

**GÁLIA MELONS PRODUCTION IN PROTECTED ENVIRONMENT UNDER DIFFERENT IRRIGATION DEPTHS**

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**ABSTRACT:** The study aimed to evaluate the “Gália” melons productive characteristics grown in greenhouse under different irrigation levels, and conducted with and without soil cover by plastic mulching. Experiments I (WC) and II (WtC) were conducted simultaneously in a protected environment, using a completely randomized design (CRD), where plants of Gália melons (Hybrid Nectar cv.) received five levels of water depth defined by 50, 75, 100, 125 and 150% of evapotranspiration (water requirement), with four replications, differing only by utilization (WC) or not (WtC) of plastic mulching. The results showed that the variables productivity, average weight, length and diameter of the fruits were affected by different levels of water replacement in the soil regardless the use or not of the soil cover. The largest reductions in productivity 46.32 and 32.03% were observed for the treatment of 50%, compared to the treatment of 100% for experiments I (WtC) and II (WC), respectively.

**KEYWORDS:** irrigation management, protected environment, productivity.

**INTRODUCTION**

Nobles Melons such as “Gália” type increase every day their market share, mainly due to their productive and qualitative characteristics. The successful production of this type of melon depends on the use of technologies that allow the maximization of profit and increased productivity with minimal power supply, water and labor.

Given the current water crisis some technologies can be employed to minimize waste and promote the rational use of water in the Brazilian agriculture, which represents approximately 54% of the fresh water consumed in the country (BRAZIL, 2012).

The micro irrigation stands as a technology to be used in water economy; beyond the economic aspects of agricultural production (FRIZONNE et al., 2012). Another technology is coupled to plastic mulching, which together with the drip irrigation reduces loss of soil humidity by evaporation and reduces the irrigation need by the cultures (SAMPAIO& ARAÚJO, 2001).

In this regard, irrigation management becomes an important tool to increase the efficiency use of water, the productivity and the economic return of crops. The hydric balance can be used by keeping the soil always close to field capacity, preventing the plant suffers with water stress.

Some surveys have shown that the melon is sensitive to drought with reduced production and size of the fruit if grown with water restriction (DANTAS et al., 2011; ZENG et al., 2009; CABELLO et al., 2009; LI et al., 2012). Moreover, water excess in the soil may result to reduced productivity, and quality problems on fruits in different cultures (CABELLO et al., 2009; OLIVEIRA et al., 2011; CARVALHO et al., 2011; SANTANA et al., 2009; DOGAN et al., 2008).

The melon cultivation in a protected environment, proper irrigation management and the use of plastic mulching, are widely used technologies. However, there is lack of studies on yield responses of melon under water stress effect to the climatic characteristics of the South of Minas Gerais.

Therefore, the study aimed to evaluate the production characteristics of the “Gália” type melon, nectar cultivar, grown in a greenhouse, changing the applied water depth and soil cover.

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## MATERIAL AND METHODS

The experiments were conducted in the Water and Land Sector of the Engineering Department of the Federal University of Lavras, Lavras-MG, located at 21°14'00" south latitude and 45°00'00" west longitude and 918 m altitude. The climate according to Koppen climate classification is Cwa. The average annual temperature is 20.4 °C and average annual rainfall of 1460.0 mm (DANTAS et al., 2007).

The protected environment includes wood structure, covering with metallic bow and transparent plastic films in polyethylene 150 microns with anti-UV treatment, and fully closed side, with anti-aphids screen (mono filament of high density polyethylene). Inside it was installed thermo hygrometer for monitoring air temperature and relative humidity and an A class tank reduced to compute the daily evaporation.

The study consisted of two experiments conducted simultaneously. A completely randomized design (CRD) was used where plants of *Gália* melons (cv. *hybri Nectar*) spaced 1.0 x 0.5 m were subjected to five percentage of water depths replacement of 50, 75, 100, 125 and 150% of evapo transpiration (water requirement) with four replications. Experiments I and II were conducted with the surface without ground cover (WtC) and with ground cover (WC), respectively.

The soil used for filling the pots was Oxisol clayey. The soil was removed in 0-0.20m deep layer. It was dried outdoor and sieved on 4 mm sieve. Subsequently withdrew a sample for fertility analysis which was performed in the Soil Fertility Laboratory of UFLA.

