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DEFICIT IRRIGATION IN GRAPEVINE CV. SYRAH DURING TWO GROWING SEASONS IN THE BRAZILIAN SEMIARID

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ABSTRACT: Irrigation plays an important role for grape's yield as well as on its quality for winemaking. Thus, the effects of deficit irrigation strategies on yield and quality of wine grapes cv. Syrah were evaluated in Petrolina, State of Pernambuco, Brazil. Evaluations were carried out throughout the second and third growing seasons, which were from November 2010 to February 2011 (rainy season) and from May to September 2011 (dry season), respectively. Vines were drip irrigated and the experimental design was completely randomized with three treatments and four replications. The treatments were full irrigation (FI), performed according crop evapotranspiration; regulated deficit irrigation (RDI), in which irrigation was interrupted in phenological growth stage of bunch closure, but was occasionally performed according soil water monitoring of the root zone; and deficit irrigation (DI), when irrigation was interrupted from bunch closure to harvesting. Differences on leaf water content among treatments were observed in both growing seasons and RDI and DI treatment plants presented moderate water stress. The number of bunches did not differ among treatments in both growing seasons; however, bunch weight per plant, average bunch weight and soluble solid content were higher in FI treatment during the dry season. Deficit irrigation strategies promoted water saving.

KEYWORDS: *Vitis vinifera* L., soil water content, leaf water potential.

IRRIGAÇÃO COM DÉFICIT EM VIDEIRA DE VINHO CV. SYRAH EM DOIS CICLOS DE PRODUÇÃO NO SEMIÁRIDO

RESUMO: A irrigação tem importante papel tanto na produtividade como na qualidade da uva para vinificação. Assim, este trabalho avaliou a influência de estratégias de irrigação na produção, em termos quantitativos e qualitativos, da videira cv. Syrah, irrigada por gotejamento, em Petrolina - -PE, no segundo ciclo de produção de uva, entre novembro de 2010 e fevereiro de 2011 (período "chuvoso") e no terceiro ciclo de produção de uva, entre maio e setembro de 2011 (período "seco"). O delineamento utilizado foi o de blocos casualizados, em número de 4, com 3 tratamentos: irrigação plena (IP), em que a aplicação de água foi realizada durante todo o ciclo de produção, com base na evapotranspiração da cultura; irrigação com déficit controlado (IDC), em que a aplicação de água foi interrompida na fase fenológica de cacho fechado, porém irrigações foram realizadas esporadicamente, sendo o momento de irrigação determinado pelo monitoramento da água do solo na zona radicular; e irrigação deficitária (ID), em que a aplicação de água foi interrompida na fase fenológica de cacho fechado, permanecendo assim até a colheita. Diferenças entre os tratamentos ocorreram quanto ao potencial hídrico foliar, e as plantas dos tratamentos IDC e ID apresentaram um estresse hídrico moderado. O número de cachos não foi afetado em ambos os ciclos pelos tratamentos, mas o peso de cachos por planta, peso médio do cacho e sólidos solúveis foram maiores no tratamento IP, no ciclo do período "seco". As estratégias de irrigação com déficit propiciaram uma economia na utilização da água.

PALAVRAS-CHAVE: *Vitis vinifera* L., umidade do solo, potencial de água na folha.

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INTRODUCTION

Deficit irrigation has been widely investigated as a valuable and sustainable production strategy in dry regions. By limiting water application on plant growing seasons that are sensitive to drought, this practice aims to maximize water yield and stabilize – instead of maximizing - yield (GEERTS & RAES, 2009).

In semiarid and arid regions, the irrigation management is a decisive factor for grape and wine quality, and it is also the most controllable factor (FERRERES & EVANS, 2006). Deficit irrigation can be defined as water application on crops in lower quantity of that would completely supply water necessity of plants (FERRERES & SORIANO, 2007), and the regulated deficit irrigation is one of the most promising techniques of dosing water in wine grapevine (CHAVES et al., 2007). The acquisition of reference parameters regarding grapevine performance can contribute to an enhanced efficiency of this technique (ROMERO et al., 2010).

In the Brazilian Semiarid, irrigation strategies in grapevine, such as partial drying of root system, deficit irrigation and regulated deficit irrigation have been aims of research (SILVA, 2005; BASSOI et al., 2007; SOUZA et al., 2009; BASSOI et al., 2011), demonstrating the potential of these practices. However, the conduction of studies in different seasons is essential due to high availability of solar radiation and irrigation water to supply crop's water requirements, which make possible the grapevine cultivation throughout the year in that semiarid region.

Thus, the aim of this study was to evaluate the dynamics of water in soil and in grapevine cv. Syrah depending on deficit irrigation strategies, as well as grape production in qualitative and quantitative terms, during two consecutive growing seasons, with one in the rainy season and another in dry season, in Petrolina, State of Pernambuco, Brazil.

MATERIAL AND METHODS

The experiment was installed in Experimental Field of Bebedouro, that belongs to Embrapa Tropical Semi-arid, in Petrolina - PE (latitude 9^o 8´ 8.9´´S, longitude 40^o 18´ 33.6´´O, altitude 373 m). The Syrah cultivar (*Vitis vinifera* L.) was grafted on Paulsen 1103 rootstock, with the rootstock seedlings obtained through cuttings. The planting was carried out on April 30th of 2009, in an eutrophic Red-Yellow Latosol (Ultisol), medium texture and plain landscape (SILVA, 2005), in spacing of 1 m between plants and 3 m between rows. The conduction of grapevines was trained out in espalier system, with triple cordon.

