Resultados de três anos de pesquisa sobre o uso de nutrientes e indutores de resistência no progresso do HLB e na produção de plantas doentes

Bassanezi, R.B. – Fundecitrus
Montesino, L.H. - Fundecitrus
Mattos Junior, D. – IAC
Quaggio, J.A. – IAC
Boareto, R.M. – IAC
Bové, J.M. - INRA

Manejo Nutricional e HLB Resultados de pesquisa na Florida-EUA

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20 ANOS DE PESQUISA

Inconsequential effect of nutritional treatments on huanglongbing control, fruit quality, bacterial titer and disease progress☆

T.R. Gottwald [a,*], J.H. Graham [b], M.S. Irey [c], T.G. McCollum [a], B.W. Wood [d]

Experimento com plantas individuais (12 pl./tratamento) – Valencia/Swingle 6 anos

Yield and quality of Valencia orange fruit harvested from a commercial citrus planting treated with various micronutrient and heavy metal treatments to suppress HLB in 2009 and 2010.

Treatment	Yield								Quality							
	Fruit number		Fruit weight (kg)		Number fruit dropped		Proportion fruit drop		Fruit volume (cm^3)		Fruit brix		Fruit acidity		Fruit brix acidity ratio	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
1	56.83 a[1]	27.58 a	6.13 a	3.90 a	111.42 a	39.08 a	0.66 a	0.54 a	947.9 a	1182.2 d	11.3 a	11.8 a	1.19 a	0.80 a	9.48 a	14.66 a
2	47.48 a	23.42 a	6.53 a	4.13 a	109.42 a	36.50 a	0.66 a	0.55 a	1089.6 a	1449.2 b,a	10.3 a	11.7 a	1.09 a	0.80 a	9.49 a	14.64 a
3	90.17 a	28.08 a	8.02 a	4.24 a	142.42 a	22.67 a	0.62 a	0.50 a	926.7 a	1198.5 d	10.0 a	11.8 a	1.13 a	0.77 a	8.83 a	15.44 a
4	68.67 a	22.69 a	7.10 a	3.41 a	120.08 a	27.22 a	0.61 a	0.54 a	927.3 a	1224.1 c,d	10.1 a	11.4 a	1.05 a	0.74 a	9.63 a	15.32 a
5	86.58 a	28.67 a	11.00 a	4.18 a	155.42 a	44.42 a	0.65 a	0.54 a	1081.1 a	1311.5 b,c,d	9.5 a	11.0 a	1.00 a	0.73 a	9.50 a	15.15 a
6	75.00 a	26.67 a	8.00 a	3.95 a	157.08 a	38.08 a	0.67 a	0.54 a	920.7 a	1384.8 b,a	9.8 a	11.4 a	1.16 a	0.85 a	8.52 a	13.49 a
7	49.17 a	27.83 a	6.37 a	4.49 a	109.83 a	34.42 a	0.66 a	0.59 a	1171.6 a	1360.9 b,c	10.0 a	11.3 a	1.08 a	0.75 a	9.27 a	15.09 a
8	46.83 a	24.58 a	4.99 a	4.16 a	116.25 a	23.75 a	0.73 a	0.45 a	1028.6 a	1529.1 a	10.2 a	11.3 a	1.20 a	0.77 a	8.54 a	14.73 a
9	61.25 a	43.25 a	7.37 a	6.85 a	125.83 a	32.67 a	0.62 a	0.46 a	1024.7 a	1358.0 b,c	11.0 a	11.4 a	1.21 a	0.77 a	9.25 a	14.84 a
10	91.75 a	32.11 a	10.42 a	5.15 a	168.47 a	36.08 a	0.65 a	0.56 a	1063.6 a	1415.5 b,a	10.6 a	11.4 a	1.19 a	0.79 a	8.93 a	14.49 a