At the bottom of the pots was made a hole and a connector was adapted, and a tube was connected to the pot to a 2-liter bottle for collecting the amount of water drained. Within each pot was added a layer of sand (2 kg) and on it a thin polyethylene screen. Following, the volume of the pot was completed with sieved soil and fertilized according to the result of the fertility analysis and based on the recommendation by CFSEMG (1999). In each pot was placed 0.100 kilograms of dolomite lime, 2.5 kg of commercial organic compound, 0.036 kg of urea, 0.28 kg of superphosphate and 0.0533 kg of potassium chloride.

The pots with volume of 20 liters were placed in the stands 0.20 m tall. The spacing between the countertop was 1.0m, and between the pots was 0.50m. On 02/06/2014 the melon seedlings were transplanted to pots, and placed one plant per pot.

The plants were put on vertically on single stem system, held by polythene strips arranged across the wire strands throughout their cycle. All lateral shoots until the 11th inter-node were removed, later in the subsequent nodes were left only two secondary stems per plant because in each stem has formed a fruit. In the secondary stems were removed all the emerged sprouts and pruning of the side stem was carried out, one leaf after the fruit (ALVARENGA & RESENDE, 2002).

It was used a drip irrigation system with self-compensating emitters (online) within the working pressure range recommended by the manufacturer with a flow rate of 4.0 L h<sup>-1</sup> with one dripper per plant. It was determined the uniformity coefficient of water distribution (UCD) of the irrigation system, which yielded an average flow rate of 4.02 L h<sup>-1</sup> and (UCD) of 98.13%.

Irrigation was performed daily and water volume applied to each replacement treatment was defined based on the amount of evapo-transpired water (consumed) in the treatment of 100% replacement. Before irrigation the volume of drained water was collected and measured. The volume of water to be applied in the treatment of 100% replacement was calculated based on water balance equation:  $ET=I-D$ , where ET is the evapo-transpiration (consumed volume), I was the applied volume in the previous irrigation and D is the drained volume. In other treatments the applied volume was calculated by multiplying the obtained volume for 100% treatment by the percentage set for each treatment.

In the first 12 days after transplanting (DAT) was daily applied a 10 mm water depth in order to facilitate the standardization of fruit set and seedlings. The treatments differentiation began from 13 DAT.

Harvest started on 76 (DAT), 04/24/2014, using as criteria for fruit withdrawal the peel color and the stem cavity. The control of pests and diseases, as well as the weed control was performed periodically.

After harvest the fruit was weighed individually on a digital balance accurate to 5g. To determine productivity were considered 20,000 plants per hectare, and the results were expressed as mega grams per hectare. Longitudinal and transverse diameters were determined through direct measurement of all the fruit of each treatment using a digital caliper, with values in mm.

The water efficient use ( $\text{kg m}^{-3}$ ) was obtained for each irrigation management through the relation between fruit yield ( $\text{kg ha}^{-1}$ ) and water consumption ( $\text{m}^3\text{ha}^{-1}$ ) during the crop cycle (DOORENBOS & KASSAM, 1994).

The data were submitted to analysis of variance and when significant was made regression analysis. Statistical analyzes were performed using the SISVAR version 5.3 software (FERREIRA, 2011).

## RESULTS AND DISCUSSION

In carrying out the trials WtC and WC, the maximum temperature obtained within the environment varied between 23.70 and 39.20 °C, the minimum ranged between 13.10 and 21.60 °C and average between 20.15 and 28.85 °C. It was observed that the average air temperatures were within the optimum range for better growth and yield of melon crop, between 20 and 30°C.

The average relative air humidity ranged between 61 and 90% within the protected environment with most of the time near the moisture range considered ideal for melon cultivation, between 65 and 75% (BRANDÃO SON & VASCONCELOS, 1998).

The total water depth applied in the treatment of 100% at the end of the experiments (WtC) and (WC) were 185.32 and 166.92 mm and total drained water depth was 15.96 and 13.42 mm, respectively. In the experimental treatment of 100% the total drained water evapo-transpired (consumed) was 169.36 mm (WtC) and 153.50 mm (WC). The percentage of water replacement depth and the water depth consumed in each treatment during the conduct of experiments (WtC) and (WC) are shown on Table 1.

