

NUTRITIONAL PATTERN OF CITRUS SEEDLINGS GROWN ON SUBSTRATES

VIVECITRUS – CONPLANT



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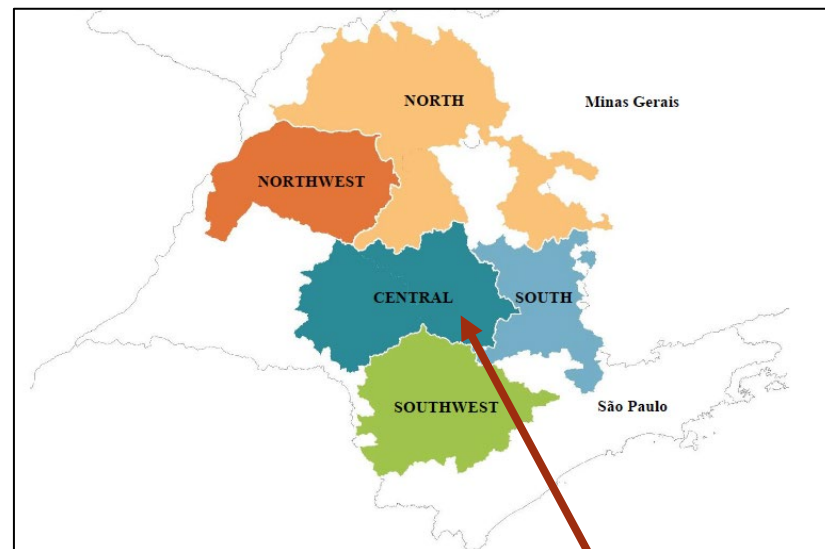


Vivecitrus

Organização Paulista de Viveiros de Mudas Cítricas

São Paulo State Citrus Nurseries Organization

- Vivecitrus, was founded in 1998 by 11 citrus growers from São Paulo, contributes to the establishment of methodologies and quality standards for seedling production, according to the standards of plant sanitary defense of the Department of Agriculture and Supply of the State of São Paulo.



Vivecitrus office

Brazilian Citrus Belt: 461,921 Ha

Fundecitrus - 2022

São Paulo State Screen Houses





Citrus nursery Industry

- 23.515.210 nursery citrus plants were produced in São Paulo in a screen houses (SAA, EDA, 2021).
- 322 nurseries (Screen houses)

**Average selling price for nursery plants:
US\$ 1.50 - 3.00**



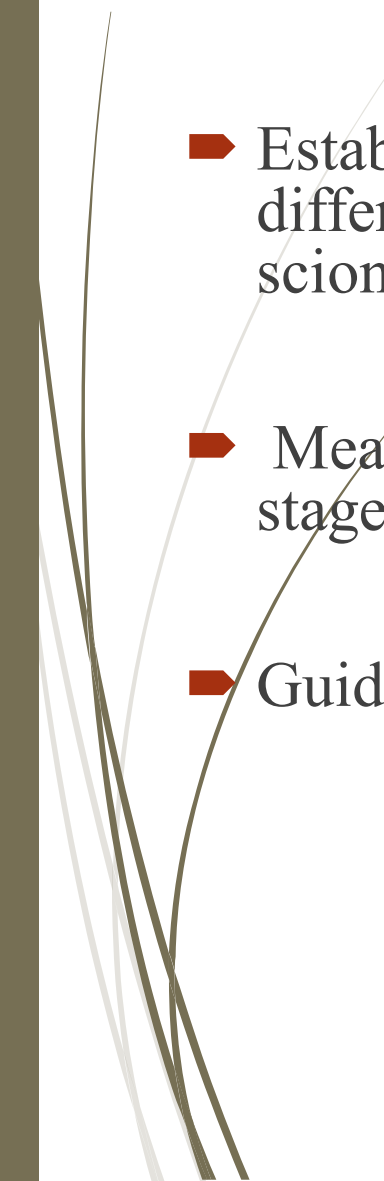


Important

- Providing essential nutrients at the right doses at the right time, in the right proportions and forms are key actions to have sustainable nurseries



The aims of this worked:

