Boron in South America

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U.S. Borax

We were first to mine borates on a large scale

20 MULE TEAM BORAX™

150 YEARS OF INNOVATION

Our history dates back to 1872

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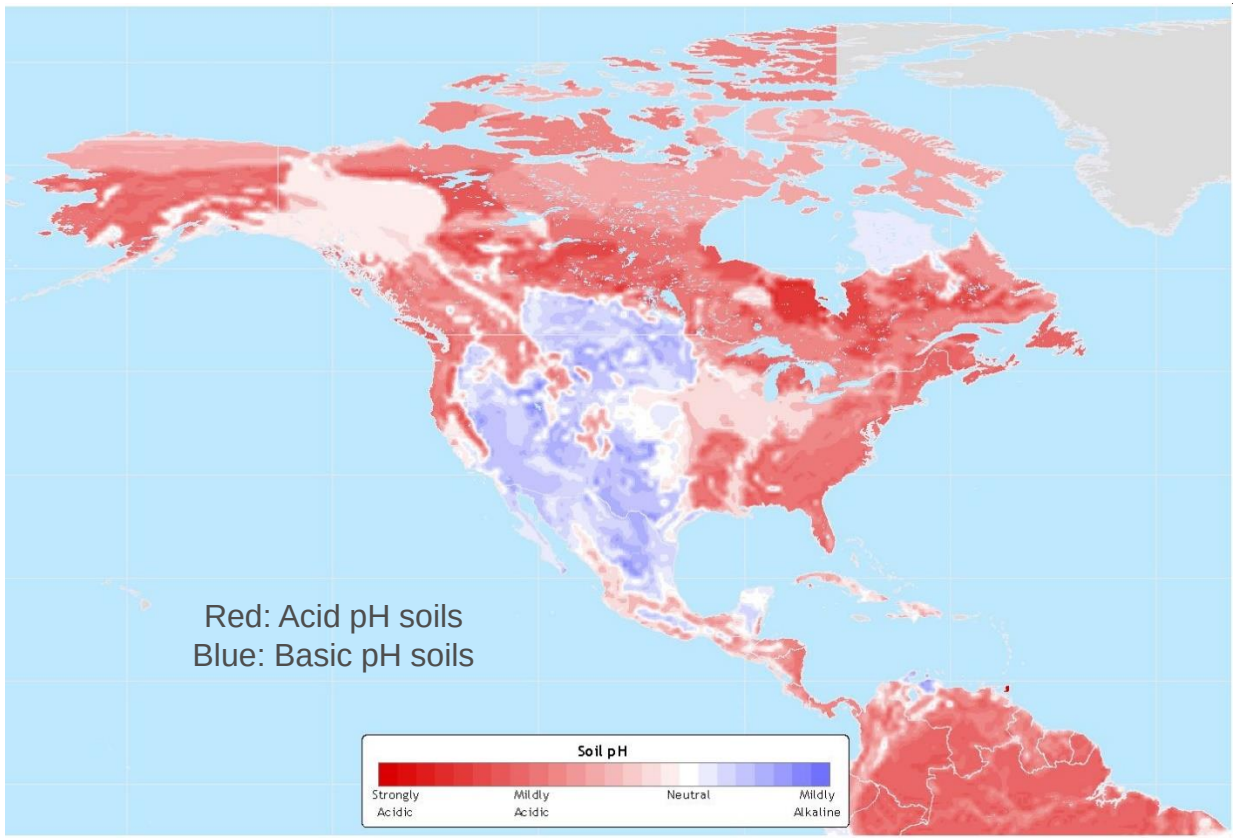
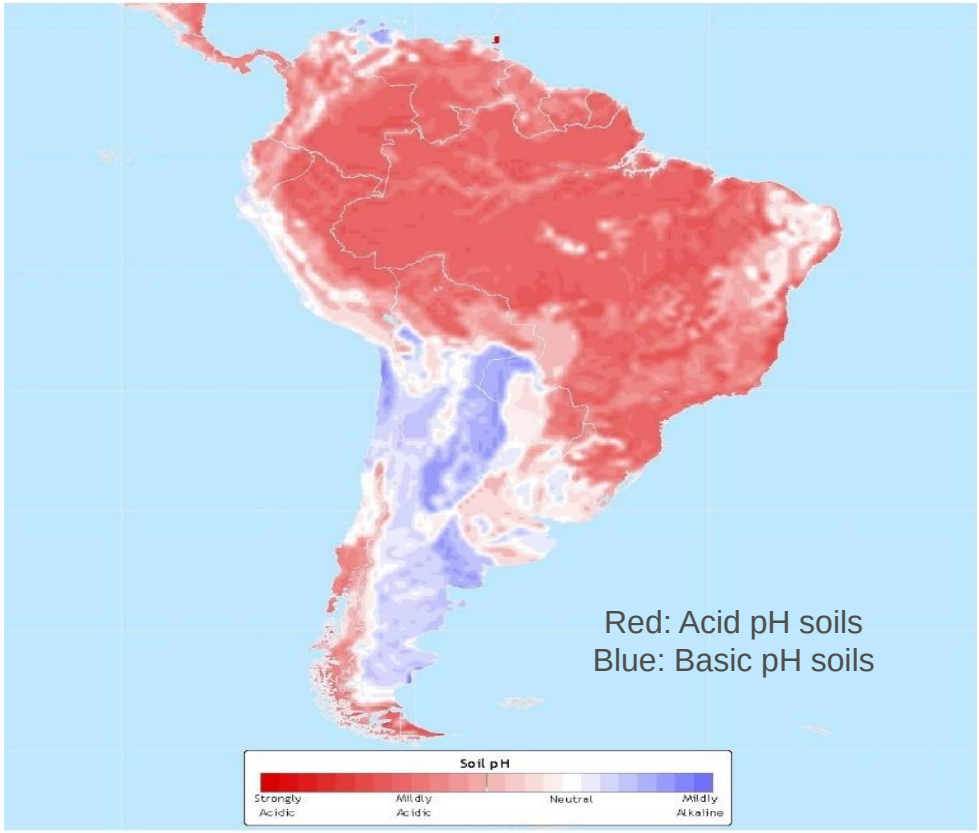
Soil pH in Americas

