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Estimating of water consumption of cherry trees

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Summary: Despite of its importance there is no exact information on water use of new scion/rootstock composite trees, which would be needed to optimized irrigation. Our research purpose is to define exact water-demand of different rootstock/scion composite trees, calculating seasonal weather changes and by using the results decrease irrigation costs. The investigations are carried out in Soroksár, at the Experimental Farm of Corvinus University of Budapest in May 2008. From among the investigated trees two are budded onto *Prunus mahaleb* 'Érdi V' seedlings, two on ''Korponay' seedlings.The sapflow measurements are carried out using Dynamax Flow 32 equipment with Dynagage trunk sensors. The first daily maximum of sapflow was around 10:00 a.m. (2.5 kghour^{-1}), the second maximum was always between 14:00–15:00 p.m. (2 kgday^{-1}). Comparing to the very intensive morning water uptake by 20:00 p.m. the water flow slowly reached the minimal level. Significant differences can be seen on rootstocks: trees on 'Korponay' rootstock always showed more intensive sapflow and a higher morning peak than trees on 'Érdi V'. But later during the day they have the same run.Based on our results the water quantity transpired only by the trees reached in May 86–104 mm, while the precipitation was only 42.4 mm. This means a 40-60 mm deficit in the orchard, which should have been supplied by irrigation despite of the satisfying horticultural performance of the orchard.In the first half of the month beside the steady vapor pressure deficit the shoot and leaf surface growth could cause the increased sapflow.

Key words: water consumption, sap flow measurement, temperature, air humidity, cv. Rita, rootstocks

Introduction

Optimal water supply of cherry trees is essential in production of high quality fruit in required size. In the USA twenty-five-year-old sweet cherry trees irrigated to their full requirements may use from 76 to 100 cmha $^{-1}$ of water with apparently similar horticultural performance by the trees (*Hanson & Proebsting*, 1996). Cherry trees in practice are irrigated in the first half of the season especially at intensive shoot and fruit growth to avoid plant water deficits. Due to the global climate changes the lack of water or the increasing costs of irrigation may become the critical point of fruit growing. This makes the knowledge on water consumption of sweet cherry trees an important issue for irrigation planning. Despite of its importance there is no exact information on water use of new scion/rootstock composite trees, which would be needed to optimized irrigation. That is why a series of measurements started in 2007 with the aim to investigate the water use of trees as well as to investigate factors influencing the transpiration of trees. Several methods have been used to determine transpiration in individual trees. Since transpiration is closely related to xylem sapflow (*Fernandez & Moreno*, 1999; *Bethenod* et al., 2000), this method can be used to measure water use. However, in some cases (water stress, high evaporative demand, etc.) sap flow can temporarily be higher or lower than the transpiration level (*Jarvis*, 1985; *Katerji*, 1986; *Alarcón*, 2000). The relative accuracy of the sap flow method compared with direct weighting of water losses is reported to be about ±10% in controlled environment (*Steinberg*, 1990). For planning economized water-usage, intensifier, climate-conditioning irrigation, it is highly recommended to observe ahead several environmental factors. Such as sap flow, what we measure by using a special sap flow meter. Our research purpose is to define exact water-demand of different rootstock/scion composite trees, calculating seasonal weather changes and by using the results decrease irrigation costs.

Our paper focuses to measurements carried out in May 2008 on sweet cherry 'Rita' in the intensive shoot and fruit growth season with the aim to estimate the water use of trees.

Materials and methods

The investigations are carried out in Soroksár, at the Experimental Farm of Corvinus University of Budapest in May 2008. The experimental orchard is planted to 4 x 2 m spacing with 1250 treesha $^{-1}$ density. The cultivar is 'Rita', which ripe early, last week of May. Trees selected for investigations are four-year-old (planting year 2004 spring), trained to Hungarian spindle, their height is around five meters, not headed yet. From among the investigated trees

two are budded onto *Prunus mahaleb* 'Érdi V' seedlings, two on 'Korponay' seedlings, trunk cross-sectional area see in *Table 1*.

