2º BORON DAY BRAZIL

BORO NA CITRICULTURA

2º Boron Day Brazil

ESALQ/USP - Piracicaba

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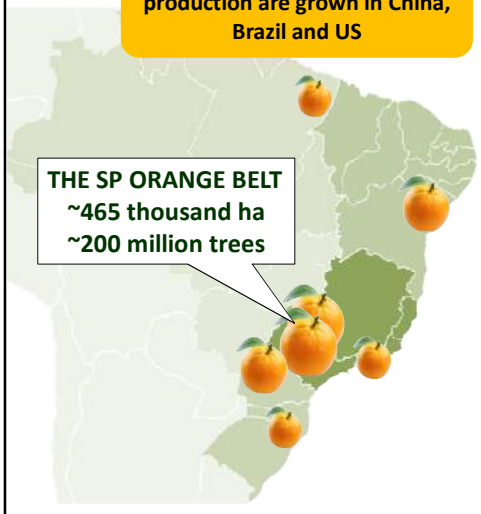
The Brazilian citriculture in numbers

60% of the world's total citrus production are grown in China, Brazil and US



- ✓ Brazil is one of the **major Citrus producer** in the world (**oranges ~90%**; lemons, limes and mandarins ~10%)
- ✓ The state of **São Paulo, Triângulo Mineiro and North of Paraná** are responsible for **>85% of the orange production** in the Country
- ✓ Of these, **80% go to the citrus industry** and it represents **85% of international world trade of concentrated juice**

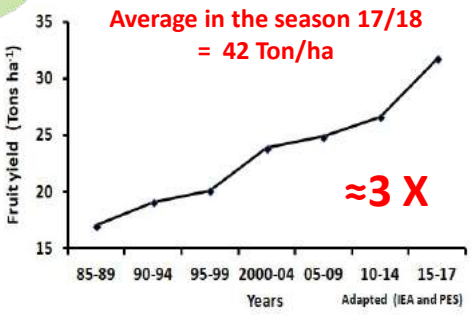
B problems in the citriculture

Citrus trees are considered sensitive to **B deficiency**

Factors that intensifying B deficiency:

- ✓**New rootstocks with higher B demand**
- ✓**Reduction of the spray volume per area**
- ✓**Increase in the number of products in the tank mixture**

Factors that intensifying B deficiency



In the last 30 years Citrus productivity in Brazil has increased almost 3 times

Challenge = Citros 100 Ton/ha

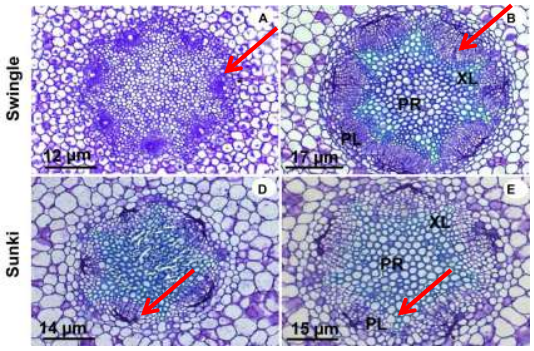
... looking at oranges out of the box!

Boron deficiency

+ B -B

Foto: Boaretto

Cross sections of roots under light microscopy

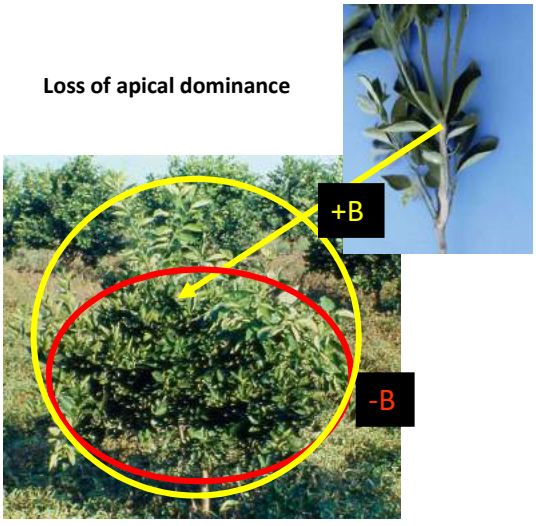


PR: parenchyma
XL: xylem
PL: phloem

(Mesquita et al., 2016)

Boron deficiency

Loss of apical dominance



Fruit drop
(severe conditions of B deficiency)

Boron toxicity

335 mg kg^{-1}

≈1000 mg kg^{-1}

B range (deficiency x toxicity)