Low pH soil is a good indication of boron (B) deficient soils





Atlas of the Biosphere
University of Wisconsin-Madison

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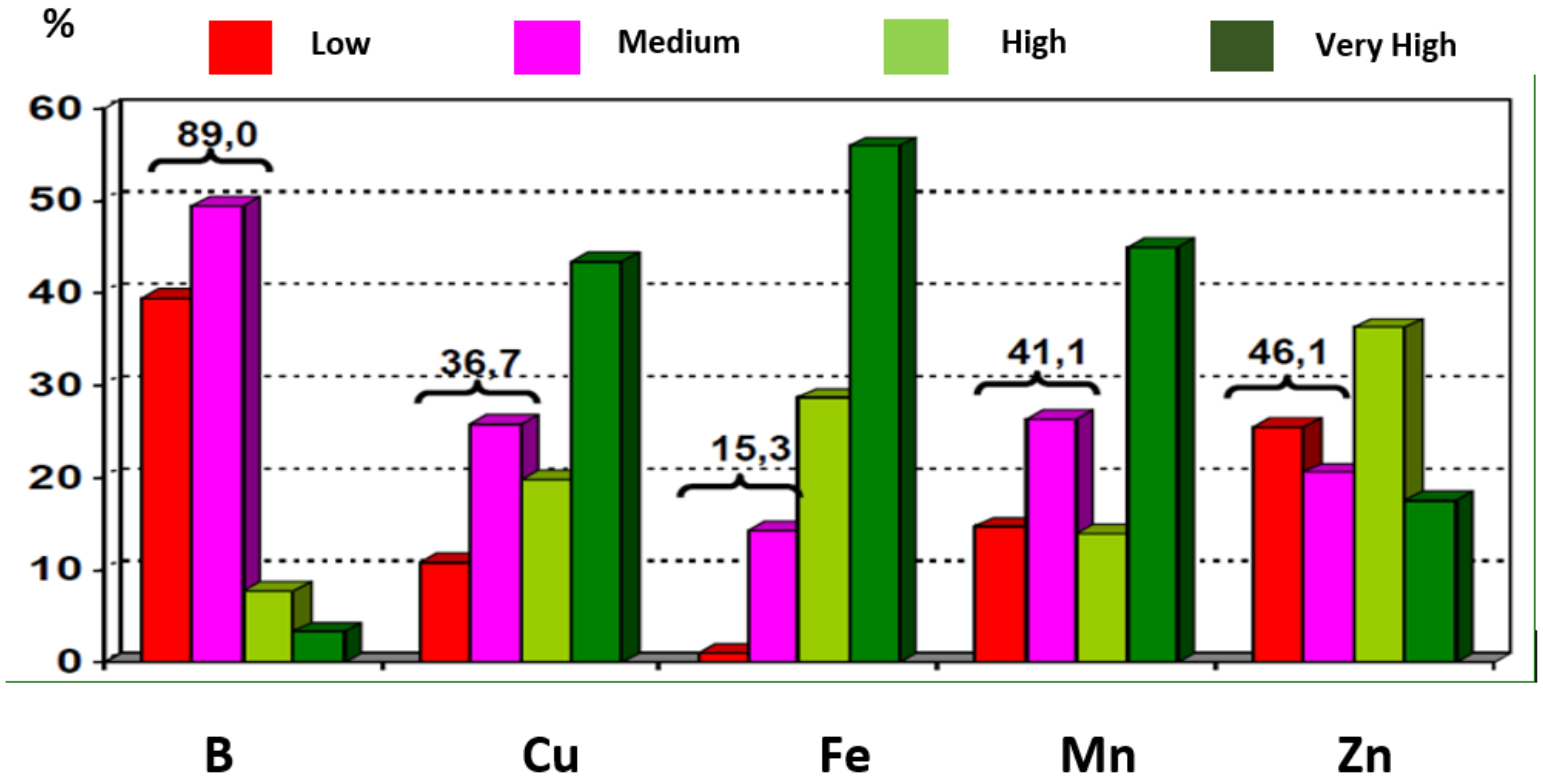
Micronutrient deficiencies in Brazil

Boron (B) is the most deficient micronutrient in Brazilian soils
Zinc (Zn) is the second most deficient micronutrient in Brazilian soils



Modified from Abreu et al, 2005.

