Scientia Horticulturae 119 (2008) 55–58

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Purple spot in loquat (*Eriobotrya japonica* Lindl.) is associated to changes in flesh-rind water relations during fruit development

N. Gariglio [a], C. Reig [b], A. Martinez-Fuentes [b], C. Mesejo [b], M. Agustí [b,*]

[a] *Facultad de Ciencias Agrarias, Universidad Nacional del Litoral, Kreder 2805 (3080), Esperanza, Santa Fe, Argentina*
[b] *Instituto Agroforestal Mediterráneo, Universidad Politécnica de Valencia, Camino de Vera, s/n, 46022 Valencia, Spain*

ARTICLE INFO

Article history:
Received 18 June 2008
Accepted 7 July 2008

Keywords:
Fruit growth
Osmotic potential
Pressure potential
Physiological disorder
Water potential

ABSTRACT

Experiments were conducted to assess the link between purple spot in loquat fruit (*Eriobotrya japonica* Lindl.) and changes in the water relations of the flesh and the rind. Panicles were thinned to 1, 3 or 5 fruit or left unthinned (control), fruit wrapped in foil or exposed to the sun, or trees grown under plastic (night temperature >15 °C) or in the open (night temperature 5–3 °C) to induce different levels of the disorder. Typically, spotting increased with thinning (R^2 = 0.95), and was higher in exposed fruit (26.3% of fruit affected) than in wrapped fruit (nil), and higher with cool nights (16.2%) than with warm nights (2.7%). Mean tissue water potential (Ψ_w) was similar in the flesh and rind, whereas osmotic potential (π) was higher (less negative) in the flesh, and pressure potential (Ψ_p) lower in the flesh. There were no consistent effects of thinning on Ψ_w, whereas π of the rind decreased (more negative) with thinning during fruit color break. This response was associated with an increase in Ψ_p (more positive) in the rind at the same time. The external rind of exposed fruit had lower π than the external rind of warped fruit, and higher Ψ_p. Similarly, the fruit from trees grown under cool nights had lower rind π and higher rind Ψ_p than fruit under warm nights. These results suggest that low rind π and high rind Ψ_p are associated with purple spotting in loquat, and possibly reflect relatively high sugar concentrations in the flesh that increases the gradient of solute concentration between the flesh and the rind, making easy a dehydration process in the rind, which is responsible for purple spot.

1. Introduction

Loquat fruit (*Eriobotrya japonica* Lindl.) are highly sensitive to purple spot, a physiological disorder which affects the crop in Taiwan (Liu et al., 1993), Brazil (Ojima et al., 1976) and Spain (Tuset et al., 1989), some times decreasing its commercial returns by up to 50%.

Histological studies revealed that purple spot is due to cellular dehydration which appears initially at the deepest cells of the rind and finally affects all rind tissue; nevertheless, neither the structure of the cuticle nor its permeability to water are affected, and therefore, the dehydration of the rind is not caused by excessive fruit transpiration. Besides, the cells of the flesh are not affected (Gariglio et al., 2002).

The incidence of purple spot is influenced by environment and cultivation. Low temperatures at color break correlated with purple spot incidence over seven years in Alicante, Spain, and its incidence was reduced by increasings night temperatures in a greenhouse (Gariglio et al., 2003b). Further, no fruit were affected when they were covered (Gariglio et al., 2003b). On the other hand, fruit from non-thinned trees had little spotting, whereas close to 35% of fruit were affected when panicles were thinned to a single fruit (Gariglio et al., 2003a). Thinning reduces competition among developing fruit, thus increases flesh sugar concentration (Agustí et al., 2000), which correlates with the incidence of spotting (Gariglio et al., 2003a), and modifies flesh-rind sugar partitioning (Gariglio et al., 2007). These observations lead us to hypothesize that dehydration of the rind is due to changes in flesh-rind sugar concentration when the fruit are growing rapidly (Gariglio et al., 2003a, 2007).

According to the epidermal-growth-control hypothesis of growing organs (Kutschera, 1989, 1992), the inner tissue provides the driving force for growth, whereas the peripheral cells limit it, thus determining the rate of elongation. As a consequence, physical flesh-rind stress altering tissue–water relationships has been reported (Peter and Tomos, 1996; Opara et al., 1997).

The aim of this research was to examine the water relations of flesh and rind of loquat fruit growing under different conditions which vary the incidence of purple spot. We used fruit thinning, different night temperatures and exposure to sunlight to vary the incidence of the disorder in experiments conducted in Spain.

* Corresponding author. Tel.: +34 963879330; fax: +34 963877331.
E-mail address: magusti@prv.upv.es (M. Agustí).

0304-4238/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.scienta.2008.07.006

2. Material and methods

2.1. Plant material and experimental procedure

The experiments were carried out using 15-year-old 'Algerie' loquat trees (*E. japonica* Lindl.), grafted onto loquat seedlings and grown at Alicante, Spain (38°39′N; 00°07′W). The trees were planted at a 4 m × 3 m spacing, on a loamy clay, with drip irrigation. The experiments were laid out in randomized complete blocks, with single-tree plots and six replicates per treatment.

To determine the effect of thinning on purple spot, panicles were hand-thinned to 1, 2, 3 or 5 fruit when they were 10 mm in diameter (phenological stage 702 of the BBCH scale; Martínez-Calvo et al., 1999). Not thinned panicles (9–12 fruit per panicle) were used as control. To study the effects of night temperature, trees were grown in a plastic house (6 m wide, 20 m long, 5 m high) and the temperature maintained above 15 °C at night with an electric heater. Trees growing in the open, where the average minimum night temperature was 8.3 °C, were used as controls. To analyze the influence of exposure, 20 fruit per tree were wrapped in aluminium foil for 30 days before harvest, using uncovered fruit nearby on the same panicle as controls. For the last two experiments all the panicles were thinned to 2 fruit at the 702 phenological growth stage. The percentage of fruit affected by purple spot was evaluated at harvest.

