incredibly important and if trees are stressed at that point, obviously we are going to have effects on the root growth, on reserve accumulation, and on bud development. That is something that we are not used to in the Western Cape and I think we need to start looking at whether our trees are starting to become stressed in the post harvest period and for how long."

In conclusion, she considered whether there are periods when trees need less water. "Yes, there are. In apples it's a bit more tricky than in stone fruit, but certainly for the longer season apple cultivars, you have a period between the end of cell division, but before the fruit really starts swelling out quickly in terms of volume growth."

"So, reduce irrigation in that period between cell division and the next phase that is sensitive, that of bud initiation. This is a short window where people have tried regulated deficit irrigation and all you do is reduce shoot growth, vegetative growth, and you don't have a negative impact on the fruit development, during this phase of low fruit growth." However, in practice, it may be quite difficult to focus on this stage in terms of water saving and the irrigation strategies discussed by Jan Rossouw in his presentation might be easier to apply.

**WATCH MIDGLEY'S PRESENTATION ON OUR YOUTUBE CHANNEL [HERE](#).**



## STRATEGY FOR IRRIGATION PRACTICES DURING DROUGHT WHILE CONSIDERING PLANT PHENOLOGY

# DEVELOPING A DROUGHT STRATEGY BASED ON PLANT PHYSIOLOGY

Mico Stander from independent consultancy Agrimotion spoke about developing a drought strategy. A successful strategy starts with understanding the phenology of the fruit tree.

**"IT'S VERY** important for us to know what's happening in our crop at a specific time of year, because if we do something right, or if we do something wrong, that is going to have an impact on various processes in the plant," Stander told the audience.

"At the same time when we have fruit cell division, it could be overlapping with flower induction, and then initiation is more or less the same time as we start rapid fruit growth and it's toward the end of shoot growth. So, it's shoot growth and fruit growth and flower bud initiation that are all affected, depending on the degree of stress that you allow."

Apples undergo cell division in the first 40 days after full bloom. In the next 40 days, rapid cell enlargement takes place. These are critical stages. Stander explained how irrigation stress at these times can lead to losses later. Intervention after the impact occurs will not reverse the damage.

A controlled irrigation deficit up to 40 days after full bloom will reduce vigor. Less shoot competition may stimulate cell division. However, cell division is quite sensitive to water stress and decreasing irrigation below what the tree needs at this point may have a very negative effect on eventual fruit size. Between 40 and 80 days after full bloom, moderate stress reduces fruit size. Fruit size is also decreased by moderate stress during ripening and early ripening may occur. Post harvest, moderate stress limits the formation of reserves.

Severe stress at all stages can lead to fruit drop. Shoots may die back, trees can suffer sunburn and lose vigor and reserves. It is difficult to define stress as moderate or severe. Root development and water infiltration determine the effect of irrigation deficits on stress. Orchards on shallow soils will be at greater risk of drought stress than those on deep soils. Sandy soils hold less water but allow for deep root penetration.

Stander went on to show how the above concepts apply when developing a drought strategy. The goals are to maintain

profitability, minimize economic losses and maximize tree survival.

"Water budgeting is exactly what we all need to do. As farmers, I hope you are budgeting," Stander smiled. "Financially, you need to make sure that you can get through the season."

"Water budgeting generally isn't done because our allotment is usually enough, or too much, and we make it through. What we need to do this season is decide how much water we will allocate to which orchards." Since it is difficult to decrease irrigation in pome fruit trees according to phenological stages, it is easier to rather decide on orchards that should get their full allotment of water compared to those that should receive less or those that should be removed.

### **His method for drawing up a water budget consists of five steps.**

1. Determine water use, per block, per week, in the previous one to three seasons.
2. Determine the income and yield, per block, in the previous one to three seasons.
3. Calculate the income and yield per unit water, per block, up to harvest.
4. Rank the blocks according to the income per unit water.
5. Class the blocks according to strategy:
  - Class 1: Optimal management, maintain optimal profit.
  - Class 2: Reduce yield, maintain marginal profits.
  - Class 3: Remove harvest, cut canopy back, keep orchard alive.
  - Class 4: Do not irrigate, remove orchards.
  - Class 5: Non-bearing, irrigate sparingly to preserve vigor.

WATCH STANDER'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

Stander worked through a detailed example to show how to calculate a water budget. "I would recommend that you have your applied water per block on a weekly basis. This will allow you to group and add the water up for each phenological stage, for each block, as these won't be the same for all of your orchards."