In this study, the researched objects were second grape growing season (pruning on November 10 of 2010 and harvest on February 28 of 2011 – 110 days) and third grape growing season (pruning on May 10 of 2011 and harvest on September 8 of 2011 – 121 days). The irrigation strategies assessed in both seasons were: 1- full irrigation (FI), in which irrigation was carried out according to crop evapotranspiration (ETc) replacement, which is, with no water restriction to plants in both growing seasons; regulated deficit irrigation (RDI), in which irrigation was performed to ETc reposition until phenological growth stage of bunch closure, by BAGGIOLINI scale (1952), at 64 and 48 days after production pruning - dapp (second and third seasons, respectively), with further interruption but with occasional irrigations to raise soil water content (θ, $m^3.m^3$), at effective depth of root system (0.60 m), as described by SILVA (2005), according to measured values of θ at 0.15; 0.30; 0.45; 0.60; 0.75; 0.90; 1.05 and 1.20 m of depth, by the neutron attenuation technique; 3- deficit irrigation (DI), in which irrigation was conducted reposing ETc until phenological growth stage of bunch closure, and being interrupted until harvest of each growing season.

The drip irrigation system was used, with emitters spaced 0.5 m in planting row (2 emitters per plant), with assessed flow of 2.5 $L.h^{-1}$ and pressure of 100 kPa. The irrigation was calculated on a daily basis, through reference evapotranspiration (ET_0) estimated daily by Penmam-Monteith method (ALLEN et al., 1998), with the aid of parameters measured by automatic weather station installed 60 m away from experimental area. The crop evapotranspiration determination (ETc, mm) was carried out because of the product between ET_0 and the crop coefficient (kc), for each phenological stage of grapevine. The applied values of kc were recommended by BASSOI et al. (2007), observing the event of phonological stages in accordance with BAGGIOLINI scale (1952).

The statistical design was completely randomized, with three treatments (irrigation strategies FI, RDI and DI), and four replications. Each parcel was composed of 48 plants, divided in 2 rows.

The leaf water potential (Ψ_{leaf}, MPa) was measured from the beginning of maturation phenological stage until mature bunch stage, in both growing seasons. The assessments were carried out between 2 h and 4 h, in 3 adult leaves collected from the middle portion of productive branches and in each of the 4 replications of irrigation treatment. The collected leaves were stored in plastic bags in order to prevent dehydration of collected material, for the immediate measures of Ψ_{leaf}, with the aid of pressure chamber Scholander (PMS Instrument Co, model 1000).

During the period of both harvests, number and weight of bunches were assessed (kg) per plant and per parcel, for subsequent estimation of bunch average weight (g). In sequence, 100 berries were separated from stalk, conserving the pedicel, and later on this material was weighted in digital analytical scale and allocated into measuring cylinder of 500 mL. The cylinders were calibrated with 300 mL of water. The variation of water volume was considered as the equivalent of 100 berries volume. The same 100 berries were macerated and grape must volume was obtained with the aid of measuring cylinder. Still using the must, analyses of soluble solid contents were conducted (TSS, °Brix), using portable refractometer ATAGO brand, Pocket PAL 1 model; of total titratable acidity (TTA) expressed in g. L^{-1} and tartaric acid, according to IAL (2005); and of pH, using digital gauge.

The water use efficiency (WUE, kg.m^{-3}) was determined by means of the ratio between total yield of fruits (kg) and the quantity of water applied by irrigation (m^3). The WUE was also considered taking into consideration the rainfall occurred in each grape growing season.

RESULTS AND DISCUSSION

The total rainfall occurred during grape second season (November of 2010 to February of 2011, in rainy season) and third growing season (May to September of 2011, in dry season) was of 252 mm and 70.3 mm, respectively. In second growing season, December of 2010, in phenological stages of visible bunches, separated bunches, separated flowers and in the beginning of flowering, by BAGGIOLINI scale (1952), rainfall occurred in accumulated quantity of 142.2 mm; and until the beginning of irrigation treatments, in January 14 of 2011 (65 days after pruning - dap), it was 146.6 mm. Between 66 dap and 110 dap (harvest), 105.4 mm occurred, with 80 mm precipitated in the morning of harvest day. In third growing season, until irrigation interruption in treatments RDI and DI, in June 28th of 2011 (48 dap), the rainfall was of 0.4 mm; after this date, 26.8 mm of rain occurred in between the maturation phenological stages (60 dap) and mature bunch (106 dap). The last rainfall (5.2 mm) occurred at 108 dap, 13 days before harvest, at 121 dap.

During the second grape growing season, the accumulated ETc was of 424.4 mm, while the gross irrigation depth (GID) totalized 385.4 mm for FI treatment, 256.2 mm for RDI treatment and 247.8 mm for DI treatment. In third grape growing season, the accumulated ETc was of 375.8 mm, with GID of 437.5 mm, 203.1 mm and 167.5 mm for treatments FI, RDI and DI, respectively. In studies performed in Petrolina, at the same experimental field of this study, the grape water demand throughout its cycle was of 471 mm (dry season) and 244 mm (rainy season), for cv. Superior, in overhead trellised vine conduction system (AZEVEDO et al., 2008); and 426 mm, for cv. Syrah, in conduction system on espaliers (SILVA, 2005).

Before irrigation interruption in treatments RDI and DI, GIDs of 247.8 mm (second season) and of 152.0 mm (third season) were applied in all treatments. Consequently, the average values of θ, in each treatment and in both seasons, were close between 0.15 and 0.60 m of depths (Figure 1) and between 0.75 m and 1.20 m (Figure 2). Still, the values of θ remained in similar intervals.

