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Real-time Drip-irrigation Scheduling of Watermelon Grown with Plasticulture

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A two-year study was conducted in North Florida on a fine-sandy soil, to develop and test a crop factor for watermelons (*Citrullus lanatus* Thunb.) grown with plasticulture and daily drip-irrigation. Crop water use was calculated daily by multiplying Class A pan evaporation (Ep) with the proposed crop factor values 0.20, 0.40, 0.70, 0.90, and 0.70 for period 1–2, 3–4, 5–8, 9–11, and 12–13 weeks after transplanting, respectively. 'Mardi Gras' watermelons were established in a factorial combinations of 126, 168 and 210 kg/ha of N and 33%, 66%, 100% and 133% of the reference irrigation rate. The effect of N rate and the interaction irrigation × N rate were not significant on total marketable yield, individual fruit weight and total soluble solids. Watermelon yield responded quadratically to irrigation rate for both years. The results suggest that the highest watermelon yields would be achieved with a combination of 168 kg/ha of N and irrigation scheduled in real-time using daily Class A pan evaporation values multiplied by crop factor values of 0.24, 0.48, 0.84, 1.08, and 0.84 for period 1–2, 3–4, 5–11, 12, and 13 weeks after transplanting, respectively, which corresponded to the seasonal irrigation amounts of 450 and 343 mm in 2001 and 2002, respectively.

In the Best Management Practice era, the simultaneous optimization of irrigation and fertilization management of vegetable crops is essential to meet, at the same time, economical yield, high quality production, and environmental sustainability. Along with Georgia, California, and Texas, which represented 24%, 16%, and 10% of the national watermelon production, respectively, Florida is one of the most important watermelon producing states.

Watermelon production in Florida had a value of $152,468,000 for 10,000 ha (24,800 acres) harvested in 2007, which represented 16%, 19%, and 32% of the national watermelon acreage, production, and value, respectively (USDA–NASS, 2009).

Detailed production recommendations are available for watermelon in Florida (Olson et al., 2007). Highest fruit yields on a sandy loam soil occurred with the application of N at 168 kg/ha (150 lbs/acre; Hochmuth and Cordasco, 2000).

While watermelons have been traditionally grown on bare-ground, direct seeded, and without irrigation, the current practice is to use triploid (seedless) varieties, raised beds, with polyethylene mulch, transplant, and drip-irrigation (Olson et al., 2007). Drip-irrigation offers the potential for precise water management (Sammis et al., 1990), with flexible scheduling, efficient application of fertilizers (Ghawi and Battikhi, 1986; Hartz, 1996), increasing yields, plant and fruit growth, root development (Bhella, 1988), and fruit quality (Srinivas et al., 2004). However, to take complete advantage of the potential of drip-irrigation, irrigation scheduling is central in terms of timing and volume applied (Hartz, 1996).

Taking into consideration the typical Florida sandy soils, characterized by low water holding capacity, water management is essential for the success of vegetable crops. Water stress may increase the incidence of blossom-end rot (Maynard and Hopkins, 1999) and result in lower yield, while excessive field moisture may cause losses of nutrients, such as NO_3-N and K, out of the root zone.

Drip-irrigation scheduling can be based on crop monitoring, soil moisture monitoring, or on water budgets. The first two approaches give information about when to irrigate; however, with the crop monitoring method, the decision to irrigate is made only after the plants have suffered drought stress, which may negatively affect the crop yield (George et al., 2000). Therefore, the second method is more commonly used to determine when to irrigate. The third approach provides the volume of water that is necessary to keep the soil water content over the root zone at the field capacity. When used together, the second and third approaches provide proper timing and quantity of irrigation, respectively.

The timing of irrigation is based on maximum soil water tension, which at field capacity ranges from 7 to 10 kPa for sandy soils (Hartz, 1996; Hochmuth and Hochmuth, 1994) to 20–25 kPa (Hartz, 1996; Olsen et al., 1993; Smittle et al., 1994) for loamy and clay soils.