- Establish the nutritional patterns of seedlings of the different rootstock development and combinations of scions and rootstocks cultivated in summer or winter.
 - Measure the amount of nutrients extracted in the different stages of citrus nursery tree formation.
 - Guide nutritional management in nurseries
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Nutritional
pattern of citrus
seedlings





Associados

Agromillora P e C de Mudas Vegetais Ltda
Blasco & Almeida Mudas Cítricas
Citrograf Mudas
Citrosol Qualidade em Mudas
Dragone Mudas
Fiorese Citrus
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Padrão Nutricional de Mudas de Citros



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Pedro Roberto **FURLANI**
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Camilo Lázaro **MEDINA**

Boletim Técnico
Vivecitrus/Conplant
Araraquara (SP), agosto de 2008



How to diagnose nutrition problems in citrus nursery trees ?

Relevant issues:

- 1- The nutritional patterns of citrus orchards wasn't matches to the values found in good nursery trees.
- 2- There are different species and many stages of development
- 3- Cultivation in pots containing substrates that have little nutrient storage capacity.
- 4- Climate is variable and can influence the plant development and nutrient demand

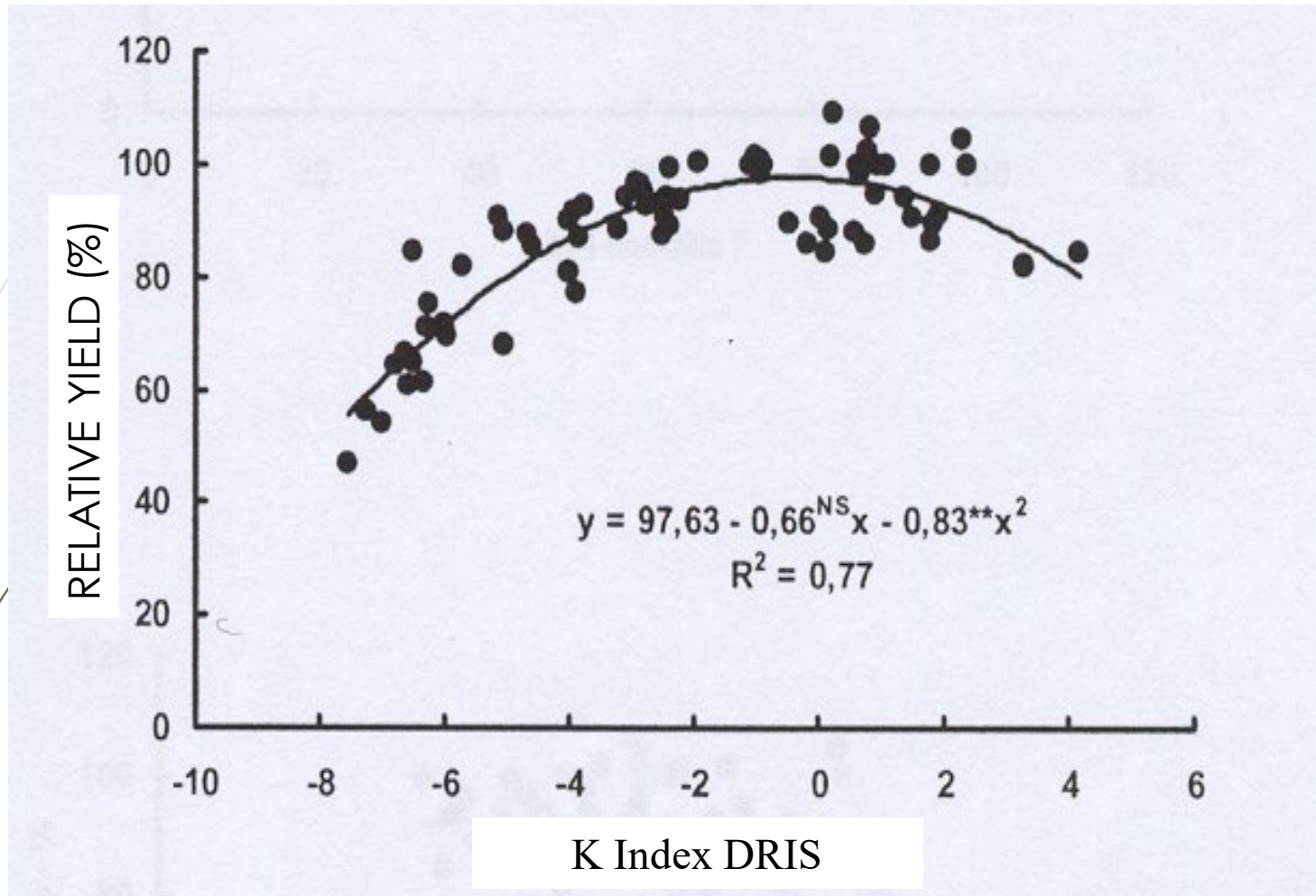


Methods

- Diagnosis and Recommendation Integrated System, DRIS (Beaufils, 1973)

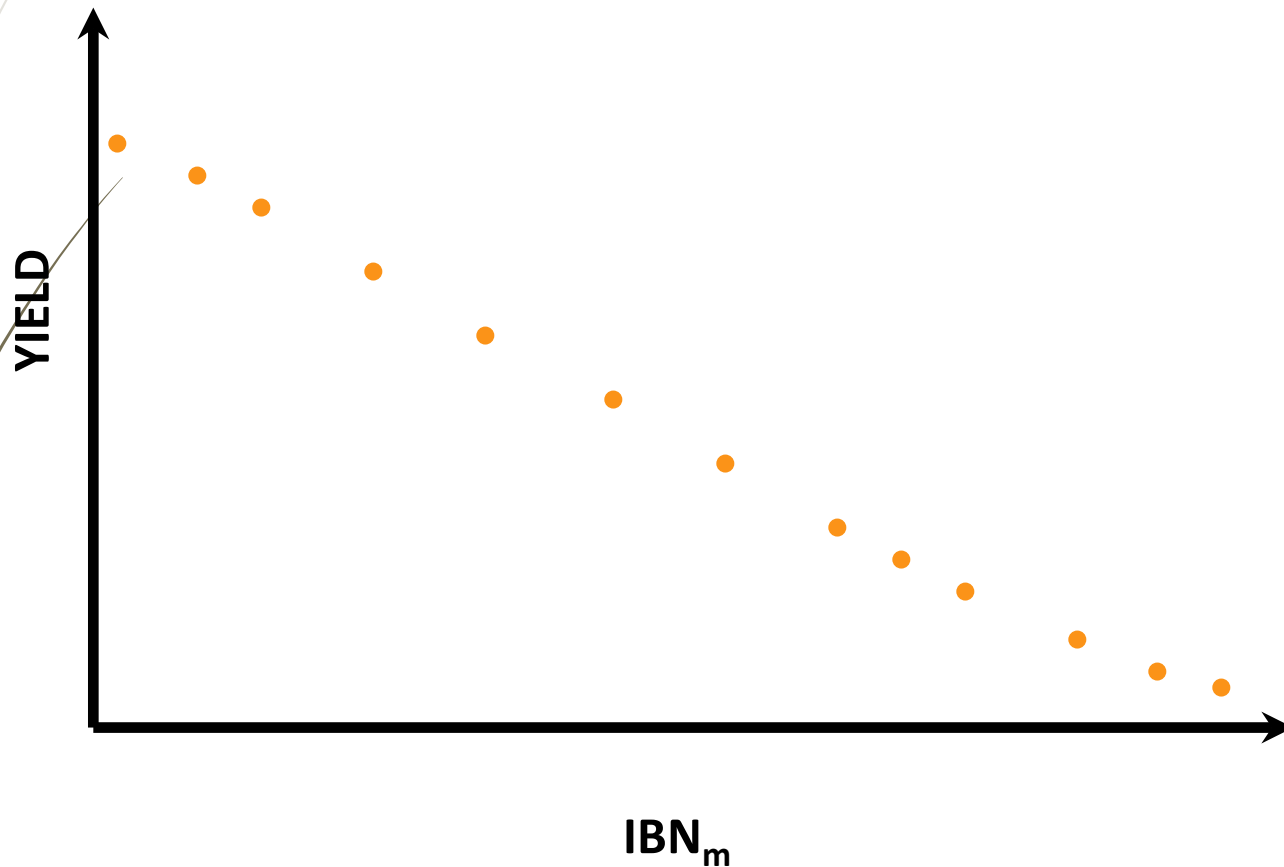
This method was chosen to define nutritional patterns in the different stages of plant development.

