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How to solve the problem of lack of foliar nutrient thresholds for other than conventional production systems?

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HORTICULTURE FOR A WORLD IN TRANSITION
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Introduction

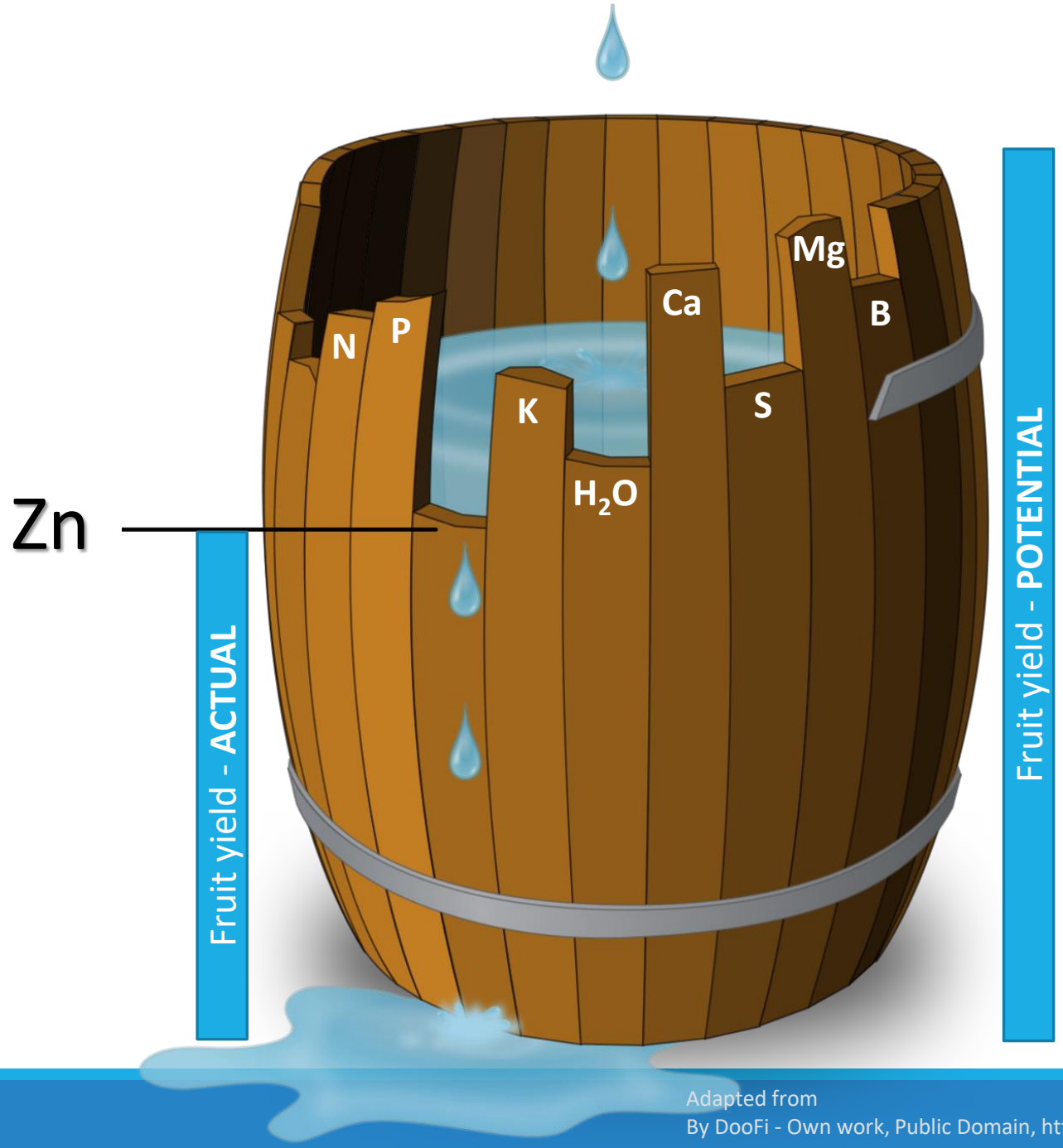
- Evaluation of the nutritional status of banana plants

Production factors optimization
- Land
- Labor
- Capital

- Plant analysis + Critical leaf nutrient thresholds (CLNs)

Nutritional diagnosis

- Liebig's law of minimum (*to be fair*, Carl Sprengel's law)



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Introduction

- What do we have of **critical leaf nutrient thresholds** (CLNs) for banana?