Tukey's Studentized Range (HSD) Test. Tested at the $p = 0.10$ and 0.05 level, no difference between p levels was detected.
Treatments were:
1) Control (standard commercial citrus fertilization, pest and weed control program without micronutrient enhancements). All subsequent treatments received the same minimal control plus augmentations as noted.
2) K phosphite first application 4.7 L/ha; subsequent applications 2.35 L/ha.
3) K phosphite as in treatment 2 plus wettable powder nutrients, Mg 6.3–9.5 kg/ha, Mn 6.3 kg/ha, Zn 3.17 kg/ha, Mo 58.6 g/ha mixed in water at 2642 L/ha (500 gal/ac). Applied three times yearly, with the exception of Zn applied 4 times yearly.
4) K phosphite as in treatment 2, wettable powder nutrients as in treatment 3, plus SAVER® (= salicylic acid as an SAR compound) at 1.17 L/ha.
5) K phosphite as in treatment 2, plus Mn^{++} metalosate 3.5 L/ha plus standard citrus surfactant.
6) K phosphite as in treatment 2, plus Mn^{++} carbonate 0.45 kg/tree plus standard citrus surfactant, applied at the base of each tree.
7) K phosphite as in treatment 2, plus Cu^{++} metalosate 0.58 L/ha plus standard citrus surfactant.
8) K phosphite as in treatment 2, plus Zn^{++} metalosate 3.5 L/ha plus standard citrus surfactant.
9) Magna-Bon® Cu injection 60 ppm/5 ml/tree via injection per month.
10) Silver PDS polymer formulation via injection PDS/Silver at 0.005 g of silver per 100 g of carrier material ~0.005% silver.

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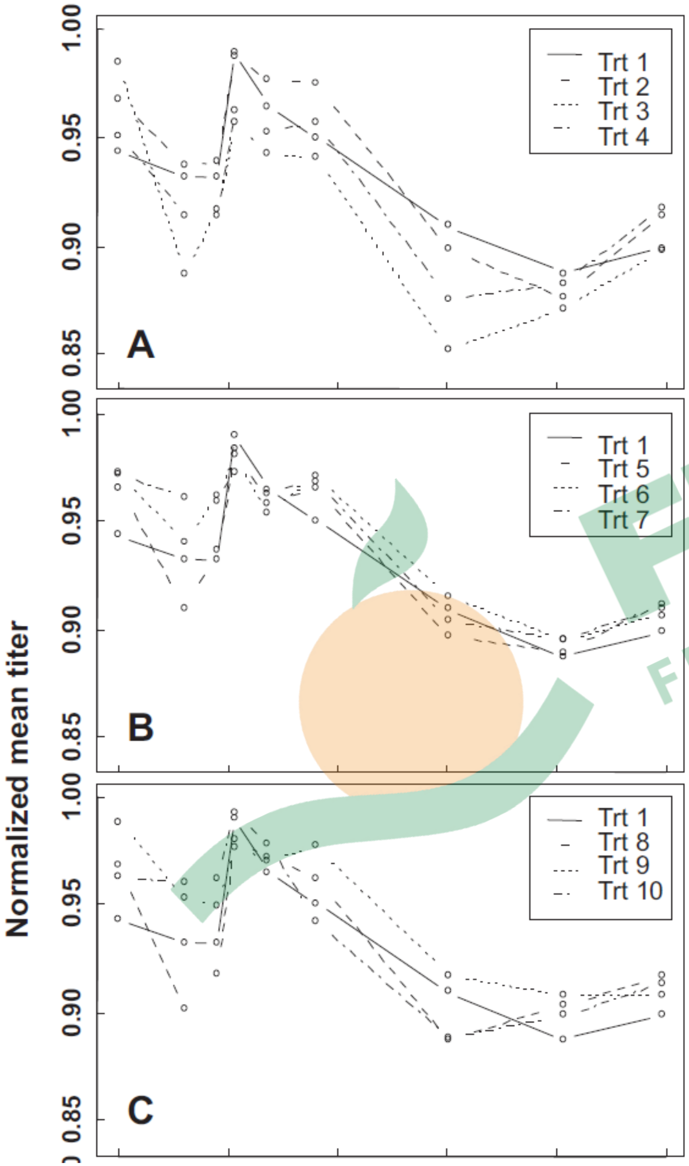


There was no significant difference in normalized *Las* bacterial titer among the ten micronutrient treatments. Titer fluctuated each year and in general was lowest during the hottest summer months and highest in late fall (Fig. 1A–C).

