Objectives & Rationale

Information regarding optimum irrigation during the first few years of young apple trees are lacking in South Africa. We specifically tested the hypothesis that water stress promotes deep root growth of apple trees. Furthermore, any successful irrigation programme must allow trees to fill their allotted canopy space as soon as possible and preferably save water. The objective of this study was therefore to determine the most effective irrigation schedule for the optimum performance, including root growth and root distribution, of young apple trees in newly established orchards on gravelly soils which are wide-spread in apple-growing regions of South Africa.

Methods

The irrigation experiment was conducted at Oak valley Estate in Elgin on a gravelly Kroonstad. soil with Big Bucks over a period of four years. Three irrigation treatments replicated five times
were applied from planting until the first crop in the fourth year. Irrigations were remotely applied using cell phone technology, a controller, hydraulic valves and water meters. Soil water content was continuously captured on data loggers and climatic factors monitored on site. Root growth and distribution were studied using rhizotrons and soil mapping in profile pits while vegetative growth was measured annually and yield components in the fourth year. Plant water potential as a direct indicator of water stress were measured during two seasons. From evapotranspiration figures, reference evapotranspiration and evaporation values, crop coefficients were calculated which were split into a basal crop coefficient and an evaporation coefficient.

Key Results

The monthly and seasonal water requirements of young apple trees were quantified. These requirements increased over the years. January and February were the months of peak evapotranspiration. Evapotranspiration also increased with shorter irrigation cycles due to more evaporation from the soil surface. Together with weather data, the monthly crop coefficients that were calculated, can be used to schedule irrigation. Relationships between soil water content and pre-dawn water potential, leaf water potential and stem water potential yielded plant water potential values that can be used to schedule irrigations or calibrate soil water instruments.
Roots of the young apple trees penetrated to 1,0 m *i.e*. maximum depth above an impenetrable layer, during the second season. Significantly more roots penetrated deeper into the soil with larger quantities of water applied less frequently at the end of the first season. At the end of the third season this pattern remains. It can be concluded that short cycle irrigations such as irrigation twice a week will favour shallow root growth while longer cycle irrigation promotes more roots in the deeper soil layers. Although lateral root distribution was confined to the irrigated soil volume under the ridges, longer irrigation cycles encouraged roots to grow further towards the inter-row space. Actively growing roots were found throughout the season, a few even in winter, but two peaks of new root growth occurred in September/October and in March, respectively.

After four years the above-ground vegetative growth of all treatments was still the same. At harvest of the first crop, short cycle irrigation yielded significantly bigger apples, but its total apple yield was not significantly different from that of the two longer irrigation cycles.

Conclusion and Discussion / Recommendation

In conclusion and taking into account all the results, irrigation at a soil water potential of -30 kPa that should correspond to approximately weekly irrigations, is recommend for young non-bearing trees. This schedule should allow a deep and well-developed root system, vigorous shoot growth and a lower water use than more frequent irrigations. A model to predict water use of young apple trees are currently still being developed and should become available in 2021.