

Relations among Valencia Orange Yields with Soil and Leaf Nutrients in Northwestern Paraná, Brazil

Jonez Fidalski ^{1*}, Pedro Antonio Martins Auler ¹ and Valdomiro Tormem ²

¹ Instituto Agrônômico do Paraná (IAPAR). Caixa Postal 564. CEP 87701-970. Paranavaí-PR, Brazil;
² EMATER-PR/Paraná Citros S.A. Caixa Postal 28. CEP 87701-970. Paranavaí-PR, Brazil

ABSTRACT

The Valencia orange orchards established on soils of low fertility in the Northwest region of Paraná State, Brazil, have showed symptoms of Mg deficiency and reduced fruit yields. The objective of this study was to verify the relationship between yield with soil and leaf nutrients during 1996/97 growing season. Two sites of low and high productivity were selected in seven orchards. Leaf and soil samples (fertilized rows and interrows) were collected in 1996. The results showed that the citrus yields were negatively related with soil Mg/K and Ca+Mg/K ratios in the fertilized rows, and fruit weight positively correlated with leaf Zn in the low productivity orchards. The fruit weight was positively related with leaf Ca and soil Ca in the fertilized rows of the high productivity orchards. The results suggested an adequate lime and K fertilization managements in the fertilized rows, as well as an adequate Zn supply.

Key words: *Citrus sinensis*, foliar diagnosis, liming, K fertilization, calcium, zinc

INTRODUCTION

In the last years, orange planting has increased in Paraná State, Brazil, totalling an area of 13,001 ha (SEAB, 1999). About 50% of the citrus orchards were established in the Northwest region of the State. This region represents 15% of the total area of the State of Paraná and presents soils originated from *Caiuá* sandstone with low acidity and fertility (Fidalski, 1997). After five harvests, sweet orange trees (*Citrus sinensis* (L.) Osbeck) showed symptoms of nutritional unbalanced, such as Mg deficiency and reduced fruit size. Many orchards produced less than 800 boxes (40.8 kg each one) of fruit per hectare, which is considered to be low enough for an economic production in Paraná.

The first nutritional survey of citrus conducted in the State of Paraná (Fidalski & Auler, 1997) showed that lime applied at planting time (1989-

91) increased soil Ca and Mg levels in the first harvest (1992/93 growth season), but there was a decrease afterwards. In 1996, the soil base saturation (Ca+Mg+K/CECx100) was about 40%, a level similar to the planting time and insufficient for an economic citrus crop production. In this year, the soil chemical analysis of the fertilized rows showed high acidity and low Ca and Mg contents as compared to the interrows. The foliar analysis revealed an adequate supply of N, P and K, and high nutritional deficiencies of Ca, Mg and Zn. It is concluded that nutritional problems of the citrus orchards are related to inadequate supply of Ca, Mg and Zn.

The objective of this study was to verify the relations among Valencia orange yields with soil and leaf nutrients during 1996/97 growing season, in soils originated from *Caiuá* geological formation of the State of Paraná.

This study was carried out during 1996/97 growing season in the Northwestern Paraná,

MATERIALS AND METHODS

* Author for correspondence

Brazil, between coordinates 22°30′-23°30′S and 52°00′-53°00′W. The orchards were located at Paranaíba, São João do Caiuá, Alto Paraná, Mandaguaçu, Floraí, Amaporã and Planaltina do Paraná, all within a 50 Km radius of Paraná Citrus Industry from Paranaíba. The soils were Red Dark Latossol and Podzolic with sandy texture and low fertility to depth of 20 cm (EMBRAPA, 1984; Fidalski, 1997).

Two sites were chosen in seven Valencia orange orchards on Rangpur lime rootstock with 5-7 years old. These sites were studied before by Fidalski & Auler (1997). It was showed healthy plants, and the fertilizers and lime had been used following the recommendations by GPACC (1994). The yield data harvest 1995/96, reported by Paraná Citrus orange juice industry at Paranaíba, were employed to select the sites with low and high productivity. Orchard productivity was estimated by the number of boxes with 40.8 kg fruit per hectare, equivalent to yields of 357 trees in a planting spacing of 4 m x 7 m.