Experimento em talhões (6.800 pl./talhão) – 4 Val./Carrizo e 2 Val./Azeda 8 anos

Programa convencional

Com ization program. For those blocks receiving conventional fertilization in 2007–2008, foliar applications with an air-blast sprayer at 1400 L/ha consisted of:

- 14–3–7–0.05 (N–P–K–B) or 14–7–7–0.05 (N–P–K–B) at 65.48 L/ha plus 22.24 kg/ha K-phosphite (K-Phite® 0–28–26; or Nutri-Phite® Magnum 2–40–16; Biagro Western, Visalia, California, USA) applied as a dormant spray.
- 15–2–18–3 (N–P–K–Mg) plus 0.075 Fe EDTA at a rate of 112.08 kg N/ha applied as a dry broadcast fertilizer twice per year in fall and late winter.
- 10–0–10 (N–P–K) applied at a rate of 112.08 kg N/ha plus 0.05 kg Fe EDTA liquid fertilizer applied in 1120 L/ha over 5 injections from spring thru early summer.

After HLB was discovered in 2009, the conventionally treated blocks received supplemental foliar applications at 1400 L/ha:

- K-Phite® or Nutri-Phite® Magnum (Biagro Western, Visalia, California, USA) at 3.51 L/ha.
- Saver® (Plant Food Systems, Zellwood, Florida, USA, contains a systemic acquired resistance SAR compound) at 1.17 L/ha.
- Manganese sulfate at 5.60 kg/ha.
- Zinc oxide at 3.36 kg/ha.
- 3–0–11 (N–P–KNO_3) (two applications post-bloom and summer 1) at 56.12 L/ha.

Table 2
Commercial block yield [boxes (kg/tree)] comparisons of the enhanced nutritional program (ENP) vs. conventional foliar spray program.

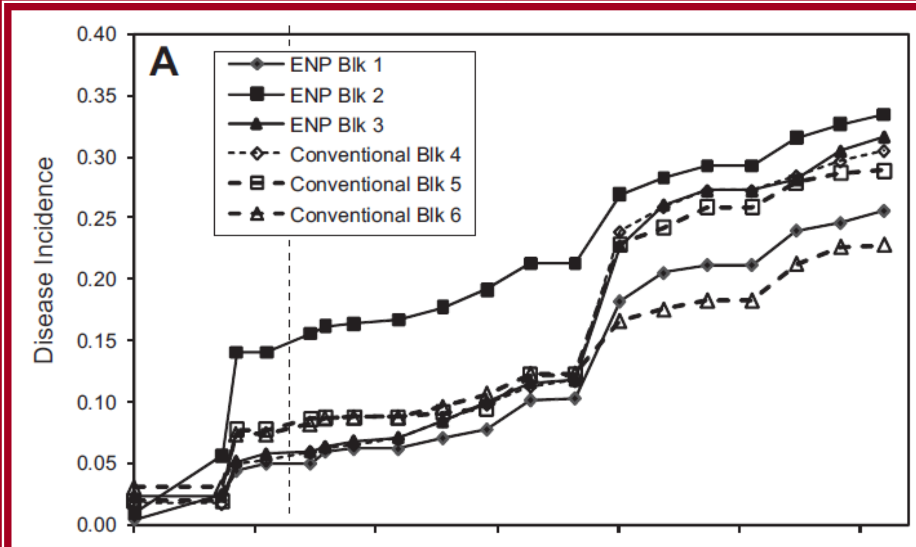
Treatment	Pre year 1	Pre year 2	Post year 1	Post year 2	Post year 3
Conventional	0.70(28.6)	1.36(55.5)	2.13(86.9)[a]	2.29(93.5)	2.59(120.4)
ENP	1.03(53.1)	1.99(81.2)	2.28(93.1)	2.96(120.8)	3.30(134.7)
Difference	0.33(13.5)*	0.63(25.7)**	0.15(6.1)ns	0.67(27.3)ns	0.71(30.0)ns

Three blocks were treated with micronutrient mixture combination and 3 blocks were treated with conventional fertilization. Blocks averaged 6814 trees/block. Pre years 1 and 2 represent yields prior to application on nutrient treatment; post years 1, 2, and 3 represent yields following nutritional treatment.

