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MINERAL ELEMENT CONTENT IN THE LEAVES OF ROOTSTOCKS USED FOR PEARS AND OF MAIDEN TREES BUDDED ON THEM

Jacek Lewko, Kazimierz Ścibisz, Andrzej Sadowski
SGGW – Warsaw Agricultural University

Abstract. Six types of rootstocks were planted at Warsaw-Wilanow, Central Poland in spring 2002: three originated from *Pyrus communis* – Caucasian pear seedlings, OHxF 333 and 'Pyrodwarf' and three from *Cydonia oblonga* – quinces S_1, MA and MC. In August they were budded with Conference and Erika pear cultivars. Mid-shoot leaves, taken at the end of August from rootstocks (in 2002) and from maidens budded on them (in 2003) were analysed for Ca, Mg, P and K content. Rootstocks differed significantly in the content of all mineral elements studied. They also affected the leaf mineral composition of maiden trees budded on them. The leaf Ca, P and K content depended on cultivar as well. A significant interaction of rootstock × cultivar on the leaf P and K content in maiden tree leaves was also noted. It has been suggested that the information about a specific abilities of rootstocks to absorb particular nutrients may serve as an additional indicator in selection of optimal rootstock for certain soil conditions.

Key words: pear, quince, rootstock, leaf mineral content, calcium, magnesium, potassium, phosphorus

INTRODUCTION

Leaf analysis for mineral elements is an important guide for sustainable plant nutrition. The influence of rootstock on apple leaf mineral content has been widely studied, both in nursery [Słowiński and Sadowski 2001, Lipecki 1996] and at different stages of growth in the orchard [Jadczuk et al. 1995, 2001; Abdalla et al. 1982]. Little information is available on pear leaf mineral content. Kłossowski and Domańska [1968] studied mineral composition of leaves of thirty different pear cultivars. They showed that cultivar significantly influenced mineral content of pear leaves grown in the same orchard and on the same rootstock. Chaplin and Westwood [1980] presented a report on influ-

Adres do korespondencji – Corresponding author: Jacek Lewko, Kazimierz Ścibisz, Andrzej Sadowski, SGGW – Warsaw Agricultural University, Department of Pomology and Basic Natural Sciences in Horticulture, Nowoursynowska 159, 02-787 Warsaw, Poland, e-mail: lewko@alpha.sggw.waw.pl

ence of different rootstocks – pear cultivar seedlings, wild *Pyrus* species seedlings, *Pyrus* clones and undefined quince (*Cydonia oblonga*) on leaf mineral element content of 'Bartlett' pear.

The objective of the present study was to assess the mineral composition of leaves of rootstocks of different origin as well as the effect of these rootstocks on the scion leaf composition in the nursery.

MATERIAL AND METHODS

The trial for evaluation of different pear rootstocks was set up on a silty loam alluvial soil, in the postglacial valley of Vistula River, in Warsaw-Wilanów, Central Poland. Soil available P content was medium, K – high, Mg – very high, according to the critical values proposed for orchard soils by Sadowski et al. [1990]. Calcium content (modified Spurway method) varied from 440 to 540 mg dm^{-3}. The following rootstocks were compared: Caucasian pear seedlings (*Pyrus communis* var. *caucasica*, Cps); pear (*Pyrus communis*) clonal rootstocks OHxF 333 and 'Pyrodwarf'; quince (*Cydonia oblonga*) clonal rootstocks S_1, MA and MC. Rootstocks were planted in April 2002, at 75×30 cm spacing. In August they were chip-budded with 'Conference' and 'Erika', at the height of 10 cm.

The trial was established in a randomised block design, with 5 replications and 25 plants in each rootstock/cultivar combination. Mid-shoot leaf samples (50 leaves per plot) were collected at the end of August of 2002 and 2003. Samples were dried at 70ºC and ground. After dry ashing at 550ºC, Ca and Mg were analysed by FAAS method, P by molybdenum-vanadate colometric method and K by flame photometry. Leaf nitrogen content was not determined, because urea foliar sprays were applied in the nursery.

The data were subjected to analysis of variance. For comparison of treatment means the Newman-Keuls test was applied, at $\alpha = 0.05$.

RESULTS AND DISCUSSION

The highest Ca content was found in the leaves of quince S_1, followed by the leaves of 'Pyrodwarf' and of quince MA, and the lowest ones in the leaves of other rootstocks (tab. 1). In leaves of maiden trees, the highest Ca content was in the maidens budded on OHxF 333, 'Pyrodwarf' and quince S_1. The lowest Ca content was found in the leaves of maiden trees budded on Caucasian pear seedlings and on quince MC. Leaves of 'Conference' maiden trees showed, on the average, a significantly higher Ca concentration than leaves of 'Erika' maidens (Table 2). No interaction of rootstock and cultivar on leaf Ca content was noted.