The soil samples were collected in the fertilized rows and in the interrows to a depth of 20 cm in each site. Ten soil subsamples were taken per site and they were composited to obtain a sample for analysis. Plant nutrition was evaluated by collecting the third and fourth leaves from fruiting branches in four quadrants of ten plants in each site (eighty leaves per sample). Soil and leaf samples were collected in each site of low and high productivity during May-July 1996, following the recommendations by GPACC (1994). The soil and leaf samples were analyzed by regular methods used by the Agronomic Institute of the State of Paraná (Pavan *et al.*, 1992; Miyazawa *et al.*, 1992). The number of fruit boxes per hectare and mean fruit weight were also measured in 1997 by the Paraná Citrus Industry. The soil and leaf nutrient chemical analysis were related to the number of fruit boxes per hectare and mean fruit weight. Data were analyzed using Pearson correlations (SAS, 1990).

Table 1. Average soil chemical characteristics in Valencia orange orchards of low and high productivity, in the fertilized rows and interrows

Site productivity	pH-CaCl ₂	Al	H+Al	Ca	Mg	K	CEC	V	Ca ⁽¹⁾	Mg ⁽¹⁾	K ⁽¹⁾	
		mmol dm ⁻³						%				
Fertilized rows												
Low	4,8	0,6	28,8	10,6	5,6	2,7	47,6	39,5	22,3	11,9	5,2	
High	4,9	0,9	28,4	10,4	6,2	1,6	46,6	39,4	22,5	13,5	3,4	
Interrows												
Low	5,4	0,3	24,1	12,1	8,1	1,6	45,9	46,3	25,7	17,3	3,2	
High	5,2	0,5	25,0	11,6	6,9	0,9	44,5	43,0	25,7	15,2	2,1	
Adequated levels	...	...	...	...	(2) > 9,0	(2) > 2,0	...	(3) > 50,0	(4) > 40,0	(4) > 10,0	(5) < 5,0

⁽¹⁾ Cation saturation (Ca, Mg or K/CEC)x100; ⁽²⁾ Quaggio (1996); ⁽³⁾ Boaretto *et al.* (1996); ⁽⁴⁾ GPACC (1994); ⁽⁵⁾ Malavolta & Prates (1994).

RESULTS AND DISCUSSION

The soil pH, H+Al, Al, Ca, Mg, cation exchange capacity (CEC), base saturation (V) and Ca and Mg saturation did not show difference between sites of low and high productivity of Valencia orange orchards (Table 1). Only the soil K content showed difference between two sites (Table 1). The levels of soil K content and the K saturation in the CEC in the fertilized rows of the low productivity orchards, were higher than the critical values of 2 mmol_c dm⁻³ and 5%, respectively, for citrus production in Brazil (Quaggio, 1996; Malavolta & Prates, 1994).

The citrus yield was not correlated with a single soil nutrient content, but was correlated with Mg/K and Ca+Mg/K ratios in the fertilized rows of the low productivity orchards only (Fig. 1). Quaggio (1996) showed that excess of K fertilization decreased citrus yield in the State of São Paulo. For the Northwestern region of Paraná, it has been found that Ca nutrition increased citrus yield in soils originated from *Caiuá* geological formation (Fidalski *et al.*, 1999a). It is also possible that Ca and Mg uptake by plants may be reduced due to the high concentration of soil K in the fertilized rows (Table 1). This hypothesis is supported due to the strong antagonism among these three cations (Ca, Mg and K) observed in the soils for Fidalski *et al.* (1999a, b).

Relationship analysis (Fig. 2) showed that the fruit weight was positively related with leaf Zn in the low productivity orchards, while in the high productivity orchards the fruit weight was

positively related with leaf Ca and soil Ca in the fertilized rows. The fruit weight did not correlated with leaf K of low and high productivity orchards, $R = 0,19NS$ and $R = 0,18NS$, respectively. The high K in the fertilized rows and leaf Zn deficiency in the low productivity orchards (Tables 1 and 2), were assumed to be the main nutritional factor in reducing fruit size. This is supported by the works published by Malavolta & Violante Netto (1989), Quaggio (1996), Fidalski & Auler (1997), and Fidalski *et al.*, (1999a, b).