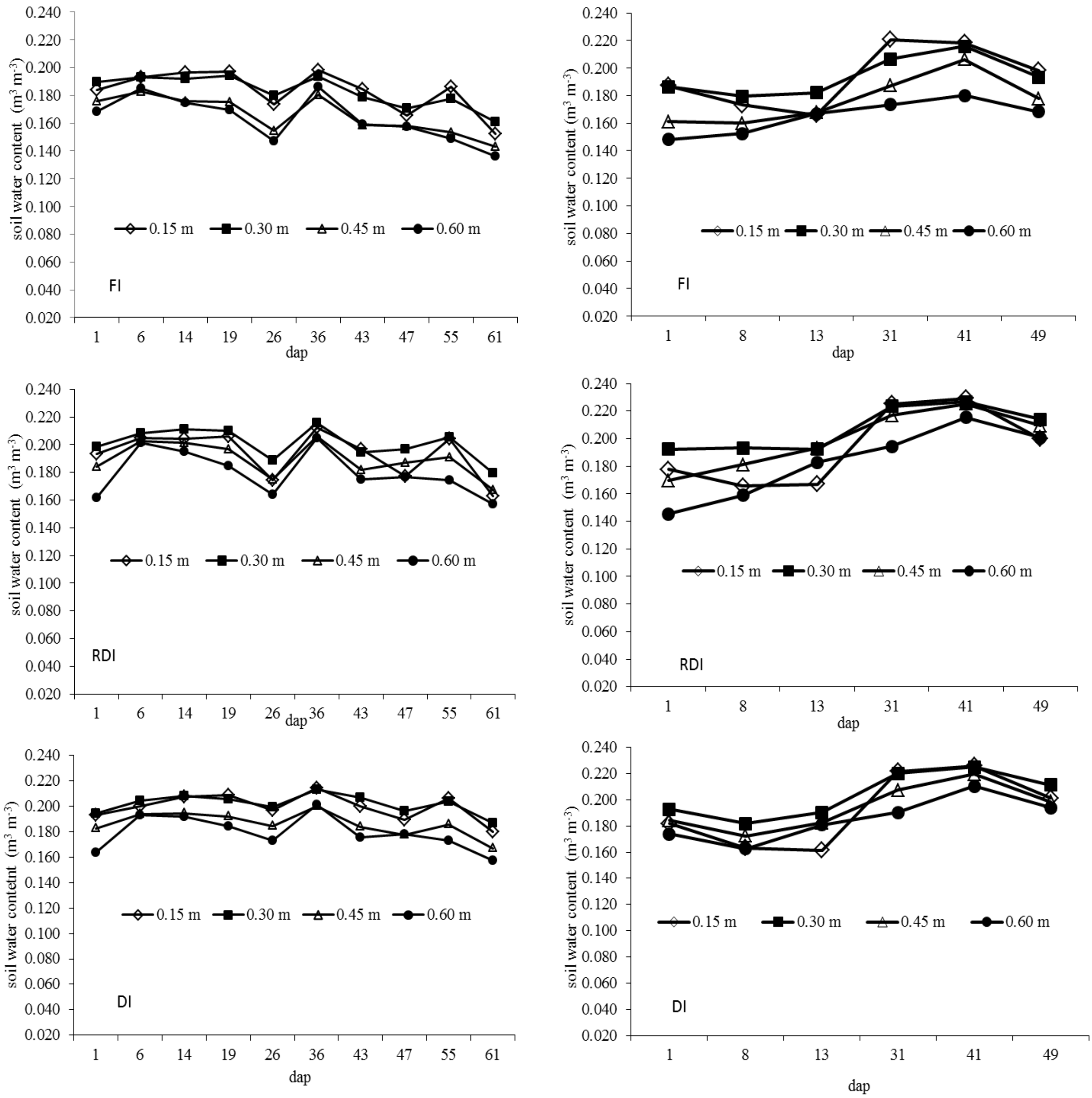
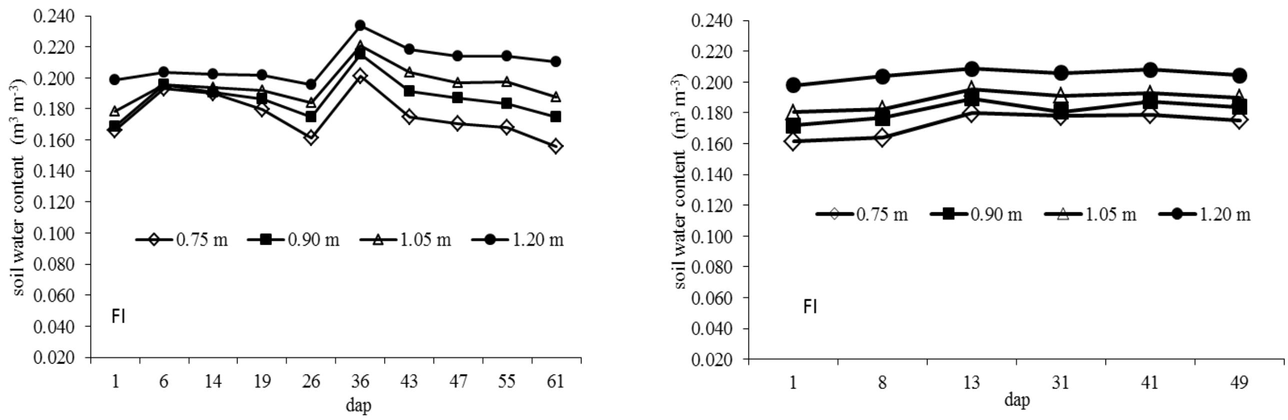


FIGURE 1. Soil water content average values at 0.15, 0.30, 0.45, and 0.60 m depths in the treatments full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI), as function of days after pruning (dap) in grape growing seasons from November 2010 to February 2011 (left) and from May to September 2011 (right).



