SAP FLOW RESPONSE OF CHERRY TREES TO WEATHER CONDITION

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ABSTRACT. – Sap flow response of cherry trees to weather condition. The main goal of our study is to measure water-demand of cherry trees budded onto different rootstocks by sapflow equipment and to study the sap flow response to the meteorological factors. The investigations are carried out in Soroksár in Hungary at 'Rita' sweet cherry orchard. The pattern of sapflow was analyzed in relation of solar radiation, vapour pressure deficit and air temperature. Between solar radiation and sap flow was found a parabolic relation, daily pattern of sapflow is in close relation (cubic) also to vapour pressure deficit. No significant relationship existed between sapflow and air temperature. The sapflow performance of sweet cherry trees on different rootstocks showed typical daily characters.

Keywords: meteorological factors, water uptake, sap flow, *Prunus Mahaleb*

1. INTRODUCTION

Sap flow (SF) measurement system is well known tool to estimate the water consumption of the trees, apart from it following the sap flow parallel the current weather circumstances the soil-plant-air interaction can be understood. Systematic attention has been intended to the study of transpiration in many scientific disciplines: in the physiology of plants, hydrology, ecology, and meteorology (Prazák *et al*., 1994; Granier *et al*., 2000; Lagergren and Lindroth, 2002; Daudet *et al*., 1999; Montero *et al*., 2001).

The capacity of carrying water from the soil to the leaves is regarded as a limiting factor, and the plant is considered to be capable of regulating the water output by transpiration depending on the water content in the plant body (Prazák *et al*., 1994). Estimation of stand transpiration requires analysis of among-tree variation of sap flow (Köstner *et al*., 1996), which is commonly scaled up to stand level and considered as representing transpiration (Lagergren and Lindroth, 2002). Recent findings suggested that sapflow or transpiration of trees may be closely linked to plant hydraulic variables and environmental factors (Du and Yang, 1995; Cienciala *et al*., 1997; Lagergren and Lindroth, 2002). There is increasing evidence of higher frequency of climatic extremes as a result of global climatic change (Karl *et al*., 1995). The annual variability of precipitation may be high and distribution of rainfall during the growing season very uneven (Mika, 2011; Bartholy *et al*., 2010).

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This may affect uncertainty in the fruit production. There has been increasing proof on the impact of climatic factors on water fluxes (Oltchev *et al*., 2002; Devitt *et al*., 1997; Calder *et al*., 1997; Welander and Ottosson, 2000). If the environmental factors vary, sap flow can fluctuate widely. It is therefore important to study the sap flow and associated mechanisms under different wheater conditions.

Sweet cherry is important commercial plantation and one of the pioneer species used successful in Hungarian fruit market (Hrotkó et al., 2009). In spite of it there is not any exact information on water use of high density sweet cherry orchards.

SF of 'Rita' sweet cherry trees on sandy soil in Soroksár was monitored by the heat balance Dynamax packaged SF measuring system in the vegetation period of 2009. Furthermore global radiation, air temperature, relative humidity, precipitation and soil moisture were measured synchronously. The SF measurements are carried out using Dynamax Flow 32 equipment with Dynagage SF gauges (Dynamax Inc., Houston, TX, USA) developed from the designs published by Sakuratini (1981,1984), Baker and Van Bavel (1987) and Steinberg et al. (1989,1990b). In our study we analyzed the sap flow rate of the trees on four different rootstocks as a function with meteorological parameters.

2. MATERIAL AND METHOD

The investigations were carried out in Soroksár (47°22'N,19°09E, 103 m above sea level) at the Experimental Farm of Corvinus University of Budapest on four selected trees in sixth leaf. The cultivar is 'Rita', ripening early, between 22 -28 May. The selected trees were budded onto *Prunus mahaleb* 'Érdi V' seedlings, on 'Korponay' seedlings, on *Prunus canescens* x *Prunus cerasus* GiSeLA 6, and on Mazzard (*Prunus Avium*). As the growth vigor of rootstocks concerns, based on the tree size in average of 9 trees the 'Érdi V' is considered as vigorous, while 'Korponay' as moderate vigorous, according to investigations of Gyeviki et al. (2009).

