Evaluation of the effect of *IrrigAid Gold* on soil rootzone water content and yield of a tomato crop (*Lycopersicon esculentum* Mill.) grown in the Besor region - Israel.

1. Abstract

The Besor region is the one of the major suppliers of fresh market tomatoes for sale in Israel. Tomatoes are grown all year round in shadehouses and greenhouses in sandy soils irrigated with purified recycled urban wastewater using drip irrigation. In this trial the ***IrrigAid Gold*** soil wetting agent was applied during the tomato growing season in order to test its effect on yield and fruit quality of tomatoes grown in the Besor region. Under the given conditions of this experiment IrrigAid ***Gold*** treatment increased soil water content. Plants responded to the IrrigAid treatments and the total yield rose by 10% while at the same time the irrigation rate was reduced.

2. Introduction

The Besor region is located in the semi arid, southern part of Israel. It is the major supplier of fresh market tomatoes for the Israeli market. Tomatoes are grown all year round in shadehouses and greenhouses covering an area of approximately 10,000 dunam (1000 Ha., 2500 acres). Drip irrigation is the only method of irrigation and in most cases complete chemical fertilizers are added to the irrigation water (fertigation). Most tomato growing areas are located on sandy loam soils (80%-90% sand and 5%-10% silt and clay). These soils are characterized by low organic matter content (0.1-0.5%) due mainly to extensive cultivation using added compost and crop residues. Regarding the Besor region, this basically low organic matter content can reduce the development of water repellency while on the other hand sandy soils are more susceptible to water repellency because of their reduced specific surface area (Dekker et al. 2009). The irrigation requirement for a tomato crop grown in a greenhouse environment is determined using a reference evapotranspiration value (Penman-Monteith or class A evaporation pan) adjusted by a crop coefficient derived from soil water balance experiments (Baille 1999). The above described method is the common technique being used by farmers in the Besor region to determine tomato water requirements. The water used for irrigation in Besor region is mainly recycled, purified urban wastewater. Taking into account the fact that water is an essential resource of which there is a chronic shortage and is therefore expensive, any means of reducing water use during the growth of the crop is desirable. One option is to use a soil surfactant which is designed to reduce water surface tension. By reducing water surface tension, irrigation is more efficient both in terms of soil wetting and infiltration. ***IrrigAid***

Gold is a soil wetting agent that was tested on several different crops including tomatoes in numerous previous trials (Santos, 2011; Lowery et al. 2004). Those trials demonstrated that in some cases application of ***IrrigAid Gold*** can enhance yields while allowing a reduction of the irrigation rate.

The aim of the current experiment was to test the influence of the wetting agent ***IrrigAid Gold*** on yield and fruit quality of a tomato crop (*Lycopersicon esculentum* Mil.) grown in a greenhouse in the local, sandy soil and with drip irrigation in the Besor region of Israel.

2. Materials and Methods

The experiment was conducted at the Negev R&D Center (34^0 23' N, 31^0 16' E, 104 m' above sea level), in a greenhouse covered with polyethylene sheeting.

In September 2010 grafted tomato plants (*Lycopersicon esculentum* Mil.) (1402 scion on Bufor rootstock) approximately 4 weeks old were hand-transplanted into local sandy loam soil beds. Beginning one week after transplanting, application of the wetting agent at three different irrigation rates was initiated. Irrigation regimes tested were: 1) 100% ("Farm Rate" + leaching fraction); 2) 70% + leaching fraction; and 3) 60% + leaching fraction. Reference evapotranspiration (ET_0) was based on daily transpiration data from class A evaporation pan located near the trial location. Multiplying ET_0 by the crop coefficient gave the 100% irrigation regime. Water loss to ET was replaced using local irrigation practices (e.g. drip irrigation).

The wetting agent ***IrrigAid Gold*** was applied through the dripper lines, in the first irrigation after transplanting (5 L/ha), followed by monthly applications (app. 4 weeks apart) at 2.5 L/ha. The wetting agent was applied in conjunction with a normal irrigation treatment.

The following data were collected during the course of the growing season: total yield, average fruit weight, post harvest data, NPK and Nitrate- N content in leaves, % of dry matter and soil water content (gravimetric and from tensiometer data).