Programa aumentado (ENP)

reated with micronutrients, treatment began on November 6, 2007, and proceeded yearly as three micronutrient sprays applied on the flush during bloom (March–April), and twice during summer (June and August). Micronutrients replaced those five components (supplemental foliar treatments) used in the conventional program immediately above, and consisted of the following components applied at 2500 L/ha:

- Serenade Max® (AgraQuest, Davis, California, USA) at 2.52 kg/ha.
- Di-Oxy Solv™ (Upstart Products, Inc., Titusville, Florida, USA) at 6.12 L/ha.
- 3–18–18 (D–K–P) at 74.82 L/ha.
- K-Phite® at 4.67 L/ha.
- Saver® at 2.32 L/ha.
- Epsom salt® (heptahydrate epsomite – 99% anhydrous $MgSO_4 \cdot 7H_2O$), at 9.54 kg/ha.
- Tecmangam® (Manganese sulfate, manganese monosulfate and monohydrate manganese sulfate mixture, Industrias Sulfamex S.A. DE C.V., Tampico, Mexico) at 9.54 kg/ha.
- Zinc sulfate at 3.14 kg/ha.
- Sodium molybdate at 0.06 L/ha.



Controle
Inseticida sozinho

Phil Stansly
SWFREC
Immokalee, FL

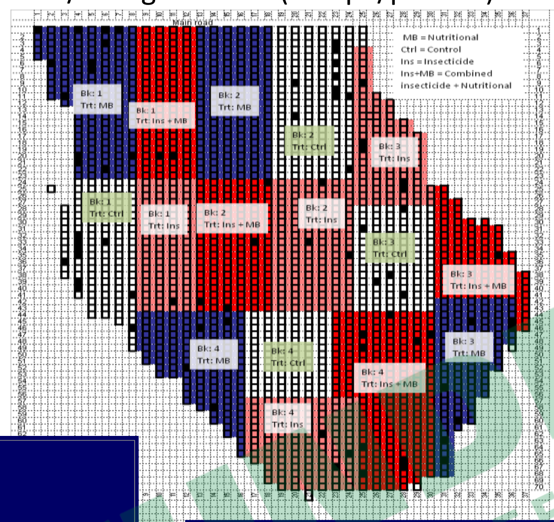
Nutricional sozinho
Nutricional+Inseticida

2008
1. Danitol 16 oz (May)
2. Delegate @ 4oz (Aug)
3. Delegate @ 4 oz (Nov)

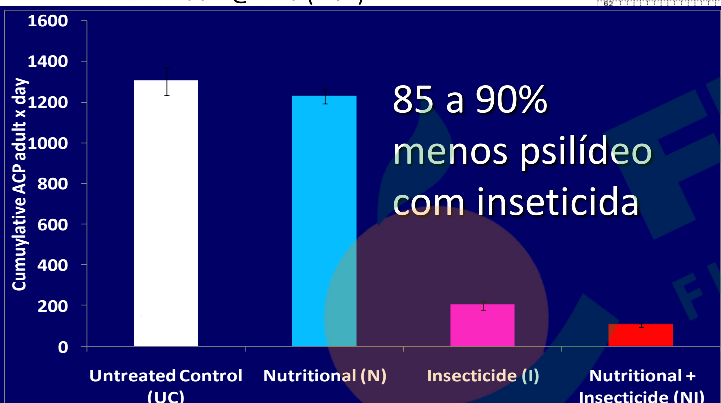
2009
4. Mustang @ 4.3 oz (Jan)
5. Movento @10 oz (Apr)
6. Lorsban @ 3pt (Sep)
7. Dimethoate @ 1 pt (Dec)

