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Simultaneous impact of the different water supply and year type on processing tomato yield

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***Summary*:** A two year (2008 and 2009) open field experiment was conducted to study the effect of irrigation on the yield parameters and fruit components of processing tomato. Two different treatments were applied: regularly irrigated (RI), irrigation cut-off 30 days before harvest (CO), compared with unirrigated control (RF). The optimal water supply was calculated from average daily temperature. The aims of the study were to investigate the effect of different water supply on yield quantity. The regularly irrigated plant stands gave significantly higher yield, and unirrigated plants showed yield loss. Water supply had strong positive (R^2=0.81) effect on marketable yield and average fruit weight (R^2=0.78). Linear regression showed, that 46.5 mm more water supply caused 10 t/ha more marketable yield, and 13.4 mm more water supply caused 1 g more in the average fruit weight. The irrigation increased the Brix yield as well.

Keywords: processing tomato, irrigation cut-off, yield

Introduction

The importance of tomato cultivation has been growing rapidly in the last decades in the world. Beside the fresh market tomatoes, the processing tomato has a great importance in the food industry, basically because of its health promoting features (*Clinton,* 1996, 1998; *Giovannucci,* 1999). The processing tomato cultivation has changed a lot recently, the production areas were decreased, but the yield is getting higher. Processing tomato cultivation is only profitable in Hungary if the yield is over 45–55 t/ha (*Fruitveb,* 2008), but the optimal yield depends on element of growing technologies, like plant propagation, irrigation method and the use of hybrids (*Helyes* et al. 2006). Ecological conditions e.g. solar radiation, temperature and precipitation take a great effect on tomato yield (*Helyes & Varga,* 1994, *Helyes* et al., 1999, *Pék* et al., 2008). It is possible to increase the yield to 90–110 t/ha with an appropriate cultivation, under irrigated conditions.

This experiment was undertaken to investigate the effects of water supplement on fruit yield of drip-irrigated processing tomatoes. Among other factors, crop management, particularly water and nutrient supply, is of primary importance of quality and quantitative yield (*Dumas* et al., 1994). The colour (lycopene content) and Brix° of processing tomato at harvest are an important quality criterion. The soluble solid content (Brix) of fruits was often very high without irrigation, this value decreased with irrigation. In spite of this the level of brix yield per hectar remarkably increased as a result of significantly higher yield quantity.

Materials and method

Tomato fruits were ensured from the test sites of Szent István University, Gödöllő, where various irrigation experiments of processing tomato were carried out (*Cselőtei* and *Varga,* 1988; *Varga,* 1988).

The experiments were carried out in 2008 and 2009. The experimental field is brown forest soil, mechanical compositions are sand, sandy-clay. Water management shows similarity to sandy soils, thus characteristics are low water capacity and good hydraulic conductivity. In summer, the soil water capacity can provide sufficient water supply for the plants only for a short period of time. The subsoil water is below 5 m, therefore it cannot influence the water turnover. Tomato cultivar (Brigade F_1) was investigated in the present study.

In 2008, the area of the experiment was 300 m^2 and the area of one plot was 25 m^2. Seeds were sown on 7th April 2008 in greenhouse and transplanted on 12th May. Tomato seedlings were planted out in twin rows, 0.4m spacing inside the raw and 1.2 m between adjacent twin rows, the space between the plants in the row was 0.3 m. There were two treatments. Regularly irrigated plants (RI) which got 297 mm irrigation water and 144 mm precipitation (441 mm together) from the beginning of May, the other was the Cut Off substance (CO) which means the irrigation was stopped at the beginning of the ripening process (got 369 mm water including precipitation); there was an unirrigated rainfed control (RF) as well which got 297 mm precipitation only. Crop density was 4,2 plant/m^2.

Treatments: RI: 411mm
CO: 297 mm
RF: 144 mm

In 2009, the test field was 500 m^2 and the area of one plot was 20 m^2. Seeds were sown on 25th March 2009 in greenhouse and transplanted on 5th May. Tomato seedlings were planted out similarly last year. There were also two treatments: RI plants, which got 261 mm irrigation water (417 mm together with the 156 mm precipitation), CO substance got 140 mm irrigation water (296 mm with precipitation) and RF stands got 156 mm precipitation. Crop density was 4.2 plant/m^2.

Treatments: RI: 417 mm
CO: 296 mm
RF: 156 mm

Drip irrigation water was given out according to the air temperature (daily irrigation water (mm) = average daily temperature × 0.2). National Meteorological Institute forecasts were used to calculate with the probable daily air temperature.

Changes of the environmental factors were monitored via measuring three parameters. During the experiment we defined the air temperature (°C), relative humidity (RH %) and incoming light intensity (μmol $m^{-2}s^{-1}$). Basic nutrition supply was given out when plants were transplanted with Agroblen 18-8-16 fertiliser, resulting 266 kg ha^{-1} K_2O. Marketable (red and green) and diseased fruits were measured at harvesting on 12th August 2008 and 17th August 2009.

The Brix was examined with refractometer (AST 1230, Tokyo, Japan). All statistical analyses were performed using the Microsoft® Excel 2002 Analysis Toolpak (Microsoft Corporation Corporate Headquarters Redmond, USA).

