THE EFFECT OF TEMPERATURE CHANGE ON LEAF SURFACE TEMPERATURE OF PLANTS IN SWEET PEPPER FORCING

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ABSTRACT

In the greenhouse during the vegetable forcing we ensured the optimal cultivation conditions for sweet pepper plants for high quality, healthy production. In vegetable forcing the soil status, light intensity, air movement, humidity, air temperature and the changes of these factors can influence the success of forcing. In Hungary the forcing area of sweet pepper (*Capcisum annuum* L.) is approximately 2500 ha. It is the most important horticultural activity. Therefore it was justified to study this plant from many aspects. The surface temperature of plants was measured in six pritamin-type sweet peppers, during of forcing. We performed our measurements in a vegetable horticulture farm of Magyarbánhegyes in summer cultivation period from July to August, on soil in plastic tunnel. The tested varieties were pritamin types, red colored Tokyo, orange colored Sayuri hybrids and their parental sweet pepper varieties, the tomato shaped red PAZ, orange PAZ and California types red colour Torkál F1 and orange colour Fellini F1 sweet peppers. Our measurements were carried out at 12[30] each time, every day.

Keywords: surface temperature, infrared thermometer, *Capsicum annuum* L., cultivation conditions

INTRODUCTION

In Hungary the most important vegetable is sweet pepper (*Capsicum annuum* L.). Its growing area is approximately 2500 ha, from which 170 thousand tons of fruits are harvested (FODOR, 2012). During the growing period a number of problems can come up, therefore it was justified to study this plant from many aspects.

In the plastic tunnels with lower airspace the temperature and ventilation can be controlled only slightly. In the summer cultivation period the air temperature can rise often above 40 °C. However, it does not always satisfy the needs of the sweet pepper. Excessive temperature can cause damage in the yield, in the transpiration of the plants and also in keeping the cells' turgor status (TERBE ET AL., 2005). In the spring-summer cultivation period the unbalanced climate of South Hungary provides different temperature values every day and every time of the day. The temperature changes can alter the leaf-temperature of the sweet pepper, which regulates the plant physiological processes - assimilation, respiration, etc.- to different extent (HELYES, 1989). From the environmental factors surrounding the plant (temperature, light, humidity, wind), the daily mean temperature is most commonly used for timing the daily water consumption and irrigation (WIEGAND AND NAMKEN, 1966). In practice, one fifth of the average temperature can give an exact value for the daily water consumption. That means that in the case of an average temperature of 18 °C, the daily evapotranspiration is 3.6 mm. The accumulation of the daily mean temperatures was used to express the state of plant development and to calculate the value of water uptake as well (VARGA, 1998). Sweet pepper is a particularly water-intensive plant. It is very sensitive to water stress (ABD-EL-BAKY ET AL., 2010). During the traditional sweet pepper cultivation on soil, the water use coefficient is 100 l/kg around, 6 °C amount of heat was off 1 mm evapotranspiration (TERBE ET AL., 2005). The more intensive forcing required meeting the water demand of sweet pepper. Therefore, today the irrigation research was aimed at the following plant parameters: the turgor status of cells, the mechanism of stoma, the colour of plants, the critical phenological stages of plants, regarding water supply, together with radiation surface temperature of plants. PAVENELLI AND TAGLIOLO (1989) also used the crop surface temperature to characterize potato (*Solanum tuberosum* L.) water supply. They found that the potato tuber was of the best quality when the maximum daily canopy temperature was not higher by more than 1.5 °C than the air temperature. In the past few years infrared remote thermometers were used for the characterization of the water supply and the irrigation design also in case of horticultural crops (TANNER, 1963; GIULINANI AND FLORE, 2000; MASSAI ET AL, 2000). According to TANNER (1963), 1 °C difference in the leaf temperature causes 10% change in the rate of transpiration. Consequently, the irrigated plants were able to evaporate more than 10% than the control plants (HAGAN AND STEWART, 1972).

Our aim was to study the changes in canopy temperature and its correlation with daily air temperature in sweet pepper parental varieties and their hybrids.

MATERIAL AND METHOD

Experimental setup

Our experiments were carried out in a vegetable horticulture farm in Magyarbánhegyes, in the summer cultivation period from July to August, on soil in plastic tunnel. The plastic-covered greenhouse was 9 m wide and 100 m long. The ventilation of the greenhouse was solved only by opening the doors at the two ends and also through the three side windows. The plants were planted on 10th May in double row arrangement, the sowing distance was 85 cm and plant to plant distance 25x25 cm. The canopy temperature of the examined plant groups was measured by RAYNGER II. (Raytech Corporation USA) infrared thermometer. Our measurements were carried out at $12^{\underline{30}}$ each time, every day.