The experimental orchard is planted to 4 x 2 m spacing with 1250 $treesha^{-1}$ density in spring 2004. Trees are trained to Hungarian spindle (Hrotkó et al., 2007). The applied heat balance method for measuring SF rates is practical and capable of great precision. In general, installation of the gauges followed procedures recommended by the manufacturer (Dynamax, 1990). Measurements were made by gauges SGA50-ws (trunk diameter: 45-65 mm), SGA70-ws (trunk diameter: 65-90 mm). The measurements were carried out by sensors set on the trunk at 40-50 cm height from the soil surface under the leaf canopy.

Sap flow was measured between May and August of 2009, on 45 sample days. Air temperature, precipitation, air humidity, soil moisture at two different depth were also measured parallel with sap flow direct in the canopy (Fig 1.). The daily observation was round the clock, outputs from the gauges were monitored every 15 sec and signals were recorded as 15 min averages apart from some error. Global radiation was registered by the Hungarian Meteorological Service, in Pestszentlőrinc 10 km far from our field.

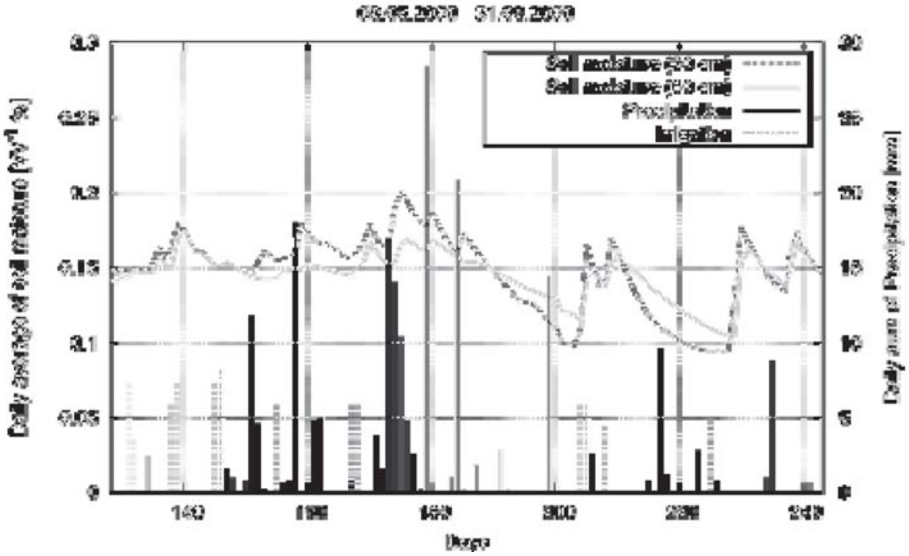

Fig 1. ***Precipitation, irrigation and soil moisture on the research field***

In the investigated period at the experimental area was 204.1 mm precipitation and the area was irrigated by dropping system with 80.25 mm water. During May and August fell circa half of the average precipitation of the flavoured in this months. In June rained 117.4 mm which is twice of the revealing mean. In July the area is come in for 80% of average rain amount. Based on the soil moisture content monitored at 30 and 60 cm depth can be said that the fisrt period of the investigation when there was adequate amount of precipitation and irrigation, the soil moisture was higher in the upper (30cm) zone while in the first dry decade of July, the water loss of the soil surface increased by evaporation that why the deeper soil layer (60cm) was more wet temporally.

3. RESULTS

We have made dimensionless profiles for the 45 measured day for each rootstocks to show the correlation between the sap flow and the meteorological elements. First we searched for the highest global radiation value. At the time of the highest radiation rate, we checked the sap flow, vapor pressure deficit, and temperature data, and have done with that values the dimensionless profiles. As the figures show there is positive nonlinear correlation between daily SF and vapor pressure deficit (VPD), with the increasing VPD sap flow rises cubic (Fig 2.). SF of trees is very intensive by the decreasing air humidity. Between SF and global radiation there is parabolic relation (Fig 3.). High level of global radiation might limit water use. In this case stomas are going to close to avoid more water loss by the transpiration. The relation between the SF and temperature is not so obvious.

