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Leaf Phosphorus Concentration in Young Rootstocks and Scion Cultivars of Citrus

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ABSTRACT

This investigation was undertaken to study the leaf phosphorus level in five seedling rootstocks and in their twenty two combinations with certain citrus cultivars, all grown in the field for three years under uniform cultural practices. Data obtained showed highly significant interactions between specific scions and rootstocks. Increase in scion leaf phosphorus was evident in 'Clementine' mandarin on 'Troyer' citrange, 'Hamlin' and 'Washington' navel oranges on 'Cleopatra' mandarin, and 'Washington' navel on sour orange. In general, 'Cleopatra' mandarin and 'Troyer' citrange supplied their scion leaves with more phosphorus than 'Rangpur' lime, rough lemon or sour orange. Regardless of the rootstock used, 'Clementine' mandarin, 'Prior Lisbon' lemon and 'Washington' navel orange were able to accumulate more phosphorus in their leaves than 'Valencia' or 'Hamlin' oranges. Differences in leaf phosphorus content were detected only between two seedling stocks, being higher in rough lemon compared to 'Rangpur' lime.

INTRODUCTION

Accumulated evidence in the literature indicates that the rootstock, the scion and their combination influence the mineral composition of the citrus tree. However, it is not clear whether any variation in leaf mineral composition among citrus scion/stock combinations reflects differences in nutrient requirements or simply differences in efficiencies of securing nutrients unrelated to their requirements (1,7). In 1961, De Villiers and Beyers (3) used separate leaf composition standards to evaluate the nutritional status of certain elements for each of the 'Valencia' and the navel oranges.

In Libya, published information is lacking on the effects of citrus rootstocks on phosphorus nutrition except for a recent report (5) which indicated that 'Cleopatra' mandarin supplied considerably more phosphorus to the leaves of lemon than sour orange rootstock. In Florida, Smith *et al.* (8) showed small but significant effects of various rootstocks on the phosphorus concentration in leaves of 'Valencia' oranges.

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Wutscher and Olson (9) in comparing the effects of sixteen rootstocks on leaf composition of CES No. 3 Redblush grapefruit, reported that Troyer citrange resulted in relatively low phosphorus in the scion leaves.

This report summarizes the results of leaf phosphorus determinations in five different seedling rootstocks and in their combinations with five citrus cultivars.

MATERIALS AND METHODS

The sweet oranges *Citrus sinensis* (L.) Osbeck, 'Washington' navel, 'Valencia' and 'Hamlin', the 'Prior Lisbon' lemon *C. limon* (L.) Burm. f. and the 'Clementine' mandarin *C. reticulata* Blanco budded on five different rootstocks, namely, sour orange *C. aurantium* L., rough lemon *C. jambhiri* Lush., 'Rangpur' lime *C. limonia* Osbeck, 'Cleopatra' mandarin *C. reshni* Hort. ex. Tan. and 'Troyer' citrange [*Poncirus trifoliata* (L.) Raf. X *C. sinensis* (L.) Osbeck] were transplanted to the field in late February 1972. The soil in the permanent place is a deep sandy loam known to be high in calcium carbonate and of a pH 7.9 or slightly higher.

For the three orange cultivars, a randomized block design with three replications was adopted. Each of the main blocks was divided in three sub-blocks. The sub-block represented one orange cultivar on the five rootstocks under test. Every scion/rootstock combination was planted in a single four-tree row which constituted one replication. The scion/rootstock combinations of the 'Clementine' mandarin and the 'Prior Lisbon' lemon consisted of three trees lined in a straight row; replicated twice. The seedling rootstocks were planted in a single-tree plots; replicated three times.

All plants were subjected to the same cultural practices and maintained under a uniform elemental N:P:K fertilizer with a ratio of 1:0.22:0.42, respectively. During the first three years in the field, each plant received a total of 150, 210 and 400 grams of pure nitrogen, split in five applications during each growing season successively. All the phosphate and potash fertilizers were applied once a year.

Composite leaf samples from each replication were collected during early October, 1974, from 7-month old spring cycle growth. Sample preparation for chemical analysis and phosphorus determinations were carried out on dry-ashed leaves according to Chapman and Pratt (2).