13,416 soil samples from 21 Brazilian states were collected and analyzed by the laboratory of the Institute Agronomic of Campinas (IAC)

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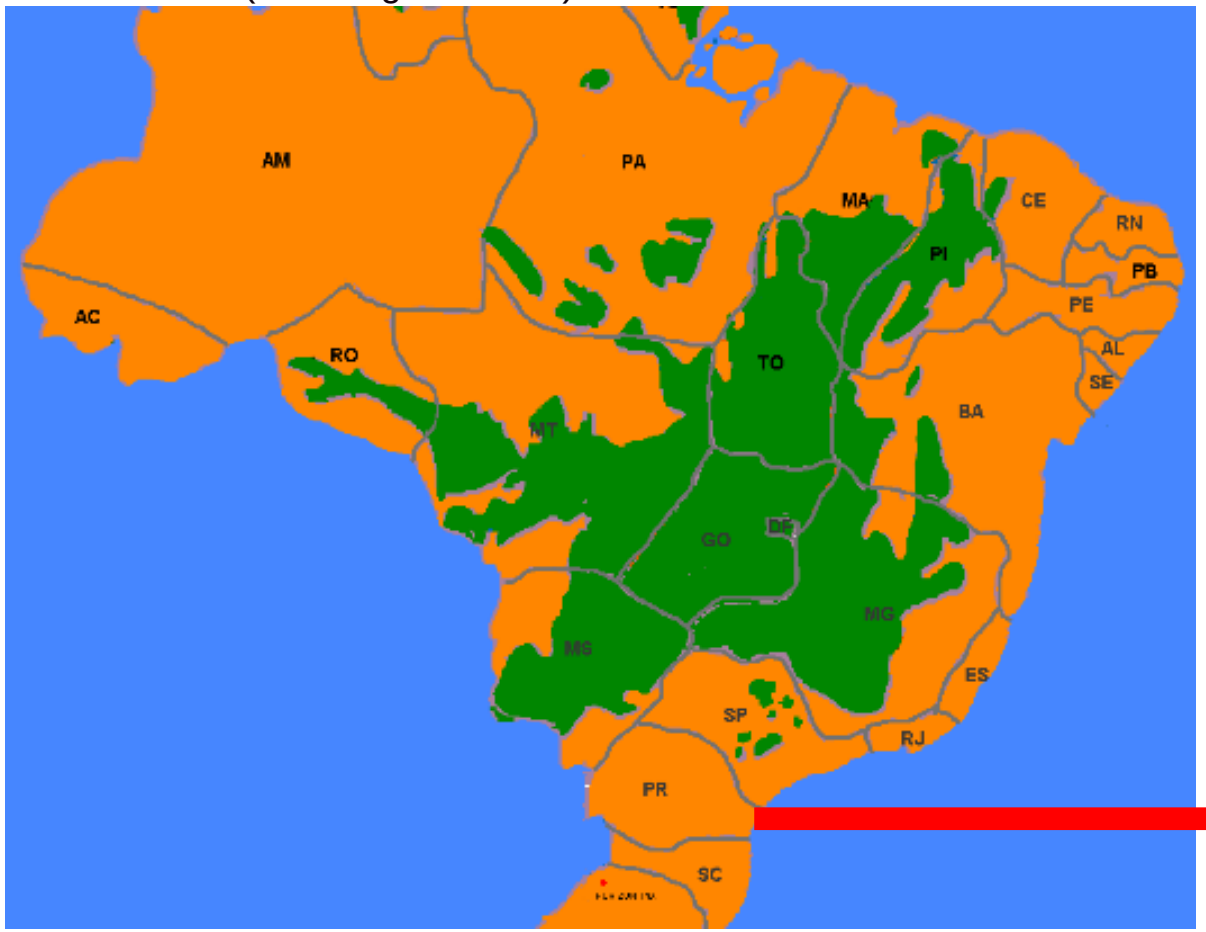
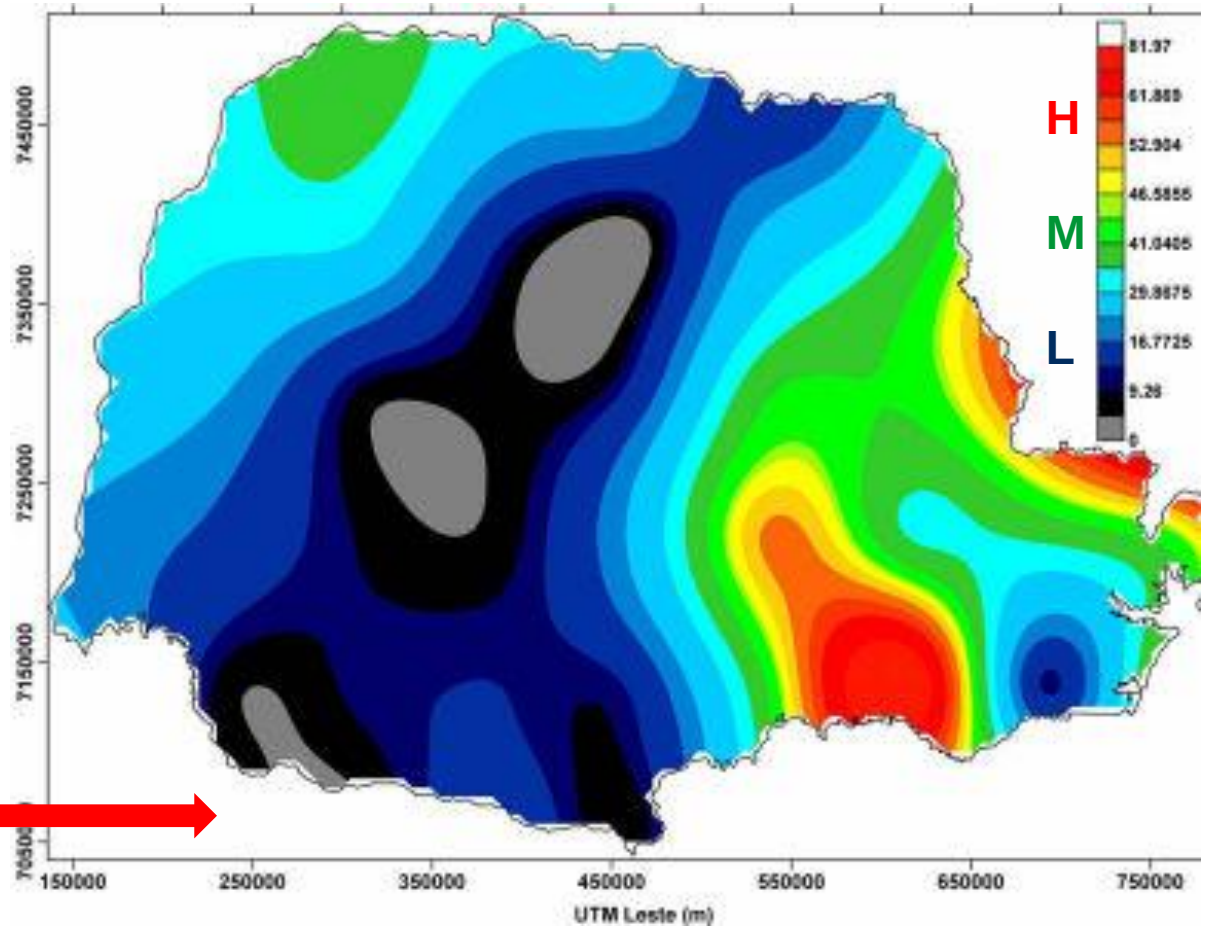
Availability of boron in Brazilian soils