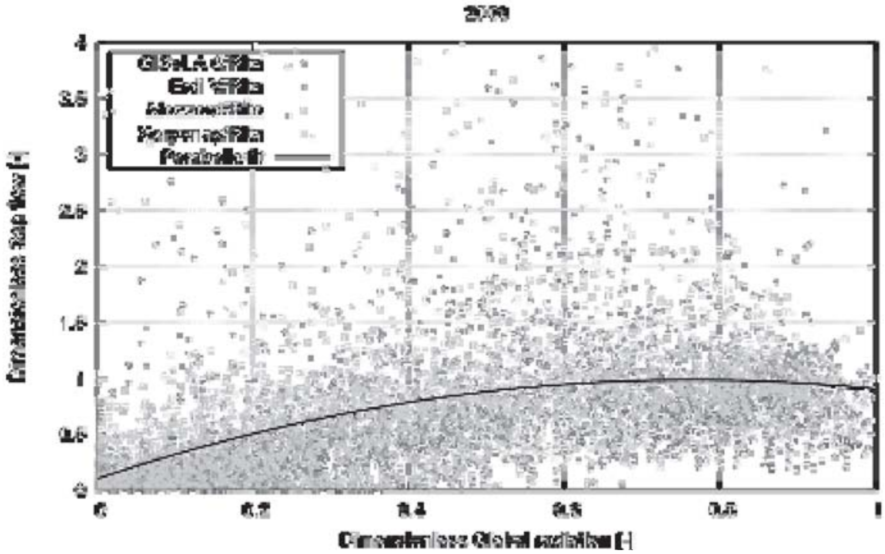

Fig 2. ***Non-linear regression between the sap flow related to the vapor pressure deficit*** $f(x)=ax^3+bx^2+cx+d$

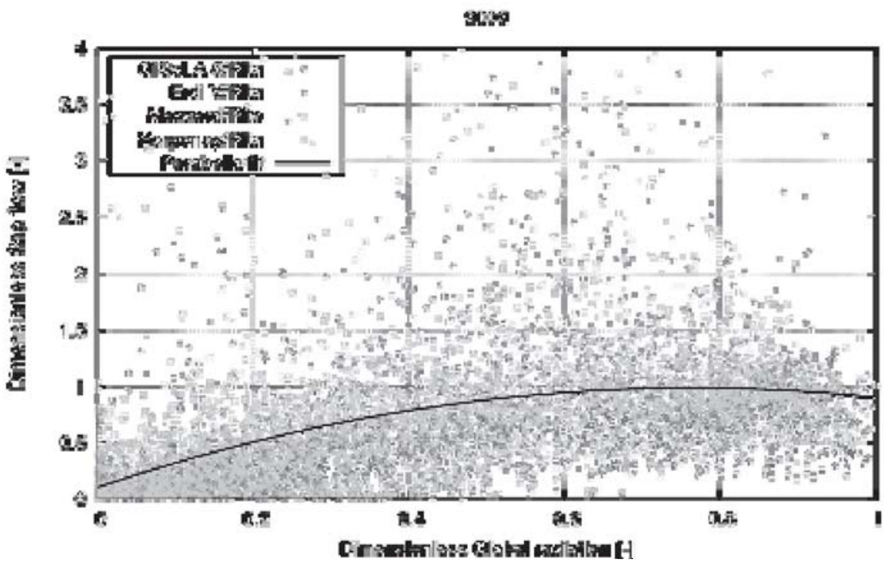

Fig 3. ***Non-linear regression between the sap flows related to the global radiation*** $f(x)=a(x-b)^2+c$

Typical diurnal sap flow (SF) course are shown on Fig 4. and Fig 5. In the morning around 6:00 a.m. started the increasing sap flow which became quite quick and reached the first daily maximum (1.7 lh^{-1}) around 8:00, between 10:00 and 14:00 there is not so high variability in the transpiration, the curves can be marked by plateau. On the two selected days the second highest level is shown between 14:00-16:00. Comparing to the very intensive morning sap-flow after 18:00 p.m. the water flow slowly reached the minimal level. Daily SF curves of trees with different rootstocks run near to each other and SF reach the peaks almost at the same period. On the13th of May there was 3.5 mm irrigation and the day before 7.5 mm, in the previous 10 days there was not any rainfall, and the soil moisture set ~0.15VV%. At the 80% of the day sap flow did not exceed $1lh^{-1}$. On the 3th of July between 8:00 and 16:00 the SF passed $1lh^{-1}$. In the previous 10 days fell 61.4 mm precipitation.

