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The effect of cooling irrigation on the blooming dynamic of plum

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Summary: The objective of the present study is to explore the effect of cooling irrigation (aspersion) on the beginning of bloom and on the micro-climate of the plantation. The results show that the water sprayed in the orchard by micro-jet influenced decisively the temperature of the plantation. At higher temperatures (around 20 °C), the drop of temperature may attain 5–7 °C. A low relative humidity of the air may increase the relative effect, The frequent repetition (20 minute intervals) may keep the temperature low also in the buds. The beginning of bloom may delayed for more than ten days. The dynamics of blooming was characterised by a logistic curve in the treated as well as in the control plot. In the treated plot, the curve was steeper than in the control in spite of equal temperatures measured in the plots. Under our (Hungarian) climatic conditions, the method is successfully used to delay blooming dates. The main result is the diminution of the frost damage in the spring and the security of yield. The costs and water requirement should be calculated later.

Key words: regulation of microclimate, cooling aspersion, blooming time

Introduction

Irrigation in national horticultural practice is mainly used for just water supply. At the same time the water sprayed irrigation has a powerful influence on the changes of temperature. When the air's temperature is high (about 20 °C or higher) the evaporative cooling irrigation significantly decreases the plant surface and air temperature. The cooling effect is stronger when the air is dryer. By using the cooling irrigation regularly the temperature of canopy can be decreased so that the beginning of blooming can be delayed. In the case of early blooming start the probability of climatic frost is high which can cause serious damages in orchards. The cooling irrigations beneficial effect comes forward in the case of temperature reduction and frost protection. Below the freezing point the coexistence of water and ice provides for the flowers that the surface temperature remains around 0 °C, while the temperature of the surrounding air falls to even –8 °C. In national and international practice the frost protective irrigation is wide spread but with the use of cooling irrigation the protection against frost could be significantly escalates.

Materials and methods

The experiments were performed on the Experimental Farm of the Debrecen University, Pallag. The measures are referred to the plum plantation with 4×1.5 m planting design and the crowns are trained to funnel shape. The plum variety was "Havanta" planted in 2004.

The dynamics of bloom influenced by the seasonal temperature were examined earlier in apple and sour cherry plantations by *Lakatos* et al. (2006, 2008, 2009). In the present case the, the possibility of influencing the micro-climate was on the stake.

A special station equipped thermometers perform measurements with high sensitivity platina sensors mounted on the branches of the trees near to the buds. The sensors were distributed in the crown at five points, in the center and on the four cardinal directions on the periphery. The sampling time was 10 minutes for each.

The dynamics of bloom were studied according to the system described by *Nyéki* (1980, 1989, 1990, 2002).

The experiment started in 2010 March. The system of irrigation was established for the purpose to produce anti-frost treatment and regulating the micro-climate. The sprinklers' role was first the prevention of frost damage, but in the present program, on the contrary, the cooling of the air by increasing the evaporation and increasing the relative humidity. The treatment began nearly one month earlier than the expected blooming. The position of the micro-sprinklers was planned in three levels (around the trunks, a few cm near to the soil, in the crown region and above the crown, a half meter higher).

The program started the sprinklers every 20 minutes for two minutes. The cooling effect was uniform in the whole

space of the crown. In this case, we did not observe the effects of the various levels, because the evaporation was not intense during that period, and the cooling was extended to the whole crown. The most effect was due to the contact-evaporation on the wet surfaces. Measurements were made to register the three levels together.

Results

During this one month period, the temperature of the crown space of the sprinkled trees was 1.5–2.0 °C lower as a mean than in the non-cooled check *(Figure 1).* Around noon, the difference was even 3–4 °C. The less difference was in the early morning hours: 0.5–1.0 °C.

At low temperatures, evaporation is less intense. The data prove that around 10 °C temperature, during the night, the drop of temperature was still 2.0–2.5 °C *(Figure 2).*

The most conspicuous effect was experienced above 20 °C daytime maximum temperatures, when the buds were 7–8 °C cooler than the check.

During the day a pause of the sprinklers' activity, the temperature recovered the check within 2 hours. The frequent spraying in an important condition of success.

On warm days, when the maximum attained 20 °C, and at strong radiating heat, the cooling effect ensues quickly, the drop of temperature is 5 °C within half an hour *(Figure 4).* In the irrigated plantation during the night, the cooling may maintain temperatures 3–4 °C lower than in the check. Nevertheless, the variation of the temperature is during the night moderated.

The effect of irrigation not only lowers the temperature but also its variation. On days, when clouds built up and the temperature dropped, the irrigated plot was less influenced *(Figure 5).* Irrigation diminished both, warming up and cooling down, thus the risk of heat-stress and sunburn have much less chances.

The retarding effect on blooming of cooling irrigation was measured on three selected trees and as a check on three dry trees. Daily counts on 100 flowers traced the effect of the treatment. Non-irrigated trees started blooming at April 5–6, whereas the irrigated trees later by 7–8 days. In Figure 6, the rising angle of the sigma-curve was less steep. The time between start of bloom and full bloom lasted 8 days instead of 5 days in the check. The slowing down of the dynamics lasted during the whole blooming period. The dry check finished bloom at April 15 whereas the irrigated at April 25, the blooming period was prolonged by 2 days.