It is observed for treatment of 100% that the total water depth applied to the experiment (WC), was less than the one applied in the experiment without plastic ground cover (WtC), with a saving of 9.36% in water consumption. This difference in consumption took place mainly in initial and development of culture, since evaporation factor is predominant. In all treatments the amount of water applied was lower in those with plastic mulching, representing a saving in water consumption above 9%.

TABLE 1. Depth Percentage of corrected replacement of applied water depth (PC), consumed water level (CW) for each treatment applied in the experiments (WtC) and (WC).

Trat. (%)	-----PC (%)-----		-----CW (mm)-----	
	WtC	WC	WtC	WC
50	54.71	54.37	92.66	83.46
75	82.07	81.55	139.00	125.20
100	100.00	100.00	169.36	153.50
125	136.78	135.92	231.66	208.66
150	164.14	163.11	277.98	250.38

In Figure 1 are shown the values for the water depth evaporated from “A” class tank diminished and the ratio between water consumed (Wc) and evaporation of the tank (Ev) obtained for treatment 100% of the consumed water depth during conducting experiments (WtC) and (WC).

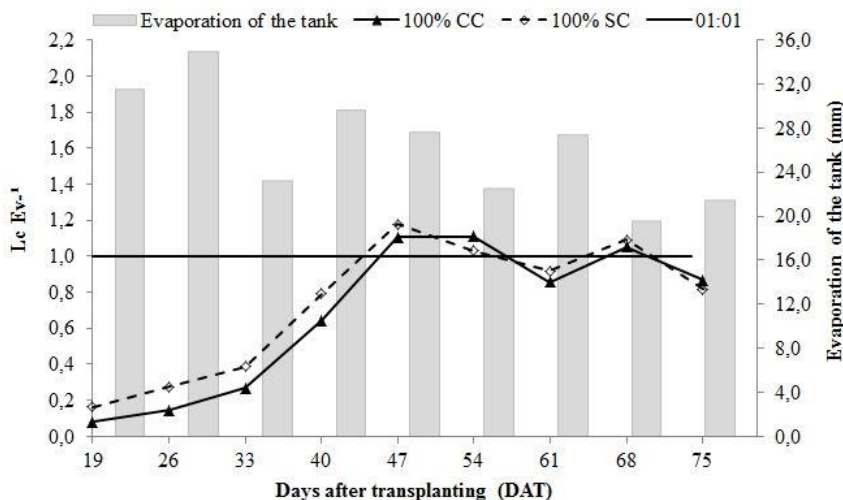


FIGURE 1. Relationship between the water consumed in the treatment 100% and the evaporation in the reduced tank to a cumulative of 7 days during the experiments (WtC) and (WC).

It is observed that the evapo-transpired depth (consumed) used until 47 (DAT) was less than evaporation of “A” Class tank reduced and installed inside the environment, from there, the values approached, and the relation remained close to the unit 68 (DAT), and fell again.

There was a lower water consumption in general, at the initial stage of culture, regardless of the use or not of the soil cover, as reported by PIRES et al. (2013), corroborating with the results of this study.

MOTTA et al. (2010) evaluated the water storage in a Cambisol cultivated with melon crop; drip irrigated, with and without soil surface cover, and concluded that the soil surface covering increased water storage, especially in initial and vegetative stages of the culture.

In Table 2 is presented the summary of the analysis of variance for the WC experiment. It can be seen that the variables were significantly affected by treatments.

TABLE 2. Variance analysis for average productivity in Mg ha<sup>-1</sup> (PROD), average fruit weight in grams (AFW), length in mm (FL), and diameter in mm (FD), for the treatments (Experiment WtC).