BEAUFILS, E. R. Diagnosis and Recommendation Integrated System (DRIS). A general scheme of experimentation and calibration based on principles developed from research in plant nutrition. Pietermaritzburg, South Africa: University of Natal, 1973, 132p. (Soil Science Bulletin, 1).



Relationship between DRIS K index and apple tree yield
(NACHTIGALL, 2004)

Relationship between yield and average nutrient balance index (IBNm) established by DRIS





IMPORTANT STEPS FOR DRIS ANALISES

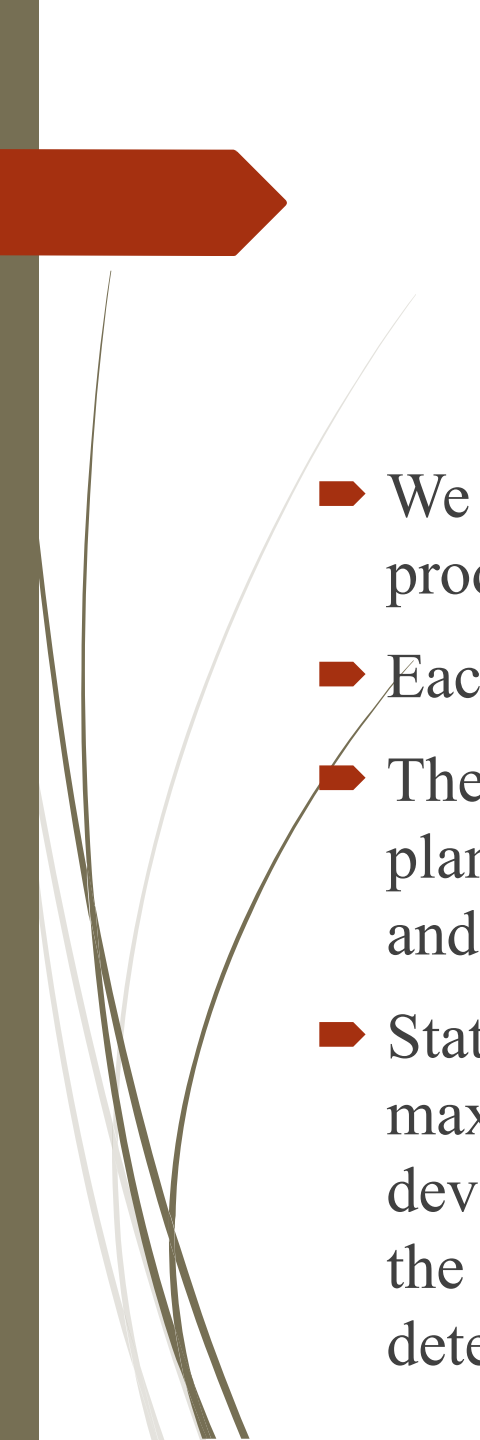
1 - Define reference population (Several good plants from the Vivecitrus samples were collected)

2- Establish the relationships between Nutrients N/P, N/K, etc.

3- Calculate functions $f(N/P)$, $f(N/K)$

4- Calculate the INDICES IN , IP , etc.

5- Calculate ibn or $IBNm$



Material used to define the standard population of the nurseries trees

- We analyzed 290 samples of rootstocks and plant cups produced in winter and 237 in summer.
- Each sample contained 20 plants per batch
- The average height of the substrate at the top of the plant, the diameter, the date of transplanting, grafting and sampling were noted
- Statistical analysis: For evaluation of the results, the maximum and minimum values, means, standard deviation, standard error and interval of confidence for the mean ($P < 0.05$, T test) of each material studied were determined

