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Effects of different periods and levels of water deficit on physiological, productive and quality parameters of pomegranate cv. Wonderful fruits

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Abstract. Pomegranate is a crop tolerant to water deficit and is suitable in areas of water scarcity. This work presents results from a three year study on different levels of water deficit applied at the beginning, end or during the growth period of the pomegranate cv. Wonderful fruit under full production and young plants raised in 1 m^3 containers. Over this period the following parameters were measured: gas exchange, chlorophyll fluorescence, soil and xylem water potential, solar radiation intercept, osmotic adjustment and fruit and shoot growth. Fruit weight, yield and size were determined at harvest. The results help determining controlled water stress thresholds and periods for the production of fresh fruit.

I – Introduction

Pomegranates are known for their ability to withstand long drought periods and for their relatively low water requirements for producing optimal crops, as compared to other fruit trees. This is one of the main reasons why pomegranates have been planted in semi-arid and arid zones of Chile where irrigation water is scarce and droughts are frequent. A strategy for saving water in fruit production under such conditions is controlled deficit irrigation (CDI) which consists of reducing irrigation under its optimal level during periods in which such restrictions do not affect the amount and quality of the harvested fruits.

In this study we aimed at studying the effect of different levels and periods of water deficit on the yield and quality of a commercial cv Wonderful pomegranate orchard in central Chile (trial 1) and the effect of drought on container grown two year old Wonderful pomegranate plants (trial 2).

II – Materials and methods

Trial 1: measurements were performed during the 2009-2010 and the 2010-2011 seasons on a commercial cv. Wonderful pomegranate orchard which was planted in 2004 in a 3 x 5 m frame in the Chacabuco province (Metropolitan Region: 33º04'S 70º45'W) on a sandy loam. In both seasons the farmer's irrigation was used as reference control treatment. During the 2009-2010 season four irrigation treatments were implemented from the beginning of February till the end of harvest (may 2010): daily irrigation (T1), and irrigation each 3rd (T2: control treatment), 6th (T3) and 9th (T4) day. In the 2010-2011 season the irrigation frequency was kept constant (each 3rd day) and we applied either a moderate deficit irrigation (TM), by reducing from 12 to 8 drippers per plant, or a sever deficit irrigation (TS), by reducing from 12 to 5 drippers per plant. These treatments were applied from fruit set to the final fruit growth stage (period 1) or from then to harvest (period 2) or throughout both periods. Shoot growth, gas exchange, as well as yield and fruit size were measured on four replicate plats per treatment during both seasons.

Trial 2: eight cv. Wonderful pomegranates were grown for two years in 1 m^3 containers in a 1:1:1 mixture of sand, soil and organic soil. Plants were drip irrigated in order to keep adequate water availability in the soil and a drought treatment was implemented on half of the plants by withdrawing irrigation for 42 days during the summer (no rain fell during that period). Thereafter, irrigation was reestablished to the level of un-stressed plants. Before, during and after the 42 day water withdrawal measurements of chlorophyll fluorescence, gas exchange and leaf shedding were performed on stressed and un-stressed plants.

III – Results and discussion

As shown on Fig. 1, increasing the irrigation frequency from the commercial standard of once every 3rd day to daily irrigation significantly increased shoot growth but did not significantly affect fruit growth. Both, shoot and fruit growth, were not reduced by halving the commercial irrigation frequency but severely decreased when applying a third of this frequency (Fig. 1). Yield, on the other hand, was similar between daily and commercial frequency but was reduced with the less frequent irrigation treatments (Fig. 2). Results of the second season of trial 1 showed that most treatments significantly reduced individual fruit weight except for the moderate water deficits applied during the second period and during the whole period, which had lower averages but where not significantly different from the control treatment (Fig. 3). Similarly, all water deficit intensities and periods reduced yield as compared to the control treatment; the lowest reduction in yield was achieved with the moderate water stress during the second period (Fig. 4).

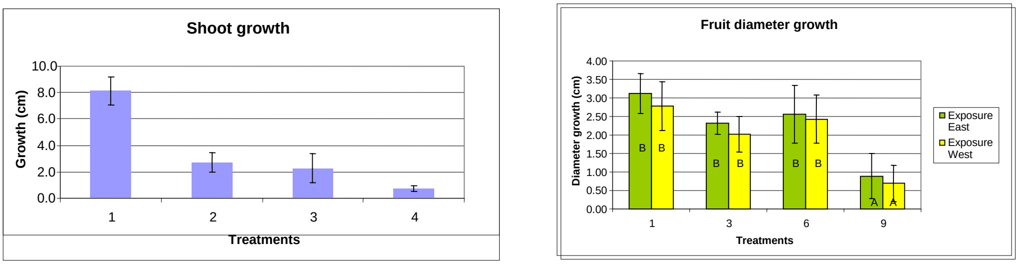

Fig. 1. Shoot growth and fruit diameter growth as affected by irrigation frequency: daily (1) and each 3rd (2), 6th (3) and 9th (4) day.