Cerrado region in Brazil (green)
Based on 518 soil analyzes (0-15 cm), 60% of soil analysis were very deficient in B (< 0.2 mg/dm^{-3} of B).



Modified from Malavolta et al, 1985.

State of Parana (PR), Brazil
High (H), medium (M) and low (L) availability of boron (B) in the soil



Modified from Motta et al, 2010.

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Solubility of borates by type

The solubility of borates depends on the source material and the interaction of boron with sodium (Na), calcium (Ca) and magnesium (Mg). The more Mg and Ca a borate has in its composition, the less soluble this mineral will be.

Hydroboracite

$CaO \cdot MgO \cdot 3B_2O_3 \cdot 6H_2O$

Calcium and magnesium borate

Insoluble in water

Colemanite

$2CaO \cdot 3B_2O_3 \cdot 5H_2O$

Calcium borate

Partially water soluble

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Solubility of borates by type

Ulexite

$Na_2O \cdot 2CaO \cdot 5B_2O_3 \cdot 16H_2O$

Calcium-sodium borate

Partially soluble in water

Kernite

$Na_2O \cdot 2B_2O_3 \cdot 4H_2O$

Sodium borate

Water soluble

Tincal or Borax

$Na_2O \cdot 2B_2O_3 \cdot 10H_2O$

Sodium borate

Water soluble

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Borates commonly used in agriculture

Product/fertilizer		Chemical formulation	Solubility in water (g/L at 20° C)
Unrefined Borates	Hidroboracite (10 - 15% B)	$CaO{\cdot}MgO{\cdot}3B_2O_3{\cdot}6H_2O$	0.8 g/L
	Colemanite (8 - 15% B)	$2CaO{\cdot}3B_2O_3{\cdot}5H_2O$	4.7 g/L
	Ulexite (8 - 15% B)	$Na_2O{\cdot}2CaO{\cdot}5B_2O_3{\cdot}16H_2O$	10.9 g/L
Refined Borates	Dehybor® (anhydrous borax, 21% B)	$Na_2B_4O_7$	19.0 g/L
	GRANUBOR® (borax pentahydrate, 15% B)	$Na_2B_4O_7{\cdot}5H_2O$	26.5 g/L
	Optibor® TG (boric acid, 17.5% B)	H_3BO_3	47.2 g/L
	SOLUBOR® (DOT, 20.5% B)	$Na_2B_8O_{13}{\cdot}4H_2O$	97 g/L

U.S. Borax, 2021.

