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Agricultural water management
ELSEVIER
Agricultural Water Management 82 (2006) 387–398
www.elsevier.com/locate/agwat

Improving water-use efficiency of young lemon trees by shading with aluminised-plastic nets

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Accepted 21 August 2005
Available online 12 October 2005

Abstract

The experiment was carried out in a research field near Murcia, Spain, over a 3-week period between August 29 and September 17, 2001. Measurements obtained by the continuous monitoring of sap flow and parameters derived from trunk diameter fluctuations were compared with discrete measurements of conventional plant–water status indicators in potted young lemon trees (*Citrus limon* (l.) Burm. Fil, cv. Verna) grafted on sour orange (*Citrus aurantium* L.) rootstock. Eight trees were used in the experiment, four of which were placed under a rectangular shading net, while the other four were maintained in the open air. The decrease of sap flow in shaded trees with respect to the exposed trees was evident every day. The net also affected trunk diameter changes, with the shaded trees showing lower values of maximum daily shrinkage. High radiation reduced the leaf water potential. In the early morning, the shaded plants opened their stomata later than the plants growing in the open air, and so the transpiration in the latter was higher than in the former during the first hours of the day. However, the net photosynthesis rate was not increased in the exposed plants during these hours of the morning. In the central hours of the day, the leaf stomatal conductance values of exposed plants were lower, as were their instantaneous photosynthesis rates, than the corresponding values in

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0378-3774/$ – see front matter
doi:10.1016/j.agwat.2005.08.003

the shaded trees. As a result of the photosynthesis/transpiration balance, it was observed that the best integrated daily water-use efficiency corresponded to the shaded treatment.

Keywords: Lemon; Plant–water relations; Radiation; Sap flow; Trunk diameter changes; Water-use efficiency

1. Introduction

There is increasing world-wide interest in improving plant–water-use efficiency, since water is increasingly scarce, especially in regions where precipitation is low, evapotranspiration is high and drought periods are frequent. Such is the case in many Mediterranean areas, which are characterized by long periods of intense irradiance and high temperatures, with average midday temperatures frequently reaching 30 °C or more.

Citrus trees are characterized by a large canopy with a correspondingly large evaporative surface (Cohen and Fuchs, 1987). By contrast, stem and root hydraulic conductivities are low (Castle, 1978; Moreshet et al., 1990). In extreme conditions, such as those found in Mediterranean climates, these characteristics may result in a transpiration rate which exceeds the water absorption capacity, resulting in a high plant–water deficit (Kriedemann and Barrs, 1981). To avoid such situations, shading nets have been used to reduce the radiation load in crops, since nets reduce and redistribute the radiation load more efficiently to the plants growing underneath (Allen and Lemon, 1974). Nets also reduce turbulence and produce a humid blanket, which contribute to decreasing environmental evaporative demand (Allen, 1975). It is very well known that plant–water uptake depends on both physiological and environmental factors, especially solar radiation and vapour pressure deficit, and from the coupling degree of the plant with the atmosphere (Jones, 1992). Therefore, if the net radiation of a tree can be reduced, the direct effect should be a proportional reduction in transpiration (Penman, 1948), perhaps avoiding a water deficit. However, since the light underneath shading nets is altered, any effect of such an alteration on the physiological processes related to plant growth needs to be investigated.

The objective of this study was to evaluate the influence of reflective aluminised polypropylene shading nets on photosynthetic performance of citrus plants, by measuring CO_2 assimilation, transpiration rates, stomatal conductance and leaf water potential. Our hypothesis relates if it is possible to increase the water-use effciency of lemon trees by shading with aluminised-plastic nets.

2. Material and methods

2.1. Experimental site and plant material

The experiment was conducted in a research field near Murcia, Spain, over a 3-week period between August 29 (day 241) and September 17 (day 260) 2001. Two-year-old lemon trees (*Citrus limon* (l.) Burm. Fil) cv. Verna on sour orange (*Citrus aurantium* L.)