Adjustment in the Recommendation for Lime Requirements in Sandy Soils in the Brazilian Cerrado – 1st Approximation

Flávia Cristina dos Santos
Soil Fertility Researcher

Embrapa Maize and Sorghum

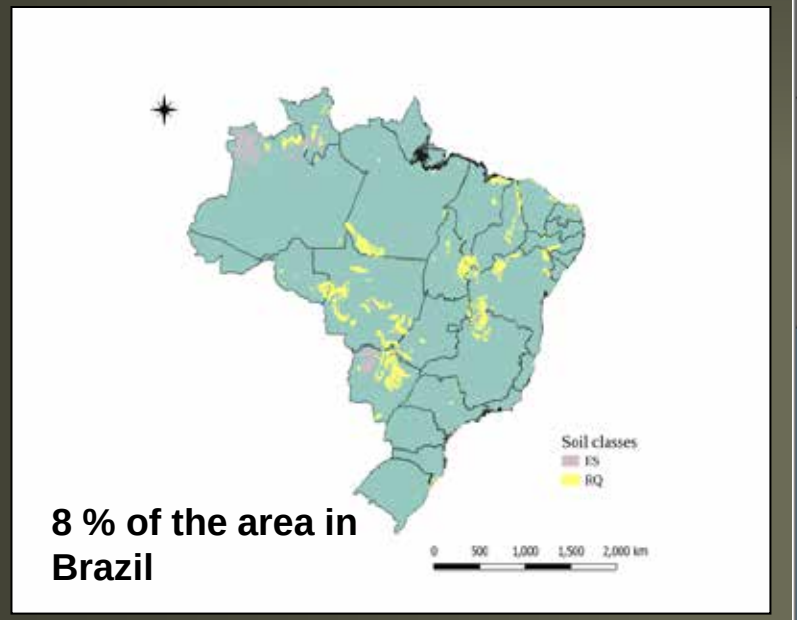
Collaborators: Henrique Souza
João Herbert
Manoel Ricardo
Reinaldo Cantarutti
Daniela Facco
Rodrigo Knevitz

Embrapa

MINISTRY OF AGRICULTURE AND LIVESTOCK

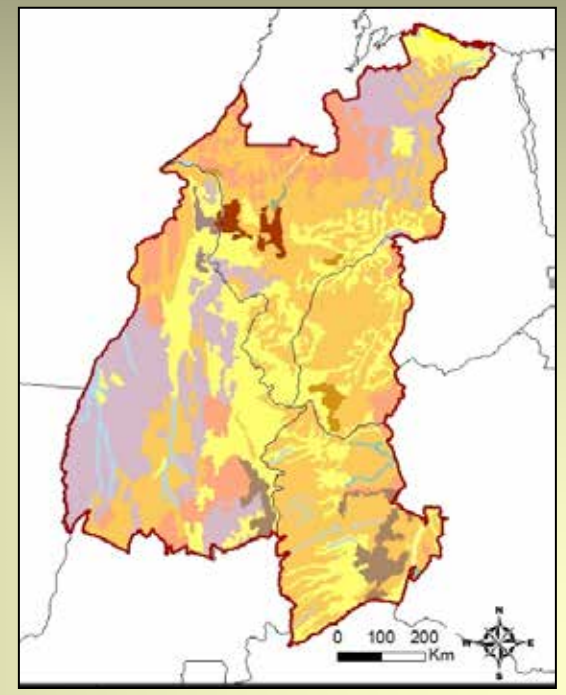
BRAZILIAN GOVERNMENT
BRASIL
UNITING AND REBUILDING

Importance of Adjusting Liming Recommendations for Sandy Soils in Brazil and the Matopiba Region (Entisols/Quartzipsamments)



8 % of the area in Brazil

Matopiba: a new agricultural frontier in the country, with great potential for agribusiness development and approximately 73 million of hectares, 20% of which consists of sandy soils.