RESULTS AND DISCUSSION

Under the growing conditions of this study, it is worthy to report that all scion cultivars on 'Troyer' citrange rootstocks showed relatively the least growth and vigor when compared with the same cultivar on the other rootstocks tested. Leaf analyses of oranges on 'Troyer' citrange were excluded due to their inadequate vegetative growth within replicates.

Scion and rootstock influences

It was found that rough lemon roots were able to supply its own leaves with significantly higher amounts of phosphorus (0.178%) than 'Rangpur' lime (0.152%). Otherwise, no differences in leaf phosphorus concentrations were detected between 'Cleopatra' mandarin, 'Troyer' citrange, sour orange or 'Rangpur' lime (Table 3). This corresponds with the results reported earlier (6), where the analysis of the whole

Table 1 Influence of rootstock on scion leaf phosphorus in three-year-old, field-grown[a], lemon and mandarin cultivars

Rootstock	Scion		
	'Prior Lisbon' lemon	'Clementine' mandarin	Mean for stock
	Mean per cent phosphorus in dry leaves[b]		
Sour orange	0.142a	0.158b	0.150
Rough lemon	0.158a	0.160b	0.159
'Rangpur' lime	0.161a	0.153b	0.157
'Cleopatra' mandarin	0.166a	0.159b	0.163
'Troyer' citrange	0.167a	0.183a	0.175
Mean for scion	0.159	0.163	

[a]N:P:K in fertilizer was maintained at a constant ratio of 1:0.22:0.42.
To convert P to P_2O_5 multiply by 2.3.
To convert K to K_2O multiply by 1.2.
[b]Values followed by same letter, within any one column, are not significantly different at P = 0.01, according to Duncan's Multiple Range Test.

seedling tops of the same kind of stocks were compared. However, in the same report root phosphorus concentrations of these stocks varied considerably.

In 'Prior Lisbon' lemon trees, differences in leaf phosphorus percentages ranging between 0.167% on 'Troyer' citrange and 0.142% on sour orange could be attributed to chance variations. Leaves of 'Clementine' mandarin on 'Troyer' citrange contained appreciably higher phosphorus content (0.183%) compared to the other four rootstocks (Table 1).

In general, Table 2 shows that 'Cleopatra' mandarin was able to supply its orange tops with more phosphorus than 'Rangpur' lime or rough lemon. Regardless of any of the top cultivars used, 'Cleopatra' mandarin and 'Troyer' citrange were superior to the other three rootstocks in supplying phosphorus to the leaves of their scion tops (Table 3). In

Table 2 Interaction between scion and rootstock on leaf phosphorus in three-year-old, field-grown[a], orange cultivars in comparison with the seedling rootstocks

Rootstock	Tree top				Mean of stock
	'Washington' navel	'Valencia'	'Hamlin'	Seedling rootstock	
	Mean per cent phosphorus in dry leaves[b]				
Sour orange	0.169abc	0.145cdefg	0.128efg	0.157bcde	0.150ab
Rough lemon	0.118g	0.149bcdef	0.125fg	0.178ab	0.143bc
'Rangpur' lime	0.136defg	0.128efg	0.123fg	0.152bcde	0.135c
'Cleopatra' mandarin	0.191a	0.135defg	0.163abcd	0.159bcd	0.162a
Mean for top	0.153a	0.139b	0.135b	0.161a	

[a]N:P:K in fertilizer was maintained at a constant ratio of 1:0.22:0.42.
To convert P to P_2O_5 multiply by 2.3.
To convert K to K_2O multiply by 1.2.
[b]Values followed by same letter, are not significantly different at P = 0.01. Stock means should be compared vertically; and those for tops horizontally.

