PHOTOSYNTHETIC PIGMENTS IN YOUNG NON-BEARING PEAR AND QUINCE TREES

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Abstract

Photosynthetic pigments have been studied in INRA Quince BA 29 and Quince A (East Malling) as well as in the pear cvs. 'Leonardeta' and 'Agua de Aranjuez'. Xanthophylls (neoxanthin, violaxanthin, taraxanthin and lutein), β -carotene and chlorophylls a and b were the pigments determined.

Analysis were made by high performance liquid chromatography on leaf samples harvested in the last days of April, of May and of June, from the two non-grafted quince trees and from different scion-stock combinations.

The trees were on their third leaf and had not started cropping. No visual symptoms of chlorosis were observed in any case.

The concentration of photosynthetic pigments was found to be higher in 'Leonardeta' than in 'Agua de Aranjuez' for the stock-scion combinations studied. In 'Leonardeta', the concentrations were higher when grafted on INRA Quince BA 29 than on Quince A, although the differences were not significant. In the 'Agua de Aranjuez' combinations, differences were even smaller. Similarly, the pigment concentrations in Quince BA 29 were higher than in Quince A, both when being on their own roots or when grafted on the other quince.

In pear and quince, differences in certain pigment levels and their relationships increased along the growing season, becoming statistically significant in samples harvested at the two latest dates.

1. Introduction

Pear (*Pyrus communis* L.) cultivars grafted on quince (*Cydonia oblonga* Mill.) rootstocks show great differences in the symptoms of iron induced chlorosis. In the Ebro valley (Spain), Herrero and Abadia (1962) reported that 'Leonardeta', 'Max Red Bartlett' and 'Tendral' cultivars presented better resistance to chlorosis than 'Agua de Aranjuez', 'Castell', 'Ercolini', 'Limonera', 'Roma', 'Wilder' and 'Williams'. These authors also pointed out that, even though nursery trees were more susceptibles than bearing trees, there were less symptoms in young non-bearing orchards than in older one's.

The aim of the present work was to determine in young non-bearing plantations, the feasible differences in the photosynthetic pigment concentrations between INRA Quince BA 29 and Quince A (East Malling), as well as between a pear cultivar resistant to chlorosis, 'Leonardeta', and another susceptible one, 'Agua de Aranjuez', both grafted on the two quinces above mentioned.

2. Material and methods

The work was carried out in 1986, in young non-bearing pear and quince trees planted in the winter 1983-84. Two pear cultivars: 'Leonardeta' and 'Agua de Aranjuez', and two clonal selections of quince: INRA

Quince BA 29 and Quince A, were used. In the trial, the two cited quinces and the following scion-stock combinations were included:

Quince A/Quince BA 29
Quince BA 29/Quince A
Leonardeta/Quince BA 29
Leonardeta/Quince A
Agua de Aranjuez/Quince BA 29
Agua de Aranjuez/Quince A

Soil characteristics are shown in Table 1.

Samples were harvested at the end of April, of May and of June. Photosynthetic pigments determinations were carried out in undamaged leaves of the third to the fifth internode from the tip of the shoots.

Pigment extraction was performed from disks of each sample of leaves, according to Davies (1976). Pure acetone (100%) was used as solvent in a proportion of 0.38 cm²/ml. A small amount of sodium ascorbate was added to prevent pheophytin formation. Afterwards, the extract was filtered through a membrane of 5 μ m.

The chromatographic equipment has already been described by Monge et al. (1984). Analytical grade solvents were filtered (Durapore 22 μ m filter) and degassed prior to use.

The mobile phase for pigment elution was performed in two isocratic steps. In the first one, the column was homogenized during 5 minutes with a methanol-water mixture (96:4 v/v) having the system loaded. In the second step, the sample was injected by changing the eluent by absolute ethanol (Val et al., 1986). Flow of peristaltic pump was 5 ml/min and for pigment detection, the selected wavelengths was 440 nm.

3. Results

External symptoms of chlorosis were not observed during the period in which the samples were collected. However the determination of photosynthetic pigments has shown differences on the last dates of April, which became greater and statistically significant in the samples harvested at the end of May and June. Hereafter, the level of significance $P=0.05$ is indicated with * and $P=0.01$ with **.

The concentration of photosynthetic pigments in leaves of INRA Quince BA 29 were higher than those in Quince A, both when the trees were ungrafted or reciprocally grafted (fig.1). At the end of May, there were significant differences in chlorophyll a (*) and in the sum of chlorophylls (*), and in the last days of June in lutein (*), neoxanthin (**), chlorophyll b (**), chlorophyll a (**), sum of chlorophylls (**), carotenoids (*) and xanthophylls (*).

At the end of June, the values of the chlorophyll a/chlorophyll b and chlorophyll a/ β -carotene relations and of the taraxanthin pigment were significantly greater when the rootstock was INRA Quince BA 29, indicating that the rootsystem influences the pigment level in the foliage.