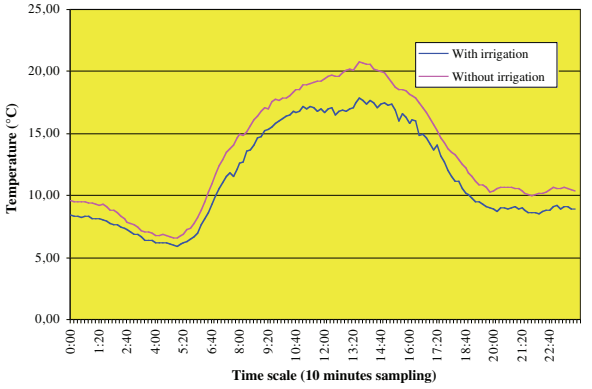

Figure 1. Mean daily temperature in the plum plantation with and without irrigation between March 15 and April 15, 2010 at Pallag

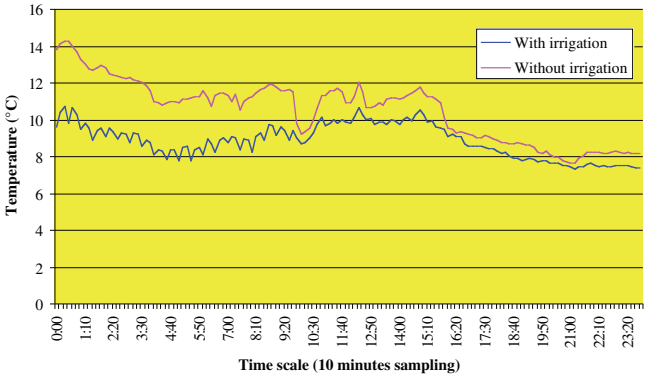

Figure 2. The effect of irrigation those days when the night temperature was high (between March 15 and April 15, 2010 at Pallag)

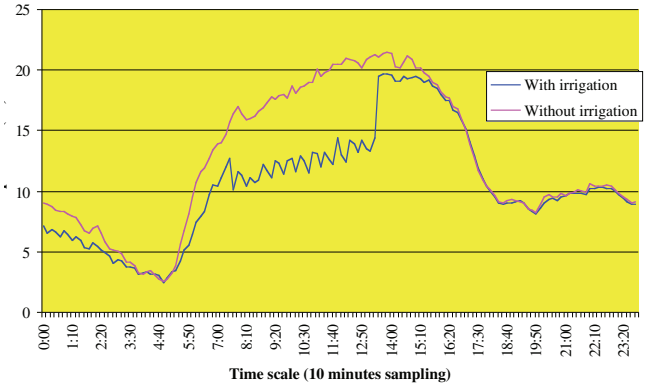

Figure 3. The effect of irrigation those days when the temperature attained 20°C at least (between March 15 and April 15, 2010 at Pallag)

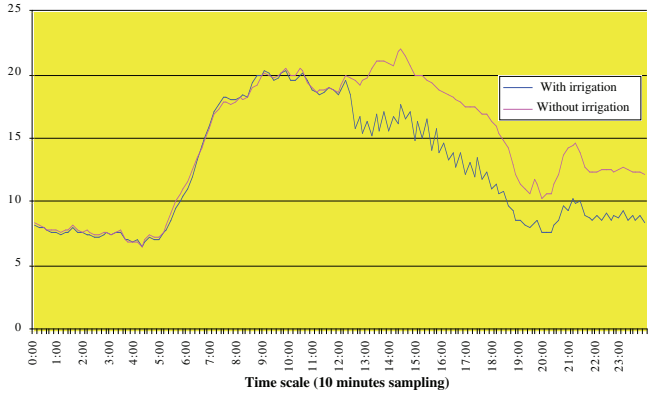

Figure 4. The effect of irrigation with different frequencies on the temperature of the plum plantation (on 12th of April, 2010 at Pallag)

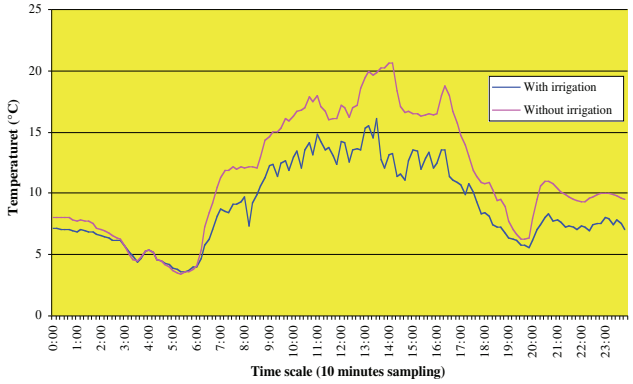

Figure 5. The effect of irrigation on the variation of temperature (on 26th of March 2010 at Pallag)

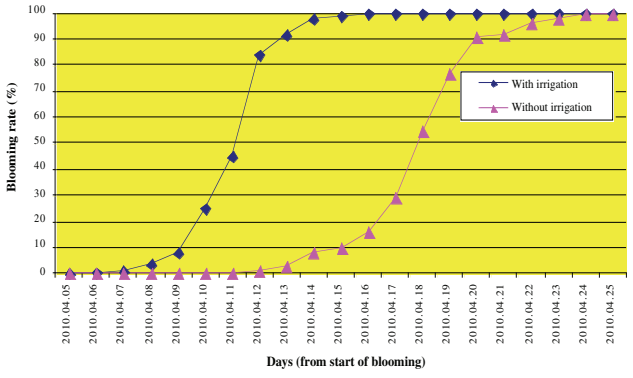

Figure 6 The effect of irrigation on the blooming dynamic of plum (between April 5 and April 25, 2010 at Pallag)

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