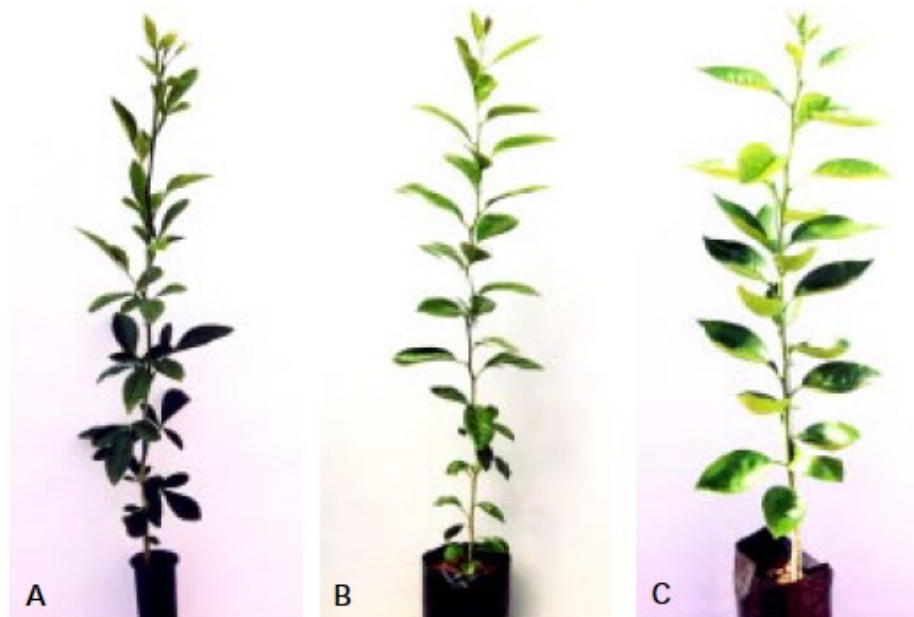
Leaf sampling pattern



- A) Rootstock ready for grafting in plastic bags (80-150 days after seeding)
- B) Grafted nursery tree at the end of the 1st growth stream (100-130 days after grafting)
- C) Nursery trees before final pruning. (150 - 162 days after grafting)

Methods

- Study of concentration and extraction of nutrients in whole plants (scions and roots)
- We analyzed 60 rootstock samples grown in little tubes and at the transplant point (A), 56 rootstocks at the grafting point (B) and 27 seedling plants ready for planting before final pruning (C).



- The analyses were carried out in the Laboratory of Soil and Plant of the Agronomic Institute (IAC), in Campinas (SP).
- BATAGLIA et al. (1983).



Photo: Queen Elisabeth's visit to IAC in 1968



Results

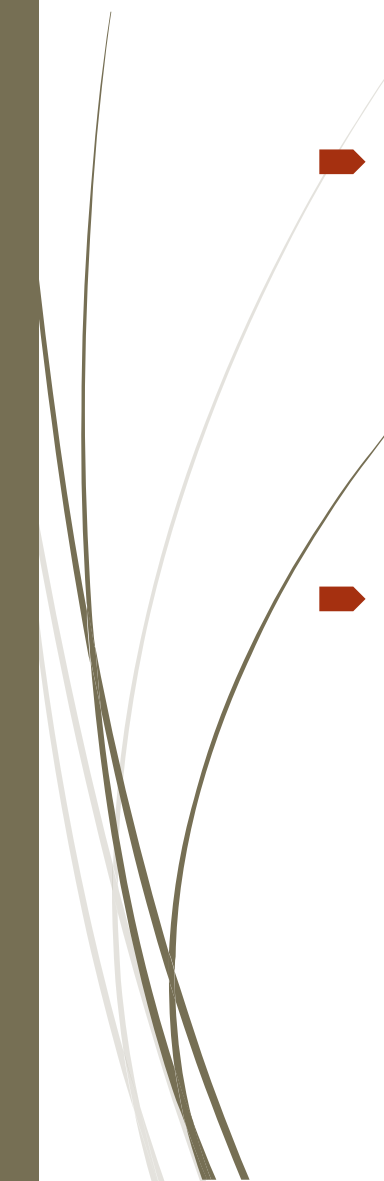
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- The research allowed the formation of 31 tables that determined the nutritional and nutrient extraction patterns of different rootstocks and nursery trees used in São Paulo citrus Industry.
 - This study can guide nutritional management in different phases of seedling growth in citrus nurseries.

Table 7: Nutritional patterns of Cleopatra, Rangpur Lime, and Sunki rootstocks and estimated optimal value obtained by DRIS for plants grown in summer.

