
Optimizing rose crop fertilization and irrigation over hourly, daily and seasonal time scales:

Ion and water uptake over daily cycles

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In our last report we showed preliminary data on the uptake of water and nutrient by ‘Happy Hour’ roses over the course of an individual flowering cycle, and found that the two rootstocks we used had no significant influence over those uptake patterns (being similar in both rootstocks). These cyclical uptake patterns were similar to those previously reported by us and other researchers (Cabrera *et al.*, 1995; Mattson and Lieth, 2005). The results indicate that still source-sink relations, specifically the sink strength – or the photosynthate demand of an organ at specific points in time – define to a greater extent the pattern of nutrient uptake and reserve mobilization. In this case, the developing flower shoots, at the time when they are rapidly developing (elongating and growing) dominate the allocation of photosynthates (carbohydrates) that little is available for roots growth and function (i.e. nutrient uptake), even in the case of an extremely vigorous root system like ‘Natal Briar’. Growers will certainly acknowledge and appreciate the size and vigor of ‘Natal Briar’ over that of the old ‘Manetti’. While it is acknowledged that ‘Natal Briar’s’ vigor is transferred to the scions (cultivars) growing on it - one of the reasons for its adoption as rootstock - the carbohydrate demand (sink strength) of the developing shoots of the scion still dominates its allocation, causing the same cyclic nutrient uptake pattern regardless of rootstock vigor.

Besides an evaluation of rose water and nutrient uptake patterns over flowering cycles, we are interested in the behavior of such patterns over smaller time –scales, namely daily and hourly. Figure 1 shows the hourly data we obtained over two specific day cycles (24-hour periods) over the course (phenology) of one growth and flowering cycle. The first 24-hour cycle (Day 15) corresponds to the day when the shoots were rapidly elongating (growing) and whole plant nutrient uptake was at its lowest point in this flowering cycle, and the second 24-hour cycle (Day 33) corresponds to a day just before flower harvest.

As expected, and regardless of rootstock and sampling day during crop phenology, daily water uptake (transpiration) peaked at mid-day, between 12pm and 2pm (Fig. 1A, C), corresponding to the period of maximum evapotranspirative demand, and minimal during midnight hours. Plants on ‘Natal Briar’ tended to have slightly higher diurnal water uptake rates than those on ‘Manetti’, but these differences were not statistically significant. Data from our previous studies in our greenhouses have rarely shown statistically higher biomass and leaf dry weight yields of plants growing on ‘Natal Briar’, albeit their raw values have been often numerically higher than in ‘Manetti’. We suspect that slightly higher foliage dry weights (and possibly higher leaf areas) in ‘Natal Briar’ might have contributed its slightly higher hourly water use. A self-evident observation is that hourly transpiration rates in plants on both rootstocks were higher during the day preceding flower harvest, when biomass leaf area per plant was higher.

Regarding total ion (salt) uptake, it was readily apparent that its average hourly rates were significantly lower for the day when shoot elongation rate was at its lowest (Day 15) compared to day preceding harvest (Day 33). Furthermore, negative hourly uptake rates were observed on Day 15, mostly in night hours (~9pm to ~7am), but were hardly observed before flower harvest. Negative values in net ion uptake rates (i.e. net ion efflux) suggest the plants are not only not absorbing ions, but in fact excreting or losing ions from the plant

into the surrounding soil solution. An integration of the hourly uptake rates (area under the curve) for Day 15 reveals that barely, if any, net ion uptake occurred for that day. Conversely, on Day 33, near the point of flower shoot harvest, net uptake rates were for the most part positive, and integration of the daily ion uptake rates shows the maximum whole plant daily values over the course of the flowering cycle. Maximum ion uptake rates, on both days, roughly corresponded with the maximum rates of water uptake, albeit the plants on the ‘Manetti’ rootstocks showed a peak pattern that was slightly displaced to later hours in the afternoon.

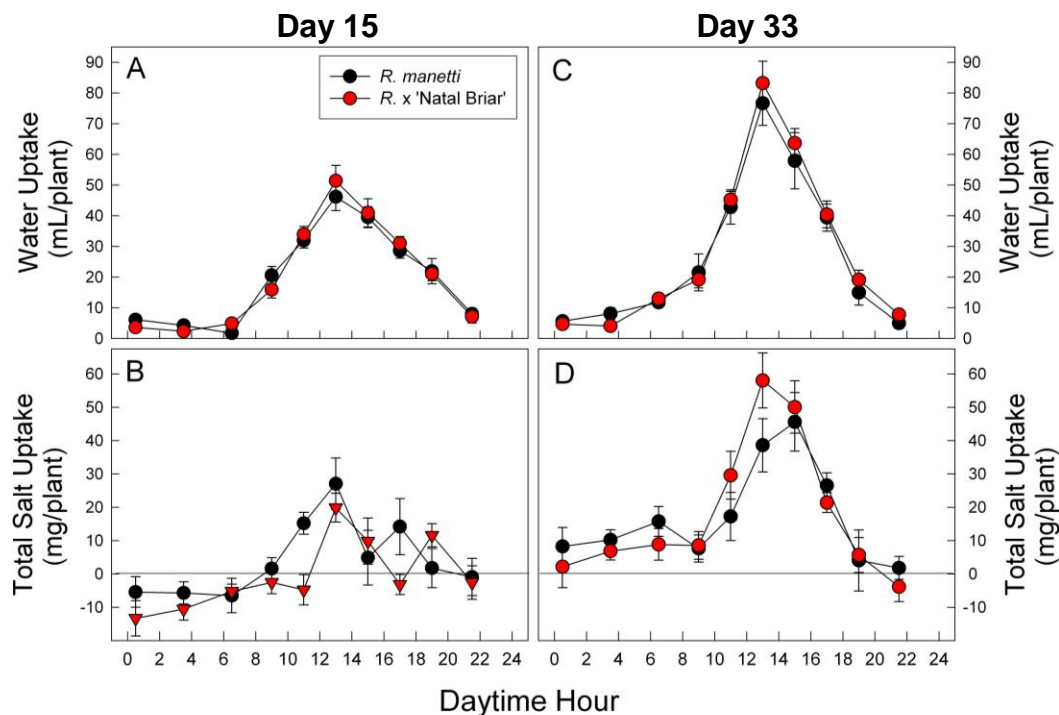


Figure 1. Hourly patterns of water (A, C) and total ion (salt) uptake (B, D), for two days in the growth & flowering cycle of hydroponically-grown ‘Happy Hour’ roses grafted on the rootstocks *R. manetti* and *R. x 'Natal Briar'*. Data points are means of nine plants.

In 1996 we obtained some data on diurnal nitrate-nitrogen uptake that pointed to maximum uptake rates in the afternoon hours, with a peak displaced by several hours over that observed for water (Cabrera et al., 1996). That information, obtained in the cultivar ‘Royalty’ growing on the rootstock ‘Manetti’, was considered interesting but was not pursued anymore. This information, along with the preliminary information shown in Figure 1 above, warrants further observation and in the next report we hope to have additional data on this. We are keeping in mind that the ultimate objective of this research is to see the feasibility of adjusting not only seasonal but diurnal (hourly) fertigation management practices and programs in a way that enhances the efficiency of water and nutrient uptake while maintaining, or even maximizing shoot growth and elongation.

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