Main classes of Matopiba's soils (Soil Taxonomy)

- Ultisols, Oxisols (Kandic)
- Oxisols
- Entisols
- Alfisols (Plintaqualfs), Ultisols (Plintaquults) and Subgroups Plinthic (Oxisols, Ultisols, Alfisols, Entisols and Inceptisols)

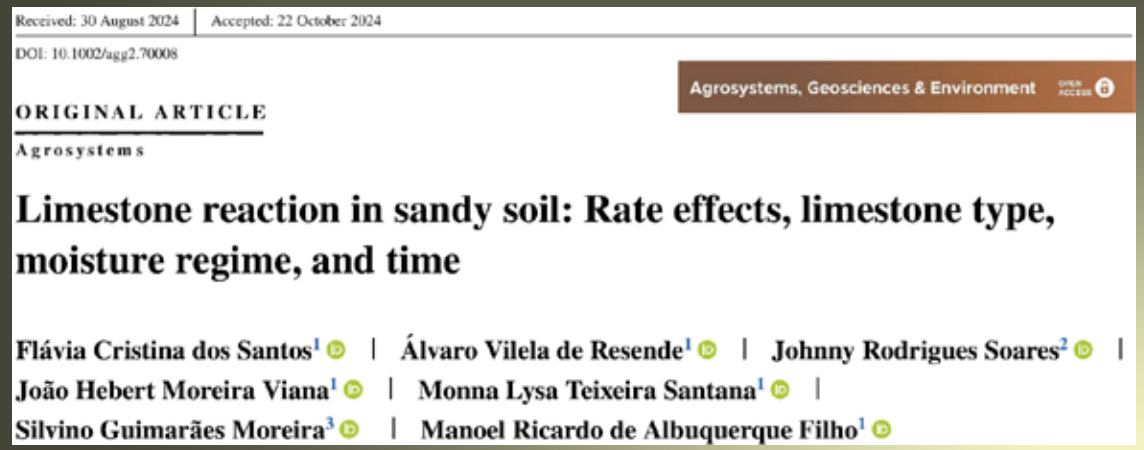
The main concern with liming sandy soils is that producers have been applying excessively high lime rates (**6 to 15 t ha^{-1}**) when opening new production areas, far exceeding the recommended rates (**around 2 to 3 t ha^{-1}**)

Unfortunately, scientific research came later in an effort to understand this issue.

Crop yields were higher at the higher lime application rates, and the expected problems associated with these higher doses were not observed in the field: soil pH (H_2O) remained below 7.0, and no micronutrient deficiencies were detected in the plants.

Embrapa

Greenhouse experiment – no plants



Received: 30 August 2024 | Accepted: 22 October 2024

DOI: 10.1002/agg2.70008

Agrosystems, Geosciences & Environment

ORIGINAL ARTICLE

Agrosystems

Limestone reaction in sandy soil: Rate effects, limestone type, moisture regime, and time

Flávia Cristina dos Santos[1] | Álvaro Vilela de Resende[1] | Johnny Rodrigues Soares[2] | João Hebert Moreira Viana[1] | Monna Lysa Teixeira Santana[1] | Silvino Guimarães Moreira[3] | Manoel Ricardo de Albuquerque Filho[1]

Treatments:
4 rates of limestone – 0, 1, 2, and 4 x recommended lime rate – RLR
2 irrigation type: daily and monthly
3 additional treatments (3 rates of filler limestone under monthly irrigation)

Evaluations: soil sampling at 1, 2, 3, 6, and 12 months after limestone application

Greenhouse experiment – with plants (grass, sorghum, and soybean)

Treatments: 4 rates of limestone
0, 1, 2, and 4 x recommended lime rate – RLR

Evaluations: soil sampling at 1, 2, 3, 6, and 12 months after limestone application

4 RLR (4 tons ha^{-1})
maximum pH (7.0)
maximum Ca + Mg (3.8)

Field experiment – Xanxere Farm (Bahia State)

ISSN 1807-1929
Revista Brasileira de Engenharia Agrícola e Ambiental
Brazilian Journal of Agricultural and Environmental Engineering
v.27, n.10, p.820-827, 2023
Campina Grande, PB – http://www.agriambi.com.br – http://www.scielo.br/rbeaa
agriambi
DOI: http://dx.doi.org/10.1590/1807-1929/agriambi.v27n10p820-827

Nonlinear modeling of liming reaction and extractable base curves[1]

