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Seasonal Changes of Water Potential Stomatal Conductance and Transpiration in the leaf of Cherry-Trees Grown in Shelter

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Summary: Seasonal changes of water potential, stomatal conductance and transpiration were studied from May till the end of October 1994, in the leaf of cherry-trees (*Prunus avium*) grown in the shelter and planted at four tree densities:100, 200, 625 and 1600 stems/ ha (10m X 10 m, 7m X 7m, 4m X4m and 2,5m X 2,5m spacing)
The spacing treatments did not seem to affect the internal water status of the sheltered cherry-tree. The seasonal pattern of conductance and transpiration generally responded to the leaf water potential pattern. The stomatal conductance and transpiration in the leaf of the sheltered trees were higher by the end of July, than that of the unsheltered-trees. Stomata seemed to corespond firstly to the increase of Vapor Presure Deficit (V.P.D.) and then to the decreased of the leaf water potential, preventing water loss for both the unsheltered cherry-trees and the herbaceous species.
These findings support the concept that the sheltered cherry-trees were less adaptable to drought condition than these grown out of the shelter.

Key-words sylvo-pastoral system, plant water balance

INTRODUCTION

Information concerning potential production in forest-pasture systems is very limited in the Mediterranean area. Furthermore, the adoption of new forest growth models, based on wide spaced trees plantation (250 trees /ha) improved the timber quality and resulted in very good forage production quality (Liacos 1986)

The shelters are recently considered of key importance for establishing a forest -pasture production system based on wide spaced tree plantation. This method allows the trees to grow in idividual shelters without excluding grazing animals from the planted area. Hence, there is the need to investigate the growth of the trees in shelters and especially their water balance, whitch strongly affects the growth (Hsiao, et al 1985 ; Schulze, 1986 ; Landsberg, 1989) and witch is strongly affected by microclimatic conditions in the shelters.

This experiment investigated the physiology of the water balance of trees in shelters in order to understand the factors limiting growth.

MATERIALS AND METHODS

The experiment was carried out in Northern Greece (Macedonia region) where plants of *Prunus avium* were planted in four tree densities: 100, 200, 625 and 1600 stems/ha, corresponding to four spacing treatments: 10mX 10m, 7m X 7m, 4m X 4m and 2,5m X 2,5 m. Most of them were protected with shelters. The establishment of the plantation took place in 1992 on a native vegetation dominated by perennial grasses.

Environmental and climatic parameters were measured during the experimentation period (from the end of April up to the end of October) in and out of shelters by an hygro-measuring multisensor system. The following parameters were measured: Ambient temperatures in °C, relative humidity in %, dew point temperatures in °C, wet-bul temperature in °C.

The vapour pressure deficit (V.P.D.) as an integrated index of environmental drought was calculated from the formula V.P.D.=$e_s(T)$ -e_a where e_a is the vapour pressure of unsaturated air and $e_s(T)$ the saturated vapour pressure of air at the same temperature (Landsberg, 1986).

The stomatal conductance and the transpiration were measured by a steady state porometer on the intact and fully expanded leaves of cherry trees (the 3rd or 4th leaf from the apex). The leaf water potential was measured at the same leaves by the chamber pressur method (Turner, 1981a ; Koide *et al*, 1991).

Measurements were obtained at noon (12-13h) six times (24/5, 9/6, 4/7, 25/8, 22/9, 50/10/1994) during the experimentation period. The value of each physiological parameter was the average of five measurements. The values of the physiological parameters of the forage cover were the average of the three dominant forage grasses (*Poa pratensis, Agropyron repens and Dactylis glomerata*).

The major problem which was coming across in this methology was the taking off the shelter for one or two minutes during the measurements (60" for the conductance and transpiration and 40" for the leaf water potential). This implies a change of microclimatic factors which had already established in the shelter.

DISCUSSION

The adoption of the shelters, for cherry trees, seems to cause a differentiation of the microclimatic conditions integrated to the seasonal pattern of V.P.D. (fig.1). Obviously, the V.P.D. in open air was significantly higher than that in the shelter, from mid-June up to the end-September. The shelter seems not to affect the V.P.D. during the cool season period. Furthermore the spacing treaments did not present significant differences for the values of V.P.D. This seasonal pattern of the V.P.D. inside and outside the shelter suggests that the trees inside the shelter might be grown in the lower V.P.D. and consequently they should have better water balance.

In fact, the seasonal changes of total water potential (fig.2) on the leaf of the cherry-trees grown outside the shelter was more negative in comparison to the water potential of the trees grown inside the shelter. However, the differences were not as great as it would be expected. This fact might be attributed to the faster growth of the sheltered tree. This implies the formation of greater transpiratory surface, causing in turn a greater water loss and more negative water potential, although the V.P.D. was not so high. (Davies, 1986 ; Jarvis, 1981).

The root system of the sheltered trees, on the other hand, seems to be very weak (Dupraz and Sibbald, personal communication 1992) to absorb great quantities of water in order to counterbalance the relative water deficit imposed to the leaf tissue.

The decrease of the water potential implies a decrease of stomatal conductance and consequently of transpiration in order to prevent water loss (Schulze *et al*,1975). In fact, the stomatal conductance as well as the transpiration in the sheltered trees drastically decreased during July-August (fig.3 and 4) probably as a consequence of a decrease of water potential. However, the conductance and the transpiration of the trees grown out of the shelter were very low and their seasonal changes were very small. This could be accounted for by the fact that stomata have shown to be more sensitive to V.P.D. (Losch and Tenhunen. 1981) than to internal water status. This response of stomata and transpiration to the high V.P.D. may be part of the plant' s first line of defence against the internal water deficit (Mansfield and Davies, 1982 ; Davies, 1986).