Conventional cultivation
Cavendish…

New genotypes
Climate changes
Organic production…

- How to generate specific CLNs for a new crop condition?

- How to check if CLNs (newly generated or from literature) are valid under my cultivation conditions?

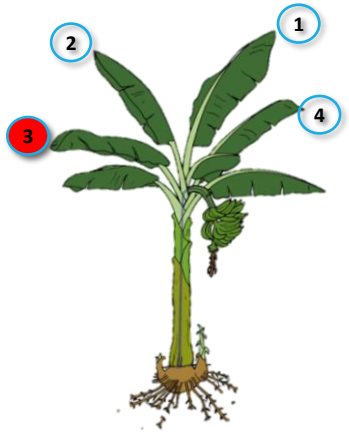
Material & methods

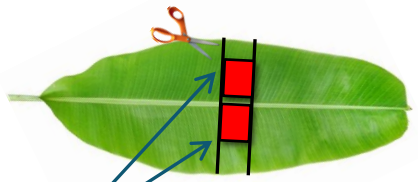
- **Optimal leaf standards from a field survey / database**
  - ✕ long-term calibration experiments
  - Farm, growers association/cooperative, region…
- Our database
  - Demonstrations plots
    - Sources and doses of organic and mineral fertilizers, liming materials...
  - ‘Grande Naine’
  - Two production cycles
  - Acid Oxisol with low natural fertility

Material & methods

- Our database

180 records
- Leaf nutrient concentrations
  N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, and Zn
- Fruit yield (t ha^{-1} $year^{-1}$)





Material & methods

1. Split the data set into two subpopulations

Variable	High-yield subpopulation[a]		Low-yield subpopulation[b]	
	Mean	Standard deviation	Mean	Standard deviation
N (g kg^{-1})	31.7	2.2	31.8	2.6
P (g kg^{-1})	1.7	0.1	1.8	0.1
K (g kg^{-1})	27.5	2.8	24.4	3.6
Ca (g kg^{-1})	6.4	1.0	6.0	1.6
Mg (g kg^{-1})	3.0	0.6	3.1	0.7
S (g kg^{-1})	2.5	0.7	2.3	0.5
B (mg kg^{-1})	13.5	5.0	12.3	4.3
Cu (mg kg^{-1})	6.4	1.6	6.3	2.1
Fe (mg kg^{-1})	104.3	30.5	61.9	81.2
Mn (mg kg^{-1})	95.1	30.9	121.1	77.9
Zn (mg kg^{-1})	13.3	1.9	15.8	3.8
Yield (t ha^{-1} $year^{-1}$)	57	2.9	42	6.6