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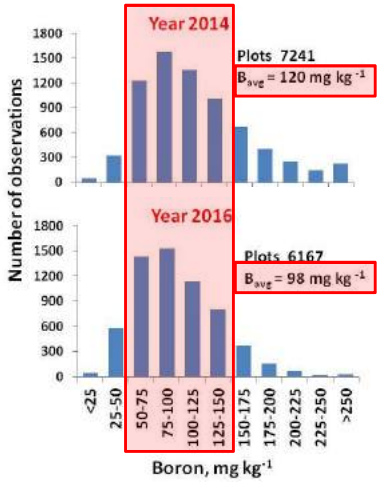
CITROS	LOW	OPTIMUM	HIGH
	-------	mg kg^{-1}	----
B	<50	50-150	>150
Cu	<10	10-20	>20
Fe	<50	50-150	>150
Mn	<35	35-70	>70
Mo	<0,5	0,5-2,0	>2,0
Zn	<50	50-75	>75

B previous recommendation = 36-100 mg kg^{-1}

High productivity orchards
≈60,000 ha of oranges
(15% the Brazilian orange belt)



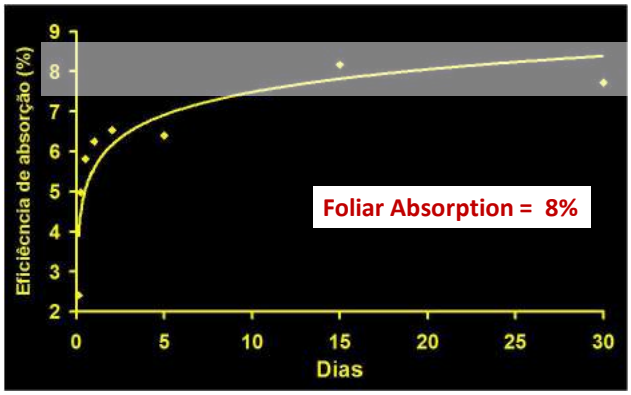
How supply Boron to Citrus plants

LEAF **X** **SOIL**

- ✓ADVANTAGES AND DISADVANTAGES
- ✓FORM OF APPLICATION
- ✓RATES
- ✓SOURCES

B foliar aplication

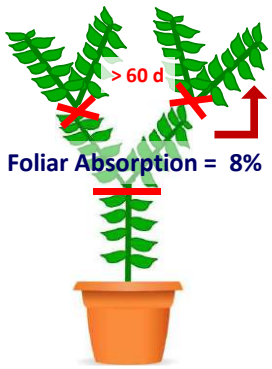
^{10}B foliar spray



Evaluations: 3, 6, 12 , 24, 48 hours, 5, 15 30, 75, 120 and 240 days

Boaretto et al. (2005)

B Redistribution of foliar supplying



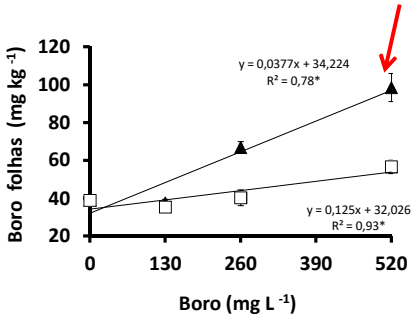
REDISTRIBUITION (^{10}B)	DAYS AFTER SPRAYING			
	30	75	120	240
	---------- % ----------			
NEW PARTS grown after spraying	---	0,3	0,4	2,5
PARTS SPRAYED	100	99.7	99.4	96.8
OLD PARTS protected during spraying	0	0	0.1	0.7
REDISTRIBUTION	**0**	**0.3**	**0.5**	**3.2**

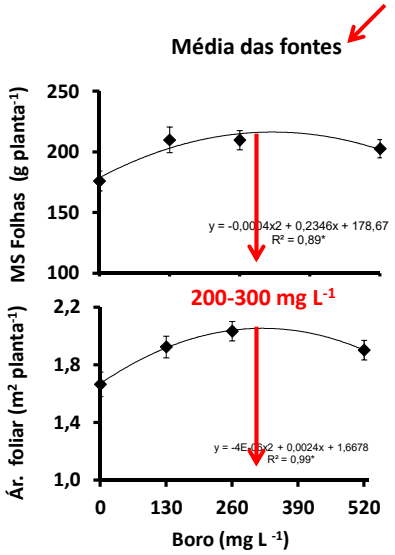
Boaretto et al. (2005)

Foliar fertilization (sources)

▲ Borato de Cálcio (flowable)

□ Ácido bórico





Macedo et al. (2017)

B supply (soil x leaf)