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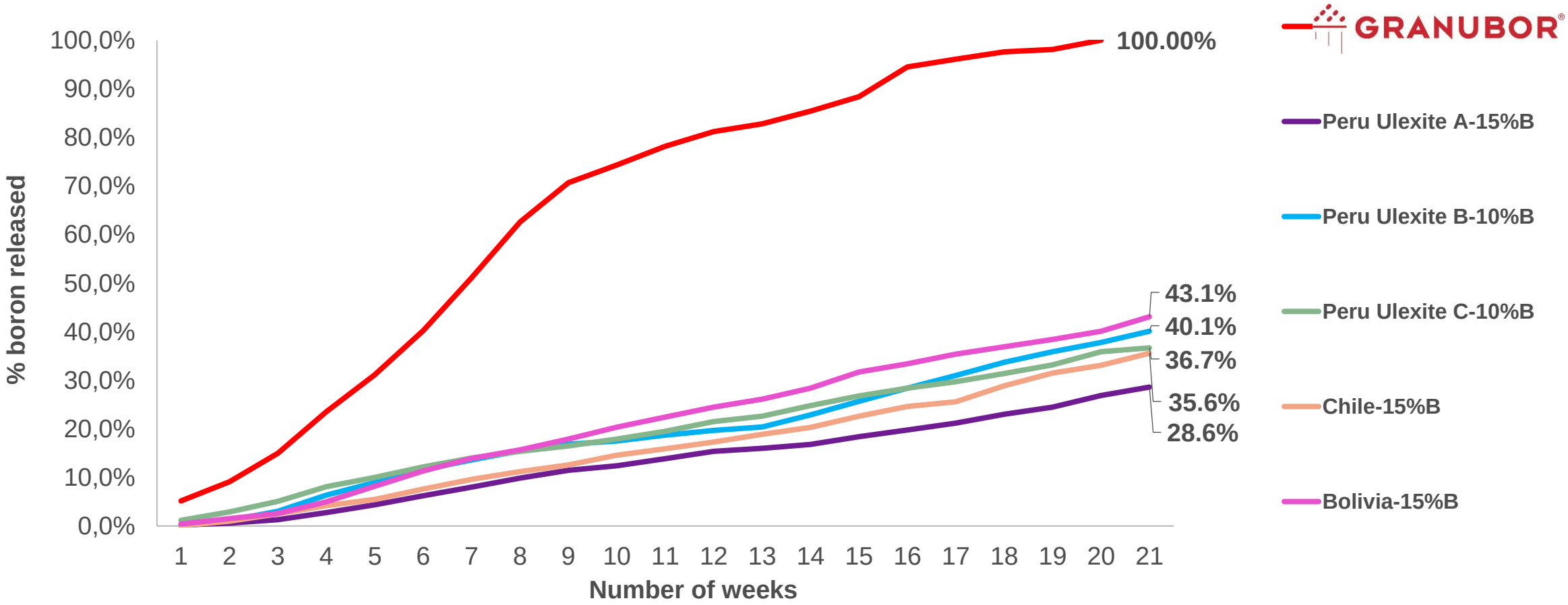
Solubility with different sources of borates

- Unrefined borates (ulexites) release between 28 - 43% of the total boron content
- Refined borates have greater solubility over 20 weeks, due to the absence of impurities and calcium in their composition



U.S. Borax, 2008.

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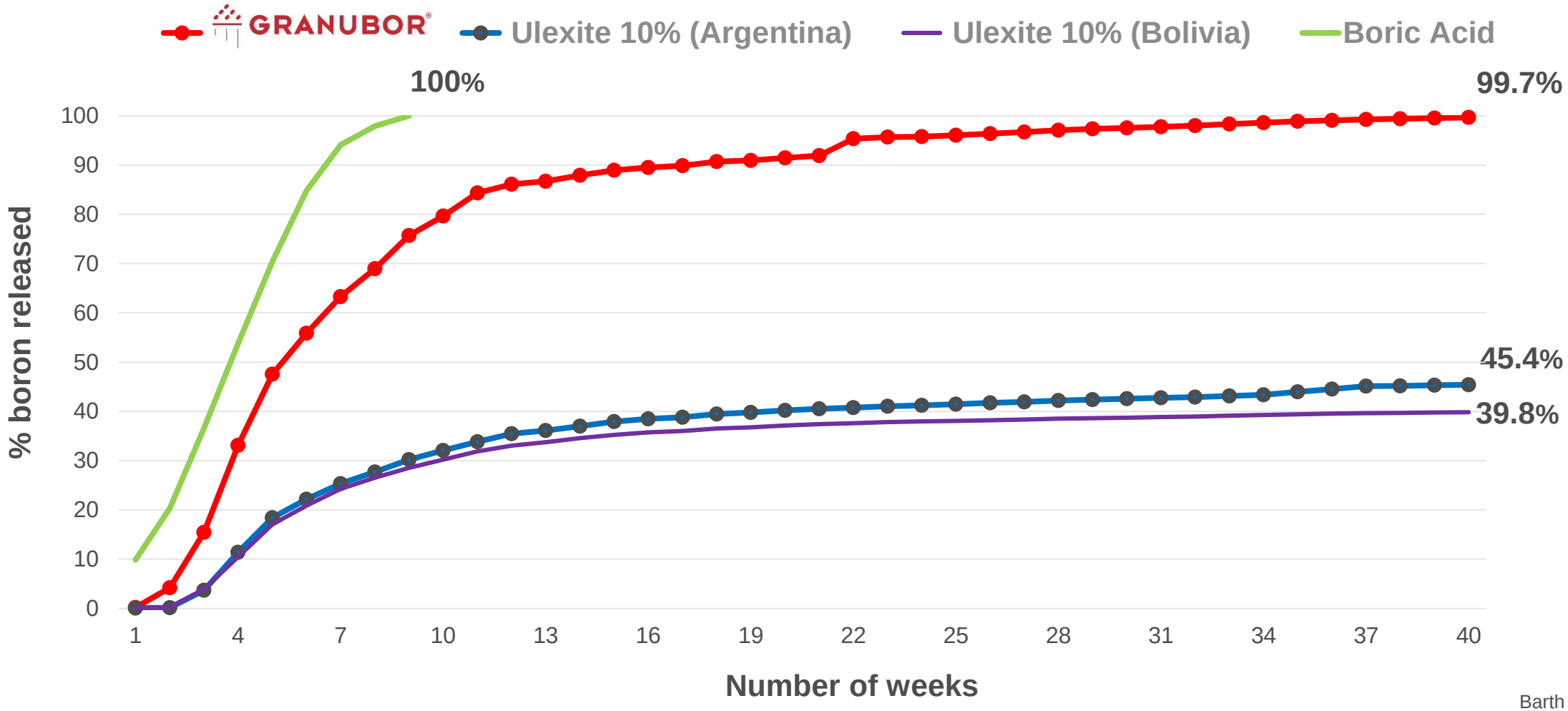
Boron release curves