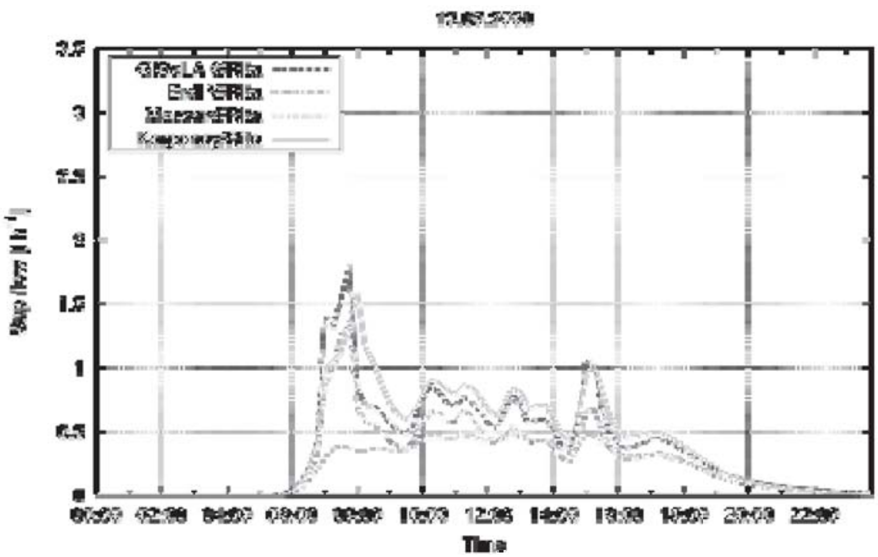

Fig 4. ***The daily sap flow trend on the selected day***

4. CONCLUSION

The sap flow course is determined by the current weather conditions. The most important factor which has an effect for the water uptake is the global radiation and vapor pressure deficit. It can be written by parabolic and cubic functions.

Many reports exist about studying the influence of light, drought, temperature and soil fertilization on transpiration (Welander and Ottosson, 2000; Montero *et al*., 2001), controlled under some special experimental conditions. The data we report was obtained under field conditions. Our results suggested that air VPD and global radiation were the major factors determining SF, while air temperature were only minor factors, which accorded with the studies of Daudet *et al*.(1999) on *Juglans regia* L. Strong positive correlation between daily transpiration rate and daytime mean VPD for *E. grandis* and *P. radianta* was also found by Myers *et al*.(1998). Considerable differences are found between trees on different rootstocks in the daily sap flow course. On the selected days the sap flow of the tree budded on dwarfing rootstock starts the most intensive.

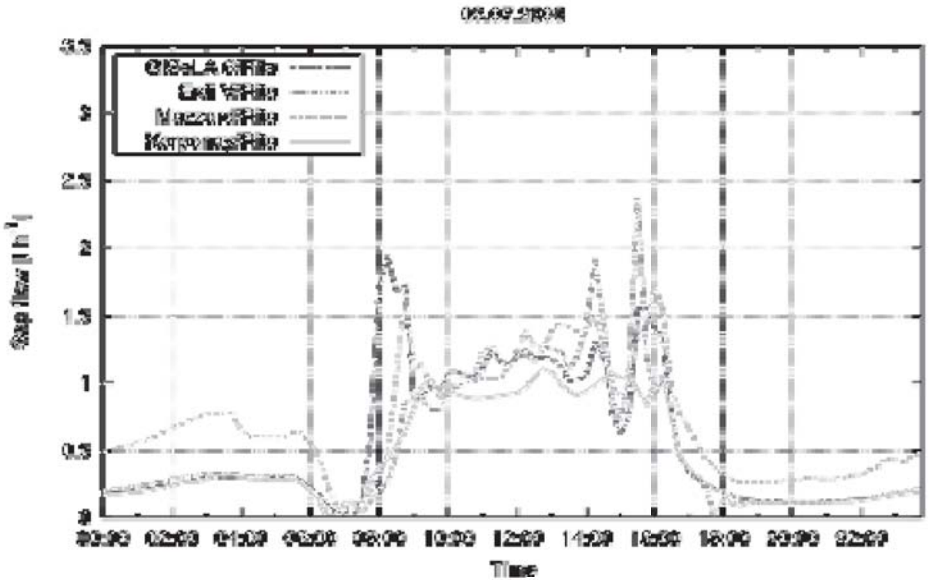

Fig 5. ***The daily sap flow trend on the selected day***

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