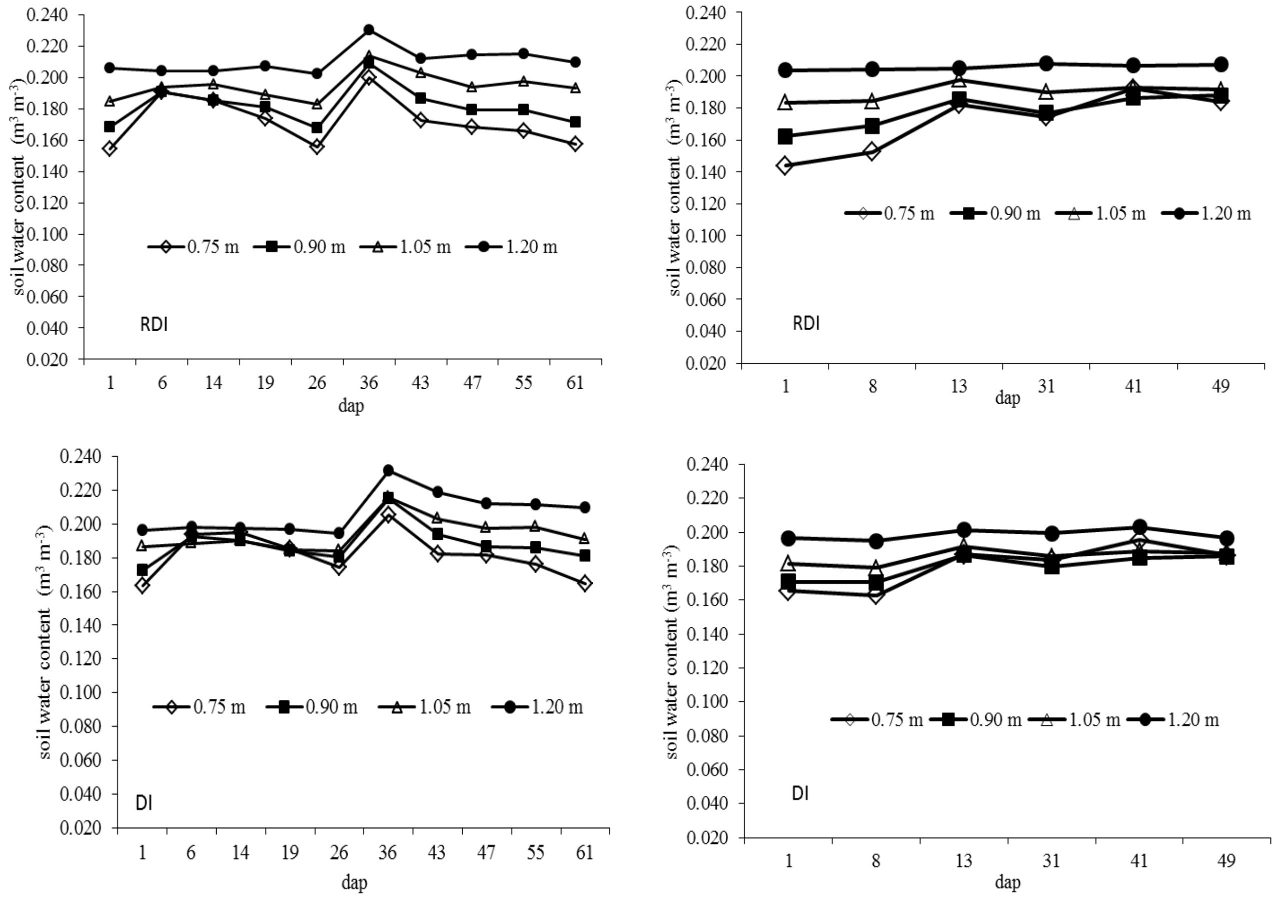


FIGURE 2. Soil water content average values at 0.75, 0.90, 1.05, and 1.20 m depths in the treatments full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI), as function of days after pruning (dap) in grape growing seasons from November 2010 to February 2011 (left) and from May to September 2011 (right).

During the second season, in all depths, (Figures 1 and 2, left), an increase of θ until 6 dap is observed due to irrigation initiation, and another increase due to rainfall occurred between 31 and 37 dap (132.9 mm). Consequently, the irrigations were stopped between 31 and 41 dap, which caused a reduction of θ between 36 and 43 dap in all depths. The reduction of θ between 55 and 61 dap, between 0.15 m and 0.60 m of depth, can be explained by the diminution of kc value from 1.0 to 0.8 at 54 dap. It must be highlighted that the effective depth of grapevine cv. Syrah on rootstock cv. Paulsen 1103 is of 0.6 m, according to SILVA (2005), which contribute to greater water absorption until this depth. In third season (Figures 1 and 2, right); the increased values of θ occurred caused by the beginning of irrigation practice and rainfall of 37.6 mm at 8 dap and of 4.4 mm at 14 and 15 dap. Nonetheless, the increased values of θ were greater in second season due to rainfall magnitude.

In the second grape growing season, from 65 dap, alterations in values of θ through the monitored soil profile were evidenced (Figures 3 and 4, left).

