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## WATER PRODUCTIVITY IN FUNCTION OF THE REGULATED DEFICIT OF IRRIGATION IN THE PHASE OF MATURATION OF GRAPE APIRÊNICA IN THE VALLEY OF THE SAN FRANCISCO

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**ABSTRACT:** The aim of this work was to evaluate the effects of irrigation water depths and cut-off timing in the maturation stage of Superior Seedless grape grown in the of the San Francisco River region , to obtain simultaneously maximum yields and water use efficiency . The experiment was carried out in a commercial farm, Agrobrás Tropical S.A., Casa Nova, Bahia State, Brazil. The statistical design was in random blocks, in a factorial scheme of 3x3 with four replicates, with timing of irrigation cut-off (at 21, 13, and 5 days before harvest) and three irrigation depths applied (100, 50 and 0% ETc) and an additional treatment which represented the grower's practice. The grapevines used between 335 and 390 mm of water in the production cycle of the grape. The yield and water use efficiency by grapes were evaluated, where the highest yield was  $34.85 \pm 6.84$  and lowest  $24.68 \text{ t.ha}^{-1} \pm 3.0$  and the water use efficiency ranged from 6.42 to 9.32  $\text{kg.m}^{-3}$  of water.

**KEYWORDS:** *Superior Seedless*, water use efficiency, water stress

**INTRODUCTION:** Superior Seedless is one of the main seedless grape cultivars grown under irrigation in the San Francisco valley region. Irrigation technology can increase both yield and quality of agricultural crops (GOMIDE, 2002). However, both excess and deficit of water can markedly affect irrigated crop yields and consequently the economic returns of this production system (SAAD & LIBARDI, 1994).

The adaptability of plants to water stress conditions is mediated by it's duration and magnitude. When the water deficit occurs during the initial period of berry growth, it may reduce the final fruit size and delay in maturity (ÁVILA NETTO, 2000).

The efficient use of irrigation water is becoming increasingly crucial, in face of the scarcity of water and higher costs of agricultural inputs, thus making it indispensable the utilization of appropriate irrigation management techniques. One of the possibilities investigated to increase water use efficiency in irrigated agriculture is through the reduction of the water applied without provoking a decrease in yields (DINAR, 1993 & LETEY, 1993).

The aim of this work was to evaluate the effects of timing and depths of regulated deficit irrigation at the maturation of grape, towards the maximization of water use efficiency by the Superior Seedless grape variety grown in the Submedium San Francisco River.

**MATERIALS AND METHODS:** The experiment was carried out at the Agrobrás Tropical do Brasil S/A farm, located in the county of Casa Nova-BA, Sub medium San Francisco region. The climate is a semi-arid, BSw<sub>h</sub>, according to Köppen, with an yearly average of rain of 400 mm. The soil was

classified as ARGISSOLO VERMELHO AMARELO and its physical-hydrical characteristics were: sand ( $821.3 \text{ g} \cdot \text{kg}^{-1}$ ), silt ( $40 \text{ g} \cdot \text{kg}^{-1}$ ), clay ( $146 \text{ g} \cdot \text{kg}^{-1}$ ), bulk densidade ( $1.37 \text{ kg} \cdot \text{dm}^{-3}$ ), field capacity ( $0.4151 \text{ cm}^3 \cdot \text{cm}^{-3}$ ) and permanent wilting point of ( $0.1493 \text{ cm}^3 \cdot \text{cm}^{-3}$ ).

The grape variety Superior Seedless was used, grafted onto the cultivar SO4, at four years of age and second production cycle, spaced at  $3.5 \text{ m} \times 2.0 \text{ m}$ , using a trellis system using line drip irrigation and self-compensating emitters spaced at  $30 \text{ cm}$  with a flow rate of  $2.55 \text{ L} \cdot \text{h}^{-1}$ , applied on a daily frequency except for Sundays.

The experimental design was a random blocks in a  $3 \times 3$  factorial and four replicates, with three different timings of irrigation differentiation at 21 (E21); 13 (E13) e 5 days before harvest (E5), and three irrigation depths, 100% (L100); 50% (L50) e 0% (L0) of the net irrigation requirement (Etc) and an additional treatment "D" corresponding to the producer's water management scheme and corresponding reduction in applied water before harvest. Four central plants per plot were used.