The experimental design was a completely randomized trial with five replications for each treatment. Data were evaluated by one-way ANOVA. Tukey's test was used for comparison of means. (JMP 5.01 software, SAS Institute Inc).

3. Results

3.1 Soil water content

Gravimetric soil water content data is presented in figure1. Plots treated with ***IrrigAid Gold*** **(IG)** exhibited higher water content when compared to the control plots. Soil water content data collected from tensiometers is shown in figure 2. The displayed data relates to March 2011 when the plants were five months old and well developed. During the month of March, ET rates and temperatures began to increase (Fig. 3). It can be seen that water tension in the treated plot was significantly lower in comparison to the plot without the IG treatment.

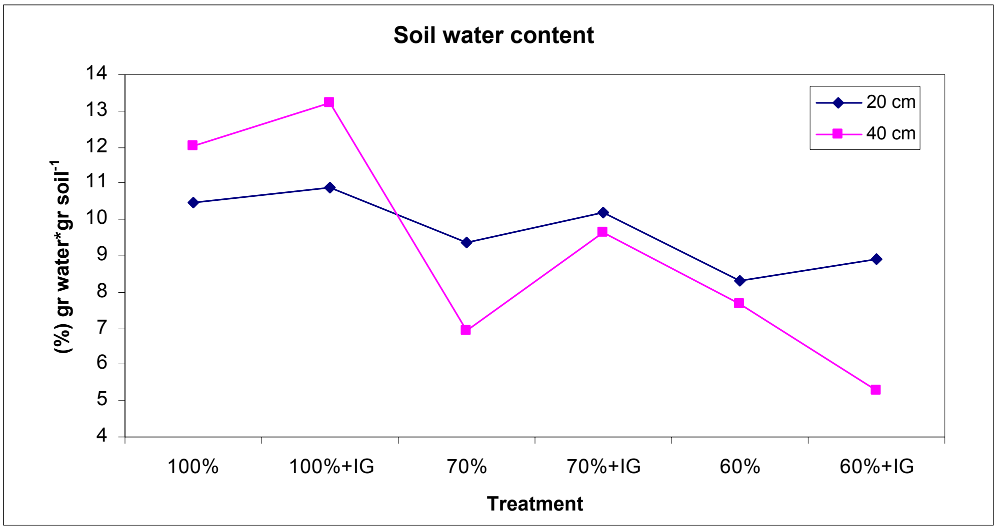

Figure 1. Gravimetric soil water content from two depths: 20 cm and 40 cm.

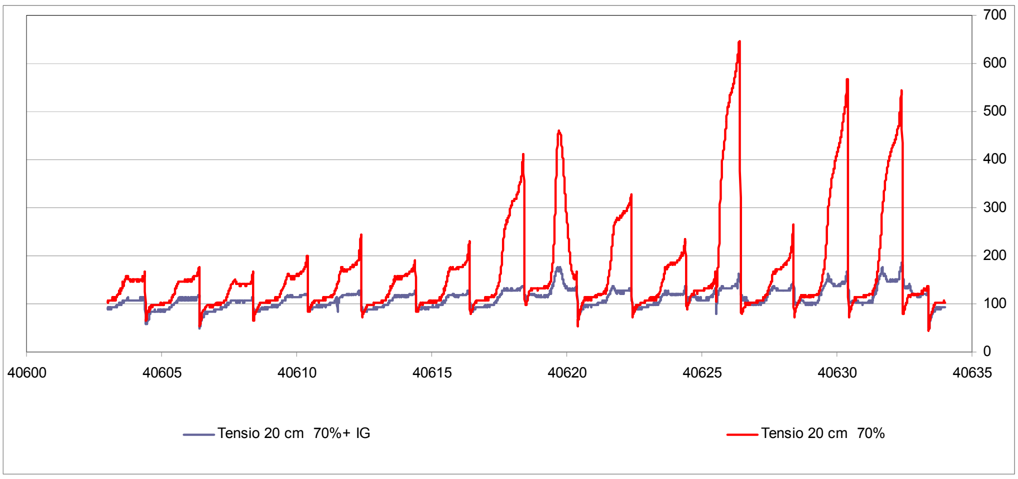

Figure 2. Water tension in soil during March 2011. Blue line- plots treated with ***IrrigAid Gold***. Red line not treated. In both cases irrigation was 70% of farm rate.

