COMPARISON OF LEAF MINERAL CONTENT, CARBON ASSIMILATION AND STEM WATER POTENTIAL OF TWO APRICOT (*Prunus armeniaca*) CULTIVARS GRAFTED ON 'CITATION' AND 'MARIANNA 2624' ROOTSTOCKS

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Abstract

'Citation' (peach x plum) has been suggested to be a size-controlling rootstock for apricot that could allow denser planting and achievement of full production in the orchard's early life compared with standard rootstocks. In California, growers have observed that apricot trees grafted on 'Citation' often show yellowish foliage and are thought to require more frequent irrigation. To investigate this phenomenon, leaf photosynthetic rate, stem water potential, and leaf content of N, P, K, Zn, and Fe were measured in late summer on 'Royal/Blenheim' and 'Patterson' apricot cultivars grafted on 'Citation' and on 'Marianna 2624' rootstocks. Orchard management was consistent with standard practice. Leaf N and Zn contents were significantly lower in the trees grafted on 'Citation'. There was also a significant difference in N and Zn between the two cultivars; however, this difference disappeared when expressing the mineral content in $mg.dm^{-2}$ of leaf area. Leaf P content was lower on 'Patterson' leaves, but there was no rootstock effect. Leaf photosynthesis was measured on September 23 and 29 between 10: 30 and 11: 30 a.m. Trees on 'Citation' had significantly lower assimilation rates than those on 'Marianna 2624'. Differences in leaf photosynthesis were associated with the lower leaf N and Zn contents. 'Citation' had higher (less negative) stem water potential than trees on 'Marianna 2624' when measured at midday on the same day as gas exchange. 'Citation' rootstock may have reduced N and Zn uptake capacity and, as a consequence, may require more careful fertilizer management than 'Marianna 2624'.

1. Introduction

Rootstock can control the vigor of fruit trees independent of length of growing season (Gaudillere, *et al.*, 1991; Kruczynska, *et al.*, 1990). Dwarfing rootstocks have been used in fruit tree species to reduce tree size allowing for denser planting and earlier full orchard production. However, the rootstock may also affect other features of tree physiology, like nutrient-uptake capability and leaf mineral content (Kecskemeti and Nyujto, 1985; Tagliavini, *et al.*, 1992; Ugolik and Holubowicz, 1990; Ystaas, 1990).

'Citation' rootstock (peach x plum) has been developed and used as a size-controlling rootstock for apricot. In California, growers have observed that this rootstock improves fruit quality, often advances fruit maturity, and may improve yield. 'Citation' produces very few root suckers. New apricot orchards are commonly planted with 'Citation' rootstock. California growers have noted that trees on 'Citation' often show a paler green color of foliage than trees on standard plum rootstocks (i.e., 'Marianna 2624,' 'Myrobolan 29 C,' 'Myrobolan seedling') or peach (i.e., 'Lovell' or 'Nemaguard' seedling), suggesting that this rootstock may affect aspects of tree physiology other than vigor.

In the present work we compared the effects of 'Citation' and of 'Marianna 2624' rootstocks on leaf mineral content, carbon assimilation rate, and stem water potential with

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two apricot cultivars.

2. Materials, methods, instruments

The trial was carried out in a 3-year-old orchard of 'Royal/Blenheim' and 'Patterson' apricot cultivars grafted on both 'Citation' and 'Marianna 2624' rootstocks. Trees were spaced 5m x 3m on a Yolo clay-loam soil and irrigated with a low-volume microjet irrigation system. Orchard management was consistent with standard practice for apricots in the Winters area on Yolo clay-loam soil (no added nitrogen during the first 2 years and 22.4 kg ha^{-1} in 1993).

Gas exchange was measured on 5 mid-shoot, upper-crown, sunlit leaves on each of 5 randomly chosen trees per each rootstock-cultivar combination, using a portable open system infrared gas analyzer (LCA-2, Analytical Development Corporation, Hoddesdon, Herts, UK). Measurements were taken on September 23 and 29, 1993, both cloudless days, between 10: 30 and 11: 30 a.m., when trees had the highest assimilation rates.

Stem water potential was measured at midday after gas exchange measurements on 2 leaves per tree using previously bagged leaves, as described by Begg and Turner (1970). After gas exchange measurements, sample leaves were collected and leaf area was measured with an electronic leaf area meter (LI-3000, LI-COR Inc., Lincoln, NE). Next, leaves were oven dried at 70° C for at least 48 hours and leaf N, P, K, Fe, and Zn content were determined by the Division of Agriculture and Natural Resources (DANR) Laboratory, UC Davis, CA, according to standard methods of analysis. All data were analyzed by a two-factor analysis of variance (2 rootstocks x 2 cultivars).

3. Results

N and Zn content was significantly lower on trees grafted on 'Citation' rootstock when compared to trees on 'Marianna 2624' (Table 1). N values were significantly lower both when expressed as percent dry weight (Table 1) and on a leaf area basis (Table 2). 'Patterson' had significantly lower N and Zn content than 'Royal/Blenheim' when expressed as percent weight (Table 1); however, due to the higher (although not statistically significant) specific weight of 'Patterson' leaves, this difference was not found when the mineral content was expressed on a leaf area basis (Table 2). Leaves of 'Patterson' had no visible color difference from those of 'Royal/Blenheim'.

Leaf P content was not affected by the rootstock, but was significantly lower on 'Patterson' compared to 'Royal/Blenheim'. Leaf K and Fe content was not significantly different for both the rootstocks or the cultivars (Table 1).