The effect of irrigation on tomato yield depends on the actual weather conditions, basically the air temperature and precipitation (quantity and dispersion).

Figure 1. shows average daily temperatures and precipitations during the two year period.

Results and discussion

There were significant differences between the control and irrigated plant stands according to the water supply which was formulated the canopy values also. The regularly irrigated tomato plants' yield exceeded the unirrigated ones in each year. It is emerged from the study that the irrigation has a positive effect on the amount of the harvestable yield. Effect of irrigation (RI, CO) increased the marketable yield with 100% respectively in 2008. In 2009, according to the less precipitation, the treatments showed significantly higher differences.

Water supply had strong positive (R^2=0.85) effect on marketable yield and average fruit weight (R^2=0.89). Linear regression showed, that 46.5 mm more water supply caused 10 t/ha more marketable yield, and 13.4 mm more water supply caused 1 g more in the average fruit weight. We could establish strong positive (R^2=0.65) water supply effect on harvested number of fruits per hectare. These results are demonstrated in *Figure 2.* calculated from two years data.

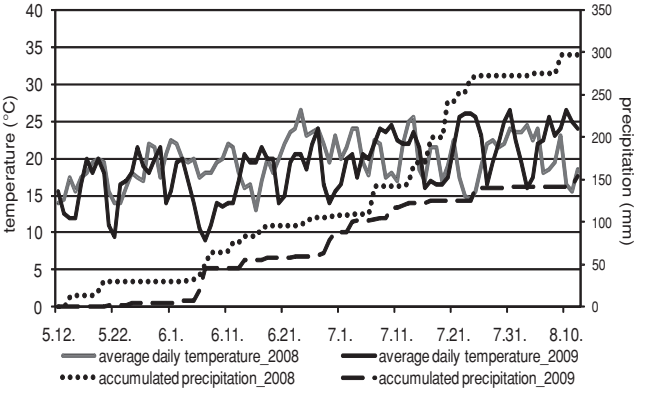

Figure1: Meteorological data during tomato vegetation period in 2008 and 2009.

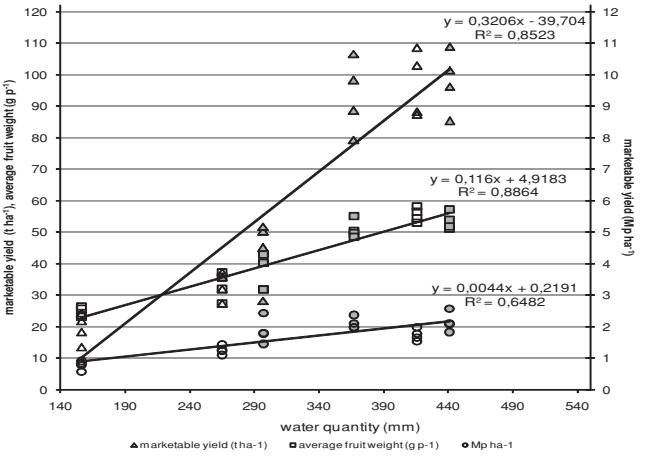

Figure 2: Correlation between water and total marketable yield, pieces and fruit weight of processing tomato in 2008 and 2009 (Brigade F_1). The symbols show: ■ ●▲: 2008 data, □ ○△: 2009 data.

Regular irrigation caused a significant decrease in the Brix° of individual tomato fruits, while it resulted in a significant increase of Brix yield per hectare *(Table 1.)*

Table 1: Average yield parameters of marketable tomato fruits

		Average fruit weight (g)	Mp ha-1	Marketable yield (t ha^{-1})	Brix°	Brix yield (t ha^{-1})
2008	RF	36.8±5.6^b	1.9±0.4^c	43.9±10.6^b	5.5±0.2^a	2.4±0.6^b
	CO	53,6±2.7^c	2.2±0.3^c	101.9±1.9^c		
	RI	51.9±1.7^c	2.2±0.3^c	98.0±9.7^c	6.5±0.2^a	5.4±0.7^d
2009	RF	24.8±1.6^a	0.8±0.2^a	19.5±4.7^a	9.0±0.6^d	1.6±0.3^a
	CO	33.1±4.4^b	1.3±0.1^b	41.3±2.0^b	7.7±0.4^c	2.6±0.3^b
	RI	55.5±2.3^c	1.7±0.2^c	96.7±10.6^c	6.1±0.4^b	3.7±0.8^c

Rainfed (RF) cut off (CO) regularly irrigated (RI). For each column bearing different superscript letter indicate significant differences according to Tukey's test. Values mean ± SD

Rainfed (RF) cut off (CO) regularly irrigated (RI). For each column bearing different superscript letter indicate significant differences according to Tukey's test. Values mean ± SD

Conclusions

Better water supply results higher yield and significantly reduces the soluble solids (Brix°) of tomato fruit. However, the effect of irrigation to increase yield is stronger than the decreasing effect on Brix°. Therefore, the irrigation increases the Brix yield as well.

Acknowledgement

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