Leaves of OHxF 333 rootstock and leaves of maiden trees on this rootstock had the lowest Mg concentration (tab. 1). Leaves of all other rootstocks and leaves of maidens on these rootstocks showed higher Mg concentrations. This result is in agreement with the report of Chaplin and Westwood [1980]. In one of their experiments 'Bartlett' pear on quince rootstock showed a significantly higher leaf Mg content, in comparison with the same cultivar on clonal OHxF. Leaf Mg content did not depend on cultivar (tab. 2). This confirms the results of Kłossowski and Domańska [1968], who found slight differences in Mg concentration due to cultivar. No interaction of rootstock and cultivar on leaf Mg content was noted.

The lowest P content was found in the leaves of OHxF 333 and of the quinces MA and MC (tab. 3). The highest P concentration was found in the leaves of Caucasian pear seedlings. When the leaf P content of maiden trees was compared as mean values for both cultivars, it appeared higher on Caucasian pear, on OHxF 333 and on 'Pyrodwarf' than on quinces MA and MC. However, this was true for 'Erika' maidens only, as shown by the interaction presented in table 4. The leaf P content of maidens depended on cultivar; it was, on the average, higher in 'Erika' than in 'Conference' leaves (tab. 2). However, the interaction of cultivar and rootstock was manifested also in this case (tab. 4). Leaves of 'Erika' had a higher P content on *Pyrus* rootstocks only, while no differences due to cultivar were found on *Cydonia* rootstocks.

Table 1. Ca and Mg content in leaves of rootstocks and of maiden trees budded on these rootstocks (% d.m.)
Tabela 1. Zawartość Ca i Mg w liściach podkładek oraz okulantach gruszy na tych podkładkach (% s.m.)

Rootstock Podkładka	Calcium – Wapń		Magnesium – Magnez	
	leaves of rootstock liście podkładek	leaves of maiden trees [2] liście okulantów gruszy	leaves of rootstock liście podkładek	leaves of maiden trees liście okulantów gruszy
Caucasian pear seedling Siewki gruszy kaukaskiej	0.84 a [1]	1.00 a	0.143 b	0.218 c
OHxF 333	0.86 a	1.18 b	0.089 a	0.158 a
'Pyrodwarf'	1.17 bc	1.17 b	0.138 b	0.184 b
quince S_1 pigwa S_1	1.27 c	1.23 b	0.160 b	0.267 d
quince MA pigwa MA	1.12 b	1.13 ab	0.152 b	0.244 cd
quince MC pigwa MC	0.96 a	1.03 a	0.158 b	0.237 cd

[1]Mean separation, within the columns, by Newman Keuls test, at $\alpha = 0.05$ – Średnie rozdzielenie, w obrębie kolumn,według testu Newmana Keulsa, at $\alpha = 0,05$
[2]Mean values of two cultivars – Srednie wartości dwóch odmian

Table 2. Ca, Mg, P and K content in leaves of maiden trees, depending on cultivar; mean values for six rootstocks, % d.m.
Tabela 2. Zawartość Ca, Mg, P i K w liściach okulantów gruszy w zależności od odmiany, średnie wartości szesciu podkładek, % s.m.

Cultivar – Uprawa	Calcium Wapń	Magnesium Magnez	Phosphorus Fosfor	Potassium Potas
Conference	1.22	0.221	0.215	1.61
Erika	1.03	0.215	0.233	1.33
Significance of difference [1] Istotność różnic[1]	**	n.s.	**	**

[1]n.s. – non-significant – nie istotne; ** – highly significant – bardzo istotne

Table 3. P and K content in leaves of rootstocks and of maiden trees budded on these rootstocks, % d.m.
Tabela 3. ZawartościP i K w liściach podkładek oraz okulantów gruszy pączkujących na podkładkach, % s.m.

Rootstock Podkładka	Phosphorus – Fosfor		Potassium – Potas	
	leaves of rootstock liście podkładek	leaves of maiden trees [2] liście okulantów gruszy	leaves of rootstock liście podkładek	leaves of maiden trees liście okulantów gruszy
Caucasian pear seedling Siewki gruszy kaukaskiej	0.226 c [1]	0.239 c	1.35 a	1.27 a
OHxF 333	0.166 a	0.240 c	1.59 d	1.31 a
'Pyrodwarf'	0.197 b	0.232 bc	1.47 bc	1.21 a
quince S_1	0.193 b	0.217 ab	1.56 cd	1.70 b
quince MA	0.165 a	0.205 a	1.49 bc	1.63 b
quince MC	0.158 a	0.209 a	1.39 ab	1.68 b

[1]Mean separation, within the columns, by Newman Keuls test, at α=0.05 – Średnie rozdzielenie, w obrębie kolumn,według testu Newmana Keulsa, at α = 0,05
[2]Mean values of two cultivars – Średnie wartości dwóch odmian

Table 4. P content in maiden tree leaves of two cultivars on six different rootstocks
Tabela 4. Zawartość Pw liściach okulantów gruszy dwóch odmian na sześciu różnych podkładkach

Rootstock – Podładka	Conference	Erika	Difference – Różnica
Caucasian pear seedling Siewki gruszy kaukaskiej	0.225 a [1]	0.253 b	0.028 * [2]
OHxF 333	0.216 a	0.265 b	0.049 **
'Pyrodwarf'	0.214 a	0.249 b	0.035 **
quince S_1	0.213 a	0.221 a	0.008 [n.s.]
quince MA	0.200 a	0.210 a	0.010 [n.s.]
quince MC	0.220 a	0.198 a	0.022 [n.s.]