The irrigation depths were calculated using the Penman-Monteith (Allen et al., 1998) equation with climatic data obtained from an automated weather station situated at the Experimental Field of Bebedouro, Petrolina-PE, (EMBRAPA, 2007) using crop coefficients ( $K_c$ ) from Soares & Costa (2000), defined for the maturation phase as  $K_c = 0.8$  in the first week,  $0.6$  in the second week and  $0.4$  in the third week from the beginning of treatments.

The water depth applied daily was calculated beginning at the dry pruning stage until harvest in order to obtain total depth for each treatment for the whole production season. Crop yield and water use efficiency were evaluated as a function of water depth applied per treatment and timing of irrigation cutoff date at the maturation stage.

The grapes were harvested according to the farmer's schedule on 10/24/2007, at 105 Days after pruning - DAP.

Water use efficiency, WUE, was determined for each treatment from the relationship between yield and cumulative water depth applied from pruning to harvest.

Yield data were submitted to a variance analysis and means compared through the Duncan test at 5% probability for the source of variation (water depths, and timing of application of regulated deficit irrigation), using the SAS 9.0 Windows version.

**RESULTS AND DISCUSSION:** The cumulative irrigation depths for each treatment along the phenological cycle of the grape are shown (Figure 1). In the treatments in which the irrigations were completely cutoff, E13L0 and E5L0, the cumulative depths remained constant ( $367.34 \text{ mm}$ ) and  $e$  ( $387.87 \text{ mm}$ ) respectively throughout the maturation phase. However for the E21L0 treatment, there was an additional fertigation applied after the cutoff date (at the  $89^{\circ}$  DAP) with an increase from  $330.84 \text{ mm}$ ,  $334.14 \text{ mm}$ , while the other treatments showed a gradual increase in depth applied (Figure 1A e 1B).

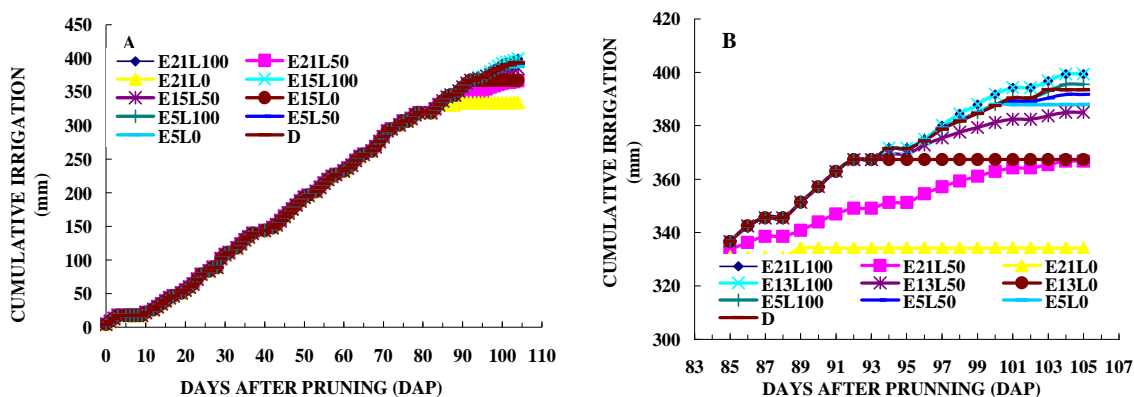


FIGURE 1. Cumulative irrigation depths for each treatment a) along the grapevine production cycle; b) in the maturation phase, Agrobrás farm, Casa Nova – BA

Similar irrigation depths were found by Avila Neto et al., (2000), in a work done in the same region where the grape cv. Itália used 333.6 mm for the season. Similarly, Bucks et al., (1985) obtained seasonal values from 310 mm to 485 mm, in Arizona, for the Perlete table grapes.

Figure 2 shows the grape yields of the different treatments. Mean yield comparisons showed significant variations at a Duncan's ( $P < 0,05$ ), with the highest value of  $34.85 \text{ tha}^{-1} \pm 6.84$  from the E5L100 treatment, and the lowest from the E5L0 treatment of  $24.68 \text{ tha}^{-1} \pm 3.06$  (Figure 3).