Photosynthetic pigment concentrations in 'Leonardeta' was higher than in 'Agua de Aranjuez' (fig.2). By the end of May, there were significant differences in lutein (**), chlorophyll b (*), and chlorophyll a (**), sum of chlorophylls (**), xanthophylls (**), chlorophyll b/xanthophylls (*) and sum of chlorophylls/carotenoids (*) relations; and at the last days of June, there were differences in neoxanthin (*),

violaxanthin (*), lutein (*), chlorophyll b (**), chlorophyll a (*), sum of chlorophylls (*), carotenoids (*), xanthophylls (*) and chlorophyll a/ chlorophyll b (**) and chlorophyll b/ xanthophylls (*) relations.

'Leonardeta' had a higher concentration of pigments when grafted on INRA Quince BA 29 than on Quince A. However, differences were not statistically significant. In 'Agua de Aranjuez', the pigmentation differences were even smaller.

4. Discussion

Chlorosis caused by iron deficiency is largely widespread in soils of the Ebro valley, because of its high pH and content of active lime. Herrero and Abadia (1962), observed more acute symptoms of chlorosis in 'Agua de Aranjuez' than in 'Leonardeta', in different plantations with similar characteristics of soil to the plot where the orchard now studied was located (Table 1). Also, the quinces of Provence (INRA Quince BA 29 belongs to that type) are traditionally considered less susceptibles to this chlorosis than quinces of Angers (Quince A) (Brossier, 1963).

In this work, both in pear and quince trees, no visual symptoms of chlorosis were observed, although the analytical methods used showed that differences in their levels occurred. These differences were already found in April, but only at a significant level after May, corresponding the highest concentrations of pigments to 'Leonardeta' and INRA Quince BA 29.

It could happen that once the plantation studied started to bear fruit, visual symptoms of chlorosis could appear, as it has been previously observed that young non-bearing trees are less susceptibles to this chlorosis than bearing trees (Herrero and Abadia; 1962).

Although no other data has been found by the authors on the levels in photosynthetic pigments of pear and quince, the results obtained show that the concentrations in all the combinations studied ranged in the normal levels in higher plants.

The photosynthetic pigments are located mainly in the thylacoid membranes, in holochromic aggregates (pigment protein complexes), being their main function to harvest and transport the light energy through the reaction centres. Iron deficiencies reduce the concentration of all photosynthetic pigments (Monge et al., 1987), in particular in the chlorophylls inducing the characteristic yellowness of the leaves. Also, the ratio chlorophyll a/ chlorophyll b is dramatically altered, in the cases of severe deficiency (Val et al., 1987).

In general, the INRA Quince BA 29 has higher concentrations in every pigment studied, both when used as rootstock or when ungrafted. The results obtained seem to indicate that under our environmental conditions (soils of high pH and high content in active lime) the Quince BA 29 has a greater ability to synthesize light harvesting pigments. However, the ratio between chlorophylls is being unaltered in the different combinations along the trial.

The greater concentration of photosynthetic pigments found in 'Leonardeta' when grafted on INRA BA 29 than when on Quince A shows that the rootstock affects the levels in the scion. This effect was smaller on 'Agua de Aranjuez', indicating that the cultivars respond differently to the same stock.

Attention should also be paid to the stoichiometry between photosynthetic pigments and whether this is being altered in a variety when grafted on different rootstocks. In the present work the ratios between antenna pigments and core complex pigments were found unaltered. The light harvesting complexes are richer in chlorophyll b and xanthophylls, while the reaction centres are characterized by contents mainly of chlorophyll a and β -carotene (Melis et al., 1981; Lichtenthaler et al., 1981; 1983).

To conclude, we can say that in the absence of visual symptoms of chlorosis, a close relationship has been observed between the scion-stock combinations with higher concentration of photosynthetic pigments and those previously reported with a greater resistance to iron chlorosis.

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Figure 1 - Concentrations of xanthophylls (neoxanthin, violaxanthin and lutein), β -carotene and chlorophylls a and b in Quince BA 29, Quince A and in the scion-stock combinations Quince BA 29/Quince A and Quince A/Quince BA 29.

Figure 2 - Concentrations of xanthophylls (neoxanthin, violaxanthin and lutein), β -carotene and chlorophylls a and b in the scion-stock combinations: Leonardeta/Quince BA 29, Leonardeta/Quince A, Agua de Aranjuez/Quince BA 29 y Agua de Aranjuez/Quince A.

Table 1 - Soil Characteristics of the experimental orchard.

Horizon	Depth (cm)	pH	Carbonates (%)	Active lime (%)	Texturas class
Ap	0-35	7.95	27.7	11.1	Clay-loam
B	35-60	7.90	23.7	7.7	Loam
C	60	-	-	-	Graves