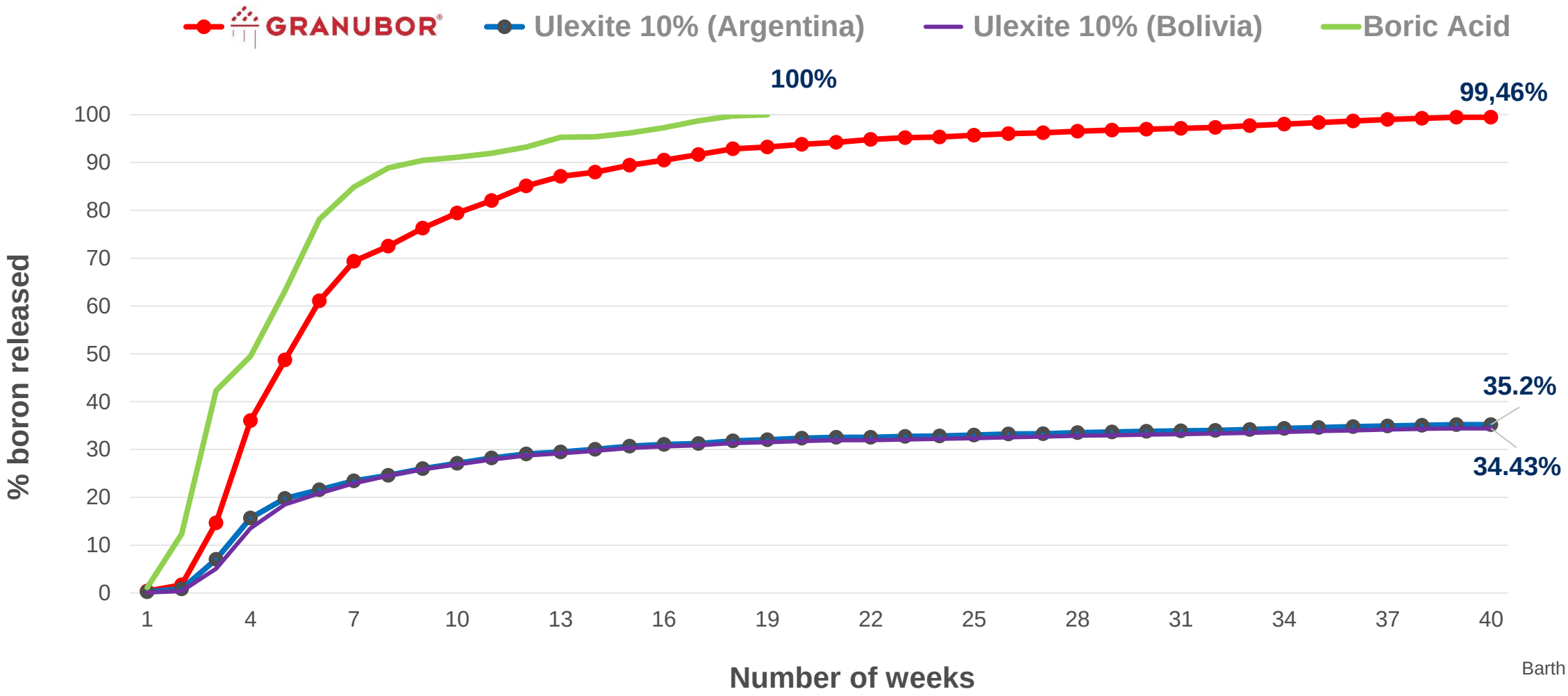
Study conducted over 40 weeks in sandy soil (pH 4.7). Fundação ABC, Brazil.



Barth et al, 2017.

Boron release curves

Study conducted over 40 weeks in clay soil (pH 4.2). Fundação ABC, Brazil.



Barth et al, 2017.