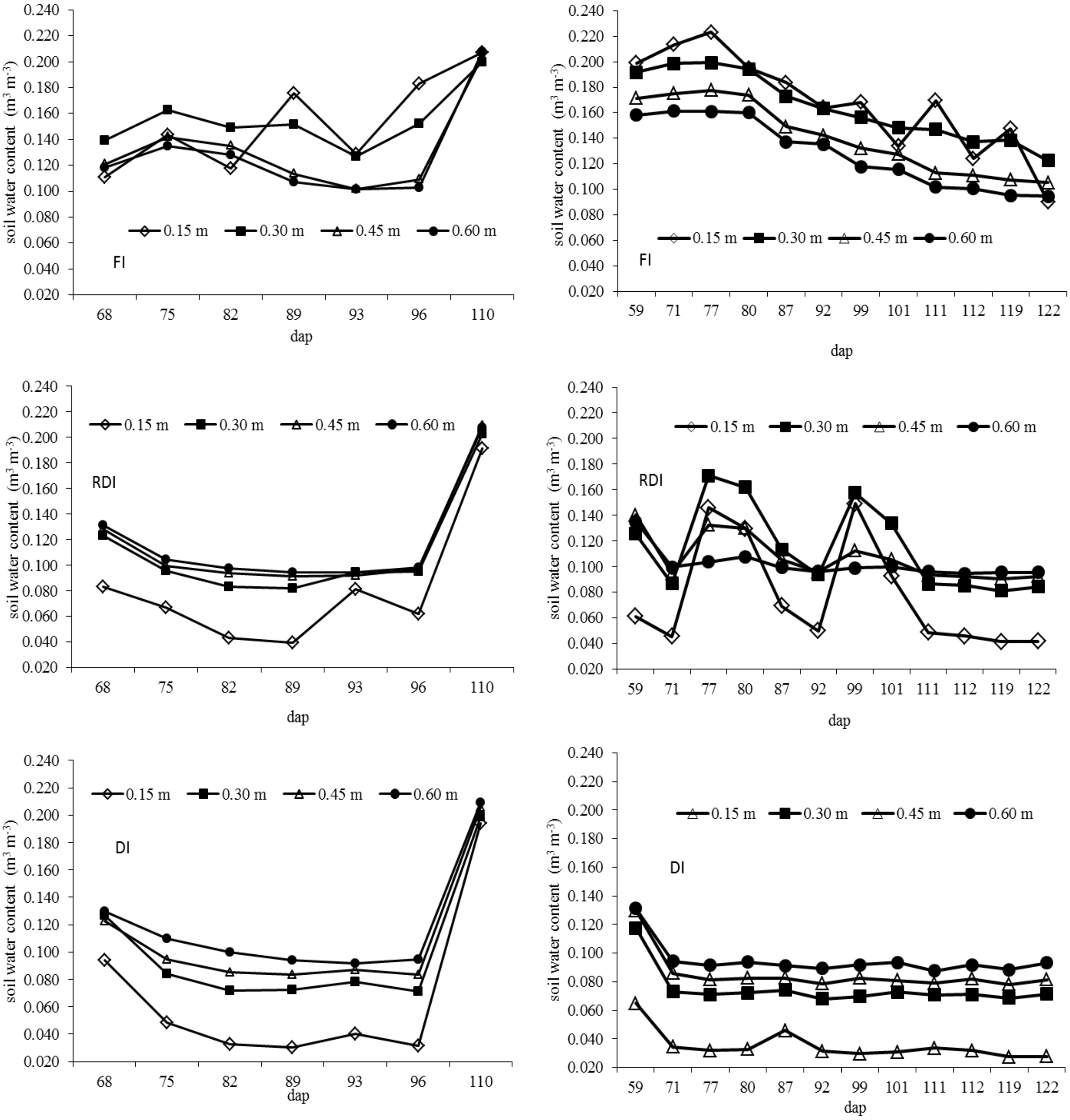


FIGURE 3. Soil water content average values at 0.15, 0.30, 0.45, and 0.60 m depths in the treatments full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI), as function of days after pruning (dap) in grape growing seasons from November 2010 to February 2011 (left) and from May to September 2011 (right).