In all measurements the intact leaves were examined, which were exposed to direct sunlight and located under the top, young sweet pepper fruit. To determine the air temperature the ABAKO 10506, for root-zone temperature the PK-1 digital thermometer was used. The statistical analysis was carried out by Microsoft ® Excel 2003 Analysis ToolPak module.

Plant meterial

The surface temperature was examined in six pritamine-type sweet pepper varieties. The tested varieties were pritamin types, red color Tokyo, orange color Sayuri F_1 hybrids and their parental sweet pepper varieties, the tomato shaped red PAZ, orange PAZ and California type red color Torkál F_1 and orange color Fellini F_1 sweet peppers.

Sayuri hybrid = PAZ orange X Fellini F_1 orange.

Tokyo hybrid = PAZ red X Torkál F_1 red.

RESULTS

The data obtained were determined by statistical calculation of the rates of changes in leaf surface temperature. To make comparison easier, not the absolute temperature, but the differences between the leaf surface and air temperature are shown. This condition may be negative, if the air temperature is higher than that of the leaf surface. *Figures 1* and *2* show that after the cooling down in the period from July 12 to 13 the air temperature was always higher than that of the leaves. *Figure 1* shows the different air and surface temperatures of Sayuri F_1 and parental varieties during the measurements. In these types of plants the parents show differences prior to the cooling, but the Sayuri F_1 did not differ significantly. In *Figure*

2 the changes of air and surface temperatures of Tokyo F_1 and parental varieties can be seen during the measurements. From the beginning of the measurements to the cool-down there was a similar trend as in the yellow varieties. From 13 July, however, significant difference occurred between the parental lines and the Tokyo F_1. During this period the leaf surface temperature of Torkál F_1 showed the greatest difference to air temperature. It was lower by 5.7 °C on average. It means that the cooling effect of transpiration prevailed in this variety and this variety evaporated the most. In the case of PAZ red type this value was only 3.9 °C, while the Tokyo F_1 hybrid showed the smallest difference, which was 2.6 °C, that is half of that of the variety Torkál F_1 used as pollinator.

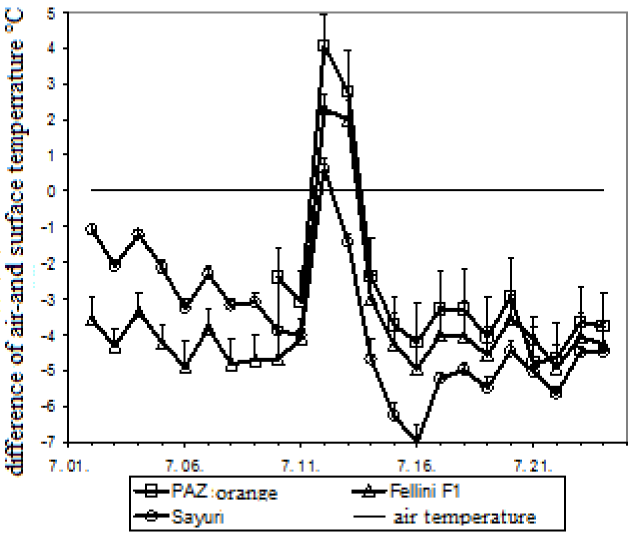

Figure 1. The changes of air and surface temperatures of Sayuri F_1 and parents varieties during the measurements. (n= 4; P= 0,05)

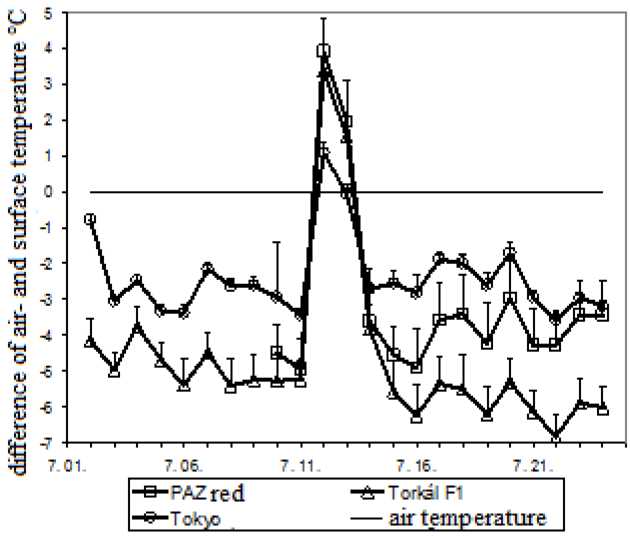

Figure 2. The changes of air and surface temperatures of Tokyo F_1 and parental varieties during the measurements. (n= 4; P= 0,05)