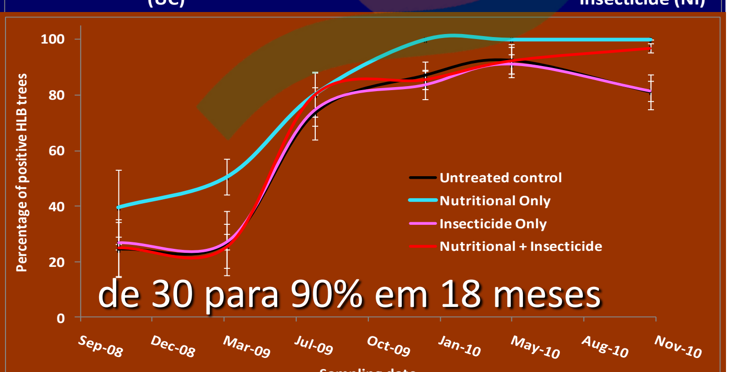
2010
8, Danitol @ 12 oz (Feb)
9. Delegate @5 oz (May)
10. Lorsban @ 3pt (Jul)
11. Imidan @ 1 lb (Nov)

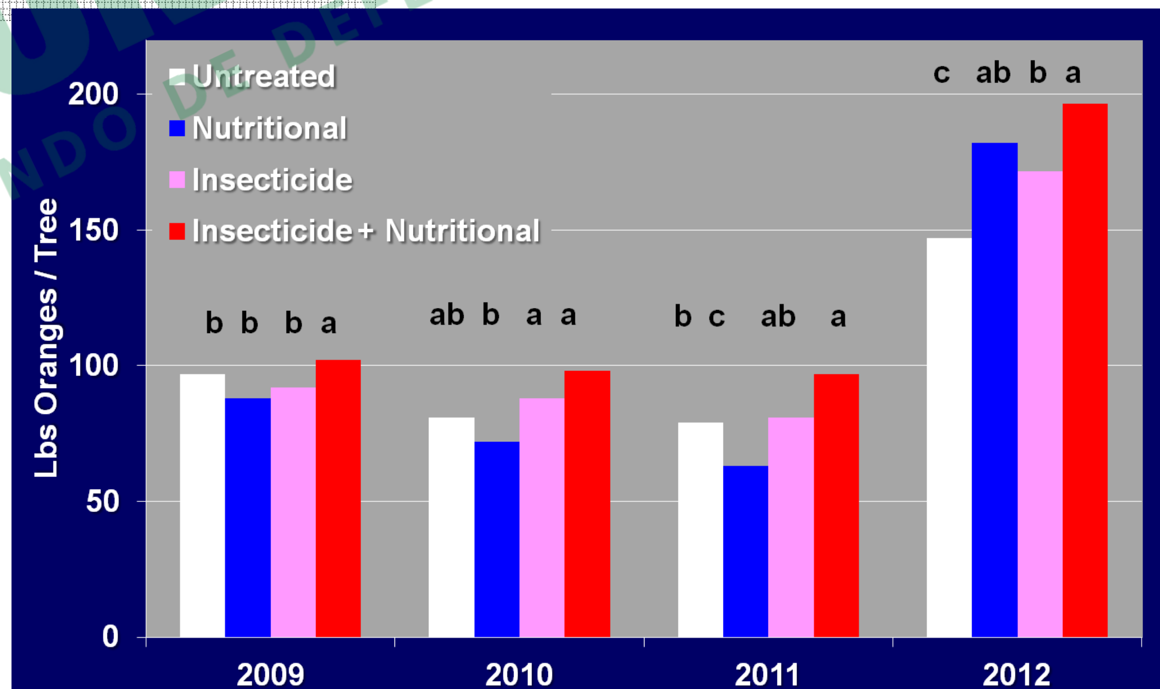
Valencia/Swingle 6 anos (124 pl./parcela)



Nutrient Program 3 times/year	Rate/ac
Serenade Max WP	2.25 lb
Saver (Salicylic acid)	1 qt
3-18-20 with K-Phite	8 gal
13-0-44 fertilizer	8.5 lb
Techmangan ($MnSO_4$)	8.5 lb
Zinc Sulfate	2.8 lb
Sodium Molybdate	0.85 oz
Di-Oxy Solv Organic	2 qt
Epsom Salts	8.5 lb
435 oil	5 gal