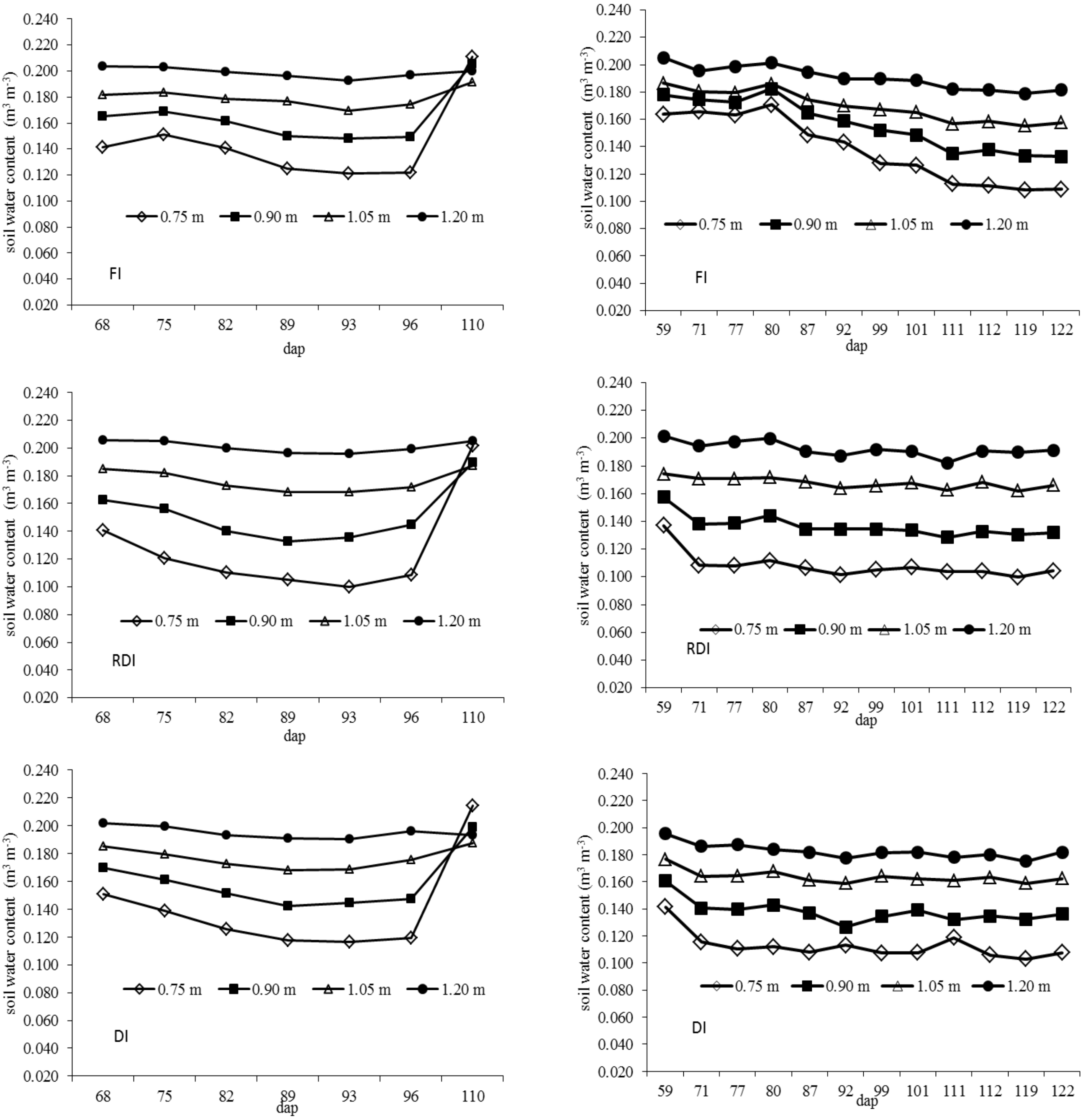


FIGURE 4. Soil water content average values at 0.75, 0.9, 1.05, and 1.20 m depths in the treatments full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI), as function of days after pruning (dap) in grape growing seasons from November 2010 to February 2011 (left) and from May to September 2011 (right).

A raise of θ took place in FI treatment at 68 dap, primarily in layers of 0.15 m and 0.30 m, thanks to a rainfall of 7.5 mm, between the 71 and 75 dap. This has caused irrigation interruption at 73 to 75 dap, and culminated in drop of θ starting from this date due to kc modification at 78 dap from 0.8 to 0.5, attributable to the beginning of maturation. Nevertheless, in treatments RDI and DI, by cause of irrigation interruption (65 dap), a decline in θ occurred until 89 dap, essentially in depth of 0.15 m. At 93 dap, the RDI treatment exhibits slightly increased values of θ, most evidently in depths of 0.15 and 0.30 m, as consequence of irrigation performed at 91, 92 and 93 dapp. The applied water volume was not sufficient to make it equal to FI, as a result of deficit from previous days, since the irrigation was conducted based on water demand of the day. Furthermore, in FI treatment, there was a diminution of 27.3% in θ at depth of 0.15 m, manifested between 89 and 93 dap, evidencing high water demand by the plant (Figure 3, left). Depths between 0.75 m and 1.20

(Figure 4, left) presented higher values of θ than the ones found in superior depths (0.15 to 0.60 m), for all treatments, and its values did not suffer alterations throughout time, indicating that irrigations in FI and RDI wetted predominantly the soil layer from 0 to 0.6 m of depth. The only observed modification in layer from 0.75 to 1.20 m of depth was at 110 dap, in all treatments, as consequence of rainfall occurred between 107 and 110 dap, which totalized 90.5 mm. The values of θ in all treatments were increased, confirming that water infiltrated and was redistributed in soil down to 0.9 m of depth, until 110 dap.

In third grape growing season starting from 59 dap, the increment on θ down to 0.60 m (Figure 3, right) manifested only in FI treatment, most evidently in depth of 0.15 m, and from 80 dap, θ gradually decreased. This was principally due to kc value change from 0.7 to 1.0 at 22 dap, a reduction to 0.8 at 83 dap and to 0.5 at 91 dap. In RDI treatment, θ was being lowered in depths from 0.15 to 0.60 m, starting from 59 dap; at 73; 76; 94 and 97 dap, irrigations were performed and provided the raise of θ at 0.15; 0.30 and 0.45 m of depth. In DI treatment, that included 72 days without irrigation, θ showed low values, but at 83 dap, by cause of 10.9 mm rainfall, it slightly increased from θ to 0.15 m of depth.

Still regarding third growing season, and for depths between 0.75 and 1.20 m in FI treatment (Figure 4, right), the values of θ were within the limits of the same variation interval in depths from 0.15 to 0.60 m (Figure 3, right). Only from 87 dap, a gradual θ decline started in depths of 0.90; 1.05 and 1.20 m. About RDI and DI treatments, the results were extremely similar. From 59 dap, the θ reduction was perceptible from irrigation interruption at 49 dap; and from 77 dap, there was a stabilization of θ values until the end of the third growing season. The irrigations performed at 73; 76; 94 and 97 dap, in RDI treatment did not induce θ increase in depths from 0.75 to 1.20 m.

The average values of Ψ_{leaf}, measured in each treatment and in both growing seasons, are presented on Figure 5.

