TECHNICAL BRIEF

November 2016
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Improving the water use efficiency and profitability of wine grapes

A Water Research Commission (WRC) study has successfully tested different drip irrigation strategies and canopy manipulation combinations to improve the water use and yield of wine grapes.

Background

Close to 70% of vineyards for the production of wine in South Africa are irrigated and/or established under drip irrigation (compared to less than 23% twenty years ago).

Different irrigation strategies and canopy management combinations can make a difference to the water requirement, vegetative growth, yield components, and wine quality. However, prior to this study, which was initiated in 2011 by the WRC with co-funder, Winetech, this had not been investigated in South Africa. The study was undertaken by the Agricultural Research Council (ARC) Infruitec-Nietvoorbij.

It was envisaged that the results of the study would enable farmers and growers to plan and apply specific irrigation and canopy management practices for their individual vineyard needs and, in so doing, managing limited and expensive resources i.e. water, electricity and labour, to produce economically viable grapes. This knowledge could also aid viticulturists and irrigation consultants with the recommendations for scheduling individual vineyard blocks.

Experimental layout

The experiment was carried out in a commercial vineyard outside Robertson in the Breede River valley. The vineyard is situated on the floodplain of the Poesjenels River.

Shiraz grapevines, grafted onto 110 Richter rootstock, were planted in August 2000 in a northwest/southeast row direction after the soil was double delved (cross-ripped) to a depth of 0.8 m during soil preparation. Grapevines were planted 2.5 m x 1.22 m and trained onto a five-strand lengthened Perold trellis system.

Three different irrigation strategies were applied to the grapevines, namely irrigation at 30%, 60% and 90% plant available water (PAW) depletion. For each level of PAW depletion, the grapevine canopies were left to grow naturally and hang open, or shoots were tucked into trellis wires without the suckering (removal) of water shoots, or shoots tucked into trellis wires with the suckering of water shoots.

All together nine different irrigation/canopy manipulation treatments were affected. A tenth treatment was also implemented, namely irrigation at 90% PAW depletion and mechanically pruned (the other methods were hand pruned).

Soil water content (SWC) and irrigation volumes applied

Irrigation applied at low PAW depletion levels more than doubled irrigation volumes compared to grapevines irrigated at high PAW depletion levels. Due to accelerated sugar accumulation which resulted in different harvest dates, canopy management practice indirectly reduced pre-harvest irrigation volumes.

Grapevine vegetative growth

Under the given conditions, the different canopy manipulations did not affect total lead area per grapevine within an irrigation strategy. non-suckered grapevines produced more shoots compared to suckered ones.

More frequent irrigation of grapevines caused more vigorous shoot growth. Within the same irrigation strategy, non-suckered VSP grapevines tended to produce lower cane mass compared to suckered VSP and sprawling canopy grapevines.

Grapevine water status

Mid-day lead- and stem water potential in grapevines within the same irrigation strategy did not differ, irrespective of the canopy manipulations applied. However, sprawling canopy grapevines tended to have lower mid-day lead- and stem water potential than the VSP grapevines.

Grapes from grapevines subjected to severe water constraints ripened more rapidly than those experiencing no or medium water constraints.

Evapotranspiration

Higher irrigation frequencies resulted in higher evapotranspiration losses from the grapevine root volume of soil (ET_{GR}), while losses from under sprawling canopies, particularly those irrigated at 30% PAW depletion, tended to be higher in February than those with VSP canopies.

The evaptranspiration losses from the grapevine work row volume of soil increased in periods that followed rainfall incidences and was much lower than the ET_{GR}. As a result, the monthly full surface evapotranspiration (ET_{FS}) was much lower than the monthly ET_{GR}. The seasonal ET_{FS} was more sensitive to irrigation frequency than to different canopy manipulations.

During the three seasons, the mean crop coefficient (K_C) for grapevines that were irrigated at 30% PAW depletion were higher compared to those of other strategies, with those irrigated at 90% PAW depletion being the lowest. Grapevines irrigated particularly at 30% and 60% PAW depletion, grapevines with sprawling canopies tended to result in higher K_C values during ripening than those with VSP canopies.