The very low values of leaf water potential observed in the forage cover (fig.2) suggest that the forage species have been passed at the second line of defence, i.e. at the direct response of stomata to the water potential (Davies, 1986). This may involve a distress signal to the guard cells to promote stomata closure and consequently to decrease the transpiration (fig.3 and 4) (Mansfield and Davies, 1982).

CONCLUSIONS

Trees grown in the shelter did not seem to dispose of two distinct lines of defence against drought condition; their stomata responded only after the end of July to both conditions inside the leaf (decrease of leaf water potential) mainly and external conditions (increase of V.P.D.). These trees were therefore less adaptable to drought conditions.

Trees grown out of the shelter as well as the herbaceous species seem to prevent the internal water deficit by a more efficient strategy. Their stomata close as early as the V.P.D. increases and after this line of defence, from the end of July, the stomata probably respond directly to low water potential.

The spacing treatments did not seem to affect water balance of the cherry-trees.

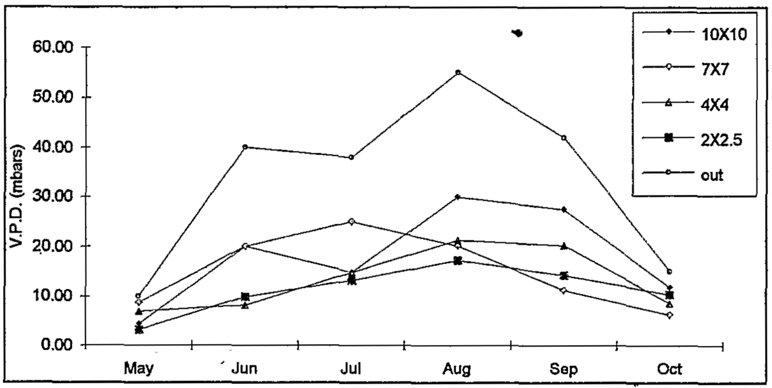

Fig. 1 The seasonal pattern of the vapour pressure deficit insite (10X10, 7X7, 4X4 and 2X2.5), and outsite (out).

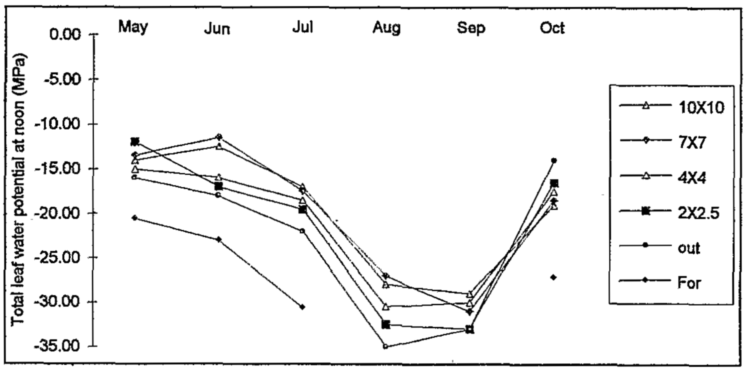

Fig 2 The seasonal changes of maximum leaf potential in the four spacing treatments in the shelter (10X10, 7X7, 4X4 and 2X2.5), out of the shelter (out) and forage (For).

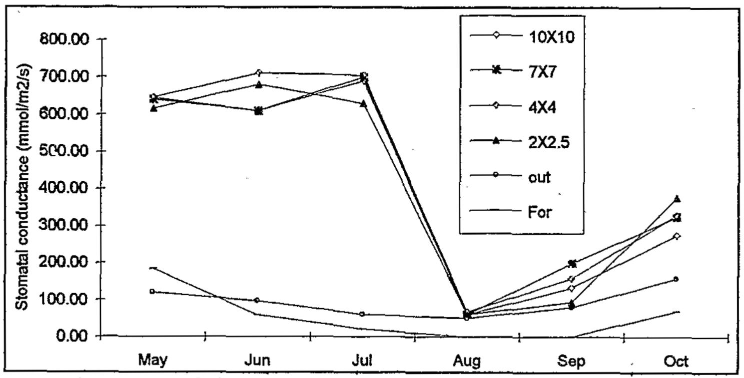

Fig. 3 The seasonal changes of the stomatal conductivity in the four spacing treatments in the shelter (10X10, 7X7, 4X4 and 2X2.5), out of the shelter (out) and forage (For).

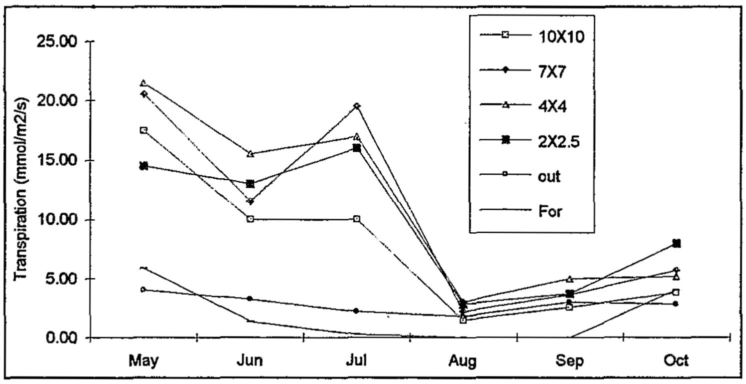

Fig. 4 The changes of transpiration over the growth period for the trees grown in the shelter (10X10, 7X7, 4X4 and 2X2.5), out of the shelter (out) and forage (For).

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