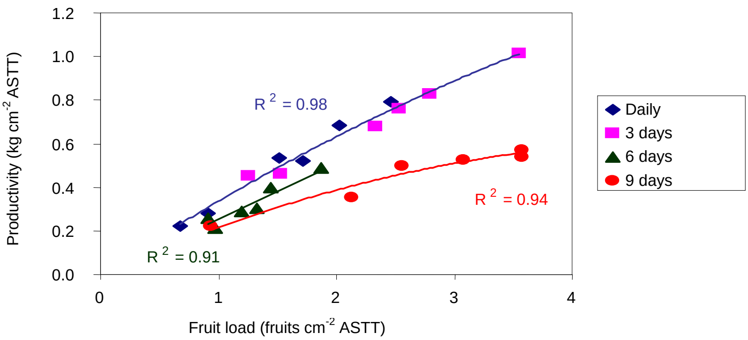

Fig. 2. Relationship between yield and fruit load as affected by irrigation frequency: daily (1) and each 3rd (2), 6th (3) and 9th (4) day.

Regarding trial 2, the drought treatment progressively reduced its photosynthesis and stomatal conductance as compared to non stressed plants; both variables completely recovered after reestablishing irrigation (Fig. 5). The plants submitted to total irrigation withdrawal lost most of their leaves but no significant differences in variable to maximal chlorophyll fluorescence (Fv/Fm) was observed (data not shown).

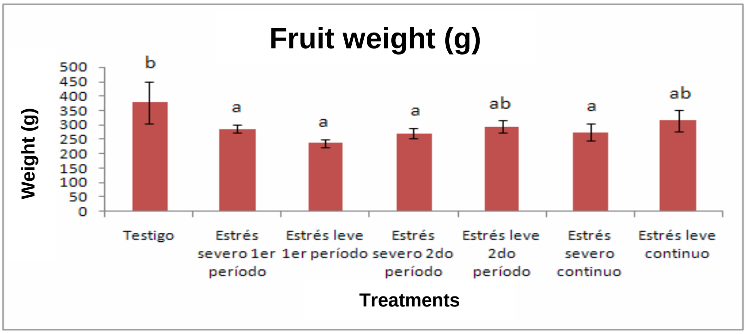

Fig. 3. Effect of different water deficit intensity and periods on individual fruit weight.

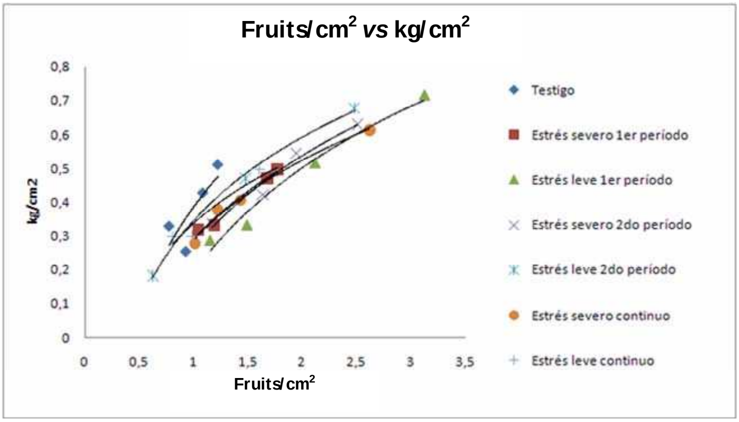

Fig. 4. Relationship between yield and fruit load as affected different water deficit intensity and periods.

Taken together, these results indicate that, although pomegranates can withstand drought by reducing their transpiration through a reduction of their stomatal conductance and leaf area, lowering irrigation beyond commercial recommendations affects yield and fruit size. If deficit irrigation should be applied as a strategy for saving water, less harm to yield and fruit size will be caused when applying such deficit late in the season, between the last fruit growing stage and harvest.

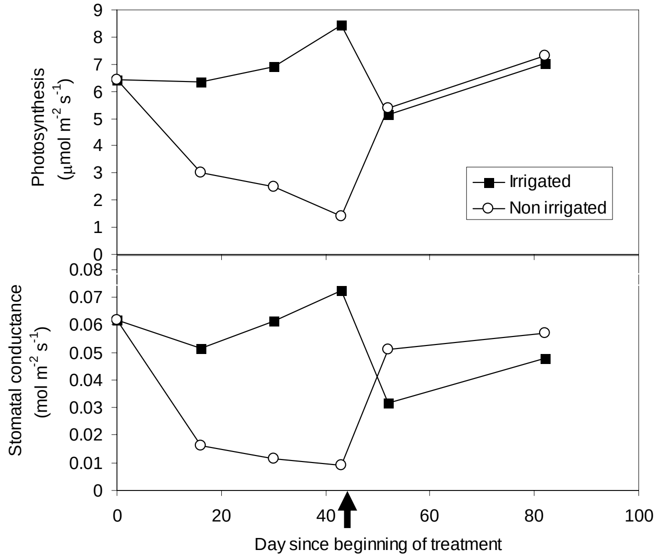

Fig. 5. Photosynthesis and stomatal conductance as affected by irrigation withdrawal (day 1) and reestablishment (day 42: indicated by black arrow).