Characteristic	Rootstock ⁽¹⁾			Optimal Value set by DRIS
	Cleopatra	Rangpur Lime	Sunki	
Age, days	75 - 87	70 - 82	86 - 96	-
Height, cm	89 - 101	76 - 115	75 - 86	-
Diameter, mm	3,8 - 4,4	5,0 - 5,8	5,0 - 5,3	-
N, g/kg	34,0 - 36,9	34,6 - 37,3	28,1 - 32,4	33,9
P, g/kg	2,4 - 2,9	2,3 - 2,6	1,9 - 2,3	2,1
k, g/kg	19,1 - 22,1	18,2 - 23,4	12,8 - 16,5	18,3
Ca, g/kg	22,5 - 27,3	21,1 - 24,5	25,6 - 31,7	27,4
Mg, g/kg	3,2 - 3,9	3,4 - 4,0	3,3 - 3,6	3,8
S, g/kg	3,0 - 3,7	2,9 - 3,2	3,2 - 4,0	3,4
B, mg/kg	105 - 143	65 - 120	72 - 140	—
Fe, mg/kg	110 - 140	113 - 211	72 - 140	—
Mn, mg/kg	135 - 190	53 - 71	60 - 93	—
Cu, mg/kg ⁽²⁾	36,0 - 38,9	4,6 - 7,5	15,7 - 30,9	—
Zn, mg/kg ⁽²⁾	26,7 - 33,8	20,4 - 51,3	27,3 - 41,8	—

⁽¹⁾ Values corresponding to the mean confidence interval ($P < 0.05$).

⁽²⁾ Cu and Zn concentrations were altered by sprays. For this reason, it is not reliably interpret the results regarding these nutrients.

Table 9. Statistical averages and estimated optimal value obtained by the DRIS Index of macronutrients, so set for the rootstocks Tangerine Cleopatra, Rangpur Lime and Tangerine Sunki (CRS), for plants grown in winter and summer.

Nutrient	Statistical mean per rootstock						Optimal value obtained by DRIS	
	Cleopatra		Rangpur		Sunki		General (CRS)	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
N, g/kg	26,9	35,5	30	36	28,8	30,2	24,6	33,9
P, g/kg	2,5	2,7	2,8	2,4	2,3	2,1	2,2	2,1
k, g/kg	16,7	20,6	22,8	20,8	18,6	18,6	15,5	18,3
Ca, g/kg	21,9	24,9	14,8	22,8	18,4	18,4	22,2	27,2
Mg, g/kg	2,5	3,6	2,5	3,7	2,4	2,4	2,9	3,8
S, g/kg	2,3	3,4	2,7	3	2,2	2,2	2,6	3,4

Table 10. Statistical averages and estimated optimal value obtained by the DRIS Index of nutrients, for the Citrumelo Swingle rootstock, in plants grown in winter and summer.

Nutrient	Swingle		Valor ótimo obtido pelo DRIS	
	Winter	Summer	Winter	Summer
N, g/kg	36,6	39,5	37,2	36,9
P, g/kg	2,8	2,6	2,8	2
K, g/kg	22,1	21,4	16,2	18,8
Ca, g/kg	24,8	27,1	25,9	33,8
Mg, g/kg	3,8	3,8	4,5	4,6
S, g/kg	3,1	4,1	3,5	4,5

Table 16. Statistical averages and estimated optimal value obtained by the DRIS Index nutrients, for citrus nursery trees ready before final pruning (MP) in Orange Pera/ Sunki Mandarin and Valencia Orange/Citrumelo Swingle, for plants grown in winter and summer.