The amount of water to apply can be estimated using the reference evapotranspiration or the Class A pan evaporation approach (Allen et al., 1998; Hartz, 1996). Crop evapotranspiration may be calculated by multiplying the reference evapotranspiration

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(ETo) by a crop coefficient [Kc, (Hsiao, 1990)] or by multiplying the Class A pan evaporation (Ep) with a crop factor (CF) that adjust ETo and Ep respectively, to the actual crop water use. The irrigation crop requirement (ICR) is then calculated as follow: ICR= [(ETo × Kc) – ER] or ICR= [(Ep × CF) – ER], where ER is the effective rainfall considering the presence or absence of polyethylene mulches.

To calculate crop evapotranspiration, the current irrigation recommendations in Florida for watermelons grown on bare-ground and with overhead irrigation are based on a target volume calculated with historical evapotranspiration (ETo) multiplied by Kc that are specific for a given growth stage (Simonne et al., 2007). Since polyethylene mulching significantly reduces the soil water evaporation and increases the crop transpiration, thereby affecting crop evapotranspiration (Battikhi and Hill, 1986; Ghawi and Battikhi, 1986), the Kc values developed for bare-ground crops need to be adjusted before they can be recommended for plasticulture production. When using polyethylene mulches, the general FAO (Food and Agriculture Organization of the United Nations) recommendation is to reduce the FAO tabulated Kc values, determined on bare-ground crops, by 10% to 30% (Allen et al., 1998). These recommendations have been confirmed for tomato (Amayreh and Al-Abed, 2005), and watermelon (Battikhi and Hill, 1986; Ghawi and Battikhi, 1986), grown in dry Mediterranean regions.

Daily values of crop evapotranspiration can also be calculated using local weather data and the averages can be used for irrigation scheduling purposes (Clark et al., 1996). However, since site-specific weather data are not always available, it was proposed an alternative method, to estimate the crop evapotranspiration using daily Class A pan evaporation values obtained from a Class A pan evaporimeter located on farm and crop factor values determined for specific crop growth-stages in plasticulture production (Simonne, 2000). The estimated daily crop evapotranspiration needs to be adjusted, considering that when using drip-irrigation, only part of the raised bed may be wetted (Simonne, 2000; Simonne et al., 2006), especially on coarse textured soils, where the lateral movement of the water may be limited to 25 to 30 cm (10–12 inches) from the drip emitter (Clark et al., 1996; Simonne et al., 2003).

Therefore, the objectives of this study were to 1) develop, test, and adjust specific growth-stage crop factors for watermelons grown with drip irrigation and polyethylene mulch, using daily Class A pan evaporation; 2) identify the irrigation and N rates that together result in the highest marketable yield and total soluble solids content; and 3) develop practical irrigation guidelines for watermelon irrigation management in absence of daily Class A pan evaporation data.

Materials and Methods

The experiment was conducted on a Alpine–Blanton–Foxworth fine sand soil (Thermic, coated Typic Quartzipsamments) at the North Florida Research and Education Center–Suwannee Valley (NFREC–SV). Five-week-old 'Mardi Gras' transplants were established on black polyethylene mulched beds, on 27 Mar. 2001 and on 29 Mar. 2002, three weeks after fumigating the field with a 66 : 33 (w : w) methyl bromide : chloropicrin mixture at a rate of 448 kg/ha (400 lb/acre). Beds were 2.29 m (7.5 ft) apart, and within row plant distance was 0.92 m (3 ft), which created a stand of 4792 plants/ha (1936 plants/acre). Plots were 9.15 m (30 ft) and 15.25 m (50 ft) long in 2001 and 2002, respectively. Pest management followed UF/IFAS recommendations (Olson et al., 2007).

Class A pan evaporation was recorded daily on-site using a Class A pan evaporimeter, and the amount of irrigation was calculated using selected crop factor values (Table 1) based on the same growth stages currently adopted for watermelon fertigation recommendations in Florida (Olson et al., 2007).