2.2. Water relations

In all the experiments, four fruit per tree from each treatment (located in every tree quadrant, at a height of 1.5–2.0 m) were collected on each sampling date from fruit set to maturation, for measurement of water potential (Ψ_w) and osmotic potential (π). Samples were taken at dawn when the soil, plant and atmospheric water potentials were in equilibrium (Milad and Shackel, 1992). The flesh and the rind were analyzed separately and only the external portion of the flesh used.

To measure Ψ_w and π of flesh and epidermal tissues, 5 mm disks from the equatorial area of the fruit were excised with a cork borer. Fresh tissue was used for Ψ_w, whereas frozen tissue was used for π. Disks of 1–2 mm thick for epidermal tissue and of 3–4 mm thick for flesh tissue were sliced with a blade and placed in a sampler chamber (C-52, Wescor Inc., Logan, UT, USA) connected to a psychrometer switchbox (Ps-10) and to a dew point microvoltimeter (HT-33T).

The dew point hygrometer was previously calibrated with NaCl solutions of known concentrations. To ensure initial water vapor equilibrium, Ψ_w and π were measured at least 4 h after setting the sample in the chamber. Pressure potential (Ψ_p) was calculated by the equation $\Psi_w = \Psi_p - \pi$ (Milad and Shackel, 1992).

2.3. Statistical analysis

Data on the incidence of purple spot, Ψ_w, π, and Ψ_p were analysed by analysis of variance, and comparisons of means made by Newman-Keuls' multiple range test. Percentages were analyzed after arc-sine transformation of the data. Thinning intensity and percentage of spotting relationship was evaluated by regression. The data were analyzed with Statgraphics 4.1 software (Statistical Graphics Corp.).

3. Results

3.1. Thinning

Thinning increased the incidence of purple spot (data not shown), with significant negative relationship between the percentage of fruit affected and the number of fruit per panicle ($R^2 = 0.95$; $P < 0.01$).

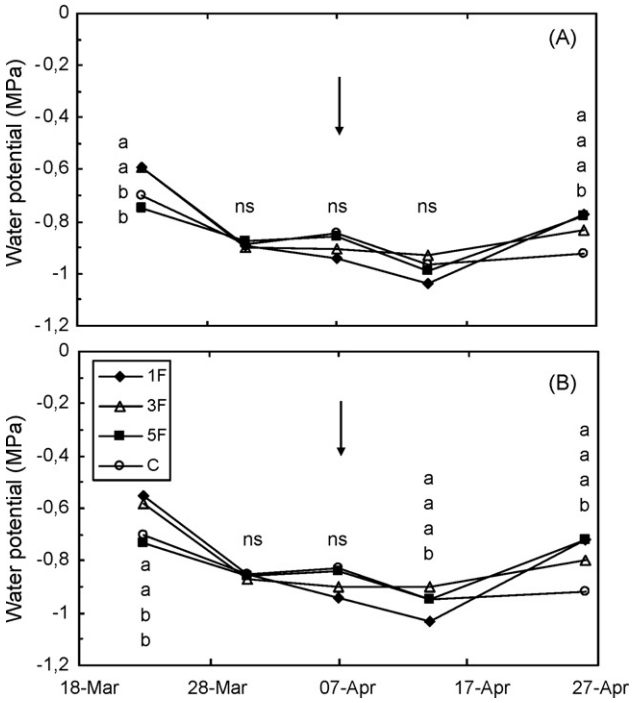

Fig. 1. The influence of fruit thinning on the time-course of water potential of flesh (A) and rind (B) of 'Algerie' loquat. Trees were thinned to 1 (1F), 3 (3F) or 5 fruit per panicle (5F) or not thinned (C). Arrows indicate time of fruit color break. Standard errors are smaller than the symbols. Means market with different letters differ significantly ($P \leq 0.05$).

In loquat, average water potential (Ψ_w) of the flesh and rind did not differ significantly (Fig. 1A and B), but changed with sampling date (Fig. 1). Water potential of both tissues decreased from the end of March up to one week after color break, and then increased (Fig. 1). Date of sampling showed statistical significance for both tissues.

Water potential also differed significantly for thinning intensity, showing a significant interaction between thinning intensity and date of sampling. However, these sources of variation of Ψ_w (thinning and thinning-sampling date interaction) did not appear to be consistent posible due to different behavior of thinning on each sampling date (Fig. 1A and B).

Mean osmotic potential (π) of the flesh (Fig. 2A) was significantly higher (less negative) than that of the rind (Fig. 2B), with the difference increasing with thinning intensity and the incidence of spotting. As for Ψ_w, π changed significantly with thinning intensity and sampling date. In the flesh, π hardly changed during fruit growth (Fig. 2A), and no clear trend was observed around fruit color break (Fig. 2A). In contrast, rind π remained almost constant throughout fruit growth in control plants, but decreased in thinned trees one week before color break (31 March) (Fig. 2B). Differences between the treatments were the greatest at color break (>0.75 MPa between control and 1 fruit per panicle) and the higher the thinning intensity, the lower rind π (Fig. 2B). There was a strong correlation btween spotting and π values increased ($R^2 = 0.97$; $P < 0.01$). After color break, rind π increased, with control fruit having higher values than fruits from thinned panicles (Fig. 2B).

The pressure potential (Ψ_p) of the flesh from control was below to 0.15 MPa during fruit growth (Fig. 3A). Fruit from thinned trees had higher Ψ_p values than the controls on the first and last