Ajuste não linear de curvas de reação de calcário e bases trocáveis

João H. M. Viana[2*], Manoel R. de Albuquerque Filho[2], Flávia C. dos Santos[2] & Daniela de A. Ladeira[3]

Treatments: 4 rates of limestone
0, 5, 10, and 20 tons ha^{-1}

Evaluations: soil sampling at 1 and 2.5 years after liming

20 tons ha^{-1}
maximum pH (7.2)
maximum Ca + Mg (3.9)

Field experiment – Trijunção Farm (Bahia State)

Agrosystem: Grass, sorghum, and soybean

Treatments: 4 rates of limestone
0, 2.5, 5, and 10 tons ha^{-1}

Evaluations: soil sampling at 2, 8, 15, 20, 26, and 32 months after liming

10 tons ha^{-1}
maximum pH (7.5)
maximum Ca + Mg (3.6)

Field experiment – Mato Grosso State

Agrosystem: soybean, grass, sorghum, crotalaria
Treatments: 3 total rates of limestone
0, 4, and 8 tons ha^{-1}

Evaluations: soil sampling at 1, 4, and 6 years after first application of liming

8 tons ha^{-1}
maximum pH (7.3)
maximum Ca + Mg (7.3)

Fotos: Daniela Facco

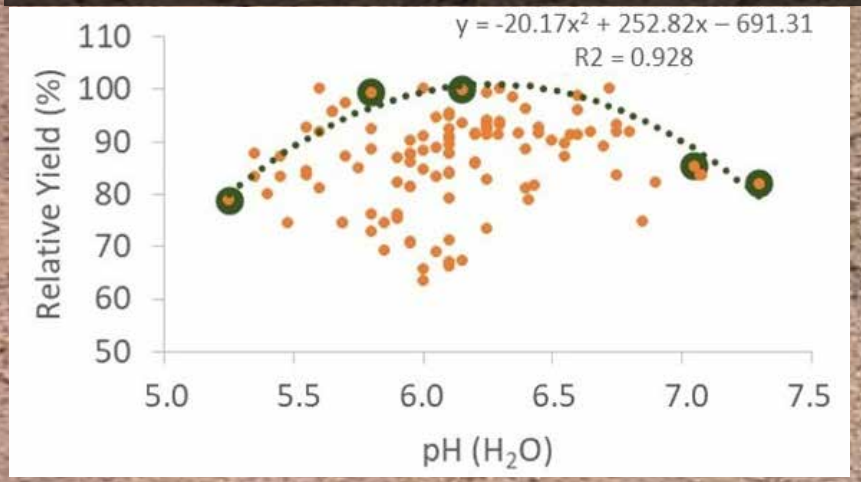
Adjustment in Lime Rate recommendation

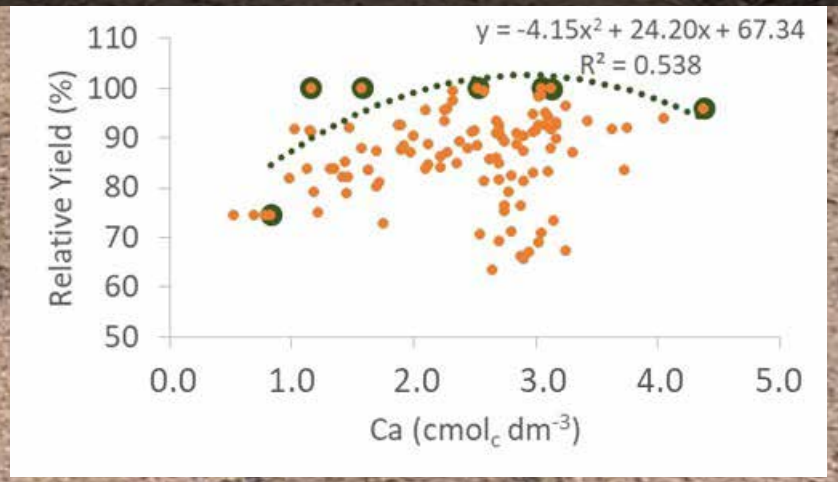
- 112 sandy soil samples (140 g kg^{-1} of clay) and soybean yield of field experiments from Bahia and Mato Grosso States (0-20 and 20-40 cm), 3 crop seasons