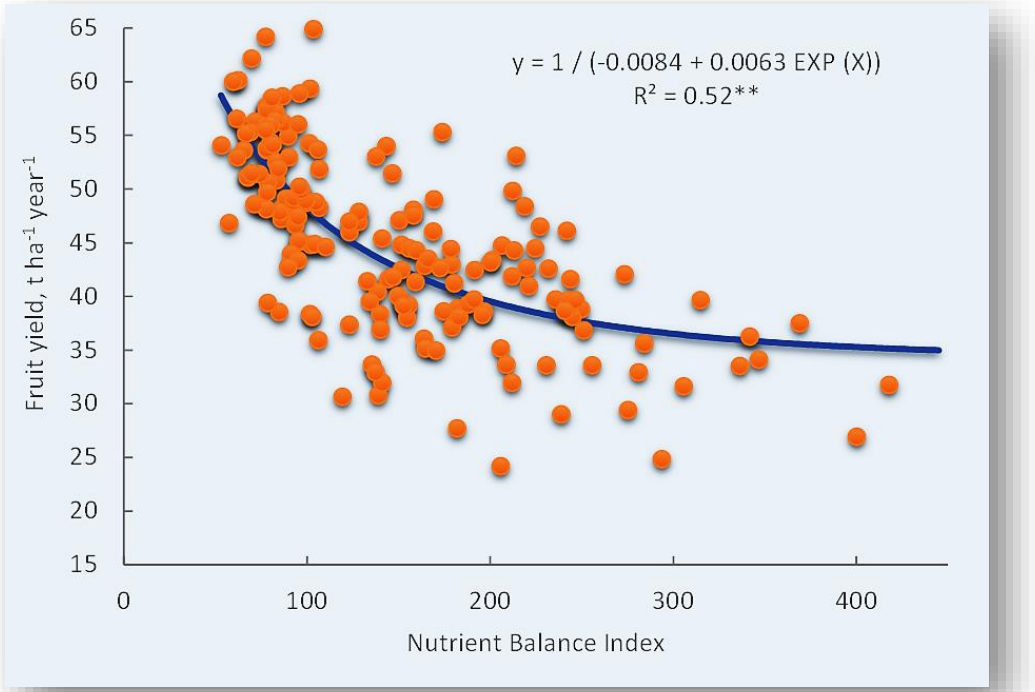
[a] Fruit yield > 51 t ha^{-1} $year^{-1}$ [b] Fruit yield < 51 t ha^{-1} $year^{-1}$

Material & methods

2. Generate DRIS norms
3. Generate DRIS indices
4. Establish multiple regressions between leaf nutrient contents of each nutrient and DRIS indices
5. Estimate the value of each multiple regression setting all DRIS indices equal to zero
6. The confidence interval (95%) for the estimated value corresponds to the SR of each nutrient estimated for local conditions
7. Evaluate K SR performance in another production area

Results

- Relationship between plant nutrient status (IBN) and fruit yield in the demonstration plots



Results

- Sufficiency ranges for nutrient contents in banana leaves

Nutrient	Weinert and Simpson (2016)	Teixeira et al. (2022)	Developed from DRIS
	g kg^{-1}		
N	28 – 40	25 – 30	30 – 37
P	1.9 – 2.5	1.7 – 2.1	1.7 – 2.1
K	30 – 40	30 – 40	25 – 31
Ca	7.4 – 12.5	3 – 12	1.9 – 4.8
Mg	3.0 – 4.6	2.0 – 5.0	2.8 – 3.6
S	–	1.8 – 2.5	1.7 – 3.8
	mg kg^{-1}		
B	10 – 20	10 – 25	11 – 16
Cu	–	7 – 20	6 – 8
Fe	–	80 – 200	60 – 143
Mn	–	220 – 1000	106 – 143
Zn	20 – 35	15 – 30	14 – 17

Results – validation of new K SR

- Performance of K nutritional diagnostics in bananas based on incidence, accuracy, and yield variation associated with true and false diagnoses

Criterion	Diagnosis[a]				Accuracy[b]	T ÷ F[c]	Σ d(Y)[d]
	T+	F+	T-	F-			
	%						t ha^{-1} year^{-1}
Australia	42	58	0	0			
São Paulo	42	58	0	0			
New K SR	42	33	25	0			

[a] **T+** = real deficiency, **F+** = false deficiency, **T-** = real sufficiency, and **F-** = false sufficiency

[b] Accuracy = (% T+) + (%T-)

[c] T ÷ F = (%T+) ÷ (%F+)

[d] Sum of the variations in fruit yield associated with the diagnoses (*n*=12)

Conclusions

- Fruit yield of Grand Naine banana plants grown in a soil of low natural fertility in Vale do Ribeira is associated with the plant's nutritional status.
- It is possible to generate optimal leaf nutrient contents standards for banana from survey data.
- The new SR for K generated specifically for ‘Grand Naine’ grown on a tropical soil of low natural fertility provides a more accurate diagnosis of the nutritional status of the plants than the SR commonly used in Brazil.

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¡Gracias!

Thanks!

Merci!

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