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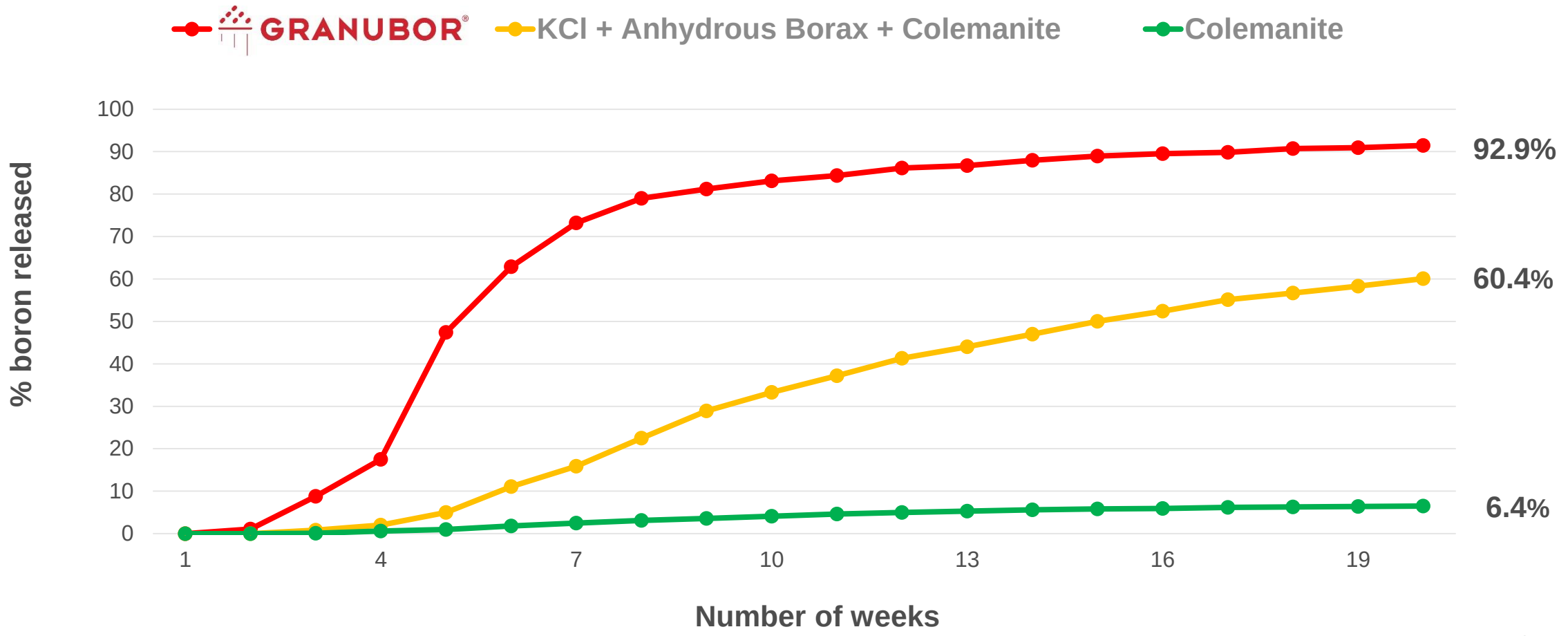
Boron release curves

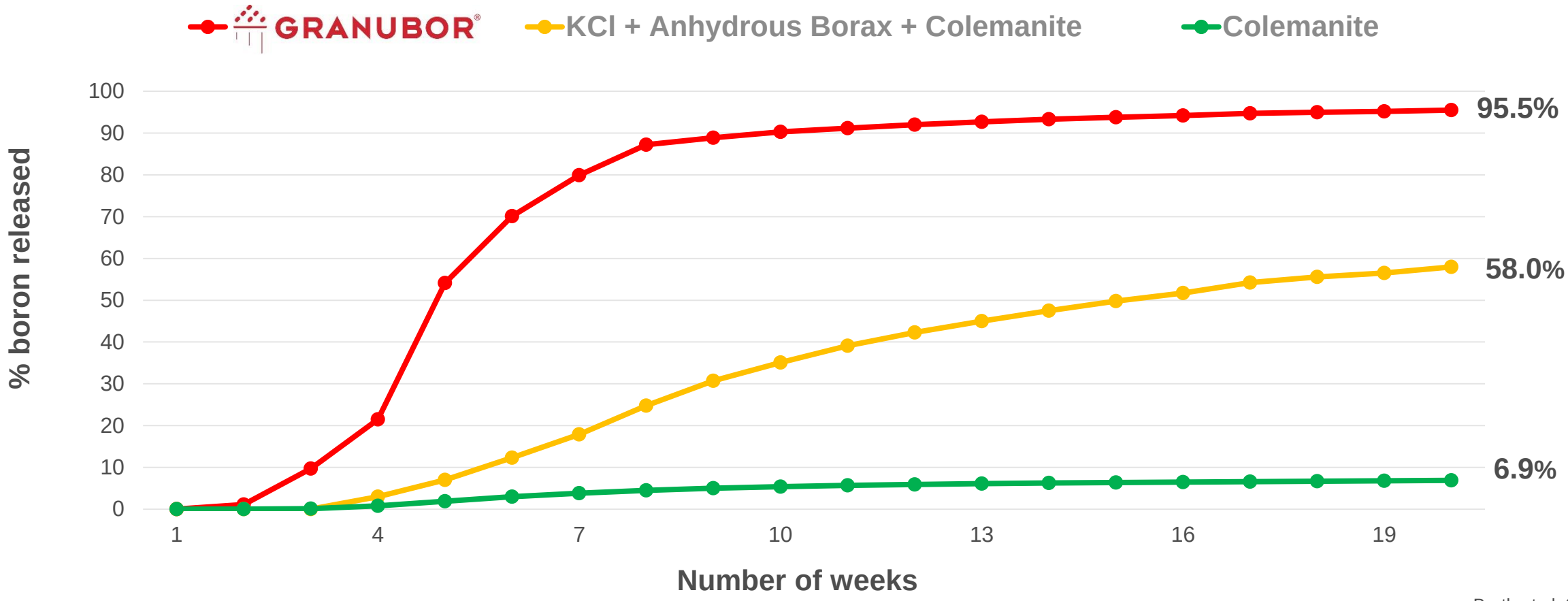
Study conducted over 20 weeks in sandy soil, and acidity corrected with ag lime (pH 5.7). Fundação ABC, Brazil.