- Boundary line method to generate fertility classes and critical levels for soil chemical properties, using the concept of relative yield.
  - Souza et al., 2024 - https://doi.org/10.36783/18069657rbcs20230154

- Fertility classes: 95% and 80% of the relative maximum yield (soil layer: 0-20 cm and 20-40 cm) – the 20-40 cm soil layer is critical in sandy soil, especially to open new areas and to recover degraded pasture

- **0-20 cm:**





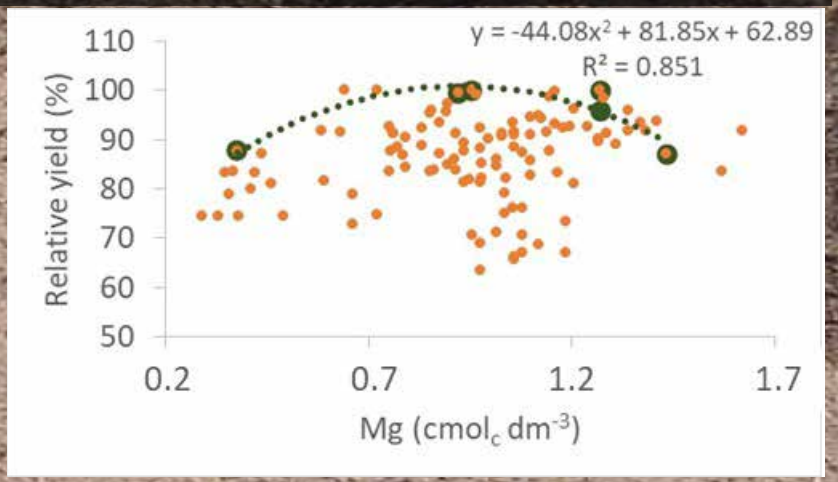


Table 1. Fertility classes and critical levels for sandy soils

0-20 cm	Very low	Low	Adequate	High	Very high	Critical level
pH(H_2O)	<5.3	5.3-5.7	5.8-6.8	6.9-7.3	>7.3	6.3
Ca ($cmol_c\ dm^{-3}$)	<0.7	0.7-1.8	1.9-4.0	4.1-5.1	>5.1	2.9
Mg ($cmol_c\ dm^{-3}$)	<0.3	0.3-0.5	0.6-1.3	1.4-1.6	>1.6	0.9
SB ($cmol_c\ dm^{-3}$)	<2.6	2.6-3.3	3.4-4.2	4.3-5.0	>5	3.4
CTC ($cmol_c\ dm^{-3}$)	<4.3	4.3-5.7	5.8-8.7	8.8-10.1	>10.1	7.2
V (%)	<29	29-44	45-77	78-93	>93	61
P ($mg\ dm^{-3}$)	<6	6-20	21-50	51-64	>64	35
K ($mg\ dm^{-3}$)	<21	21-34	35-61	62-75	>75	48
MO ($g\ kg^{-1}$)	<1	1-8	9-33	34-45	>45	21
H+Al ($cmol_c\ dm^{-3}$)	<0.3	0.3-1.5	1.6-4.2	4.3-5.5	>5.5	2.9
20-40 cm						
Ca ($cmol_c\ dm^{-3}$)	<0.1	0.2-0.4	0.5-1.4	1.5-1.9	>1.9	1.0
Mg ($cmol_c\ dm^{-3}$)	<0.05	0.06-0.1	0.2-0.6	0.7-0.8	>0.8	0.4
V (%)	<9	10-22	23-52	53-66	>66	38

Liming Rate (LR) proposal for sandy soils

LR (t ha^{-1}) = [1] + [2]

[1] 0-20 cm:

LR (t ha^{-1}) = {(1 x Al $cmol_c$ dm^{-3}) + [3.8 - (soil Ca+Mg $cmol_c$ dm^{-3})]} x soil bulk density

The value 3.8 comes from the concentrations obtained in the soil, Table 1 – sum of the Ca and Mg critical level in the 0–20 cm layer