Experimento 1
Objetivos

- Avaliar o efeito dos nutrientes (K, Zn e Mn), fosfito e salicilato aplicados via foliar no progresso da incidência e severidade de HLB e na sustentabilidade de pomares adultos de laranjeira Valencia e Natal

Material e Métodos

- LOCAL: Região Central de SP
- BLOCOS:

Bloco	Variedade	Plantio	Espaçamento	Irrigação	Status nutricional	Controle Psilídeo
1	Natal/ Cravo	Jul/2002	6,8x3,4 m	Não	Bom	Não
2	Valencia/ Cravo	Jul/2002	6,8x3,4 m	Não	Bom	Sim
3	Valencia/ Cravo	Set/2002	6,8x3,4 m	Não	Bom	Sim
4	Valencia/ Cravo	Jul/2002	6,8x3,4 m	Não	Bom	Sim

Tratamentos	Nutrientes	Quantidade	# Aplicações
T0 (‘Controle’)	NPK 20-00-24 sólido	de acordo com análise de solo	3x
T1 (T0 + ‘SP’ micronutrientes)	T0 Ácido bórico Ácido bórico foliar Sulfato de zinco (20%) Sulfato de manganês (31%)	 2,0 Kg/ha 3,0 Kg/2000 L 7,5 Kg/2000 L 3,2 Kg/2000 L	 2x 4x 4x 4x
T2 (T1 + KNO_3)	T1 Nitrato de potássio	 7,0 Kg/2000 L	 4x
T3 (T0 + ‘FL’ micronutrientes)	T0 Ácido bórico Ácido bórico foliar Sulfato de zinco (20%) Sulfato de manganês (31%)	 2,0 Kg/ha 3,0 Kg/2000 L 7,5 Kg/2000 L 12,0 Kg/2000 L	 2x 4x 4x 4x
T4 (T1 + fosfito)	T1 Fosfito 00-28-26	 5,0 L/2000 L	 4x
T5 (T1 + salicilato)	T1 Ácido salicílico	 0,1 Kg/2000 L	 4x
T6 (T3 + KNO_3 + fosfito + salicilato) ‘Completo’	T3 Nitrato de potássio Fosfito 00-28-26 Ácido salicílico	 7,0 Kg/2000 L 5,0 L/2000 L 0,1 Kg/2000 L	 4x 4x 4x
T7 (T0 + ‘Cocktail’)	T0 ‘Cocktail’*	 de acordo com o fabricante	 4x

*1º ano – Escudo Citrus (5L/2000L) e Escudo Master (2L/2000L); 2º e 3º anos – Coquetel (5 L/2000L)