Table 1. Details about the test trees

Trees on rootstocks	Stemcircle (cm)	Radius (cm)	Stemarea (cm^{-2})
Érdi V. 4/23	18,4	2,92	26,77
Érdi V. 4/24	25,5	4,06	51,75
Korponay 4/10	21,6	3,43	36,94
Korponay 4/8	26	4,14	53,81

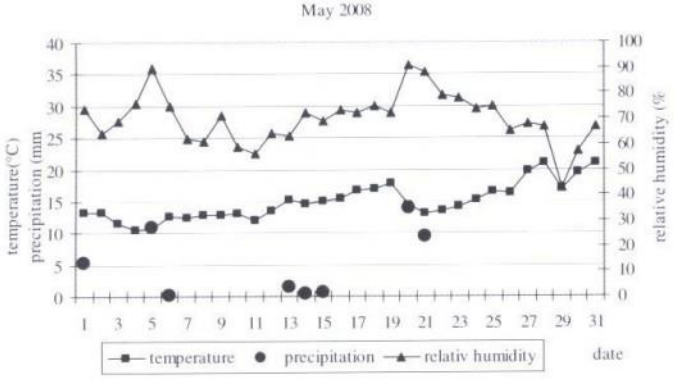

Figure 1 Daily distribution of meteorological parameters (May 2008)

The sapflow measurements are carried out using Dynamax Flow 32 equipment with Dynagage trunk sensors. Sapflow was measured on trees from 04.05 to 18.05. (15 days) and from 25.05. to 30.05. (6 days), all together 21 sample days. During May the daily average temperature (monthly average 14.9 °C, minimum 2.8 °C, maximum 29.3 °C), relative air humidity (monthly average 70%) and precipitation (42.4mm) was measured (*Figure 1*). The orchard was not irrigated in May because of the well distributed rainfall and satisfying horticultural performance of trees.

Results

Daily trend of sapflow in sweet cherry trees. In *Figure 2*. a, b the measured sap flow trend is shown on two selected days. On these days there was not any precipitation, but the days before it rained. In the morning around at 7:00 a.m. started the water flow which became quite quick and intensive, it was followed by a more balanced sap flow rate. The first daily maximum was around 10:00 a.m. (2.5 $kghour^{-1}$), the second maximum was always between 14:00-15:00 p.m. (2 $kgday^{-1}$). Comparing to the very intensive morning water uptake by 20:00 p.m. the water flow slowly reached the minimal level. Significant differences can be seen on rootstocks: trees on 'Korponay' rootstock always showed more intensive sapflow and a higher morning peak than trees on 'Érdi V' (*Figure 2 a, b*). But later during the day they have the same run.

Average xylem sapflow in trees on different rootstocks. The average daily water uptake is between 17–28 kg, from

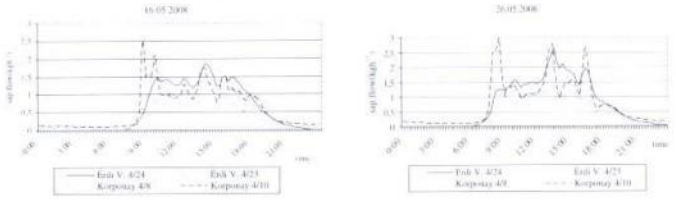

Figure 2 a, b Performance of the xylem sap-flow on some selected days in 'Rita' sweet cherry on two rootstocks

the measured data it can be calculated the average monthly water demand (*Table 2*) Studying the calculated water run for trunk cross-sectional area there is about 20% differences between rootstocks on the same varieties, but two trees on one rootstock is statistically not enough for final comparison.

Table 2. Average xylem sapflow calculated from the sampled days in May in 'Rita' sweet cherry on two rootstocks

Tree	Average sapflow ($kgday^{-1}$)	Calculated monthly average (kg)	Calculated for trunk cross-sectional area ($kgday^{-1}cm^{-2}$)
Rita / Érdi V. 4.23	17,57	544,67	0,65
Rita / Érdi V. 4.24	27,12	840,72	0,52
Rita / Korponay 4.10.	28,05	883,5	0,76
Rita / Korponay 4.8.	25,72	797,32	0,47

Trend of sapflow in May. Xylem sapflow steps up from 10–15 $kgday^{-1}$ from the beginning of the month to 30–40 $kgday^{-1}$ to the end of May, increasing to a three times higher level (*Figure 3*). In the first half of the month beside the steady vapour pressure deficit the shoot and leaf surface growth could cause the increased sapflow, but in the last days the slowly increasing vapour pressure deficit also may contribute.