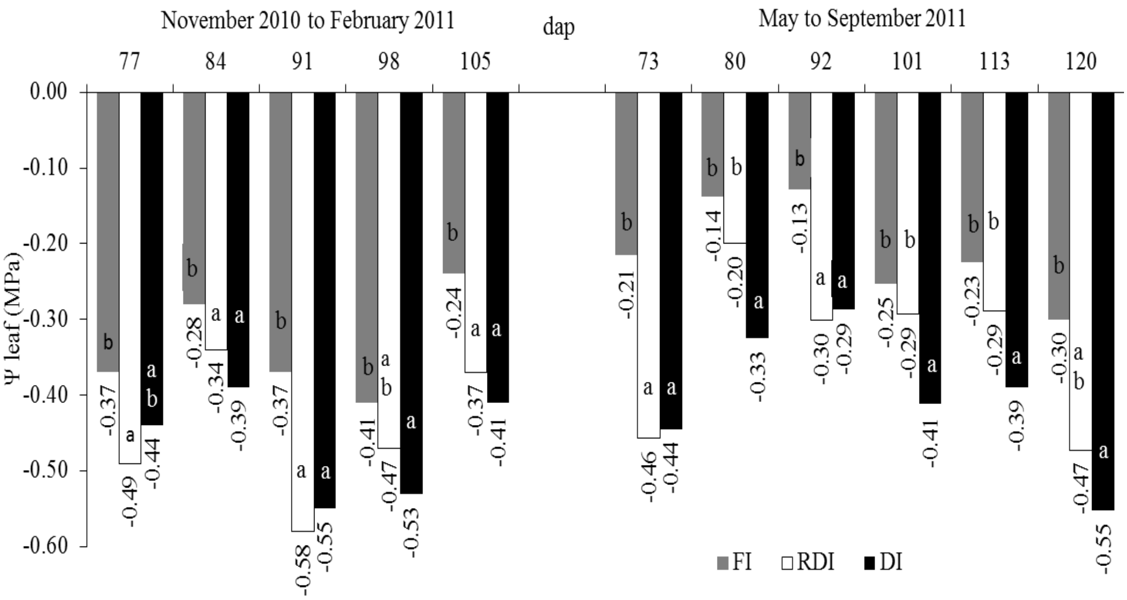


FIGURE 5. Leaf water potential (Ψ_{leaf}) in vine cv. Syrah in the treatments full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI), as function of days after pruning (dap) in grape growing seasons from November 2010 to February 2011 (left) and from May to September 2011 (right).

In second grape growing season (Figure 5, left), at 77 dap (12 days after irrigation interruption in RDI and DI), the Ψ_{leaf} in FI treatment was higher than in RDI treatment, not differing from DI treatment. It is worth noting that between 73 and 75 dap, total rainfall of 7.5 mm took place and on the evaluation day (77 dap), there was a 0.3 mm rainfall. At 84 and at 91 dap (respectively, 19 and 26 days after irrigation interruption in RDI and DI), the treatments with water restriction kept inferior water potential, differing from FI treatment. In this period, a drop in average values of all treatments occurred, and more steeply in RDI, with variation of 71%, while the others varied 32% in FI and 41% in DI, which, together with θ evaluation, signalized necessity of irrigation in RDI, as this treatment consisted of regulated deficit. Thus, at 91, 92 and 93 dap, a total irrigation depth of 8.4 mm was applied in RDI treatment. At 98 dap, a rainfall of 0.4 mm occurred and as a consequence of irrigation performed in RDI treatment, the value of Ψ_{leaf} was intermediate compared to other treatments, and did not differ from both but the FI differed from DI. At 105 dap, the RDI and DI treatments presented average values of Ψ_{leaf} similar between themselves and different from FI treatment. The increase on values of Ψ_{leaf} in 3 treatments, in the last assessment, was attributable to total rainfall of 6.3 mm at 103 and 104 dap.

During the third growing season, Ψ_{leaf} (Figure 5, right) was higher for FI treatment throughout the period of determinations. At 73 dap, 25 days after the beginning of irrigation interruption, the FI treatment was superior to the others. At 80 dap, the FI and RDI treatments were statistically similar by reason of the irrigation conducted at 73 and 76 dap to replace water in RDI treatment, and higher than DI treatment; in all treatments, the values of Ψ_{leaf} were higher than the observed in the first determination, at 73 dap. At 92 dap, the RDI and DI were once again similar between themselves but lower than FI treatment. At 101 dap, the performance observed at 80 dap repeated itself, as a consequence of rainfall occurred at 94 and 97 dap. At 113 dap, the treatments differed among themselves, as the rainfall occurred at 106 and 108 dap were of low magnitude (10 mm). At 120 dap, the values of Ψ_{leaf}, for the same treatment, decreased in relation to previously measured ones, due to reduction of water application by irrigation, and FI treatment differed from RDI.

The values of Ψ_{leaf} presented here are consistent with SILVA (2005) and SOUZA et al. (2009) findings, for cv. Syrah grapevine submitted to deficit irrigation strategies, in Petrolina. Notwithstanding, the average values of leaf water potential were near the ones found by BASSOI et al. (2011) in an experiment located at the same area and during the first grape growing season (April to August of 2010), when the average values of potential were -0.25 MPa for FI treatment, -0.37 MPa for RDI treatment and -0.38 MPa for DI treatment.

In Brazilian Semiarid, many irrigated soils demonstrate problems related to drainage, which can be associated to presence of sub superficial densed layers, low to medium soil depth, low permeability that, when associated to abundant irrigation throughout the year and for several years, can cause a significant storage of water volume in soil deeper layers, potentially exploitable by some fruit crops (SILVA et al., 2002; RIBEIRO, 2010). Consequently, during the whole period of crop development, even when under deficit irrigation in part of grape growing seasons, soil water lower than 0.6 m presented relatively high values, a fact also observed by SILVA (2005) and BASSOI et al. (2011) in the same area. Moreover, the roots of grapevine Paulsen 1103 rootstock reached depth of 1 m at 16 months after planting, with effective depth at 0.6m, and soil profile with mottled aspect, an indicative of slow drainage, was also observed (SILVA, 2005). Thus, the level of water deficit found in cv. Syrah grapevine was characterized as of moderate intensity (between -0.4 and -0.6 MPa), according to DELOIRE et al. (2004).