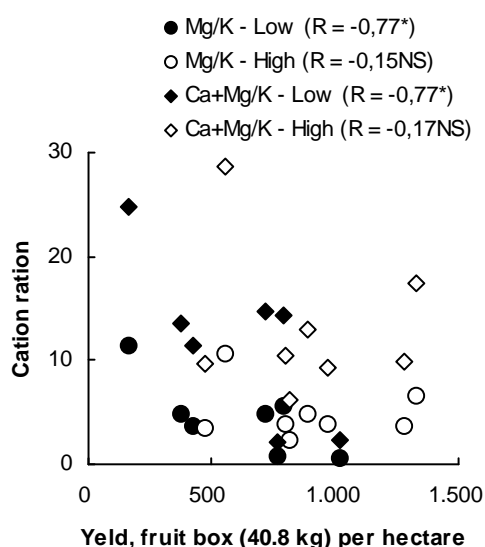


Figure 1. Relationship between yield with cation ratio in the fertilized rows of the low and high productivity orchards. NS and * denote not significant and significant at $P \leq 0,05$, respectively.

Table 2. Average leaves nutrients concentrations in Valencia orange orchards of low and high productivity, in relation to the adequate levels from May/July (Malavolta & Prates, 1994).

Site productivity	N	P	K	Ca	Mg	S	mg kg ⁻¹				
							Zn	B	Cu	Mn	Fe
Low	24,8	1,3	15,6	32,3	2,8	3,6	18,2	71,3	79,6	62,0	218,3
High	25,6	1,3	16,4	33,1	2,6	3,5	17,7	66,9	93,3	68,9	156,2
Adequate levels	22,0	1,1	10,0	30,0	2,0	2,0	25,0	60,0	10,0	25,0	150,0

The visual deficiency symptoms of Mg observed in orange orchards in the Northwestern Paraná may be related with the antagonism among Ca, Mg and K on citrus nutrition (Fidalski & Auler, 1997; Fidalski *et al*, 1999a, b). Considering these three cations, the Mg is considered to be the first nutrient that shows symptoms of nutritional unbalanced in citrus (Malavolta & Violante Netto, 1989). For the low productivity orchards it is possible that the normal yearly application of mineral fertilization (N, P and K) associated with low lime frequency increased leaching of basic

cations in the fertilized rows, specially Mg (Fidalski & Auler, 1997) (Table 1). The results of this citrus nutritional survey showed nutritional problems associated with Ca, Mg and Zn in the low productivity orchards. Similar results have been reported for the citrus orchards in the Northwestern part of Paraná (Fidalski & Auler, 1997). The results of the present work suggested the need for an adequate lime and K fertilization managements in the fertilized rows, as well as an adequate Zn supply.