VS	DF	MS			
		PROD (Mg ha <sup>-1</sup> )	AFW(g)	FL (mm)	FD (mm)
Treatment	4	322.28**	201447.30**	530.04**	329.58**
Residue	15	59.18	36988.11	86.40	56.28
CV(%)		18.90	18.90	7.38	6.23
Average		40.69	1017.38	125.98	120.45

\*\* significant by F test at 1% probability

In Figure 2 (A, B, C and D) are shown the mean values of productivity, average weight, length, and average diameter of fruits depending on the water depth obtained in each treatment. Treatments where the water depth were applied with water deficit, 92.66mm (50%) and 139.00mm (75%), the decline in average productivity (PROD), average fruit weight (AFW), length (FL) and average diameter (FD) of fruit was more pronounced. However, the treatments where the water depth was applied in excess, 231.66 (125%) and 277.98mm (150%), also promoted reduction of these parameters.

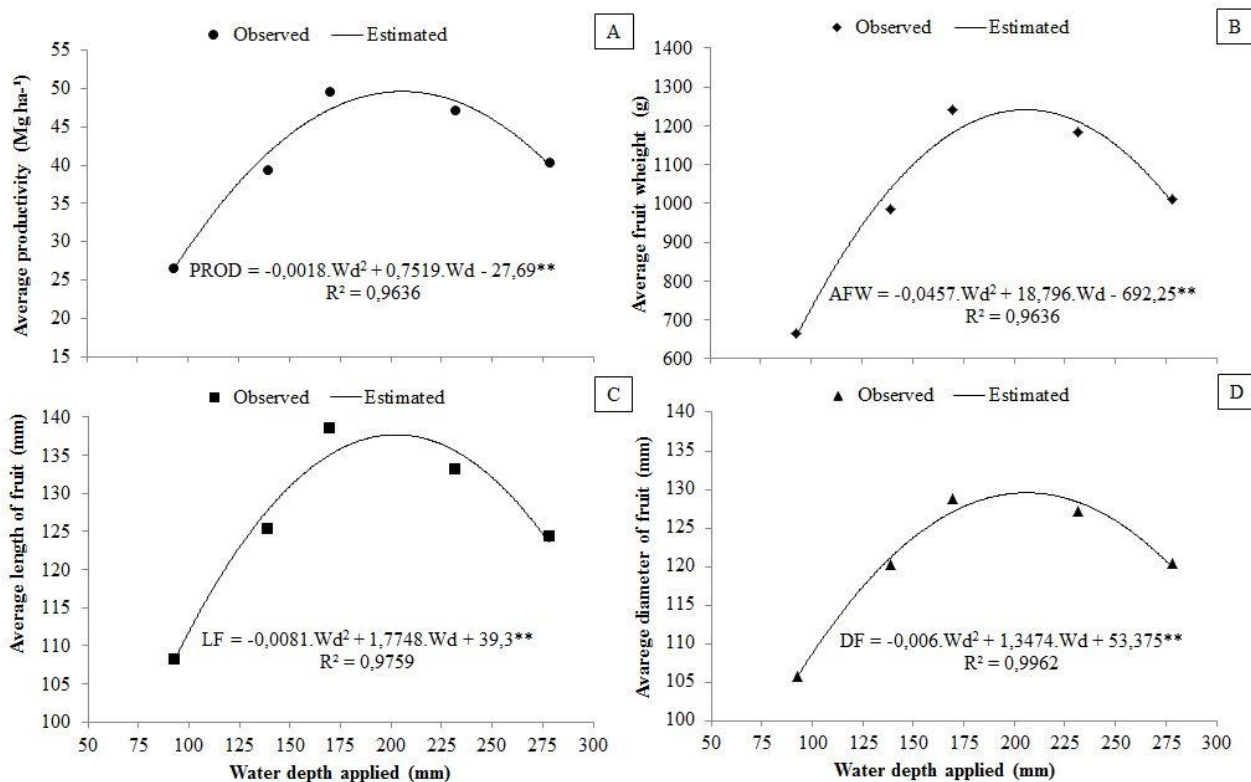


FIGURE 2. Average productivity (A), fruit weight (B), fruit length (L), and fruit diameter (D) for Gália melons, according to different water depths in experiment WtC.

There was an average productivity variation depending on water depth applied in each treatment, reaching the peaking of 50.86 Mg ha<sup>-1</sup> for a water depth applied of 208.9mm, decreasing from this point.

The regression analysis applied for the data indicate that the model well described the behavior for the considered interval with coefficients of determination ( $R^2$ ) above 95%.