Yield

Grapevines subjected to severe water constraints ripened their grapes more rapidly than those experiencing no or medium water constraints. Furthermore, grapes of sprawling canopy grapevines ripened more rapidly compared to VSP grapevines within the same level of PAW depletion.

With the exception of mechanically pruned grapevines, irrigation frequency had a more pronounced impact on yield than canopy manipulation.

Low frequency irrigations resulted in higher production water use efficiency compared to medium and high frequency irrigation. Within a given canopy management practice, level of PAW depletion did not affect the percentage of sunburnt berries. In addition, there were more sunburnt berries on the sprawling canopy grapevines within a given level of paw depletion.

Grape juice and wine characteristics

Grapes were harvested as close to the target total soluble solids level of 24°B as possible. Where severe water constraints enhanced berry maturation, juice total titratable acidity (TTA) was higher and pH lower compared to grapes that were harvested later.

Within a given PAW depletion level, canopy manipulations did not affect juice TTA contents. Irrigation applied at a higher PAW depletion level, i.e. 90%, improved overall wine quality compared to more frequent irrigation.

Within the lower levels of PAW depletion levels, non-suckered VSP grapevines produced wines of the poorest overall quality. Highest overall wine quality was obtained where non-suckered VSP, sprawling canopy and mechanically pruned grapevines were irrigated at 90% PAW depletion.

Wine alcohol content, pH, potassium, malic and tartaric acids and polyphenol concentrations were not affected by level of PAW depletion or canopy management practice.

Economic viability

Less frequent irrigations reduced summer canopy management requirements. However, grapevines bearing more shoots required higher labour inputs at harvest.

Pruning labour input requirements seem to be affected by the number of shoots produced per grapevine and the individual mass per shoot. Within the same irrigation strategy, sprawling canopy grapevines tended to require more labour inputs during winter pruning, compared to other summer canopy management strategies.

The total seasonal canopy management labour inputs decreased as the volume of irrigation water applied decreased. Sprawling canopy grapevines generally required less labour.

Pumps costs were affected by the frequency of irrigation applications, while transport costs of grapes differed minimally between treatments. During seasons with low to normal rainfall, grapevines with sprawling canopies that were irrigated at 60% PAW depletion produced the highest gross margins, followed by box pruned grapevines irrigated at 90% PAW depletion.

In seasons characterised by high summer rainfall, box pruned grapevines irrigated at 90% PAW depletion, as well as non-suckered VSP canopies irrigated at 30% PAW depletion would have the highest gross margins. This was due to the gross margin being strongly determined by the gross income.

In general, grapevines with sprawling canopies, particularly those irrigated at 60% PAW depletion, produced the best balance between yield and quality, thereby ensuring the best gross margin.

Recommendations

Based on the project results, the following criteria should be considered when deciding on what irrigation and canopy management strategies to apply to vineyards:

- Since irrigation at high frequencies increased yield sustainability, it can be recommended under comparable conditions if high grape yields are the objective.
- Since irrigation at lower frequencies increased wine colour and quality substantially, it can be recommended under comparable conditions where the objective is good wine quality or to minimise viticultural labour inputs.
- Low frequency irrigation can be applied to enhance berry ripening, thereby also obtaining higher juice TTA.
- Sprawling canopy grapevines might not be suitable for cultivars that are susceptible to sunburn, particularly if irrigation is applied at a lower frequency. Under such conditions it would be preferable to tuck shoots into trellis wires.
- Sprawling canopy grapevines might not be suitable for cultivars, i.e. Chenin blanc, that are very susceptible to rot, particularly if grapevines have low cordon heights (lower than 1.2 m) and irrigation is applied at a high frequency.
- In summer rainfall regions, higher trained cordons should be established if grapevines are not suckered and shoots left to sprawl to decrease the incidence of rot.
- Considering the gross margin analyses, the most consistent economically viable production of red wine grapes in the Robertson area would be when grapevines are not suckered, shoots left to sprawl open and where irrigation is applied at 60% PAW depletion or alternatively, grapevines box pruned and irrigated at 90% PAW depletion.

Further reading:

To obtain the report, , *Deficit irrigation and canopy management practices to improve water use efficiency and profitability of wine grapes* (**WRC Report No: 2080/1/16**), contact Publications at Tel: (012) 761-9300; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.