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# Plant Water Stress Coincidence with Evapotranspiration. A Brief Review

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## INTRODUCTION

Water influences vegetative growth and reproductive growth, yield and fruit composition through their effects on fruit size and on photosynthetic activity and Water availability is a critical factor for assessing the impact of climate change on agriculture and agricultural water management. Agriculture producers and crop managers place great care on the water supply to their crops and, as water availability might become less reliable under the actual forecasts of climate change [1], they try to maximize the water use efficiency (WUE) even at the cost of some yield loss to gain environmental and economic sustainability of their operations. Many evaluations of water use efficiency are based on instantaneous measurements on the assumption that they are representative of whole-plant WUE. Examples of instantaneous measurements are stomatal conductance, leaf photosynthesis and transpiration and canopy temperature. These measurements either can´t be automated and continuously recorded or it would be technologically too complex and extremely expensive. The relationship between instantaneous and whole-plant values sometimes are clear but often it is not, and the lack of correspondence is a methodological limitation to the applicability of the obtained results [2]. On woody plants it is possible to evaluate WUE from measurements of sap flow rate (SF) and diameter changes in conductive organs (maximum daily shrinkage (MDS) was the parameter used) that are considered good predictors of plant water status. Sap flow rate and diameter changes can be continuously and automatically measured with high resolution and recorded online; the technological development has made their use reliable and affordable.

SF and MDS are reported to be closely related to climatic variables such as solar radiation, temperature, vapor pressure deficit and evaporative demand of the atmosphere which is evaluated by the reference evapotranspiration (ETo) as computed by Allen et al. [3]. Given the relationships between SF and MDS with weather parameters that are included in the calculation of ETo [4,5], we assumed a statistical interdependency between a series of physiological indicators chronologically recorded and a simultaneously time spaced ETo data. The assumption was tested on several grapevines, with different amounts of available soil water that were fitted with dendrometers and sap flow needles. An *in situ* meteorological station collected weather data and automatically computed daily ETo. All data was sent wireless to a gateway that made it available online. The relationship between physiological indicators series and ETo series was tested by event coincidence analysis (ECA) that is concerned with quantifying the statistical interrelationships between pairs of event series [6].

SF and MDS could predict clearly the water status of the grapevines with highly significant differences and they both correlated significantly with ETo. ECA showed that and ETo high or low event triggered equivalent SF or MDS events, but not both simultaneously, one step time later with a coincidence far higher than would be expected by mere randomness. The results show that SF and MDS are good predictors of water status and they are dependent on ETo but they do not respond equally to ETo. SF and MDS are still complex predictors that can be recorded from a very limited number of plants with all the problems related to extrapolations to a large population. On other hand, ETo is a common meteor computed from data of meteorological stations, today almost conspicuous everywhere and relying data online on real time, that is valid for large areas. Following the course of ETo along the crop growing seasons, the manager knows when and how to intervene preventing damaging crop losses, especially when ETo is high that will trigger hours later events of high plant water loss.

This analysis establishes empirical relationships, but it does not explain the mechanisms underlying the phenomena that are dependent on several factors both biotic and abiotic. However, the use of computed ETo to plan just on time

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irrigation with low amount of water has been tried with good results, excessive yield losses were avoided and water was saved.

A detailed report was found by Oliveira et al. [7].

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