Table 1 enables the observation that bunch number did not present differences among treatments, in two evaluated growing seasons while bunch weight per plant and bunch average weight only presented differences among irrigation strategies in the third growing season, with the greatest values attributed to FI treatment. Between treatments RDI and DI, bunch weight per plant was higher in the first but bunch average weight did not differ between both. It should be emphasized that in the pruning, 3 buds per secondary branch and 3 secondary branches in each lateral branch (18buds/ plant) were left in all treatments and in both assessed seasons. In second growing season, the rainfall of 252 mm was considered, with 105.4 mm occurred after irrigation interruption in RDI and DI treatments, which contributes to result similarity among the treatments. BASSOI et al. (2011) found, in the first grape growing season (April to August of 2010), individual weight values of bunches that were superior in FI and RDI treatments, compared to DI treatment, at 1% of probability, as the greatest availability of water for the crop, in FI and RDI treatments, favored berries' better development. Such result was similar to findings from the third growing season.

TABLE 1. Bunch number and weight, 100 berries weight, must volume of 100 berries, total soluble solute content, pH and total titratable acidity at harvest time of two growing seasons of cv. Syrah grapes, in full irrigation (FI), regulated deficit irrigation (RDI), and deficit irrigation (DI) treatments.

Season	10 Nov 2010 to 28 Feb 2011			10 May to 8 Sep 2011		
Treatment	FI	RDI	DI	FI	RDI	DI
Number of bunches per plant	11.41 a	10.54 a	11.36 a	13.15 a	12.61 a	10.91 a
Bunch weight per plant (kg)	1.46 a	1.52 a	1.48 a	1.98 a	1.54 b	1.20 c
Bunch average weight (kg)	0.13 a	0.14 a	0.13 a	0.15 a	0.12 b	0.11 b
Weight of 100 berries (g)	188.66 a	93.15 b	182.26 a	-	-	-
Must volume of 100 berries (ml)	68.33 a	37.67 c	61.67 b	-	-	-
Total soluble solids (^{o}brix)	20.43 a	20.70 a	20.60 a	22.63 b	25.30 a	24.95 a
pH	3.60 a	3.63 a	3.63 a	3.53 a	3.58 a	3.58 a
Total titratable acidity ($g.L^{-1}$ tartaric acid)	5.90 ab	6.55 a	5.65 b	6.79 a	5.89 b	5.63 b

Still from Table 1, in the second grape growing season, the weight and the volume of 100 berries were influenced by irrigation strategies, like the occurred in the first growing season (BASSOI et al., 2011). The FI and the RDI presented, respectively, the highest and the lowest values, once the DI presented intermediary values. Weight and volume data of de 100 berries for the third growing season were not obtained.

The berries present growth that follows a double sigmoid curve, because of two growing phases intercalated with an intermediate one, with little or no berry growth. The interruption or reduction of irrigation, causing water deficit in the first stage, can reduce number of cells per berry, an effect that is not reverted with irrigation increase. Cell number, cell volume and content of organic solutes (DOKOOZLIAN, 2000) influence size or potential weigh of bunch. The irrigation interruption occurred in stage of bunch closure, before the beginning of maturation, after the first bunch-growing season. Deficit irrigation (RDI and DI) might have contributed to lower weight and volume of berries during harvest. Furthermore, reducing water availability to plants can lead to a decrement of berries diameter, which is an important factor in maceration process to obtain quality red wines, besides increasing soluble solid concentration, ratio peel/ pulp and concentration of anthocyanin (ACEVEDO-OPAZO et al., 2010).

The values of SS only presented differences among irrigation strategies in the third grape's growing season, with lower value for FI treatment, while pH remained without differences among treatments, in both growing seasons. Regarding TTA, its value in DI was inferior and differed from RDI value, but not from the FI value, which was intermediate and not different from others, in the second growing season. These differences can be attributed to rainfall at the end of this cycle, and to irrigations in FI and RDI. In the third cycle, TTA was higher in FI treatment (Table 1). In the first growing season of this grapevine, the values of SS and pH did not differ, once the values of TTA, weight and volume of 100 berries were lower in DI treatment (BASSOI et al., 2011).

In growing season between November of 2010 and February of 2011 (rainy season), water use efficiency (WUE) for FI treatment did not differ from RDI and DI treatment, but when the quantity of occurred rainfall in all growing season was not considered, the WUE of RDI and DI treatment was equal and higher than the one from FI treatment. In the following growing season (May to September of 2011, dry season), the WUE of FI treatment was inferior to the ones from RDI and DI treatments, considering or not the rainfall (Table 2).

TABLE 2. Water-use efficiency (WUE, kg.m^{-3}) in full irrigation, regulated deficit irrigation, and deficit irrigation treatments, during two growing seasons of cv. Syrah grapes.

Season	10 Nov 2010 to 28 Feb 2011		10 May to 8 Sep 2011	
Treatments	WUE (without rain)	WUE (with rain)	WUE (without rain)	WUE (with rain)
FI	1.27 b	0.77 a	3.02 b	2.34 b
RDI	1.98 a	1.00 a	4.93 a	3.05 a
DI	2.02 a	1.00 a	4.64 a	2.66 ab

CONCLUSIONS

The deficit irrigation and regulated deficit irrigation strategies in cv. Syrah grapevine, when applied during rainy and dry season, in Petrolina, altered some quantitative and qualitative grape components, in distinct ways.

However, irrigation strategies based on water restriction in wine grapevine, together with the monitoring of water quantity present in soil and in plant, enabled savings regarding water use by plants, representing an alternative for irrigation management of this crop in Brazilian Semiarid.

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