**Farmers can also apply many water saving practices to complement their water budgeting. Stander provided a comprehensive list of potential measures:**

- Mulch and remove weeds and cover crops.
- Target shaded leaves first during summer pruning. Shaded leaves are less efficient in using water than leaves in the sun.
- Severe summer pruning increases the risk of sunburn. Paint trunks white to protect them.
- Stander recommends the use of Regalis to decrease vigor.
- In autumn, forcing trees into early dormancy will reduce reserves, but save water.
- Stem renewal of young orchards will delay their crop for one year, but reduce water use.
- Feed the trees in small portions. A single large feed can stimulate excessive shoot growth.
- Remove fruit as required by the water budget.
- Irrigate at night to decrease evaporative losses.
- Adjust irrigation to reduce water delivery and wastage.

Finally, Stander compared two irrigation strategies. In partial root zone drying, one side of the root zone receives water and the other not. The watered side alternates every one to three weeks. Pome fruit resent partial root zone drying.

In deficit irrigation, less water is applied but to the entire surface of the root zone. The water will not penetrate to the deepest roots. Deficit irrigation causes stress, but is less harmful to pome fruit than partial root zone drying.

## PRACTICAL EXPERIENCE REGARDING THE EFFECTS OF DROUGHT AND DROUGHT MANAGEMENT

# A FARMER'S PERSPECTIVE ON DROUGHT MANAGEMENT

The seminar culminated in a talk by respected fruit grower Jan Rossouw of Lindeshof. He opened with a slide showing a farmer drinking the water from his rain gauge. "Fortunately, I haven't gone that far," he remarked.

**"WE CAN** probably all agree that facing drought, as we are facing now, is definitely not going to be moonlight and roses," Rossouw said. "The farm that I am managing over a number of years, scientifically calculated from sand to the heaviest soils, could do well with an average of 9 500 cubes per hectares. The 2016 season, we had 4 500."

He went on to list the possible impacts of water shortages. These include reduction in crops, smaller fruit and poor fruit quality. Drought stresses trees and complicates their management. This all contributes to financial losses.

"But, and that's why we are here," Rossouw stressed. "Don't see just one big black hole." Farmers have an extensive toolbox to help them cope with drought, but it is important to focus and find the correct balance.

Water management is crucial. Farmers need to work according to a water budget. The first step is to know how much water is available, taking evaporative losses into account. These can be up to a quarter of the water. Set up a detailed water budget. Measure water use weekly and adjust the figures if necessary.

As part of water budgeting, farmers must prioritize orchards according to economic potential and, if necessary, identify orchards for removal. This is a difficult decision, Rossouw told his audience. He cleared 24 hectares on his farm, so he knows.

Make every drop count for the remaining trees. Dig soil profiles in each orchard to determine root depths. Irrigate so that the water reaches the area of highest root concentration. Adjust the range of micro sprinklers from medium to short and irrigate at night. Tailor the irrigation schedule to the phenological stage of the trees. Monitor soil moisture at least twice a week using a probe as well as digging profiles. Give more water to the better orchards. Introduction of a short cooling cycle helps prevent sunburn. Remember to record all water use.

Rossouw put up a chart of fruit size over time. It showed that normal fruit development is achievable during drought. The key is careful water management. Mulch is an integral part of water conservation. Sandy soils need more mulch than clay. Rossouw uses wood chips and straw. In the past season he also tried growing oats during winter. When sprayed off in spring, the oats become mulch.

Rossouw emphasized that weeds compete with trees for water. Control weeds early. If weeds have grown

large, make the most of a bad situation. Cut them down for mulch, unless they have already formed seeds.

Once the tree is fruiting, there are more hard decisions to make. Farmers must adjust the crop load to match irrigation levels. Aim for a ratio of one fruit to 25 leaves. Keep apples that are in ideal sites for color development and avoidance of sunburn.

Regular fruit measurements are important. Bigger fruit are better. Received wisdom is that one fruit per cluster is ideal. Rossouw recommends leaving two apples if both are large and remove a cluster with all small fruit instead.

Control the growth of the tree to limit water loss through transpiration. Use summer pruning or Regalis. Do this early or risk increased sunburn. Rossouw reminded farmers to adapt their fertilization programs. The needs of the tree will change due to drought management measures.

Drought management also extends to harvesting. Dry conditions may compromise fruit quality. Appropriate irrigation remains essential. Determine starch and sugar content of fruit. Make sure that enough pickers are available. Labor shortages lead to late harvesting, affecting quality during storage.

Now that your trees have looked after you in a challenging season, Rossouw said, you have to remember to look after them. Apply the correct post-harvest fertilization at the right time. Winter pruning matters more than ever. There is no place for unproductive wood or poor spurs on a tree. Rest breaking is important.

Lastly, Rossouw cautioned against chemical thinning. Trees that have suffered drought can have poor reserves and may not react as expected.

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