Since, only part of the field was actually under polyethylene, and therefore irrigated, daily Class A pan evaporation values were converted to irrigation amount using a conversion factor of 10 mm Ep = 3.5 mm (0.10 inch Ep = 0.035 inch) based on the percentage of the field under polyethylene [considering that in a crop grown on beds 2.29 m apart, only 0.80 m out of the 2.29 m were actually wetted (about 35% on a hectare basis), then, 10 mm × 0.35 = 3.5 mm].

Because of the presence of polyethylene mulch and the poor lateral water movement in sandy soils, rainfall contribution to soil water was assumed to be negligible (Simonne et al., 2003).

The target water regime (100% of daily Ep values, I3) was compared with two lower (I1 and I2) and one higher (I4) level water regimes, with relative values of 33% I3, 66% I3, 100% I3, and 133% I3, for I1, I2, I3, and I4, respectively. Irrigation treatments were created by using 1, 2, 3, or 4 strips of drip tape [Ro-Drip; 0.03 mm/100 m/hour (24 gal/100 ft per hour) flow

Table 1. Water amounts in millimeters per day, needed to replenish soil moisture for selected daily Class A pan evaporation values for different growth stages of watermelon.[z]

Growth stage[y]	Weeks after transplanting	Tested crop factor	Adjusted crop factor[x]	Cold day	Warm day	Hot day	Very hot day
				Daily Class A pan evaporation (mm)			
				2.5	5.1	7.6	10.2
				mm per day			
1	1–2	0.20	0.24	**0.237**	**0.474**	**0.705**	**0.948**
2	3–4	0.40	0.48	**0.474**	**0.948**	**1.411**	**1.897**
3	5–8	0.70	0.84	**0.830**	**1.660**	**2.469**	**3.319**
4	9–11	0.90	1.08	**1.067**	**2.134**	**3.174**	**4.267**
5	12–13	0.70	0.84	**0.830**	**1.660**	**2.469**	**3.319**

[z]Based on 10 mm Ep = 3.5 mm and 90% of delivery efficiency.
[y]Growth stages used for irrigation and fertigation scheduling are the same as those described by Olson et al., 2007: 1 = Emergency; 2 = vines 15 cm in length; 3 = fruits 5 cm in length; 4 = fruits one-half mature; 5 = first harvest.
[x]Based on two years of field work.
[w]Color codes: **Green** - single irrigation event; **Orange** - split total daily irrigation amount into two applications preferred; **Red** – split total daily irrigation amount into two applications needed; **Blue** – split total daily irrigation amount into three applications needed.

rate at 69 kPa (10 psi), and 30-cm (12 inches) emitter spacing; John Deer Water Technologies, San Marcos, CA], respectively (Simonne et al., 2002).

Irrigation rates response were tested under three N rates: 126 (N1), 168 (N2), and 210 (N3) kg/ha of N, which represented 75%, 100%, and 125% of the recommended N rate, respectively, for watermelon production in Florida (Olson et al., 2007). Based on soil test results (Mehlich 1 soil extraction method), fertilizer recommendations was 168N–0P–139.4K kg/ha (150N–0P–124.5K lbs/acre). One-third of the total N and K were applied pre-transplant using 427 kg/ha (381 lbs/acre) of 13N–2P–11K and the remainder was injected weekly using a combination of KNO_3 and NH_4NO_3 according the UF/IFAS fertigation recommendations for each growth stage (Olson et al., 2007). The amount of KNO_3 was constant between the treatments to keep the same rate of K, while the amount of NH_4NO_3 was adjusted to create the N rates.

Nitrogen treatments were delivered to each plot using an additional drip tape connected to three separate fertilizer injectors for each fertilizer treatment. The irrigation lines and the fertigation lines were equipped with water meters. For each factorial combination of irrigation and N, seasonal water application rates were calculated by adding the amount of water applied by the irrigation line and that applied by the fertilizer line. The design of drip-irrigation system allowed for independent delivery of water and fertilizer, and randomization of the treatments (Simonne et al., 2002). The experimental design was a randomized complete block with 4 replications and 12 treatments (4 irrigation rates, 3 N rates).

