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The Annual Course of Transpiration in a Laurel Forest of Tenerife. Estimation with *Myrica faya*

By

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Key words: Laurel forest, sap flow, stand transpiration, *Myrica faya*.

Summary

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Tree sap flow rate was continuously measured, using the tissue heat balance technique in six trees of *Myrica faya* at the experimental site of laurel forest in Agua García mountains, Tenerife, Canary Islands, over a whole year in 1995. Sample trees were of different sizes covering the whole range of the species. A linear relation based on the diameter at breast height (DBH), was applied to scale up the transpiration data from sample trees to the whole stand assuming that all trees were *Myrica faya*.

The transpiration persisted during the whole year although it was very variable due to weather conditions. It was mainly controlled by the evaporative conditions. The maximum values of transpiration for the stand (up to 2.7 mm day^{-1}) were recorded on clear days when the air relative humidity was very low (near 20%) and the mean air temperature attained 25 to 27 °C. The annual stand transpiration amounted to 294 mm representing 30% of potential evaporation and 47% of annual precipitation. Of the total amount, 66% was registered during the summer period and 34 % during winter. These values of transpiration were lower than that registered in our previous determinations in base of *Laurus azorica* measurements.

Introduction

The estimation of annual values of transpiration in the Canarian laurel forests is crucial for the calculation of stand water balance. These forests are very

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important not only from the scientific point of view (relic of the Tertiary Mediterranean flora) but also because they play an important role in watershed management on the islands. They have the typical appearance of a cloud forest (HOLLERMANN 1981) and they consist of more than twenty different tree species although not all are living together. There are considerable differences between these forests according to the topographic and climatic situations as well as their structural and floristic composition, making difficult the study and the generalization of results from one place to another. Even at the same site, it is difficult to get accurate values of stand transpiration due to the existence of different tree species.

Sap flow methods hold important advantages over other techniques where measurements of transpiration by whole plants are required (SMITH & ALLEN 1996). In a previous paper (JIMÉNEZ & al. 1996) we presented long-term studies of diurnal, seasonal and annual dynamics of transpiration, measured directly on the tree level and scaled up to the whole stand level in a laurel forest situated in Agua García mountains, Tenerife. This was done based on direct measurements in *Laurus azorica* as one of the most representative species of the laurel forest in general and more abundant in our experimental plot. In this paper we present also the diurnal, seasonal and annual values of stand transpiration based on direct measurements in another very representative species, *Myrica faya* and these values are compared with the previous ones.

Material and Methods

Tree sap flow rate was continuously measured, using the tissue heat balance technique applying internal heating of tissues and sensing of temperature (CERMÁK & al. 1973, KUCERA & al. 1977), with a P-12 sap flow meter and data-logger (Ecological Measuring Systems, Ltd., Brno, Czech Republic), in six trees of *Myrica faya* over a whole year in 1995 at the experimental site of a laurel forest in Agua García mountains, Tenerife, Canary Islands. It consists of six tree species, *Laurus azorica* (Seub.) Franco, *Persea indica* (L.) Spreng., *Myrica faya* Ait., *Erica arborea* L., *Ilex platyphylla* Webb & Berth. and *I. canariensis* Poivet. It was described in detail in our previous papers (MORALES & al. 1996a,b,c), the climate is humid Mediterranean with an average annual temperature of 13.6 °C, relative humidity of 82 % and precipitation of 756 mm.

Sample trees were of different size (23.9, 25.1, 27.7, 28.2, 34.8, 35,2 cm of DBH) covering the whole range of the species. Tree-level sap flow data were integrated to the stand level as described by CERMÁK & KUCERA 1990, a linear relation (sap flow [kg h^{-1} $tree^{-1}$] = -0.5515 + 0.04207 DBH [cm]) was applied assuming that all trees in the stand were *Myrca faya*. Then the transpiration of mean trees of individual DBH classes was calculated from that equation. Finally the transpiration of mean trees was multiplied by numbers of trees in classes; stand transpiration was obtained by adding values of all classes.

A meteorological station (data logger, with temperature and humidity sensors, silicon cell pyranometer, anemometer and rain gauge, Skye Instruments, Llandrindod, UK) was installed on a scaffolding tower of 20 m height built on the experimental plot to have a continuum recording of main environmental factors 2 m above the canopy. Daily potential evaporation (standard stand evaporation), ET (mm day^{-1}) was calculated from the simple equation of TÜRC 1961, ET = $[(R_g/41868+50)*0.013\ T_a]/(T_a+15)$ where R_g is daily total of global radiation (J m^{-2} day^{-1}) and T_a is mean daily air temperature (°C).

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Results and Discussion

The variation of main meteorological factors during the year is shown in Fig. 1. The total global radiation was higher during the longest summer days with many oscillations due to the presence of clouds. The mean daily temperature ranged from 7°C on some winter days and 27°C in summer. The mean RH was very high most of the time with sporadic periods of very low values reaching 20%, these values correspond to higher ones of VPD and they are not associated with seasons but with the wind direction. This happened when the wind blew from the Sahara bringing very dry air.