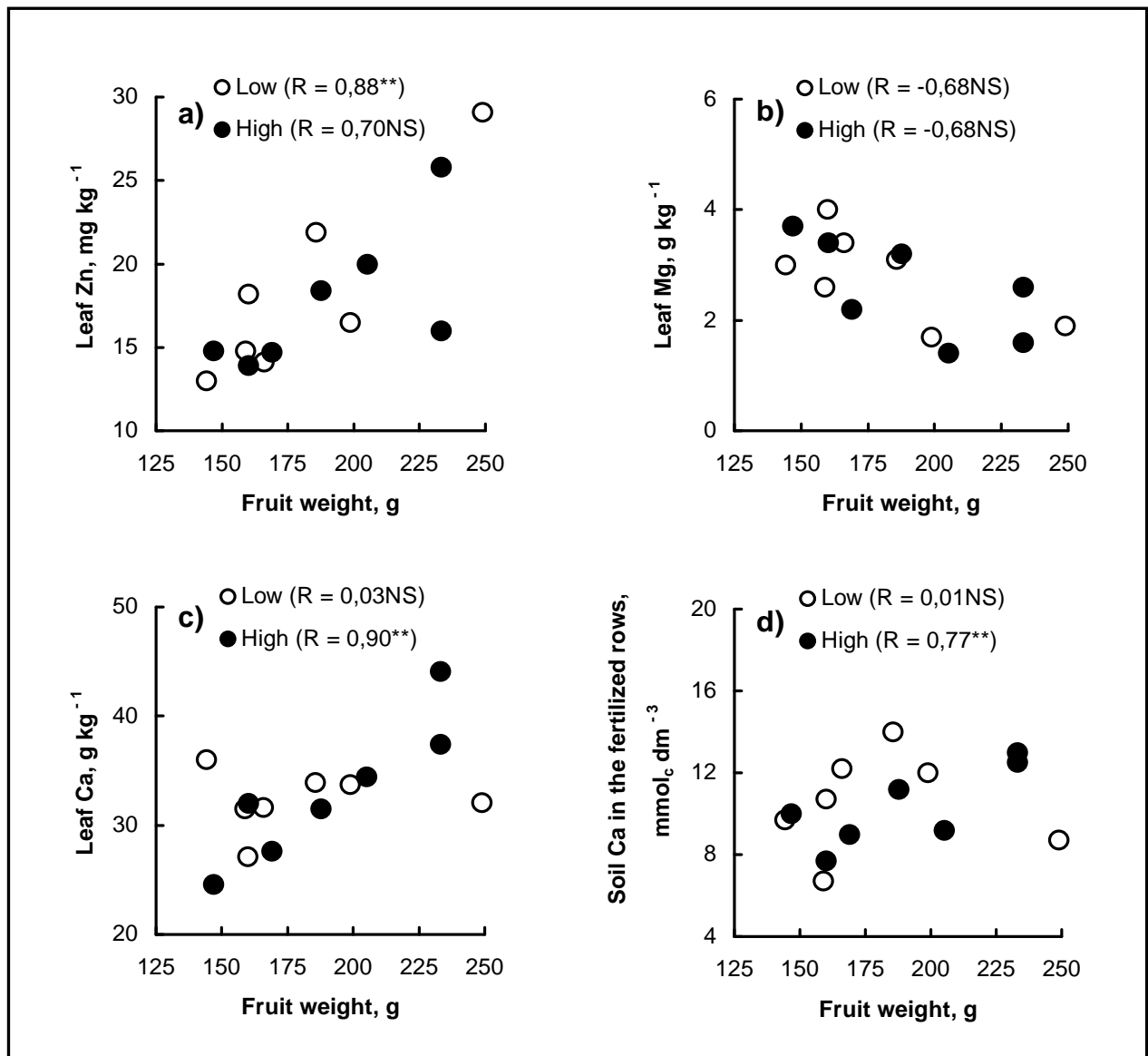


Figure 2. Relationship between fruit weight with the leaf and soil nutrients in Valencia orange orchards of low and high productivity. NS, * and ** denote not significant and significant at $P \leq 0.01$ and $P \leq 0.05$, respectively.

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RESUMO

Os pomares de laranja Valência (*Citrus sinensis* (L.) Osbeck) estabelecidos em solos de baixa fertilidade da região noroeste do Paraná, tem apresentado sintomas de desequilíbrio nutricional, principalmente deficiência de Mg e redução da produção e do tamanho dos frutos. O objetivo deste trabalho foi verificar as relações da produção e peso dos frutos com os nutrientes das folhas e do solo de sete pomares de laranja Valência na safra de 1996/97, em talhões de produtividade inferior e superior. Em 1996, foram coletadas amostras de folha e de solo nas faixas de adubação e nas entrelinhas. Os resultados mostraram que a produção de frutos correlacionou-se negativamente com as relações dos cátions Mg/K e Ca+Mg/K do solo das faixas de adubação dos pomares de baixa produtividade e, o peso dos frutos, correlacionou-se positivamente com os teores foliares de Zn. Nos pomares de produtividade superior, o peso dos frutos correlacionou-se positivamente com os teores de Ca das folhas e do solo nas faixas de adubação. Estes resultados sugerem um manejo adequado da calagem e da adubação potássica nas faixas de adubação dos pomares de baixa produtividade e um adequado suprimento de Zn.

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