Soil water tension was measured twice a week (18 and 12 times in 2001 and 2002, respectively) in all the plots receiving 100% N rate, using granular matrix sensors (model 200-5, Irrometer, Riverside, CA) placed at 15 and 30 cm (6 and 12 inches) depths and a reader (Watermark model 30 KTCD-NL, Irrometer, Riverside, CA). To quantify cumulative water stress, soil water tension (SWT) was converted into four classes [SWT<15 kPa (recommended range), 15<SWT<24 (mild stress), 25<SWT<34 (moderate stress), and SWT>35 (intense stress)] and the number of dates soil water tension at each depth fell within each class was recorded.

Watermelons were harvested twice (73 and 83 d after transplanting) in 2001 and once (66 d after transplanting) in 2002. Fruit were separated into marketable and unmarketable culls, according to the US standards for grades of watermelon (USDA, 2006). Fruits that were less than 7.25 kg (16 lb), poorly shaped, or showed blossom end rot were classified as culls. Total soluble solids content was measured with a hand-held refractometer on two representative marketable fruits from each plot.

Marketable yield, individual fruit weight, total soluble solids and soil water tension data were analyzed using analysis of variance and Duncan's multiple range tests at the 5% level of probability to detect the main effects and the interactions between irrigation rate, N rate, and year (SAS, 2004). Marketable yield, fruit weight, total soluble solids, and soil water tension responses to water rates were determined using linear and quadratic regression analysis (SAS, 2004). The irrigation regime (expressed in percentage of I3) resulting in highest marketable yield and quality were used to adjust the proposed crop factor.

Results and Discussion

Weather conditions were different each year. In 2001, the rainfall pattern between 1 and 83 d after transplanting included a dry period with five rainfalls from transplanting to the first harvest (12, 10, 20, 9, and 11 mm on 3, 4, 18, 65, and 70 d after transplanting, respectively) and a wet period, with 98 mm of rainfall falling in the last 2 weeks before the second harvest, for a total seasonal rainfall of 160 mm (6.3 inches). In 2002, a total of 105 mm (4.1 inches) of rainfall occurred during the growing season, with 60 mm falling within the last week of the crop season. Hence, rainfall only contributed minimally to the watermelon crop water requirements due to the polyethylene mulch covering the beds and the irrigation treatments created different soil moisture conditions. Daily Class A pan evaporation values ranged during the two seasons from 2 to 11 mm per day (from 0.08 to 0.43 inches per day). Actual total water amount applied to I1, I2, I3, and I4 were: 142 (37% I3), 261 (68% I3), 383 (100% I3), and 502 (131% I3) mm (5.60, 10.27, 15.09, and 19.76 inches), respectively, in 2001, and 132 (45% I3), 212 (72% I3), 294 (100% I3), and 373 (127% I3) mm (5.20, 8.33, 11.56, and 14.69 inches), respectively, in 2002.

Because irrigation was scheduled in real-time based on daily Class A pan evaporation values, and weather conditions were different each year, also the irrigation amounts were different, and interaction irrigation rate × year was significant ($P = 0.02$) when considering the number of days in which soil water tension was ≥35 kPa at 15 cm (6 inches), soil water tension data were presented by year. Irrigation regimes significantly affected the magnitude of the water stress imposed on the watermelon plants (Fig. 1). In 2001, the number of sampling dates that soil water tension remained within the recommended range at the 15 cm (6 inches) depth increased linearly and ranged between 14 and 17 for I1 and I4, respectively; however this difference was not statistically significant ($P = 0.18$). In 2002, the number of sampling dates that soil water tension remained within the recommended range at 15 cm (6 inches) depth was significantly different ($P < 0.01$) and increased linearly ranging from 2 to 9 for I1 and I4, respectively. For both years, the number of days soil water tension exceeded the recommended range at 15 cm depth tended to decrease as irrigation rate increased (Fig. 1). Similar results were found at 30 cm (12 inches) depth. Soil water tension at 30 cm (12 inches) depth tended to be higher in 2002 than in 2001. These results suggest that increasing irrigation within the selected range decreased the magnitude of the water stress imposed on the watermelon plants. The lower irrigation rates (I1 and I2) maintained soil water tension within the recommended range less often that the higher irrigation rates (I3 and I4), in particular, at the greater depth.