Valência/Swingle
^{10}B
Fertirrigation and Foliar
Sand soil

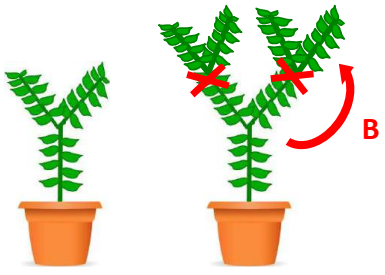
Plant part	B application treatments[1]			
	Soil		Leaf spray	
	2.0 kg ha^{-1}	1.0 kg ha^{-1}	1.0 kg ha^{-1}	0.5 kg ha^{-1}
	B_{dff}, mg kg^{-1}			
Leaves 1st flush	76.6 A a	54.4 A a	19.1 A b	7.0 A b
Leaves 2nd flush	35.7 B a	19.2 B b	9.1 B bc	1.8 B c
Leaves 3rd flush	26.4 B a	13.9 C b	4.2 C c	2.1 B d
Leaves 4th flush	6.6 C a	3.4 D b	1.6 C b	0.6 C b
Fruits (7-8 cm diam.)	5.2 C a	3.8 D a	1.3 C b	0.5 C c

3 X

Boaretto et al. (2010)

Boron Redistribution

Nutrient Solution (^{10}B)
Sweet orange
- Rangpur Lime
- Swingle Citrumelo



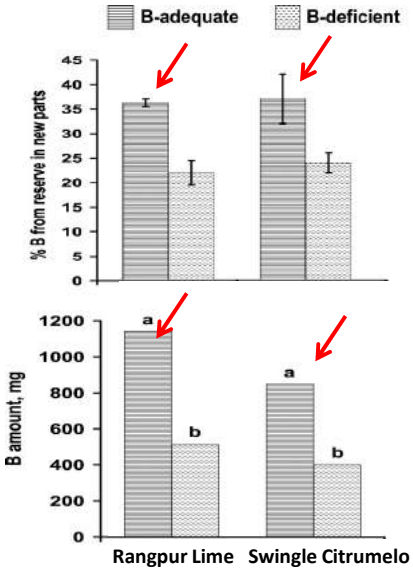
B adequate

B deficient

^{10}B adequate

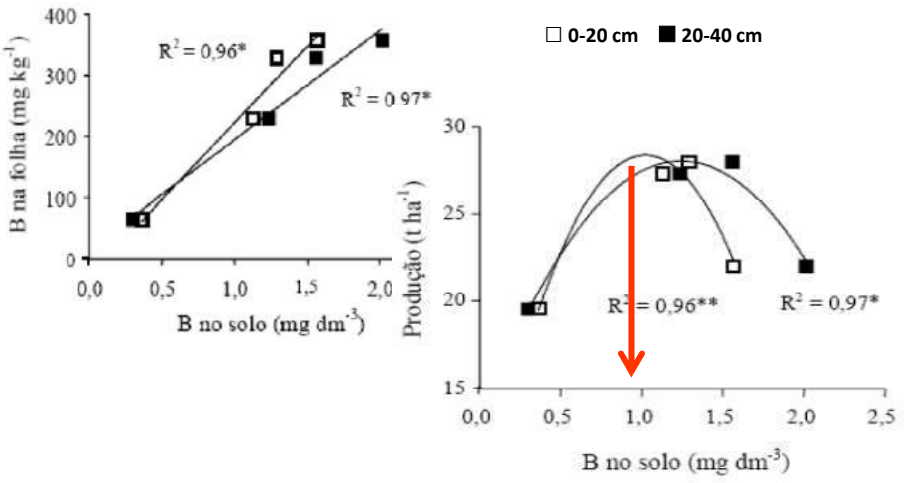
6 months

3 months



Boaretto et al. (2008)

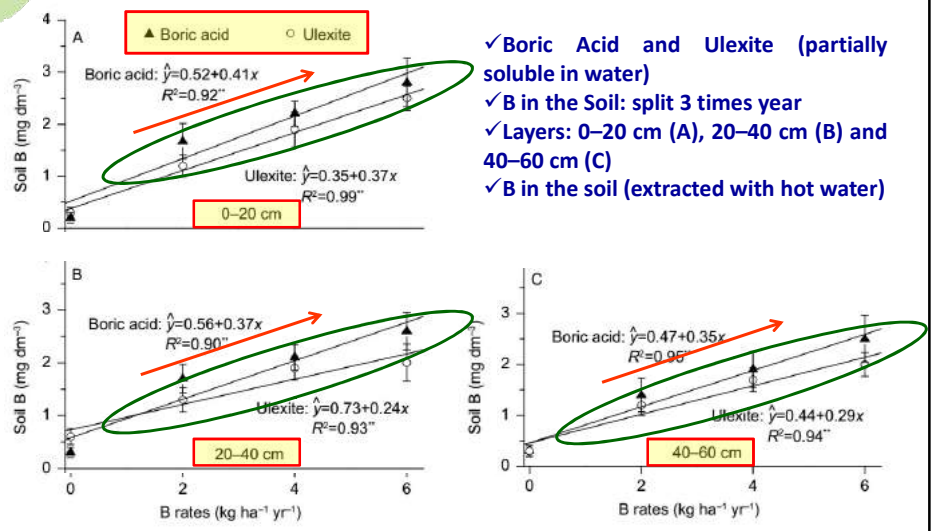
Soil fertilization



Pêra Sweet orange/Rangpur lime

Quaggio et al. (2003)