Nutrient	Pera/Sunki		Valência/Swingle		Optimal value obtained by DRIS	
	Winter	Summer	Winter	Summer	Winter	Summer
N, g/kg	33,8	33,9	37,6	35,1	38,3	38,1
P, g/kg	2,2	2	2,3	2,1	2,3	2,3
K, g/kg	22,6	25,7	23,7	26,4	24,5	24,5
Ca, g/kg	23,9	23,9	25,9	23,1	26,5	26,6
Mg, g/kg	2,4	3,6	2,7	3,7	2,3	2,3
S, g/kg	3,1	3,8	3,5	5,1	3,1	3,1

Tabel 26: Nutritional pattern for four citrus rootstocks (Rangpur lime, Citrumello Swingle, Tangerine Cleópatra e Tangerine Sunki) growing in greenhouse and citrus pots with substrates

Nutrient	Cleopatra, Rangpur lime, Sunki	Swingle
N, g/kg	25-35	30 - 40
P, g/kg	2,0 2,5	2,2 - 2.8
k, g/kg	15 - 20	16 - 22
Ca, g/kg	20-30	25 - 35
Mg, g/kg	2,7 - 3,8	3,5 - 4,5
S, g/kg	2,5- 3,5	3,0 - 4,5
B, mg/kg	50 - 120	90 - 150
Cu, mg/kg	5 - 30	5 - 30
Fe, mg/kg	100 - 200	100 - 200
Mn, mg/kg	50 - 200	100 - 250
Zn, mg/kg	20 - 50	25 - 70

Tabela 27. Nutritional patterns for nursery trees grown on substrates in protected cultivation for grafted seedlings at the end of the 1st growth stream and seedlings ready before final pruning for Pera orange/Tangerine Sunki and Valencia /Citrumelo Swingle, for plants grown in winter and summer.

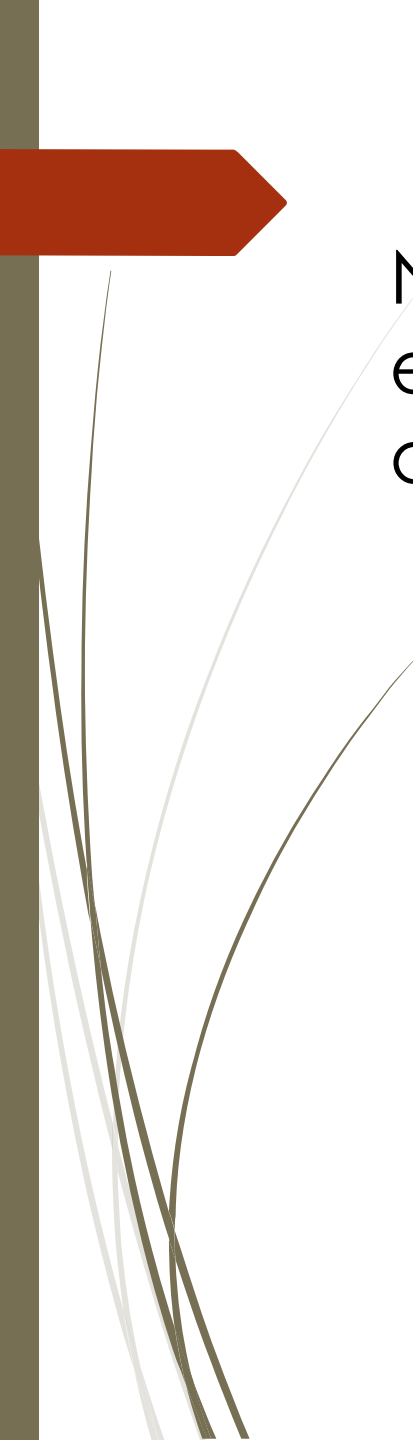
Nutrient	Citrus nursery tree 1 st flux	Read for planting Nursery Tree
N, g/kg	35 - 40	30 - 40
P, g/kg	2,2 - 2,8	2,2 - 2.8
k, g/kg	22 - 26	21 - 28
Ca, g/kg	16 - 23	20 - 27
Mg, g/kg	2,8 - 4,1	2,3 - 3,5
S, g/kg	2,5 - 3,5	2,9 - 3,7
B, mg/kg	55 - 110	90 - 170
Cu, mg/kg	5 - 30	10 - 30
Fe, mg/kg	100 - 200	120 - 250
Mn, mg/kg	40 - 200	70 - 180
Zn, mg/kg	25 - 55	40 - 90

Comparison of nutritional patterns for nursery trees by Vivecitrus Conplant (Bataglia et al., 2008) and for citrus in the orchard (koo et al. 1984)