The interaction irrigation rate × year was nonsignificant for total marketable yield ($P = 0.54$) and mean individual fruit weight ($P = 0.77$) but was significant for soluble solids concentration ($P < 0.01$; Table 2). This indicates that watermelon yield and mean individual fruit weight response to irrigation rates was similar for both years. The interaction between irrigation and N rate was not significant for total marketable yield, mean individual fruit weight and soluble solids concentration ($P = 0.42$, 0.60, and 0.17, respectively; Table 2). For both years, watermelon yield responses to irrigation rate were significant and quadratic (both $P < 0.001$; Fig. 2a). The highest total marketable yields were 55,409 and 54,949 kg/ha (49,472 and 49,062 lbs/acre) for 2001 and 2002, respectively. Highest total marketable yields were reached for irrigation seasonal amounts of 450 and 343 mm (17.71 and 13.50 inches) for 2001 and 2002, respectively. The optimal irrigation amounts (450 and 343 mm, corresponding to 17.71 and 13.50 inches) for 2001 and 2002, respectively) varied each year, but

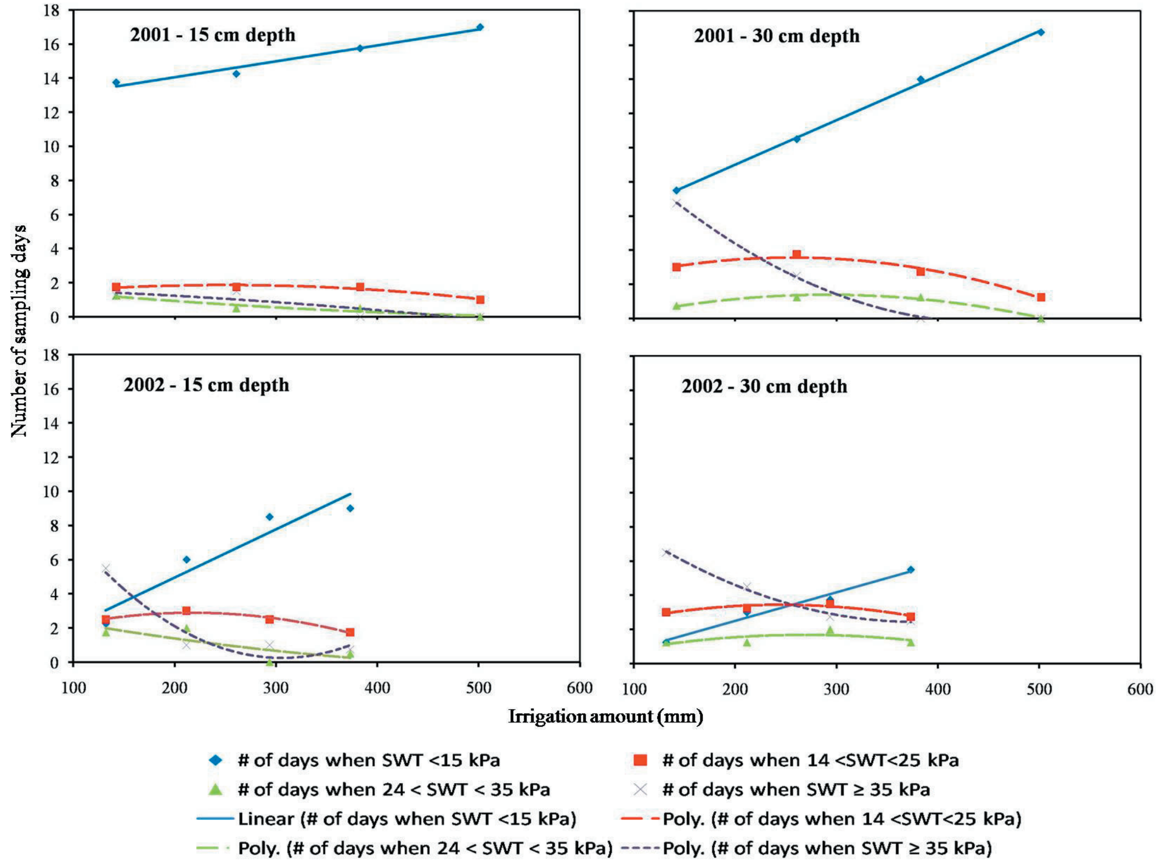

Fig. 1. Number of sampling days when soil water tension (SWT) at the 15 cm and 30 cm depth was under 14 kPa, between 15 and 24kPa, between 25 and 34 kPa and equal to 35 kPa or above for the different water rate in mm for 'Mardi Gras' watermelon grown in 2001 and 2002 on a fine sand soil.

Table 2. Marketable yield, mean fruit weight, and total soluble solids of 'Mardì Gras' watermelon grown with plasticulture and drip irrigation with different N rates in 2001 and 2002.

	Marketable yield (kg/ha)	Mean fruit wt (kg/fruit)	Total soluble solids (%)
N rate (kg/ha)			
126	48,442 a	9.10 a	11.1 a
168	49,394 a	9.19 a	11.2 a
210	50,034 a	9.45 a	11.2 a
Year			
2001	51,002 a	9.69 a	10.7 b
2002	47,578 a	8.80 b	11.6 a
Significance [z]			
N rate	NS	NS	NS
Year	NS	***	***