Table 3 shows the summary of variance analysis for the variables productivity, average weight, length and diameter of the fruits observed in the experiment WC.

TABLE 3. Variance analysis for average productivity in Mg ha<sup>-1</sup>(PROD), fruit weight in grams (AFW), length (FL), and diameter (FD), for the treatments (Experiment WC).

VS	DF	MS			
		PROD (Mg ha <sup>-1</sup> )	AFW (g)	FC (mm)	FD (mm)
Treatment	4	140.61**	6.33**	141.41**	130.35**
Residue	15	22.81	6.61	24.57	22.15
CV(%)		12.42	3.86	4.04	3.95
Average		38.45	133.56	122.79	119.22

\*\* significant by F test at 1% probability

The highest average values of productivity, average fruit weight, length (FL) and diameter (FD) of the fruit were obtained for a water depth applied to 153.50mm (100%). For water depths applied with water deficit 83.46mm (50%) and 125.20mm (75%) or excess 208.66mm (125%) and 250.38mm (150%) were observed lower values.

The average values of productivity, average weight, length, and fruit diameter as a function of water depth obtained from each treatment in the experiment with no soil cover (WtC) are shown on Figure 3 (A, B, C and D).

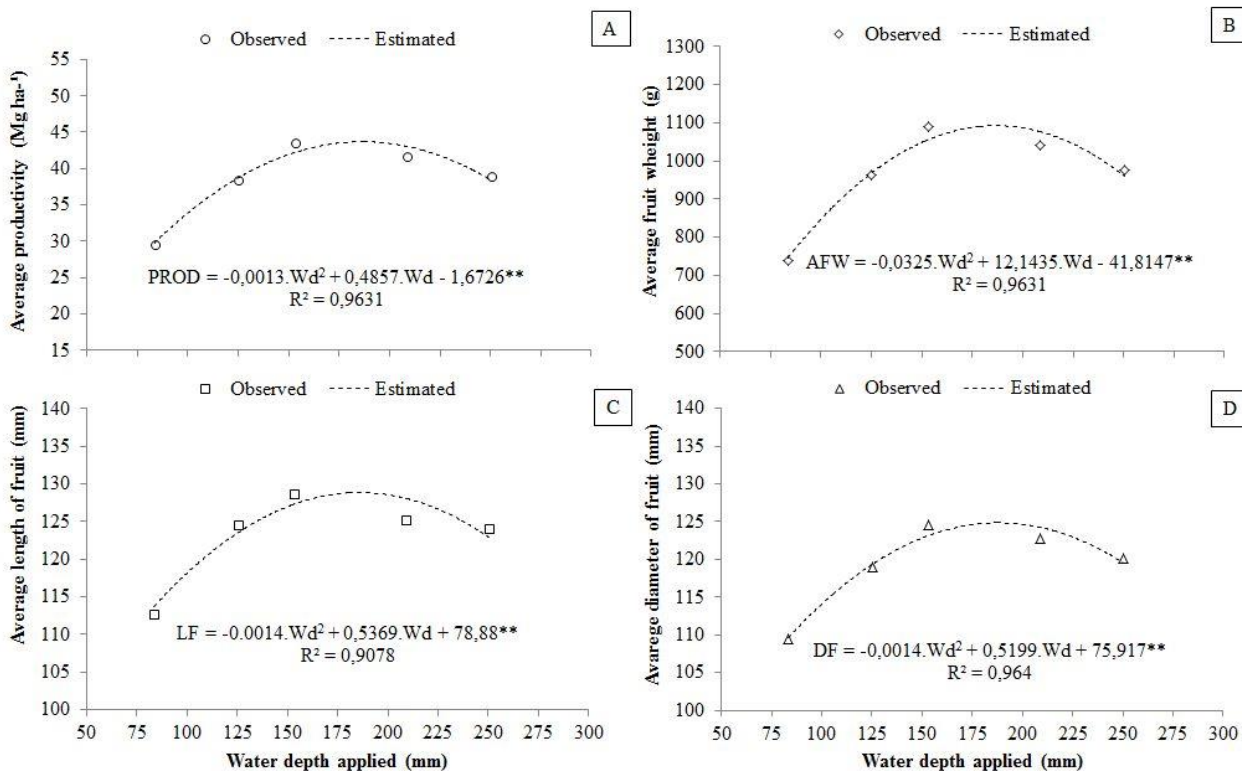


FIGURE 3. Average productivity (A), Average fruit weight (B), Average fruit length (L) and Average fruit diameter (D) for Gália melons, according to different water depth in experiment II.