Pulverizações foliares

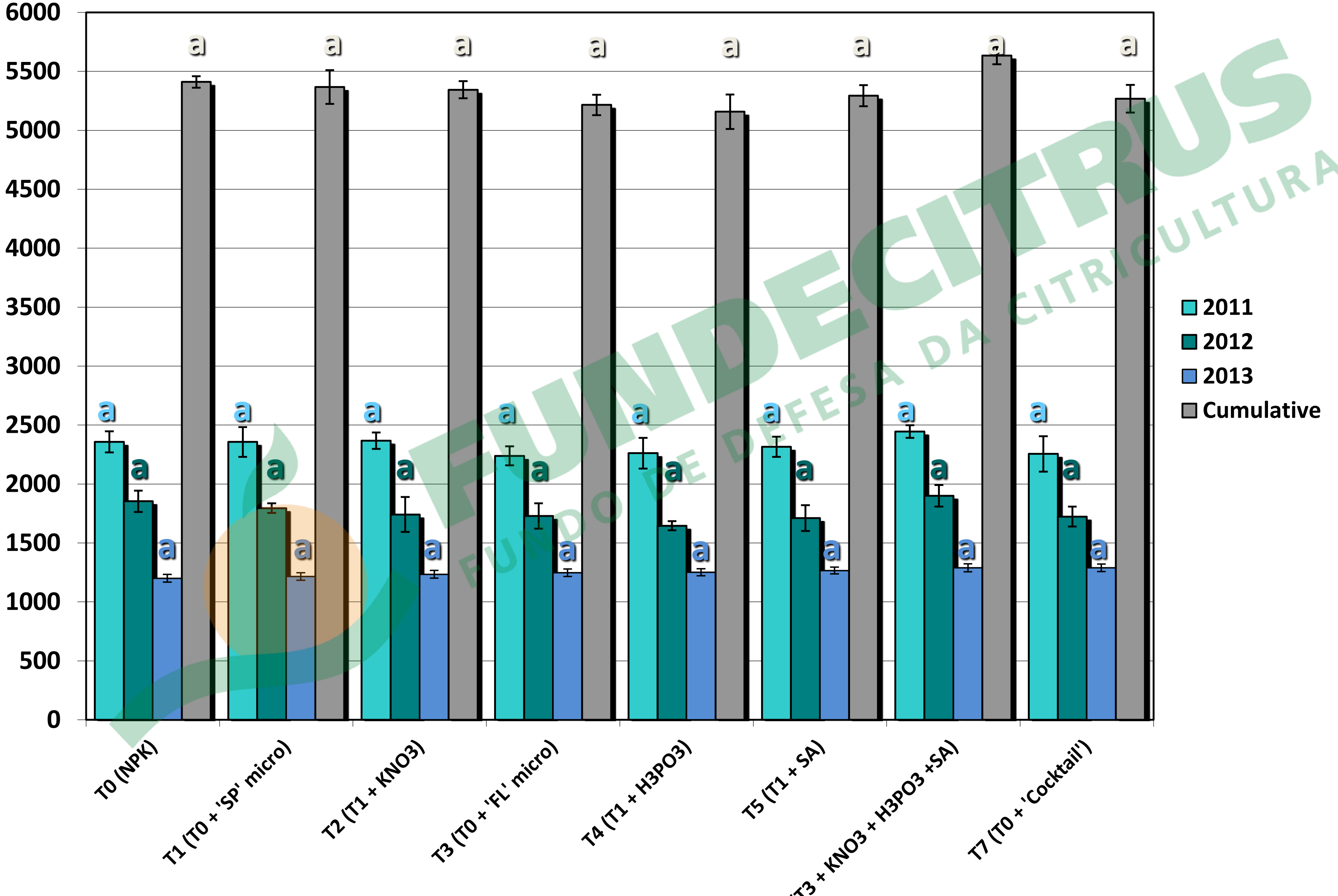
- 2010/2011 – Dez/10, Jan/11, Mar/11 e Abr/11
- 2011/2012 – Nov/11, Dez/11, Jan/12 e Fev/12
- 2012/2013 – Out/12, Nov/12, Dez/12, Jan/13 e Abr/13
- 2013/2014 – Ago/13, Nov/13, Jan/14 e Abr/14