[z]Significance of F: NS (nonsignificant) or *** (significant at 0.001), respectively. Means within each column followed by different letters are significantly different according to Duncan's multiple range test. The interaction irrigation rate × year was significant only for total soluble solids, while the irrigation × N rate was nonsignificant.

were corresponded to the same fraction of I3 (117% in both years). These results were not surprising since real-time irrigation was based on weather data from the previous 24 h, and not on long-term averages. In conclusion, the highest yields could be achieved with 1.17 × I3 (100% the reference volume). Hence, by rounding up, proposed crop factor values need to be multiplied by 1.20 (Table 1). Since for both years the crop season was shorter than 13 weeks (12 and 10 weeks for 2001 and 2002, respectively), it was not possible to verify the proposed crop factors for 12–13 WAT. Crop factors become 0.24, 0.48, 0.84, 1.08, and 0.84 for period 1–2, 3–4, 5–8, 9–11, and 12–13 weeks after transplanting, respectively (Table 1).

Individual fruit weight was significantly different ($P < 0.01$) in the two years and the irrigation rate response was significant ($P < 0.01$) and quadratic for both years, values were 9.01, 9.84, 9.99, and 9.90 kg/fruit (19.87, 21.70, 22.03, and 21.83 lbs/fruit) in 2001, and 7.62, 9.16, 9.06, and 9.29 kg/fruit (16.80, 20.20, 19.98, and 20.48 lbs/fruit) in 2002, for I1, I2, I3, and I4, respectively (Fig. 2b). Mean individual fruit weight was significantly lower with I1 than with the other irrigation treatments, while no significant difference was observed among the individual fruit weights for I2, I3 and I4 irrigation regime. Typical fruit weight for an allsweet type watermelon variety like 'Mardi Gras' may be considered a 10 kg/fruit (22.05 lb/fruit). All fruit irrigated with I2, I3, or I4 irrigation regimes would be commercially acceptable, while those irrigated with the irrigation regime I1 would be considered too small.