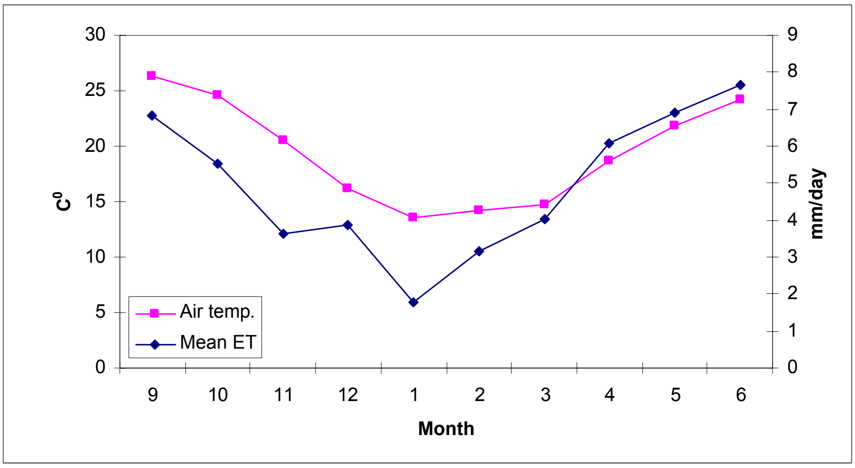

Figure 3. Mean daily temperature and ET from class A evaporation pan (September 2010- June 2011).

3.2 Yield data

Yield data collected from 1/2011 to 6/2011 is presented in figure 4. A significant difference was found between the 80% irrigation rate and 80%+ IG treatments in total yield. (Fig. 4b) (ANOVA test α=0.05). In other treatments (100% and 60%, Fig 4a, c) no significant difference was found when ***IrrigAid Gold*** was added. Mean fruit weight (Fig 4d) increased when ***IrrigAid Gold*** was added to the 80% treatment equalizing it to fruit weight from the 100% farm rate treatment.

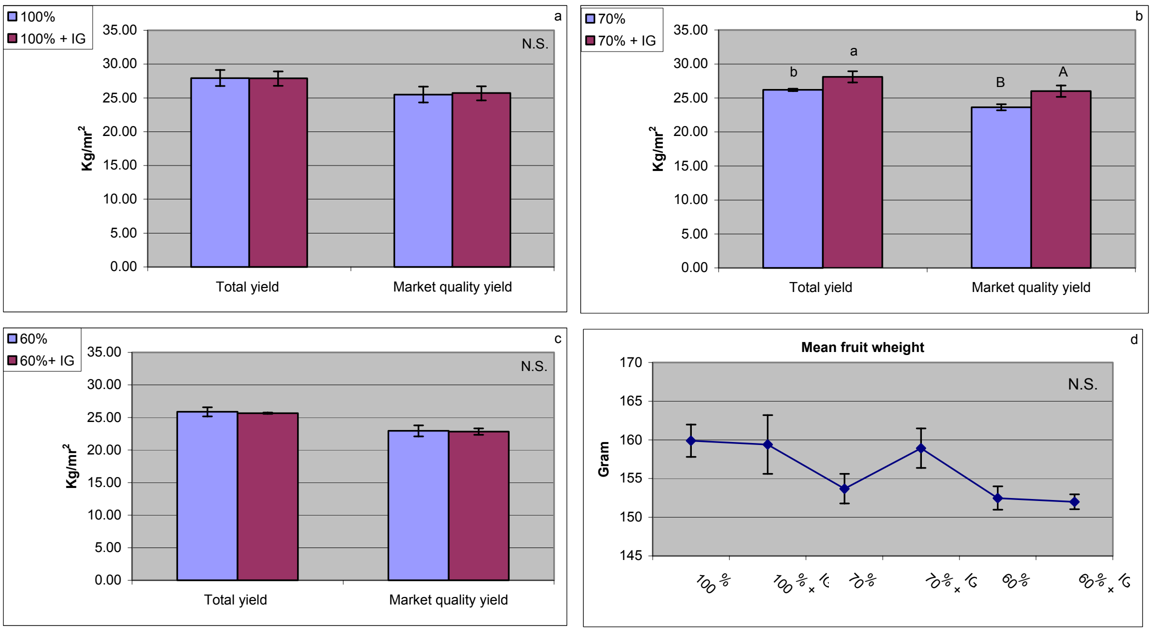

Figure 4. Yield and fruit weight data. a) mean yield (Kg/ m^2), from the 100% (farm rate) irrigation treatment; b) 70% irrigation treatment; and c) 60% irrigation treatment; d) mean fruit weigh (all values ± s.e.)

