Monitoring Irrigation in a Production Nursery©

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Arnelia Farms is a potted plant nursery as well as an export cut flower farm close to the town of Hopefield on the West Coast of South Africa. The nursery specialises in *Proteaceae* although the range is slowly expanding to complementary plant families. Except for two species which are propagated from seed the other cultivars currently in production are vegetatively propagated from mother stock. The mother stock is a high value section in the nursery and irrigation (fertigation) needs to be monitored very closely as these plants are sensitive to increased levels of nitrates and phosphate as well as water-logged conditions in winter and drying out during summer. Irrigation monitoring takes place by continuous logging soil moisture probes, weekly measuring of the total drainage water, and daily total irrigation water supplied, measuring the EC and checks by the nursery manager. Similar irrigation monitoring is done in the retail section (15-cm pots). Temperature is recorded by an automated weather station. The difference in EC calculated between the EC of the drainage water and EC of the irrigation water, as well as the soil moisture recorded with the probes, correlated well with mean daily and mean daily maximum temperature. Over time, analysis of data will improve the manager's ability to make decisions concerning irrigation and reduce the risk.

INTRODUCTION

Arnelia Farms are situated in the West Coast, close to the town of Hopefield in the Western Cape. The business consist of a 20-ha cut-flower section of which most of the produce is exported and a pot-plant nursery which produces 150,000 pots annually. The nursery also supplies rooted cuttings to protea producers on order. Arnelia Farms specialise in *Protea*, *Leucospermum*, *Leucadendron*, and *Chamelaucium*. Recently the selection has expanded to *Erica*, *Lachenalia*, and *Bougainvillea*. Arnelia Farms grow over 100 different pot-plant cultivars or species in total. Except for two species, all the plants are vegetatively propagated from our own mother stock under cover (plastic in winter and shade cloth in summer). The majority of the cultivars are sensitive to high nitrate and phosphate levels in the irrigation water and potting soil, therefore, close monitoring is necessary. The 20-cm mother stock and the 15-cm retail pot plants are closely monitored with the use of soil moisture probes, measurement of total irrigation supplied, drainage and EC, as well as the EC, pH, NO_3, and P of the potting soil. The focus of this paper will be the 20-cm mother stock as it is a very high value section in the nursery.

MATERIALS AND METHODS

The mother stock consists mostly of *Proteaceae* and *Ericaceae*, as the *Chamelaucium* is harvested elsewhere. The section was divided into nine rows; each on its own valve. Each valve contains several different cultivars. The plants were potted in 80% coir and 20% peat.

The irrigation was controlled by a solar counter connected to an Aquarius irrigation controller and the countdown was set at 1500 during winter and in summer it was reduced stepwise to 800 units. The length of irrigation cycles was determined by drainage data, probe readings, and adjusted by the nursery manager.

The total volume of irrigation was recorded from Monday to Friday per valve. Each of the nine valves was divided into four sections and in each section drainage was collected from Monday to Thursday in a saucer below the pot. On Thursdays the total drainage was recorded and a daily average was calculated. The EC of the irrigation and drainage water was measured with an EC60 pocket-size conductivity/TDS/temperature meter in $mS \cdot cm^{-1}$ (Martini instruments, Milwaukee Instruments, Inc., North Carolina, USA). The difference

between the EC measured in the drainage water and irrigation water was calculated. A Davis weather station on the farm recorded air temperature.

RESULTS AND DISCUSSION

When the difference between the EC measured in the irrigation water and drainage water (Fig. 1) increase the drainage decrease and irrigation time can be increased or the solar counter can be reduced to increase irrigation. The EC difference correlates well with mean daily air temperature (Table 1) (r = 0.75) and when warm temperatures are forecasted irrigation is increased before, rather than after the warm spell. The probe data also correlates well with mean daily (r = -0.61) and mean daily maximum air temperature (r = -0.59), respectively (Fig. 2). The probe data (Fig. 3) serves as a check and displays increasing or decreasing trends in soil moisture. The probes also record soil temperature. The soil temperature closely follows air temperature (Fig. 4), but during early spring the soil temperature is significantly higher as the tunnels are covered with plastic, which is replaced with shade cloth in November (early summer). Finally, the nursery manager checks the moisture of pots and can reference the observed information with the data collected to support irrigation changes.

Table 1. Correlation coefficients are shown for various parameters. Air temperature was recorded with a Davis weather station. The soil moisture was recorded with five continuous logging probes developed by DFM, the mean weekly drainage is drainage from 16 different pots and the EC difference was the difference between the EC measured in the drainage water and the EC measured in the irrigation water.