It is observed a quadratic polynomial drop to the average productivity as a function of the water depth applied in each treatment. The maximum productivity was 43.69 Mg ha<sup>-1</sup> for water depth of 186.88mm.

Regression analysis applied to the data indicates that the model well described the behavior for the considered range, with coefficients of determination (R<sup>2</sup>) above 90% for all analyzed variables.

Considering the treatment of 100% as a reference, that is, one that promoted greater productivity, average weight, length and fruit diameter, was attributed the relative reduction percentage for each productive variable analyzed by the treatments (Table 4).

TABLE 4. Water deficit percentage (WDP), relative decrease of productivity (RPROD), average fruit weight (RAFW), length (RFC) and fruit diameter (RFD) for the treatments applied to the experiments WtC and WC.

Trat. (%)	---WDP (%)---		---RPROD (%)---		--RAFW (%)---		---RFC (%)---		---RFD (%)---	
	WtC	WC	WtC	WC	WtC	WC	WtC	WC	WtC	WC
50	45.29	45.63	46.32	32.03	46.29	32.03	21.91	12.35	17.86	12.14
75	17.93	18.45	20.60	11.60	20.69	11.60	9.56	03.16	06.60	04.52
100	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
125	36.78	35.92	04.79	04.43	04.78	04.43	03.88	02.63	01.26	01.51
150	64.14	63.11	18.66	10.45	18.65	10.45	10.28	03.50	06.50	03.61

It is observed that both the excess as the water deficit in the plants, promoted losses in productivity, diameter and average length of the fruits in the experiments (WtC) and (WC). The decrease of 17.93% and 18.45% in evapo-transpiration water depth (consumed) obtained in the treatment of 100% caused drop of 20.60% and 11.60% in average fruit productivity in the experiments (WtC) and (WC), respectively. For the treatment of 50% where the reduction of the

water depth was more pronounced 45.29% and 45.63% were observed largest decreases in average production of 46.32 and 32.03% for the experiments (WtC) and (WC), respectively.

Corroborating with the present results, the reduction in fruit size and productivity were also observed by LI et al., (2009); ZENG et al., (2009) and SHARMA et al., (2014), when submitted melon plants to different conditions of drought, finding higher yields for treatments where the soil was kept under better soil moisture conditions.

CABELLO et al., (2009) studied the effect of water stress on the yield of melons cv. Sancho, under field conditions, they found that a deficit of 25% of the crop evapo-transpiration (ETC) did not affect significantly the production; however, water deficit of 40% of ETC resulted in a production decrease of 22% compared with the treatment without water deficit.

DANTAS et al., (2011) observed that plastic cover use provided a significant increase in productivity and the increase in average fruit weight on 20% on average compared to treatment with bare soil. According to the authors, the standard water depth of 452 mm can be reduced by up to 28% without changing the production even with lower average fruit weight by 11%.

For treatments (125% and 150%) of consumed water depth where the water was applied in excess, the productivity decreases were 4.79 and 18.66%, and 4.43 % and 10.45% for experiments with and without soil cover, respectively.

OLIVEIRA et al., (2011); CARVALHO et al., (2011); SANTANA et al., (2009); and DOGAN (2008) reported production losses due to excessive application of irrigation water. On the other hand CABELLO et al., (2009) applying 125 and 140% of the ETC found that the treatments did not significantly affect the melon production.

On Figure 4 (A and B) shows the values of water efficiency use (WEU) depending on water depth consumed in experiments without cover and with ground cover.