Total soluble solids concentration was significantly different ($P < 0.01$) in the two years, with significant ($P < 0.01$) interaction between irrigation rate and year (Fig. 2c). In 2001 total soluble solids values significantly ($P < 0.01$) decreased from 11.5% to 10.0% total soluble solids between I1 and I4. In 2002, the mean total soluble solids concentration value was 11.6% and was not

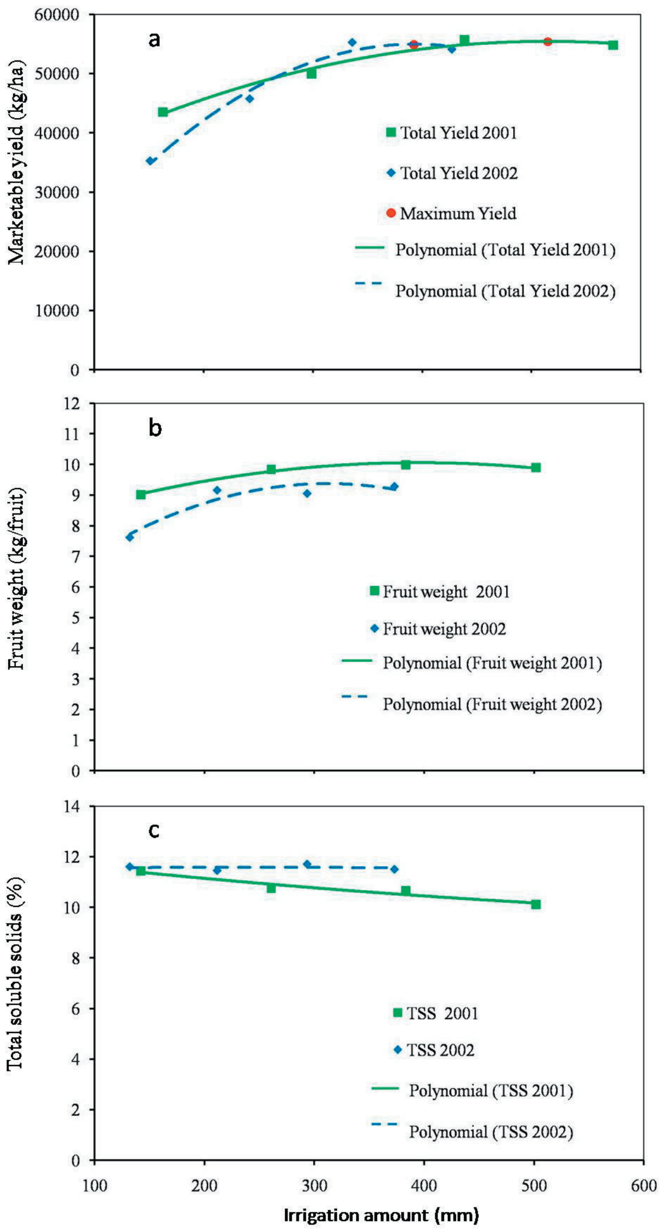

Fig. 2. Effect of actual water application rates on (**a**) seasonal marketable yield, (**b**) fruit weight, and (**c**) total soluble solids of 'Mardi Gras' watermelon grown with plasticulture on a fine sand soil in 2001 and 2002.

affected by irrigation rate (Fig. 2c). All these soluble solids values were above the minimum required by USDA grading standards of 10 % total soluble solids and support the common knowledge that increasing irrigation tends to decrease (or dilute) soluble solids concentration. However, in this experiment, the range of variation in soluble solids concentration observed was practically minimal, confirming what has been reported from others (Bang et al., 2004; Erdem and Yuksel, 2003; Erdem et al., 2005; Wang et al., 2004).

The effect of N rate was nonsignificant on total marketable yield, mean individual fruit weight and soluble solids ($P = 0.83$, 0.96, and 0.74, respectively; Table 2). These results support the current N recommendation of 168 kg/ha (150 lbs/acre) for watermelon production in Florida (Olson et al., 2007), especially when irrigation is scheduled in real-time.

These results also demonstrate the role that the implementation of drip-irrigation system in combination with real-time irrigation management have as BMPs in improving the N use efficiency, avoiding losses of N out of the root zone (Simonne et al., 2006, 2006a; Zottarelli et al., 2008), thereby reducing the need for N fertilization in excess of the current recommendations.