[2] 20-40 cm:

NC = {(1 x Al $cmol_c$ dm^{-3}) + [1.4 - (soil Ca+ Mg $cmol_c$ dm^{-3})]} x soil bulk density

The value 1.4 comes from the concentrations obtained in the soil, Table 1 – sum of the Ca and Mg critical level in the 20–40 cm layer

LR validation using the baseline soil data from Trijunção Farm, Bahia

Initial soil data ($cmol_c\ dm^{-3}$) Trijunção Farm					Proposal to increase Ca+Mg ($cmol_c\ dm^{-3}$)	Difference: critical level– initial	Soil bulk density (estimated)	LR (each soil layer)
Soil layer	**Ca**	**Mg**	**Al**	**Sum:**	**Critical level**			
(1) 0-20	0.9	0.4	0.0	1.3	3.8	2.5	1.7	4.3
(2) 20-40	0.4	0.2	0.0	0.6	1.4	0.8	1.5	1.2

LR (1+2), t ha^{-1} (calculated)	Guidelines recommendation	Maximum dose for physical efficiency, t ha^{-1} (observed)
5.5	**0.7**	**5.6**

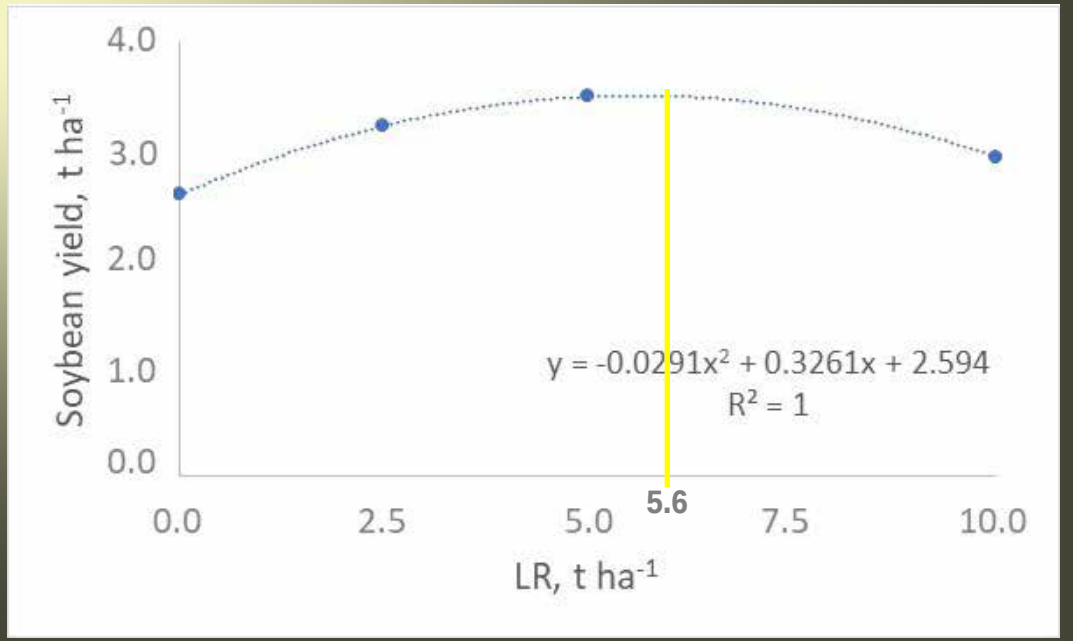


Figure 1. Soybean yield as a function of lime rates

Conclusions

- pH and Al are not difficult to correct in sandy soils
- Most demand crops: ↑ Ca + Mg - ↑ rates of limestone
- ↑ rates of limestone: imply an improved fertility of the subsurface soil layer (20-40 cm)
- No problem with micronutrients, or easy to fix with foliar fertilization
- The 1st proposal to revise liming recommendations for sandy soils in Brazil reflects the need for a stronger scientific basis, as it is important to avoid applying excessively high rates

Embrapa

Acknowledgments

Researchers, field assistants, students

flavia.santos@embrapa.br

+55 31 99130-3522






Funders

TRIJUNÇÃO

Embrapa