	Mean soil moisture at top 10 cm (%)	Mean weekly drainage (%)	EC difference calculated weekly ($mS \cdot cm^{-1}$)
Mean daily air temperature (°C)	-0.61	-0.56	0.75
Mean daily maximum air temperature (°C)	-0.59	-0.56	0.71

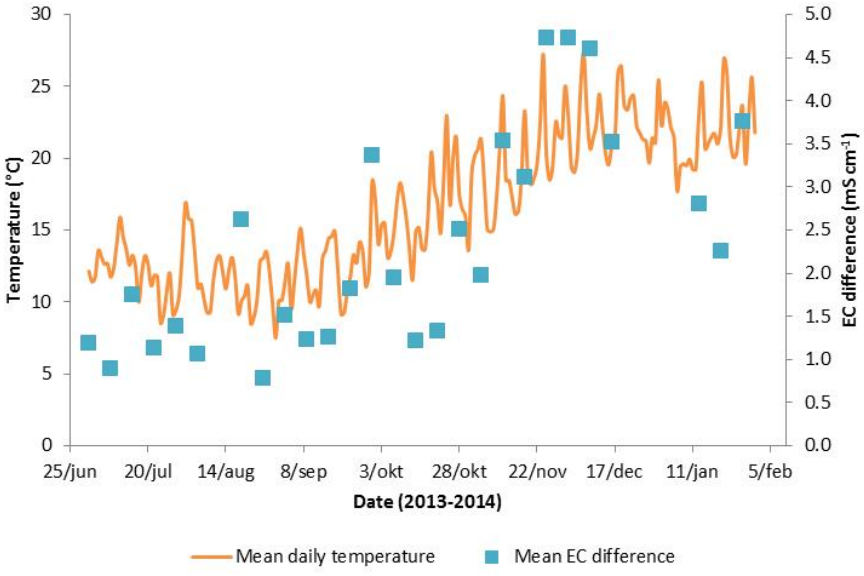

Fig. 1. Mean daily air temperature measured by a Davis weather station and mean EC difference. The EC difference was the difference between the EC measured in the drainage water and the EC measured in the irrigation water.

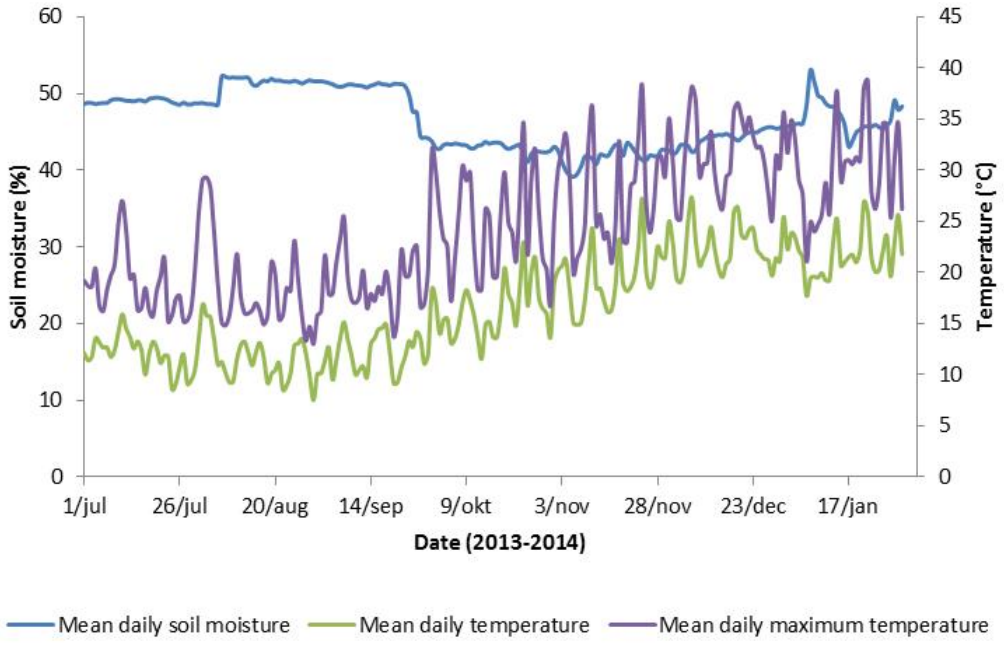

Fig. 2. Mean daily soil moisture recorded with five continuous logging soil moisture probes developed by DFM and mean daily, as well as mean daily maximum, air temperature recorded with a Davis weather station.