The use of these results, with a little simplification, may be extended to the growers that do not have a Class A pan evaporimeter in their farms and do not have access to the Florida Automated Weather Network (FAWN, 2009). Based on the Class A pan evaporation values, that in this study were ranging from 2 to 11 mm (0.08–0.43 inches), it was possible to distinguish empirically four classes of days such as "cold," "warm," "hot," and "very hot" days, which correspond, with a limited margin of error, Class A pan evaporation values of 2.5, 5.1, 7.6, and 10.2 mm (0.1, 0.2, 0.3, and 0.4 inches), respectively.

As shown in Table 1, the Class A pan evaporation values, expressed in millimeters, were converted into actual irrigation amount (mm) considering 1) the specific growth-stage crop factor; 2) the actual area irrigated, using a conversion factor of 10 mm Ep = 3.5 mm (0.1 inch Ep = 0.035 inch); and 3) an efficiency of 90% of the drip irrigation systems.

Knowing the flow rate (mm/100 m per hour; gal/100 ft per hour) of the drip tape used, it is then possible to convert the total daily irrigation amount (millimeters per day; inches per day) in total daily irrigation time (Table 3). The drip tapes most commonly used in Florida, classified as low, medium, and high flow rate, can deliver 0.020, 0.030, and 0.040 mm/100 m per hour (16, 24, and 32 gal/100 ft per hour), respectively, which, considering an efficiency of 90% and the presence of 4367 linear bed meters/ha (5808 lbf/acre) when using beds 2.29 m (7.5 ft) apart, correspond

Table 3. Approximate irrigation events needed to replenish soil moisture for selected daily Class A pan evaporation values for different growth stages of watermelon grown on mulched beds 2.29 m apart with 0.030 mm/100 m/hour flow rates drip tape.

			Cold day	Warm day	Hot day	Very hot day
			Daily Class A pan evaporation (mm)			
Growth stage[y]	Weeks after transplanting	Crop factor	2.5	5.1	7.6	10.2
			Daily irrigation times (hours, minutes)			
	Medium flow rate drip tape (0.030 mm/100 m per hour)[z]					
1	1 to 2	0.24	8 min	16 min	24 min	31 min
2	3 to 4	0.48	16 min	31 min	47 min	1 h
3	5 to 8	0.84	27 min	55 min	1 h 22 min	1 h 50 min
4	9 to 11	1.08	35 min	1 h 11 min	1 h 46 min	2 h 20 min
5	12 to 13	0.84	27 min	55 min	1 h 22 min	1 h 50 min

[z] 1= Emergency; 2= vines 15 cm in length; 3= fruits 5 cm in length; 4= fruits one-half mature; 5= first harvest.
[y] Assuming beds 2.29 m apart (4167 linear bed meters/ha) and 90% of delivery efficiency.

to about 0.873, 1.310, and 1.746 mm/hour (0.034, 0.051, and 0.068 inch/h), respectively.

Finally, considering that in Florida's sandy soil, single irrigation events above 2.620 mm (0.103 inch), about 2 h when using drip tape with a flow rate of 0.030 mm/100 m (24 gal/100 ft/hour), may cause leaching of nutrients below the root zone (Simonne et al., 2006a), it is recommended to split irrigation events greater than 2.620 mm (0.103 inch), into more than one irrigation event (Table 1).

In conclusion, these results suggest that the highest watermelon yields grown in the spring with plasticulture was achieved with irrigation scheduled in real-time using a crop factor with values of 0.24, 0.48, 0.84, 1.08, and 0.84 for period 1–2, 3–4, 5–8, 9–11, and 12–13 weeks after transplanting, respectively, using 10 mm Ep = 3.5 mm (0.1 inch Ep = 0.035 inch). These results support current N recommendations for watermelon production. Highest watermelon yields of commercial quality (size and soluble solids) may be achieved with a combination of 1.2 × I3 (100% of the target irrigation rate) and the IFAS N recommended rate. In commercial fields, these target irrigation and N fertilization rates should be fine tuned with soil moisture monitoring devices and foliar or petiole testing.

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