3.3 Dry matter, nutrients and nitrate content in leaves

No significant difference was found in dry matter content or N, P, K levels in leaves (Fig. 5 a, b). Nitrate-N content was affected by the treatments and higher nitrate-N concentration was found in leaves from 100% farm rate irrigation + IrrigAid gold in comparison to the 80% farm rate + ***IrrigAid Gold***. (Fig. 4c).

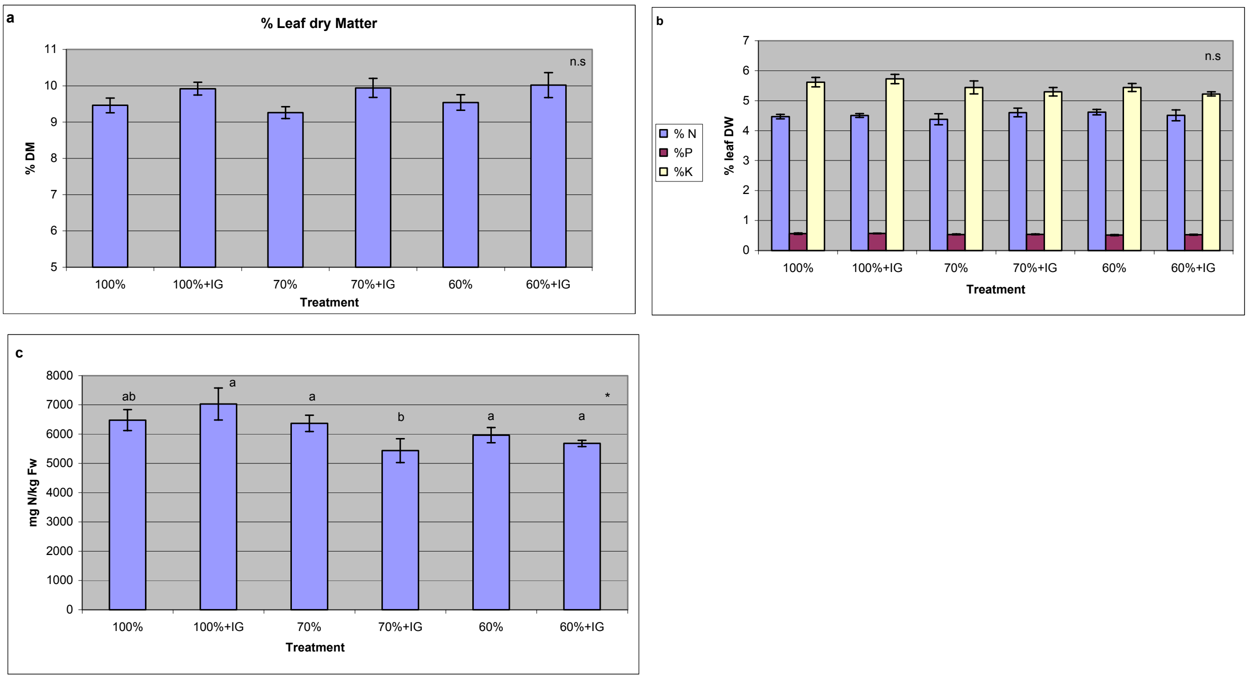

Figure 5. Nutrients and dry matter in leaves. a) Leaf dry matter; b) NPK in leaf; c) Nitrate N in leaf. (Mean values ± s.e.)

3.3 Fruit yield accumulation rate

The rate and pattern of fruit yield accumulation was similar when comparing the total and market quality yield within each treatment and between the different treatments. The increase in yield can be seen in the 80%+IG in comparison to the 80% treatment without IG (Fig. 6b) beginning approximately four months after initial fruit set.