Nutrient	Nursery trees (Ready for planting)		Optimum values for citrus orchard ⁽¹⁾
N, g/kg		30 - 40	25 - 27
P, g/kg		2,2 - 2.8	1,2 --1,6
k, g/kg		21 - 28	12--17
Ca, g/kg		20 - 27	30 - 49
Mg, g/kg		2,3 - 3,5	3 - 4,9
S, g/kg		2,9 - 3,7	2,0 – 3,0 ⁽²⁾
B, mg/kg		90 - 170	36 - 100
Cu, mg/kg		10 - 30	5 - 16
Fe, mg/kg		120 - 250	60 -120
Mn, mg/kg		70 - 180	25 - 100
Zn, mg/kg		40 - 90	25 - 100

Koo et al., 1984 in Obreza an Morgan Eds. Nutrition of Florida Citrus Trees 2nd edition ;

⁽²⁾ Mattos Junior et al. (2012).



Nutrient concentration and
extraction by the whole plant (roots
and scion)

Table 30. Average values of age, growth characteristics, concentrations of the nutrients in the aerial part and the total extraction of nutrients, in the nursery trees before pruning (Tree ready for planting).

Features	Scion /Rootstock	
	Valência/Swingle	Pera/Sunki
Age after transplant, days	244	239
Age after budding, days	142	109
Height, cm	105,3	98,7
Diameter, mm	76	7,4
Dry mater, g/plant	35,7	28
N, g/kg	24,2	21,2
P, g/kg	1,7	1,6
K, g/kg	19,3	19,2
Ca, g/kg	18,9	13,8
Mg, g/kg	3,4	2,2
S/ g/kg	2,9	1,7

Table 30 cont.. Average values of age, growth characteristics, concentrations of the nutrients in the aerial part and the total extraction of nutrients, in the nursery trees before pruning (Tree ready for planting).

Features	Scion /Rootstock	
	Valência/Swingle	Pera/Sunki
Massa Seca g/planta	51,9	38,6
N, mg/plant	1115,5	757,8
P, mg/plant	97,5	70,1
K, mg/plant	956,1	711,2
Ca, mg/plant	769,3	454,4
Mg, mg/plant	157,8	82,1
S, mg/plant	171,5	75

Table 31. Relationships between the concentrations of nutrients extracted by the aerial part in different phases

Development phase	Espécie	N	P	K	Ca	Mg	S
Rootstock transpl	Cleópatra	1,00	0,07	0,8	0,73	0,15	0,12
	Rangpur						
	Lime	1,00	0,08	0,81	0,52	0,12	0,09
	Sunki	1,00	0,07	0,79	0,68	0,13	0,10
	Swingle	1,00	0,09	0,87	0,69	0,17	0,13
Rootstock Budding	Cleópatra	1,00	0,08	0,66	0,73	0,12	0,11
	Rangpur						
	Lime	1,00	0,14	0,71	0,68	0,09	0,11
	Sunki	1,00	0,11	0,56	0,83	0,13	0,10
	Swingle	1,00	0,09	0,65	0,71	0,13	0,10
Tree ready for planting	Valência/Swingle	1,00	0,08	0,82	0,77	0,14	0,12
	Pera/Sunki	1,00	0,08	0,82	0,67	0,11	0,08

And.... Guidelines

In general, a nutrient solution containing (mg/L): N (200), P (18), K (152), Ca (140), Mg (29), S (21) can be considered balanced for the cultivation of citrus plants in substrate. However, knowledge of the chemical composition of the substrate is important to make adjustments to this nutrient solution and also to determine the concentrations of minor nutrients that should be incorporated into the final nutrient solution.

EC ~2,5

pH: 4,5-6,0

And.... Guidelines

In general, a nutrient solution containing (mg/L): N (200), P (18), K (152), Ca (140), Mg (29), S (21) can be considered balanced for the cultivation of citrus plants in substrate. However, knowledge of the chemical composition of the substrate is important to make adjustments to this nutrient solution and also to determine the concentrations of minor nutrients that should be incorporated into the final nutrient solution.

EC ~2,5

pH: 4,5-6,0



To think

To apply this recommendation it is necessary to think that the climate, the development time of nursery trees, species, etc., may require something different.

Agradecimentos

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Pedro Furlani, Ondino Bataglia e Rhuanito Ferrarezi



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