Table 3 Mean effect of the rootstock on leaf phosphorus of citrus trees

Rootstock	Tree top	
	Seedling[a]	Scion[b]
	Mean per cent phosphorus in dry leaves	
Sour orange	0.157ab	0.148
Rough lemon	0.178a	0.142
'Rangpur' lime	0.152b	0.140
'Cleopatra' mandarin	0.159ab	0.163
'Troyer' citrange	0.159ab	0.175[c]

[a]Values followed by same letter are not significantly different at P = 0.01.
[b]Mean for 5 different citrus cultivars.
[c]Mean for only lemon and mandarin cultivars.

this respect, Embleton *et al.* (4) indicated that sour orange and rough lemon rootstocks were associated with less phosphorus in their scion leaves than grapefruit or trifoliate orange. It should be noted that such generalizations are usually offset by different kinds of interactions, such as between scions and stocks, stocks and soil or other factors.

As shown in Table 2, 'Washington' navel orange was able to accumulate more phosphorus in its leaves than 'Hamlin' or 'Valencia' irrespective of rootstock. By comparing results in Tables 1 and 2, it could be deduced that both 'Prior Lisbon' lemon and 'Cleopatra' mandarin were similar to 'Washington' navel.

Scion/Rootstock interactions

Statistical analysis revealed highly significant interaction effects between specific scions and rootstocks as far as phosphorus determinations were concerned. Among the orange combinations with the different four rootstocks tested, Table 2 indicates that 'Washington' navel on 'Cleopatra' mandarin scored the highest leaf phosphorus percentage (0.191%). This level is considered within the high phosphorus range as presented by Smith (7) and Embleton *et al.* (4). On the other hand, the same 'Washington' navel top on rough lemon yielded the lowest leaf phosphorus concentration (0.118%) among the twelve orange/rootstock combinations. This again, showed to be at the upper limit of the low phosphorus range (4,7). None of the twenty two scion/rootstock combinations reported in this work appeared in the low range except probably the 'Washington' navel on rough lemon, that is, if those standard phosphorus ranges (4,7) are accepted without qualifications. This condition, if persisted, may indicate the need for a higher phosphorus level in the fertilizer ratio for 'Washington' navel orange on rough lemon to attain the suggested optimum leaf phosphorus level. A critical evaluation of the results presented in Table 2 reveals considerable variability in leaf phosphorus concentrations among the orange scion cultivars. For example, 'Washington' navel and 'Hamlin' oranges on 'Cleopatra' mandarin and 'Washington' navel on sour orange had the highest leaf phosphorus percentages. On the contrary, 'Washington' navel on rough lemon showed the lowest level obtained among the twelve orange combinations.

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تركيز الفوسفور في أوراق أصول وطعوم أصناف حمضيات صغيرة السن

عصام حسب الله – ابراهيم فهمى

المستخلص

أجري هذا البحث لتقدير عنصر الفوسفور فيأوراق خمسة أصناف حمضيات مع تركيباتها على خمسة أصول مختلفة ، جميعها منزرعة بالمكان المستديم منذ ثلاثة سنوات تحت معاملات زراعية متماثلة .

دل التحليل الاحصائي للنتائج المتحصل عليها من مجموع ٢٢ تركيبه بين الطعم والأصل على أن الفوسفور في أوراق الطعم لم يكن في المستوى المنخفض لمحتواه المثالي المعروف في أوراق الحمضيات فيما عدا البرتقال بوسرة على أصل الليمون المخرفش، وكانت نسبة الفوسفور مرتفعة في أوراق اليوسفي « كليمانتين » على أصل الهجين « ترويير » والبرتقال بوسرة على أصلى اليوسفى « كليوباترا » والنارنج .

وبصفة عامة ، ظهر أن أصلى اليوسفى « كليوباترا » والهجين « ترويير » أمدا الطعم المركب عليهما بكميات أكبر من الفوسفور عن أصول الليمون المخرفش أو الليمون « رانجبور » أو النارنج . وبغض النظر عن الأصل ، احتوت أوراق اليوسفى « كليمانتين » والليمون « لزبون » والبرتقال بوسرة على تركيزات أعلى من الفوسفور عن أوراق صنفي البرتقال « فالنشيا » و « هاملين » .

بين الخمسة أصول غير المطعمة ، كان الاختلاف المؤكد بينها هو ارتفاع مستوى الفوسفور في أوراق الليمون المخرفش عنه في أوراق الليمون « رانجبور » .