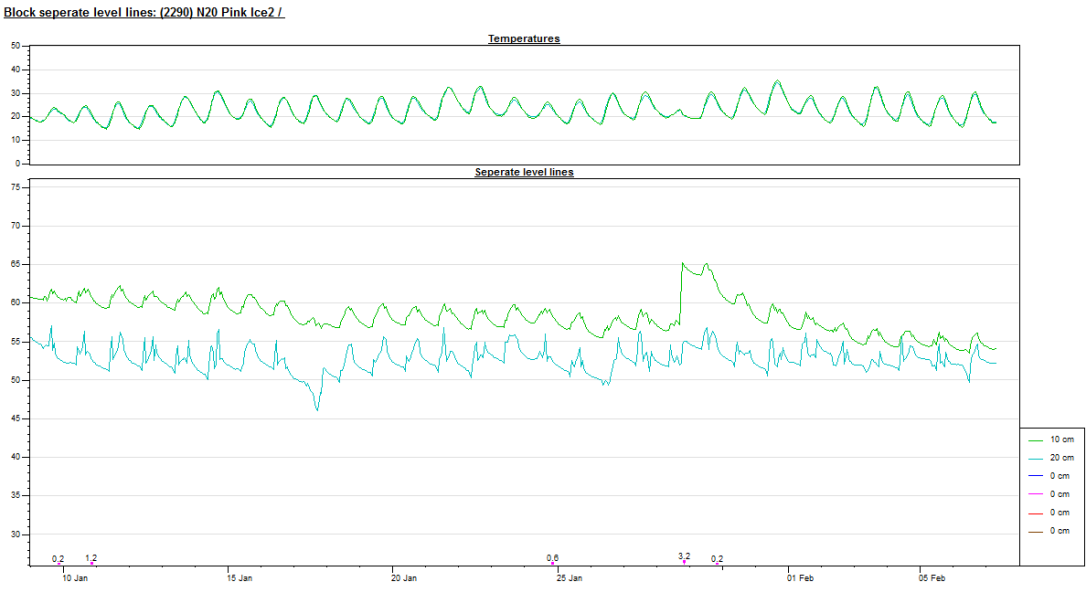

Fig. 3. A typical soil moisture graph generated by DFM Probe Utilities (bottom graph) and temperature graph (top graph). In the bottom graph, the bottom line and top line are the soil moisture levels recorded at 10 and 20 cm, respectively. The small bars on the x-axis are actual rain (mm) recorded by a Davis weather station on Arnelia Farms.

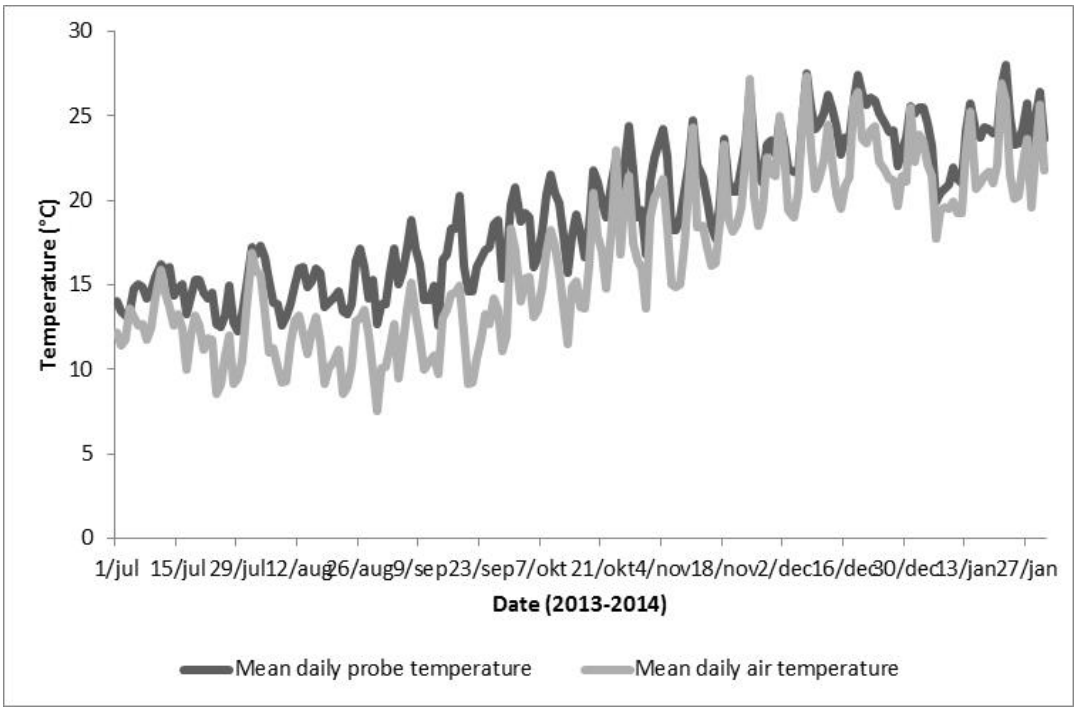

Fig. 4. Mean daily probe temperature recorded with continuous logging probes developed by DFM and mean daily air temperature recorded with a Davis weather station.

Accurate records of daily and weekly monitoring of irrigation increases irrigation efficiency and ensures maximum plant growth over time. The irrigation control points at Arnelia Farms are the solar counter which is part of the Aquarius irrigation system and the irrigation time of each valve. Preferably, one irrigation cycle of the 20-cm mother stock which includes the retail 20-cm pots that run on the same program, should not exceed 1 h. This, together with excessive drainage, limits the irrigation time of each valve. To increase the number of cycles per day the solar counter can be adjusted to count down less or more units before commencement of the next cycle. In order to make decisions on the number of irrigation cycles that need to run each day and for how long, irrigation monitoring is crucial. The main aim is to achieve 10-15% drainage on average during a week. Over time the system should be refined and changes in irrigation time or the solar counter would be anticipated more accurately during the year.