Then we tried to detect correlation between the change of leaf surface temperature and air temperature (*Figure 3*). The figure shows that the air temperature has a strong positive effect on the temperature of the leaf surface. The leaves surface temperature only rose above the air temperature in the case of lower air temperatures.

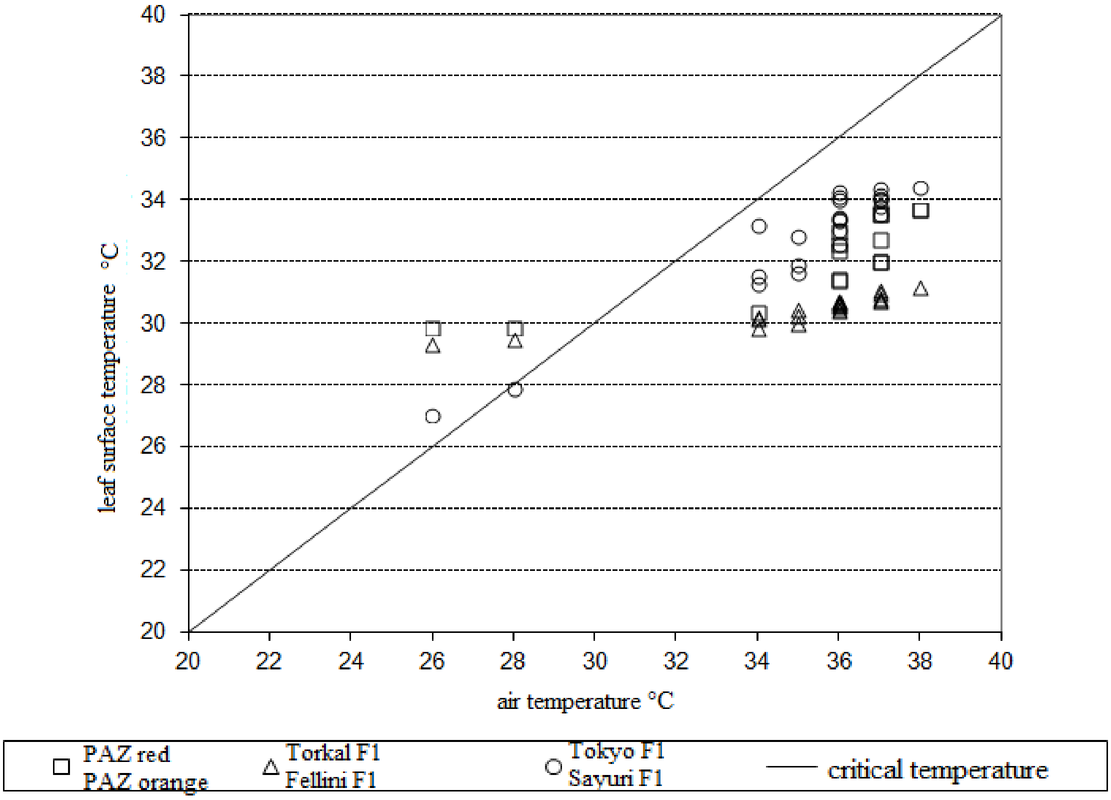

Figure 3. The change of leaf surface temperature in correlation with air temperature.

CONCLUSION

The transpiration of the plants (irrespectively of the species) is constant from late afternoon to the morning hours. We did not measure significant differences. Therefore it is appropriate to plan irrigation for this period. The significance values of the measured results demonstrated that the examined sweet pepper varieties respond differently to changes in temperature and the leaf surface temperature can vary. This means that the transpiration rate is different in the same environmental conditions, and the water use efficiency of the varieties is different. We point out that temperature changes taking place in the spring and summer forcing period can influence the pepper-type selection. Our results demonstrated that from the parental varieties and hybrids, the Tokyo F_1 used the most economical disposal of water. These examinations need to be continued and extended to the exact determination of water use, as well as the measurement of stoma conductance.

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