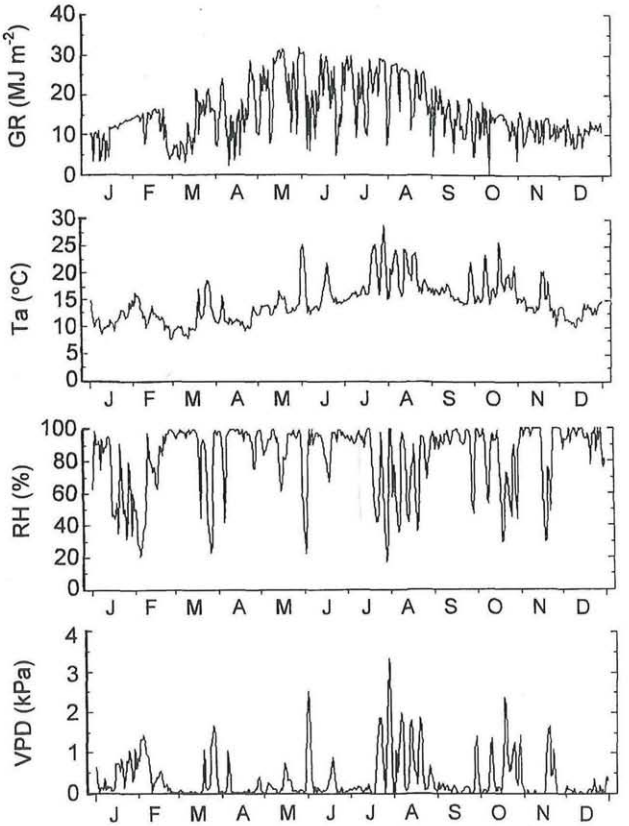

Fig. 1. Daily total global radiation (GR), and daily mean of air temperature (Ta), air relative humidity (RH), and vapour pressure deficit (VPD) along the whole year (1995), 2 m above the canopy in Agua García laurel forest experimental plot.

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Transpiration persisted during the whole year in this evergreen forest (Fig. 2), although it was very variable due to weather conditions. It was mainly controlled by the evaporative conditions, so the maximum values of transpiration for the stand (up to 2.7 mm day^{-1}) were recorded on clear days when the air relative humidity was very low (near 20%) and the mean air temperature attained 25 to 27 °C.

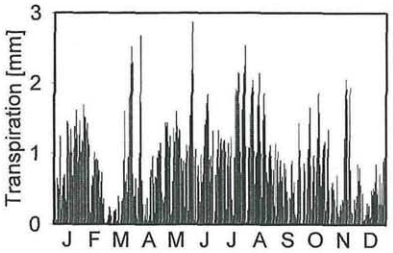

Fig. 2. Annual course of stand transpiration (daily totals) of laurel forest calculated from the continual recording of sap flow rate in the set of *Myrica faya* sample trees during the whole year 1995 (annual stand transpiration was obtained when summarizing stand daily values = 294 mm)

The precipitation was not regularly distributed during the year, similarly monthly ET was higher during the summer months, this gave a climatic water deficit during summer and the monthly transpiration was also higher during this time amounting to 37 mm in July (Fig. 3).

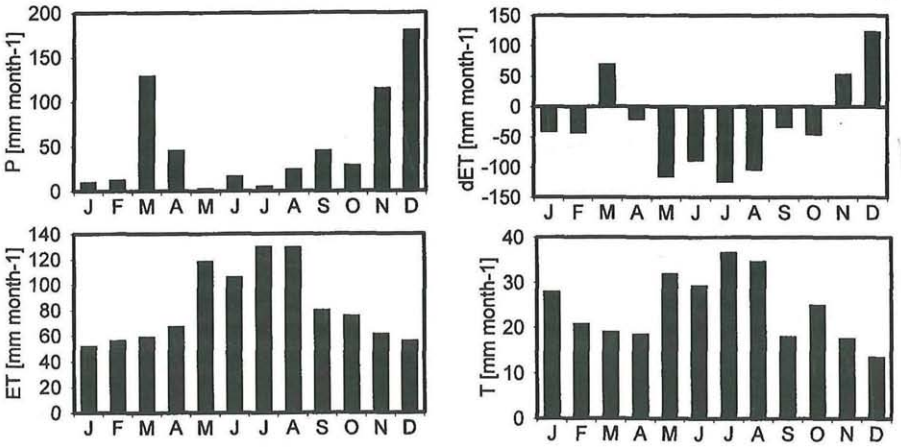

Fig. 3. Monthly totals of precipitation (P), potential evaporation (ET), climatic water deficit (dET = P-ET) and transpiration (T) of laurel forest during 1995.

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The annual stand transpiration amounted to 294 mm representing 30% of potential evaporation and 47% of annual precipitation. Of the total amount, 66% was registered during the summer period and 34 % during winter (Table 1).

Table 1. Annual and seasonal totals of laurel forest stand transpiration, precipitation (*P*) and potential evaporation (ET) during 1995.

	Potential evaporation	Precipitation	Transpiration laurel forest		
	(mm)	(mm)	mm	% ET	% P
Annual total	998	625	294	29.5	47.0
Summer (Apr.-Oct.)	710	175	195	27.5	111.4
Winter (Nov.-March)	285	451	99	35.0	22.0
Proportion of annual	100	100	100	---	---
Summer (Apr.-Oct.)	71	28	66	---	---
Winter (Nov.-March)	29	72	34	---	---

These values are in the range found in forests (LARCHER 1983) and similar to the values found in other geographical regions as in oak forests of Central Europe (CERMÁK & al. 1991, PALLARDY & al. 1995). When we compare these results with that obtained during the period June 93 to May 94, based on *Laurus azorica* measurements (JIMÉNEZ & al. 1996) we found that present values were considerably lower, although the general pattern and differences among days and months were similar. This could be due to different behaviour of different species, but we must have also in mind that the meteorological conditions were different; in this way the present measurements were done during a drier period (626 mm of rain in front of the 797 mm during the previous period). A more detailed study based in correlations with meteorological factors is being done as well as measurements in other important species as it is *Persea indica,* in order to prepare a model for the calculation of total stand transpiration based in meteorological factors. At the moment we can have a good approximation to the general variation of diurnal values of transpiration along the year in a representative laurel forest of the Canary Islands.

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