Barth et al, 2020.

Boron release curves

Study conducted over 20 weeks in sandy soil and naturally acidic soil, without limestone correction (pH 4.8). Fundação ABC, Brazil.



Barth et al, 2020.

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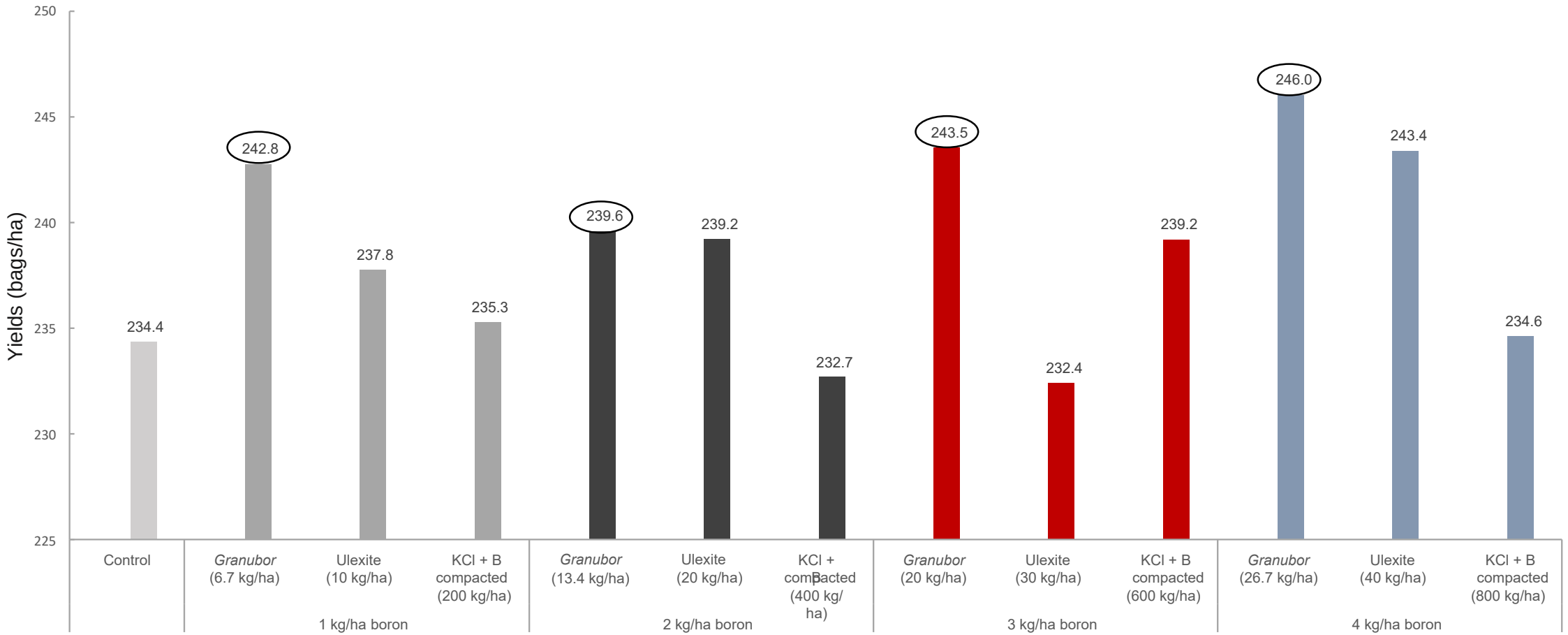
Response of corn to the application of B in increasing doses (1; 2; 3 and 4 kg/ha) using different sources available on the market

Average yield of 2019/20 and 2020/21 crops



Experiment conducted in Cruz Alta/RS, Brazil, in a soil with ≥ 42% clay

Shaich et al, 2021.

What technologies are being developed for more seamless applications of boron?

What solutions are readily available?

- Ulexite
- Colemanite
- Borax pentahydrate
- DOT
- Anhydrous borax
- Zinc borate
- Liquid fertilizers (mainly MEA+BA)

What is in the pipeline?

- New liquid formulations
- B + macro and/or micronutrients
- Slow release boron fertilizers, with better technology (B sources)

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Thank you!

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