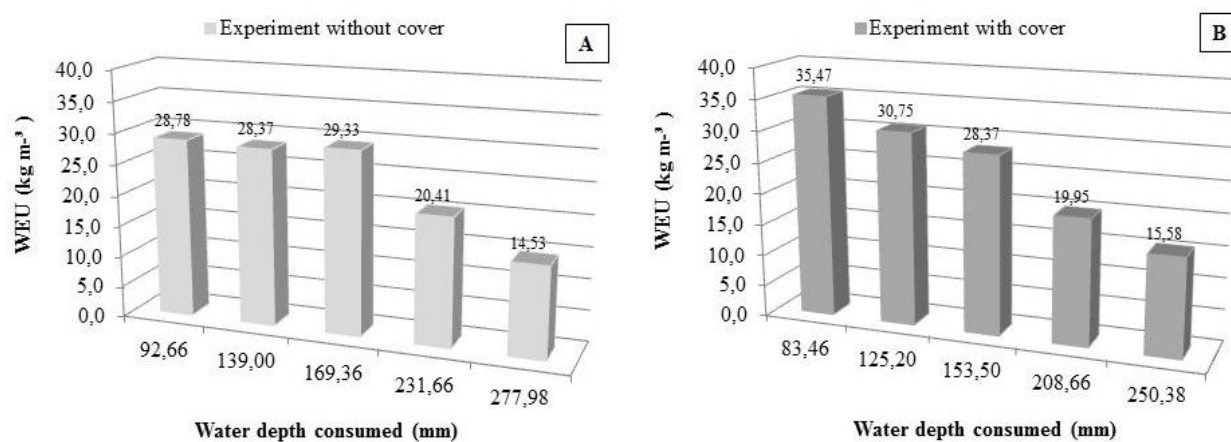


FIGURE 4. Water efficiency use (WEU) of experiment I, without mulching (A) and with mulching (B) for different water depth applied in “Gália” melon.

Further efficiency use of the water 29.33 kg m<sup>-3</sup>; 28.37kg m<sup>-3</sup>and 28.78 kg m<sup>-3</sup> were obtained for the water depth consumed 169mm, 36mm (100%); 139.00mm (75%) and 92.66mm (50%), respectively, for the experiment without plastic mulching (Figure 4A). Table 2 shows that the reduction in water evapo transpiration depth (consumed) promoted proportional loss on productivity which explains the similarity in the water efficiency use for these treatments. SOUSA et al., (2000), studying WEU on melon crop under different irrigation frequencies in the field, obtained estimated values of 28.283 kg m<sup>-3</sup>.

Similar results were observed by PIRES et al., (2013) in melon crop with irrigation management based on tensiometers (30 kPa) and crop evapo-transpiration (60, 80 and 100%). The WEU obtained was 31.53 kg m<sup>-3</sup>, 28.69 kg m<sup>-3</sup> and 28.31 kg m<sup>-3</sup> for the treatment of 80%, 100%

and tensiometry, respectively. The lowest WEU was found in the treatment where the plants were irrigated with 60% of evapo-transpiration.

Treatments where the water was applied in excess, as 231.66mm (125%) and 277.98mm (150%), the efficiency on water use was smaller on 20.4 and 14.53 kg m<sup>-3</sup>, respectively. The reduction on WEU in these treatments was due to increase on water depths and reduction on productivity, possibly due to leaching of nutrients.

In the experiment where was used the plastic mulching (Figure 4B) it observed reduction in WEU with increased irrigation depth. In this case, the productivity decrease caused by water stress was not proportionally applied. It is believed that productivity losses were mitigated by the use of plastic cover on the soil. According to SAMPAIO & ARAUJO et al., (2001) the ground cover allows the use of longer watering shift, and promote increase in production. Still according to the authors, the plastic cover retains moisture near the soil surface, forcing the roots to focus on warmer layer and most fertile soil.

As for the treatments where the water depth was applied in excess, it was observed similar behavior to experiment without plastic mulching. These results are consistent with FERRAZ et al., (2011) who observed that as water availability was increased, WEU decreases, since higher volumes of water did not provide gain in fruit weight in equal proportion to the applied water depth.

## CONCLUSIONS

The highest values of productivity, weight, length, and average fruit diameter were obtained for treatment of 100% water depth replacement on soil for both experiments (WtC) and (WC).

The water deficit and excess promoted reductions in all variables.

The water efficiency use was higher in the experiment with soil cover, except in the treatments of 100 and 125% of the water consumed.

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