[1]Mean separation, within the columns, by Newman Keuls test, at α = 0.05 – Średnie rozdzielenie, w obrębie kolumn,według testu Newmana Keulsa, at α = 0,05
[2]n.s. – non-significant – nie istotne; *significant at α = 0.05 – istotne przy α = 0,05; **significant at α = 0.01 – istotne przy α = 0,01

Table 5. K content in maiden tree leaves of two cultivars on six different rootstocks
Tabela 5. Zawartośc K w liściach okulantów gruszy dwóch odmian na sześciu podkładkach

Rootstock – Podkłaka	'Conference'	'Erika'	Difference – Różnica
Caucasian pear seedling Siewki gruszy kaukaskiej	1.40 a [1]	1.15 a	0.25 ** [2]
OHxF 333	1.36 a	1.27 a	0.09 [n.s.]
'Pyrodwarf'	1.28 a	1.15 a	0.13 [n.s.]
quince S_1	1.87 c	1.52 b	0.35 **
quince MA	1.78 b	1.48 b	0.30 **
quince MC	1.95 c	1.42 b	0.53 **

[1]Mean separation, within the columns, by Newman Keuls test, at α = 0.05 – Średnie rozdzielenie, w obrębie kolumn,według testu Newmana Keulsa, at α = 0,05
[2]n.s. – non-significant – nie istotne; *significant at α = 0.05 – istotne przy α = 0,05; **significant at α = 0.01 – istotne przy α = 0,01

OHxF 333 and quince S_1 had higher K concentration in the leaves than Caucasian pear seedlings and quince MC in the first year in nursery. In the second growing season leaves of maiden trees on all quince rootstocks had the higher leaf K concentration (tab. 3). In the case of K, a significant interaction rootstock × cultivar was also found (tab. 5). This was expressed by greater differences in the K content – due to rootstock – in 'Conference' than in 'Erika' leaves. Likewise to P, a highly significant effect of cultivar on leaf K content was found (tab. 2). However, this was true only for maidens budded on quinces and on the Cps, while no significant differences due to cultivar were found for maidens budded on OHxF 333 and on 'Pyrodwarf' (tab. 5).

CONCLUSIONS

1. Rootstocks for pear apparently differ in their ability to absorb mineral elements.
2. Rootstock may affect mineral composition of pear leaves and this effect may be manifested in different way or strength in different cultivars.
3. Quince S_1 definitely favours higher concentrations of mineral elements in the leaves.
4. Specific abilities of rootstocks to absorb particular nutrients may serve as an additional indicator in selection of an optimal rootstock for certain soil conditions.

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ZAWARTOŚĆ NIEKTÓRYCH SKŁADNIKÓW MINERALNYCH W LIŚCIACH PODKŁADEK DLA GRUSZY I W LIŚCIACH OKULANTÓW NA NICH USZLACHETNIONYCH

Streszczenie. Sześć typów podkładek wysadzono w Warszawie-Wilanowie wiosną 2002 r.: trzy pochodzące od *Pyrus communis* – siewki gruszy kaukaskiej, OHxF 333 i 'Pyrodwarf' oraz trzy pochodzące od *Cydonia oblonga* – pigwy S_1, MA i MC. W sierpniu były one zaokulizowane odmianami gruszy Konferencja i Erika. Liście pobierane w końcu sierpnia ze środkowej części pędów podkładek (w 2002 r.) i okulantów gruszy (w 2003 r.) były analizowane na zawartość Ca, Mg, P i K. Podkładki różniły się istotnie pod względem zawartości wszystkich badanych składników mineralnych w liściach, a także wpływały na skład mineralny liści okulantów gruszy. Zawartość Ca, P i K zależała również od odmiany. Stwierdzono także istotne współdziałanie podkładki i odmiany na zawartość P i K w liściach okulantów. Sugeruje się, że szczególna zdolność do pobierania określonych składników mineralnych przez poszczególne podkładki może służyć jako dodatkowa wskazówka przy doborze optymalnej podkładki dla konkretnych warunków glebowych.

Słowa kluczowe: grusza, pigwa, podkładka, skład mineralny liści, wapń, magnez, potas, fosfor

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