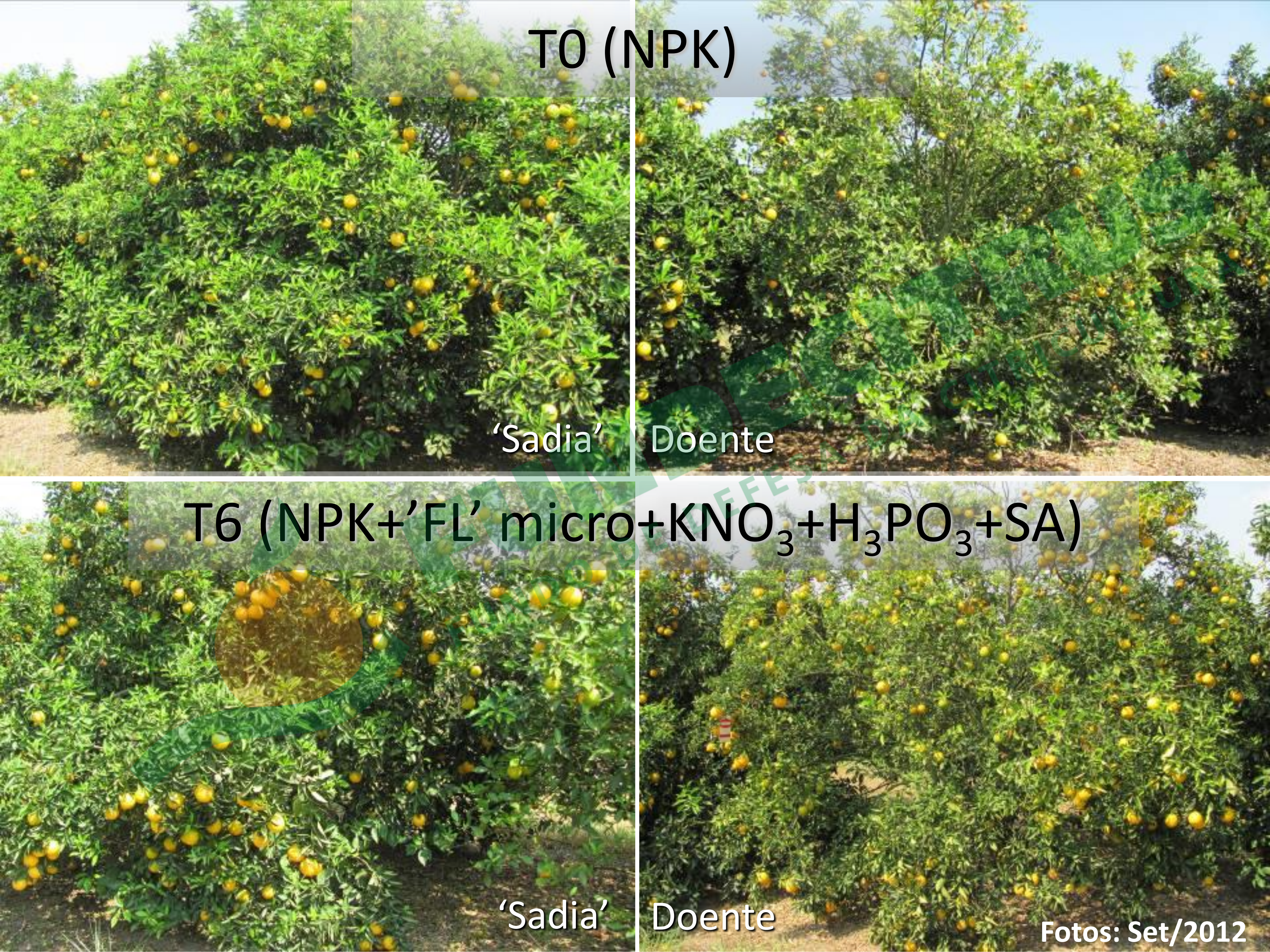
Avaliações

- **Progresso do HLB**
  - Incidência de plantas sintomáticas nas parcelas
  - Severidade dos sintomas em plantas marcadas
- **Produção**

- 20 plantas doentes e 20 'sadias' marcadas/parcela Dez/10
- 10 plantas doentes marcadas/parcela Jun/12
- 10 plantas doentes marcadas/parcela Jun/13
- Parcela total (todas doentes e 'sadias')

Produção Total da Parcela (caixas/ha)





T0 (NPK)
'Sadia'
Doente
T6 (NPK+'FL' micro+KNO_3+H_3PO_3+SA)
'Sadia'
Doente
Fotos: Set/2012

Considerações após 3 anos

Programas nutricionais testados **NÃO AFETARAM**

- Progresso da incidência de HLB nas parcelas;
- Progresso da severidade de HLB nas plantas doentes;
- Produção total das parcelas;
- Produção das plantas doentes, mas também das 'sadias';
- Qualidade dos frutos nas plantas doentes e 'sadias'.

Independente do tratamento

- A incidência de HLB aumentou (parcelas sem controle do psilídeo);
- A severidade do HLB aumentou nas plantas selecionadas com variação sazonal;
- A produção foi reduzida em relação às plantas 'sadias':
  - Dez/10: 15%, 45% e 62% respectivamente no 1o , 2o e 3o anos
  - Jun/12: 14% e 30% respectivamente no 1o and 2o anos
  - Jun/13: 9% no 1o ano
- A qualidade dos frutos dos ramos com sintomas foi pior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20 ANOS DE PESQUISA

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