Soil fertilization (sources and rates)



- ✓**Boric Acid and Ulexite (partially soluble in water)**
- ✓**B in the Soil: split 3 times year**
- ✓**Layers: 0–20 cm (A), 20–40 cm (B) and 40–60 cm (C)**
- ✓**B in the soil (extracted with hot water)**

Mattos et al. (2017)

Soil fertilization (doses x rootstock)

✓Average of B source (boric acid and ulexite)

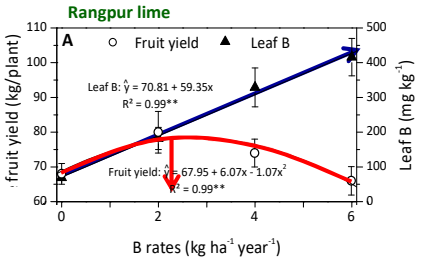
✓B rates: 0, 2, 4 and 6 kg ha^{-1} year^{-1}

✓Natal sweet orange grafted onto: A, Rangpur lime. B, Sunki mandarin. C, Swingle citrumelo.

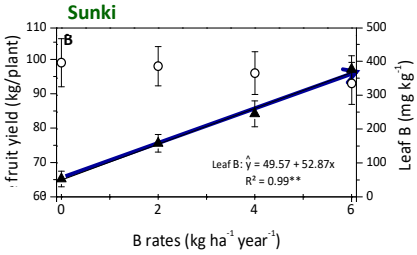
Leaf B concentration

Fruit yield

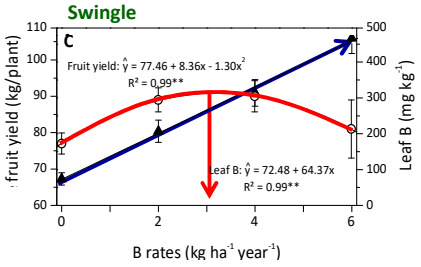
Rangpur lime



Sunki

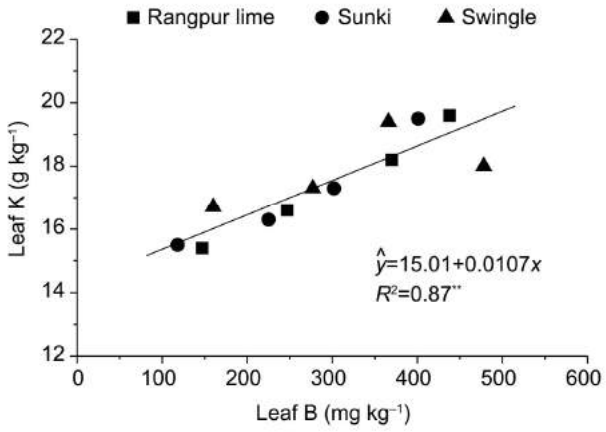


Swingle



Mattos et al. (2017)

Soil B fertilization (Potassium)



✓Natal sweet orange grafted onto: Rangpur lime, Sunki mandarin, Swingle citrumelo

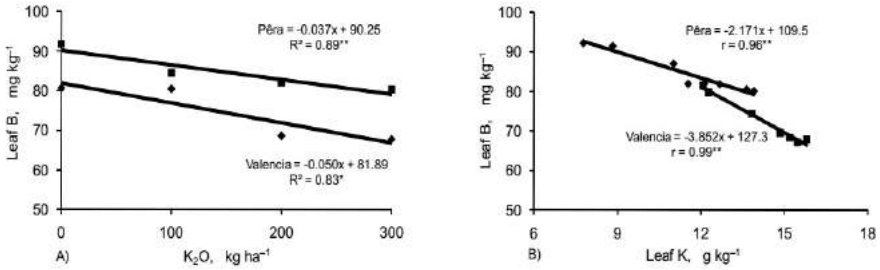
✓Average of B source (boric acid and ulexite)

✓B rates: 0, 2, 4 and 6 kg ha^{-1} year^{-1}

Mattos et al. (2017)

Potassium fertilization (B interaction)

Concentration of leaf B as affected by potassium fertilization



Two locations: Santa Cruz do Rio Pardo (Pera) and Matão (Valencia)

Quaggio et al. (2011)

Boron guidelines...

- *Application of B preferably via soil (together with herbicides)*
- *Foliar application: Young orchards (<4 years) or in complementation to soil fertilization - monthly from oct to may (B solution: 200-300 mg L^{-1})*
- *Apply: 2 kg ha^{-1} of B independent of orchard age (split 2-3x). For the 'Swingle' citrumelo, increase the dose to 3 kg ha^{-1} of B year*

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Thank you for your attention...

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