

EXECUTIVE SUMMARY

1.1 Introduction and scope of study

Economically viable fruit production in the Western Cape region of South Africa is only possible under irrigation. However, the increasing competition of industry and urbanisation for water currently allocated to agriculture necessitates a more efficient utilisation of water by the agricultural sector. Expected increases in water tariffs and predicted water shortages will also hamper the further development of irrigable land. Improved irrigation scheduling is therefore imperative to ensure optimal utilisation of water.

Besides the increasing demand by industry and urbanisation for water currently allocated to agriculture, periods of drought occur from time to time in the Republic of South Africa. Water stress experienced by fruit trees during periods of severe water deficit can be a limiting factor in fruit production. Quality of the crop is, because of its export nature, an important consideration and cannot be compromised. Strategic management of water on the deciduous fruit farm is therefore of utmost importance under drought conditions, applying the water when and where it would render the best economical benefit. Knowledge of tree response to water deficits is, however, necessary to compile a set of decision making rules concerning irrigation management under limited water supply.

Furthermore, the current trend towards high-density plantings necessitates different managerial practices to ensure the control of vegetative growth. Optimum tree growth and optimum water utilisation can be obtained by regulated deficit irrigation (RDI), a practice whereby plant water deficits are manipulated by applying less water through irrigation than the trees would have used under normal conditions. The reason why RDI is effective relates to the growth pattern of shoots and fruit. For certain deciduous fruit species and cultivars, the shoots grow rapidly during the early season and their growth slows down as rapid fruit growth begins. Water stress during this period will reduce the growth of shoots without markedly affecting fruit growth.

The RDI approach has the potential to enhance effective water use by producers. For example, the amount of water allocated to producers in the Breede River Valley during the 1998/99 season was in the order of $7\,450\text{ m}^3\text{ ha}^{-1}$, whereas the estimated water requirement for peaches at Robertson Experiment Farm was $7\,853\text{ m}^3\text{ ha}^{-1}$. A water deficit of $400\text{ m}^3\text{ ha}^{-1}$ was expected for the season. However, application of RDI from October to December could result in an estimated water saving of $1\,680\text{ m}^3\text{ ha}^{-1}$. This would mean that a saving of 23% on the water allocation could be achieved.

Information on water use by trees under varying RDI management systems, and comparison thereof to water use under conventional irrigation, would help to understand plant response under limited water supply. It could also assist in the formulation of RDI strategies. Research on the response of fruit trees to RDI during different phenological growth stages was therefore undertaken in order to optimise the application of this technique under Western Cape conditions.

1.2 Objectives

The objective of the study was to supply guidelines for irrigation scheduling of deciduous fruit trees.

In the context of this study, to supply information on the effect of water deficits on tree response to improve existing guidelines and thus aid in irrigation management decision-making during periods of limited irrigation water or alternative management practices through:

- Determining the effect of regulated water deficiencies during different phenological growth stages on shoot-, fruit- and tree growth of peach and apple trees.
- Quantifying the effect of regulated water deficiencies on the production and quality of peaches and apples.
- Determining the water consumption of these trees under regulated water deficiencies.

1.3 Structure and summary of the report

The report of the project "Evaluation of a model for water use in deciduous fruit orchards and scheduling of irrigation with the aid of meteorological data" resulted in publication of two reports. This report covered improvement of guidelines for irrigation scheduling of deciduous fruit trees. Evaluation of a model for water use in deciduous fruit orchards is discussed in a separate report, namely "Selection and calibration of a model for irrigation scheduling of deciduous fruit orchards".

The motivation for the research on the deficit irrigation studies is outlined in the Introduction (Section 1), followed by a literature review (Section 2) that covers the effect of reduced irrigation on tree response. The studies on deficit irrigation on stone fruit (peaches) and pome fruit (apples) are presented in sections 3 and 4. Results for peaches are presented for trees with a normal (3.1) and a high (3.2) crop load, respectively.