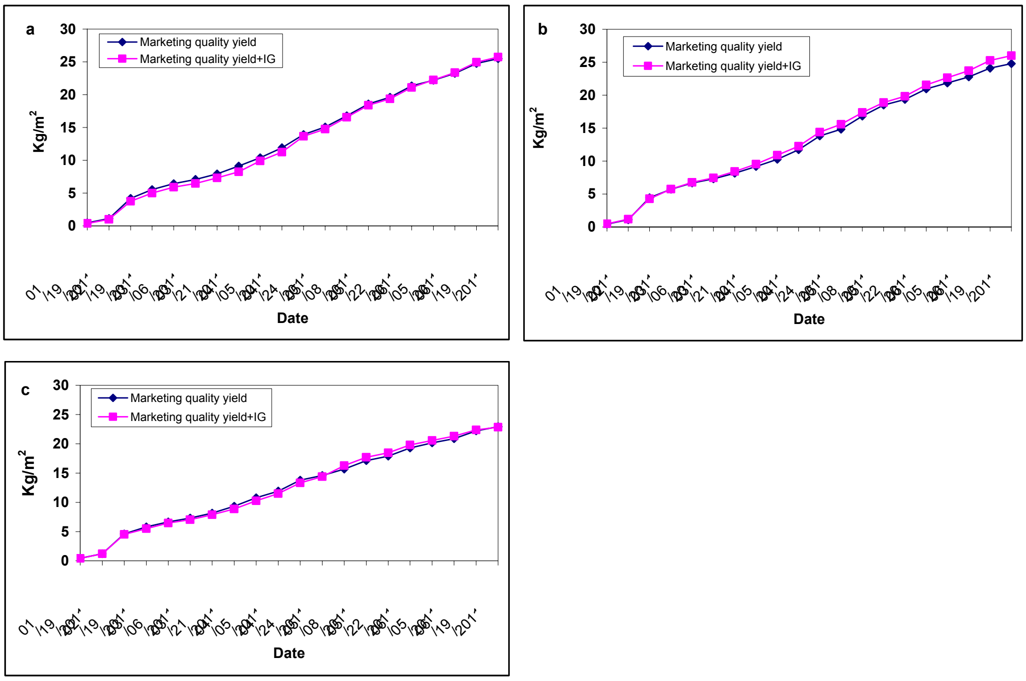

Figure 6. Total yield accumulation rate: a) 100% (farm rate) irrigation treatment; b) 70% irrigation treatment; and c) 60% irrigation treatment.

3.4 Fruit quality and post harvest tests

Post harvest tests were made immediately after fruit picking. Fruit was refrigerated in accordance with simulated commercial storage protocol. At the end of the storage period the fruit was examined for the parameters shown in table 1. The treatments did not appear to have any effect on post harvest scores of the examined fruit.

Table 1. Results from post harvest tests.

Irrigation treatment	Cracked	Firm	Flexible	Soft	Rotten	Irregular color	Fruit quality score
	%	%	%	%	%	%	(0-10)
100%	0	40	33	26	1	2	3.7
70%	0	36	41	23	0	2	4
60%	0.5	37	39	24	1	3	3.7
100%+ IG	0.33	34	38	28	2	2	3.3
70%+IG	0	37	34	29	2	2	3.4
60%+IG	0	34	45	21	1	1	4.3

4. Conclusions

According to the data presented above, and under the given conditions of this experiment, several conclusions can be drawn from the results of the application of ***IrrigAid Gold*** during the tomato growing season. First, the ***IrrigAid Gold*** application increased soil water content. This result correlates with previous work that demonstrated a rise in soil water content after ***IrrigAid Gold*** application (Lehrsch et al. 2011). This increase in soil water content was demonstrated in the data collected from tensiometers located in the plots, and from one gravimetric test. In addition, tomato plants responded to the ***IrrigAid Gold*** treatments with a 10% yield increase while the irrigation rate was reduced by 30% (Fig. 4b) in comparison to the farm rate (100% treatment). A possible explanation for this increase in yield could be an increase in average fruit weight (Fig. 4d). This, although not statistically significant, can still provide a reasonable explanation for the observed results. The treatments did not seem to have any effect on post harvest tests results, NPK content in leaves or fruit accumulation rate.

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