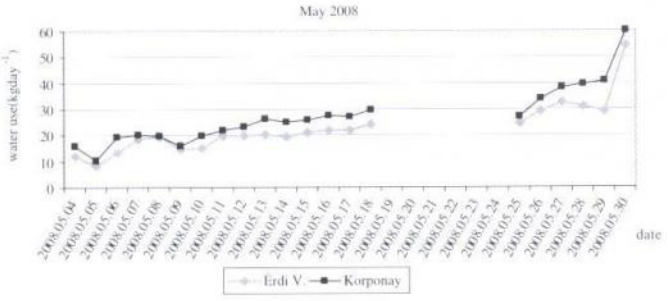

Figure 3 Daily water consumption (May 2008)

Calculation of orchard water demand and balance. After studying the sap flow data it is possible to calculate daily or monthly water demand of the cherry trees (*Table 3*). Based on our results the water quantity transpired only by the trees reached in May 86-104 mm, while the precipitation was only 42.4 mm. This means a 40–60 mm deficit in the orchard, which should have been supplied by irrigation despite of the satisfying horticultural performance of the orchard.

Discussion

There are little differences in daily trend of xylem sapflow among the days but trees on 'Korponay' seedling always start with a higher peak in the morning.

Despite of the satisfying horticultural performance of trees there is a deficit between the water consumption of trees and the precipitation.

In the first half of the month beside the steady vapor pressure deficit the shoot and leaf surface growth could cause the increased sapflow.

Further investigations are needed to consider the tree growth, leaf area growth, which may be important factor influencing the sapflow.

Table 3 Daily irrigation need on the different species (May 2008)

Date	Érdi V. $kgday^{-1}m^{-2}$	Korponay $kgday^{-1}m^{-2}$	Avarage (Érdi V., Korponay) $kgday^{-1}m^{-2}$
04.05.2008	1.52	1.96	1.74
05.05.2008	1.00	1.27	1.14
06.05.2008	1.67	2.41	2.04
07.05.2008	2.32	2.53	2.43
08.05.2008	2.40	2.44	2.42
09.05.2008	1.81	1.99	1.90
10.05.2008	1.89	2.46	2.17
11.05.2008	2.45	2.74	2.60
12.05.2008	2.49	2.88	2.69
13.05.2008	2.53	3.24	2.89
14.05.2008	2.42	3.11	2.77
15.05.2008	2.63	3.24	2.93
16.05.2008	2.75	3.44	3.10
17.05.2008	2.73	3.38	3.05
18.05.2008	3.00	3.68	3.34
25.05.2008	3.04	3.40	3.22
26.05.2008	3.63	4.23	3.93
27.05.2008	4.06	4.75	4.40
28.05.2008	3.88	4.90	4.39
29.05.2008	3.64	5.06	4.35
30.05.2008	6.80	7.48	7.14
total	58.66	70.60	64.62
calculated total for May	86.59	104.18	95.38
Precipitation (mmm^{-2}) in May	42.4		

References

Alarcón, J.J., Domingo, R., Green, S., Sánchez-Blanco, M.J., Rodrigues, P., Torrecillas, A. (2000): Sap flow as an indicator of transpiration and water status of young apricot trees. *Plant Soil.* 227: 77–85.

Bethenod, O., Katerji, N., Goujet, R., Bertolini, J.M., Rana, G. (2000): Determination and validation of corn crop transpiration by sap flow measurement under field conditions. *Theor. Appl. Climatology.* 67: 153–160.

Fernandez, J.E. & Moreno, F. (1999): Water use by the olive tree. *J. Crop Prod.* 2: 101–162.

Hanson, E.J. & Proebsting, E.I. (1996): Cherry Nutrient Requirements and Water Relations. In Webster and Looney (Eds.): Cherries: crop physiology, production and uses. *CAB International*,. pp. 243–257.

Jarvis, P.G. (1975): Water transfer in plants. *In: de Vries, D.A., van Alfen, N.K. (Eds.), Heat and mass transfer in the Plant Enviroment. Part 1. Scripta Book Co.*, Washington DC, pp. 369–394.

Katerji, N., Hallaire, M., Menoux-Boyer, Y., Durand, B. (1986): Modelling diurnal patterns of leaf water potential in field conditions. *Ecol. Model.* 33: 185–203.

Steinberg, S.L., van Bavel, C.H.M., Mc Farland, M.J., (1990): Improved sap flow gauge for woody and herbaceous plants. *Agron. J.* 82: 851–854.