Results and conclusions

Deficit irrigation of peach trees

The effects of regulated deficit irrigation on the production and fruit quality of peaches were investigated. A field trial was carried out in a twelve-year-old Neethling peach orchard at Robertson Experiment Farm. Treatments consisted of five different soil water depletion levels applied during five different growth stages. Irrigation was applied at the five soil water depletion levels of which T1 was regarded as relatively wet (irrigation was applied when the average soil matric potential reached ca. -50 kPa). T2 was regarded as normal (irrigation applied at ca. -100 kPa) and three different deficit irrigation regimes T3, T4 and T5, were irrigated at soil matric potentials of ca. -200, -400 and -800 kPa, respectively. The five growth stages were Stage 1 (cell growth), Stage 2 (slow fruit growth), Stage 3 (rapid fruit growth), Stage 4 (ripening) and Stage 5 (post-harvest).

Fruit was thinned as such to allow a low crop load in the first and a high crop load in the second season. The soil water content was monitored and irrigation was scheduled by means of a neutron water meter. Vegetative and fruit growth, fruit mass and production were measured. Fruit were examined for bruises and firmness.

Fruit size, fruit mass, fruit quality, as well as production, were not sensitive to water deficits during the different growth stages with a normal crop load. However, a tendency to reduced shoot growth with decreasing soil matric potentials was observed during the slow fruit growth, rapid fruit growth as well as the ripening stages. The application of deficit irrigation during the slow fruit growth or post-harvest stages can save substantial amounts of water with a normal crop load, provided that normal irrigation is applied during the other growth stages.

A combination of water deficits during the ripening stage and high crop load resulted in smaller fruit and lower production. Fruit size, fruit mass, fruit quality, as well as production, were not sensitive to water deficits during the cell growth, slow fruit growth or post-harvest growth stages, provided that normal irrigation is applied in the other growth stages. Irrespective of crop load, soil matric potentials down to -200 kPa can be allowed during any one of the growth stages without seriously affecting the final fruit size, fruit mass, fruit quality or production. However, this soil water deficit may then only be allowed in one of the growth stages and normal irrigation must be applied during the other four stages.

Although deficit irrigation reduced seasonal water consumption, it could not be recommended as a water saving strategy for trees with a heavy crop load, due to its negative effects on fruit quality and production.

Deficit irrigation of apple trees

The study on deficit irrigation of apples was terminated before objectives were reached. A lack of expected plant reaction was ascribed to unsuccessful induction of treatments. This was due to a combination of cool weather, large variation in soil water holding capacity, variation in tree size and unquantifiable water seepage from higher ground influencing the soil water balance. These problems were identified too late to redo the study on another plot and the remainder of the funds had been applied to other aspects of the project. Selected data are presented to illustrate the extent of the problems encountered.

1.4 Recommendations for further research

A study similar in design to the present deficit irrigation approach for apple, provided it is performed on a suitable site, could be considered, since the objectives were not realised and guidelines for irrigation scheduling of apples could not be improved. Irrigation scheduling guidelines could improve water management by producers and it will be possible to apply limited water resources more effectively if definite deficit irrigation strategies are available.

Deficit irrigation studies for the emerging olive tree industry are also needed, because many of the plantings are located in low rainfall areas, some prone to salinity. International research has shown that water stress can influence production and quality of both fruit and oil.

1.5 Capacity building

Ms Beukes obtained an MSc degree in Botany at the University of Stellenbosch through completion of the thesis titled "The effect of regulated deficit irrigation on the production and fruit quality of peaches." Valuable experience in research methodology and reporting was gained from the project and will be used in the PhD study of Ms. Volschenk with the title "The effect of saline irrigation on selected soil properties and the plant physiology, vegetative and reproductive growth of apricot trees". Capacity building amongst farmers was achieved by means of an information day, lectures at a short course, presentations at symposiums and publications.