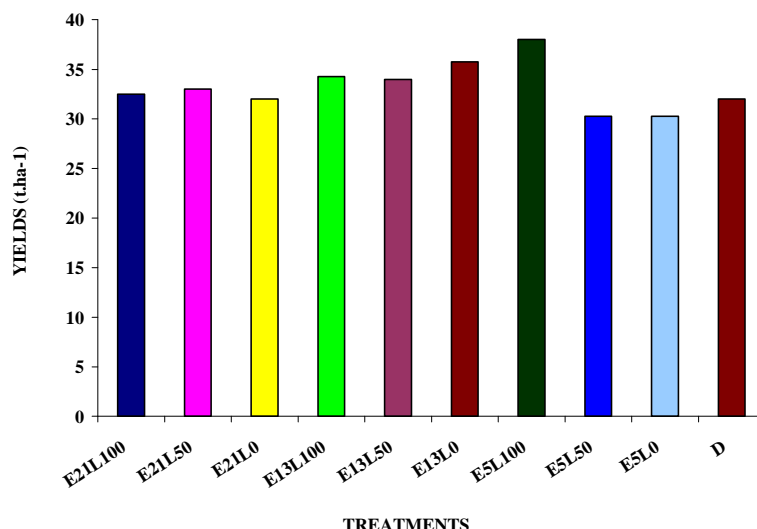


FIGURE 2. Yield as a function of depths and regulated deficit irrigation timing Agrobrás farm, Casa Nova – BA

Water use efficiency (WUE) values as a function of depths and regulated deficit irrigation timing are shown Figure 3. The highest WUE values were shown by the treatments E13L0 of  $9.32 \text{ kg.m}^{-3} \pm 1.75$  and E21L0 of  $9.08 \text{ kg.m}^{-3} \pm 1.02$ , while the lowest occurred in the E5L0 of  $6.42 \text{ kg.m}^{-3} \pm 1.69$  and E5L50 of  $6.91 \text{ kg.m}^{-3} \pm 0.80$ . The farmer's treatment (D), obtained a WUE of  $7.25 \text{ kg.m}^{-3} \pm 0.18$ , the third lowest when compared to the rest.

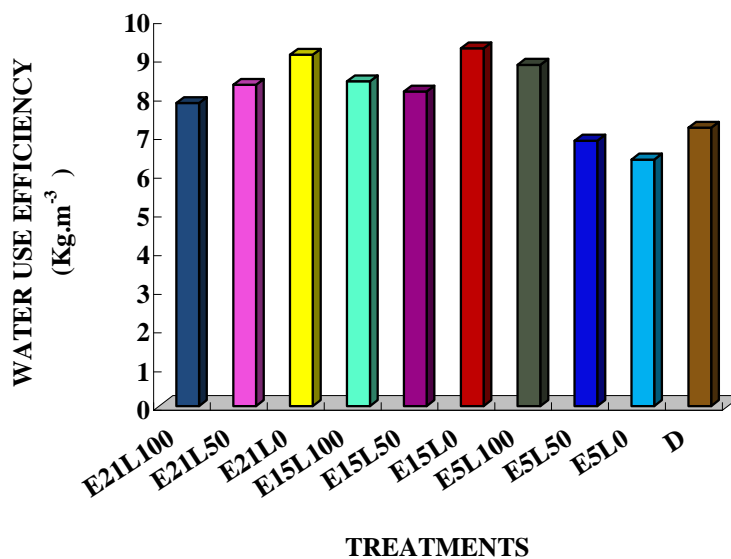


FIGURE 3. Water Use Efficiency (WUE) as a function of depths and regulated deficit irrigation timing



Brazil, August 31 to September 4, 2008

Agrobrás farm, Casa Nova – BA

The WUE values obtained in this study were markedly higher than the ones shown in the literature, as an example, Van Zyl & Van Huyssteen (1980) *apud* Smart & Coombe (1983), reported grape WUE between 1.3 e 3.0 kg.m<sup>-3</sup>, whereas Serman et al., (2004), working with irrigation depths on Superior Seedless, obtained WUE values in the range of 2.62 a 3.16 kg.m<sup>3</sup>.

It should be noted that these high WUE values presented should be adjusted, since the grapevine Superior Seedless, grown in the Submédio São Francisco region comprises of two growth cycles, per year with one of them viewing the plant formation and the other one as the production cycle per se.

**CONCLUSION:** The results showed that the regulated deficit irrigation applied at the maturation stage of the Superior Seedless grape resulted in the increases in water use efficiency, with values ranging from 6.42 a 9.32 kg.m<sup>-3</sup> of water

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