Leaf maximum photosynthetic rates were significantly higher (25 to 30%) on trees grafted on 'Marianna 2624' as compared to trees on 'Citation' (Table 2). Assimilation rate was not different between cultivars, but there was significant interaction between cultivar and rootstock (Table 2). However, the rootstock effect was similar when the two cultivars were analyzed separately. In fact, photosynthetic values were significantly lower on both cultivars when grafted on 'Citation' as compared to 'Marianna 2624', and the reduction was greater with 'Royal/Blenheim' as compared with 'Patterson' (data not shown).

The difference in rootstock effect on photosynthesis was not related to a less favorable water status of trees on 'Citation' as these trees had higher (less negative) midday stem water potential as compared to trees on 'Marianna 2624' (Table 2). 'Royal/Blenheim' had significantly lower water potential values than 'Patterson'. Stomatal conductance paralleled assimilation results. Although leaf temperature was significantly different between cultivars, likely due to the different measurement dates, the difference was only about 2°C. There was no difference in leaf temperature between rootstocks.

4. Discussion

Trees on 'Citation' rootstock had reduced leaf N and Zn content. Similar effects of the rootstock on the leaf mineral content and uptake capability have been also found in different fruit tree species. Kruczynska, *et al.* (1990) found that the rootstock affected leaf content of N, P, Ca and Mg on apple trees. Marks and Andrews (1990) observed that different levels of N fertilization influenced the leaf and fruit mineral composition of apple trees and that there were significant differences between three rootstocks. Further, similar interactions between rootstock and mineral content have been reported for apple (Leszczynski and Sadowski, 1990), sour cherry (Konrad and Ludders, 1990), and apricot (Kecskemeti and Nyujto, 1985). Tagliavini, *et al.* (1992) found that more vigorous apple rootstocks induced lower N content of scion leaves. The phenomenon was attributed to a dilution effect. In the present case, the lower leaf N is not caused by a dilution effect because the vigor was reduced, although slightly, by the 'Citation' rootstock (Southwick, unpublished data). Trees on this rootstock instead had significantly lower N content in the leaves. A similar N depletion was found on cherry trees when grafted on 'Colt' rootstock (Ystaas, 1990). 'Colt' rootstock induced a pale color in the scion leaves, like the apricot trees on 'Citation' described here. 'Colt' also reduced P and K leaf content, but the effect was greater on N. It was concluded that this rootstock is less efficient than others in the absorption of N, P, and K from the soil. The results of the present study seem to support the hypothesis that 'Citation' rootstock may reduce tree uptake capability for N and Zn.

Carbon assimilation rates were also lower on trees grafted on 'Citation' compared to 'Marianna 2624'. Net photosynthesis and N content per unit leaf area are often highly correlated (DeJong, 1982). Our results on apricot support this hypothesis as we found a clear rootstock effect on assimilation which paralleled the effect on leaf N content (Table 2).

Although 'Citation' rootstock reduced assimilation, the midday stem water potential, which is assumed to be a good index of plant water status and water stress (McCutchan and Shackel, 1992), was significantly higher on trees grafted on 'Citation' compared to trees on 'Marianna 2624' (Table 2). This indicates that the lower maximum photosynthetic rate of trees on 'Citation' was probably attributable to causes such as mineral uptake rather than water status. The lower stem water potential of the trees on 'Marianna 2624' could have resulted from the higher stomatal conductance (and therefore transpiration rate) that accompanied the higher assimilation rate of these trees (Table 2).

In conclusion, our results suggest that 'Citation' rootstock may reduce N and Zn uptake in apricot which manifests in lower leaf N and Zn content. Lower leaf N and N specific leaf weight corresponded with lower assimilation in 2 apricot cultivars on 'Citation' rootstock. Lower leaf N and growers observation concerning pale foliage suggest that N fertilization may be increased for apricot growing on 'Citation'.

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Table 1 - Rootstock and cultivar effect on leaf mineral content (% dry matter) of two apricot cultivars grafted on 'Marianna 2624' and on 'Citation' rootstocks.

Treatment	N (%)	P (%)	K (%)	Zn (ppm)	Fe (ppm)
Rootstock					
'Marianna 2624'	2.15 a	0.300 a	2.20 a	9.87 a	121 a
'Citation'	1.79 b	0.263 a	2.22 a	8.18 b	115 a
Cultivar					
'R. Blenheim'	2.09 a	0.356 a	2.27 a	9.87 a	117 a
'Patterson'	1.86 b	0.206 b	2.15 a	8.19 b	119 a
Interaction (Rootstock x Cultivar)	NS	NS	NS	NS	NS

Different letters indicate significant differences (P = 0.05). NS = nonsignificant;
* = significant (P = 0.05)

Table 2 - Rootstock and cultivar effect on maximum leaf CO_2 assimilation rate (Amax), stomatal conductance (gs), leaf temperature, nitrogen content per unit leaf area (N), specific leaf weight (SLW) and midday stem water potential (Ψxy) of two apricot cultivars grafted on 'Marianna 2624' and on 'Citation' rootstocks.

Treatment	Amax (μmol CO_2 m^2 s^{-1})	gs (mol H_2O m^2 s^{-1})	Leaf temp. (°C)	N (mg•dm^{-2})	LSW (g•dm^{-2})	Ψxy (MPa)
Rootstock						
'Marianna 2624'	16.4 a	0.110 a	22.0 a	23.7 a	1.10 a	-1.56 a
'Citation'	12.9 b	0.091 b	22.0 a	20.4 b	1.13 a	-1.28 b
Cultivar						
'R. Blenheim'	14.6 a	0.104 a	23.0 a	22.5 a	1.08 a	-1.55 a
'Patterson'	14.7 a	0.097 a	20.9 b	21.6 a	1.15 a	-1.29 b
Interaction (Rootstock x Cultivar)	*	*	NS	NS	NS	NS

Different letters indicate significant differences (P = 0.05). NS = nonsignificant;
* = significant (P = 0.05)