Agronomic Performance of Phosphate Fertilizers Varying in Solubility to Soybean in Oxisol of Brazilian Cerrado

E. Francisco

R.C. Silva

C. Kappes

S.H. Chien

F.R. César

T. Muraoka

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SSSA Division: Soil Fertility & Plant Nutrition
- Crop response to and soil dynamics of phosphorus and sulfur -
Background

Tropic of Capricorn

Acidic Soils + Generalized nutrient deficiency

Weathered soils & P management

- Natural low P
- Fe and Al oxides
- Specific adsorption
- Precipitation
- So on...

Oxisols

IPNI International Plant Nutrition Institute
Most of the "Premium" PR has been mined worldwide.

Therefore, fertilizer industry is forced to use even more lower grade PR.

Consequences

- Beneficiation / concentration
- High levels of impurities
- Water insoluble P in acidulated fertilizer
- Legislation requirements are not met
Insoluble compounds do not seem to reduce agronomic effectiveness, but the Legislation Requirements are not met.

Mullins and Sikora (1992, 1995)
Prochnow et al. (2003, 2008)
To evaluate the agronomic performance of SSP-based fertilizers varying in “Fi Index” to soybean in Oxisol of Brazilian Cerrado.
Methods

Itiquira - Mato Grosso

4 SSP-based fertilizers
(60 kg ha\(^{-1}\) P\(_2\)O\(_5\) )

Soybean (TMG 132 RR)

Oxisol (63% clay / MPAC: 1315 mg kg\(^{-1}\) )

<table>
<thead>
<tr>
<th>pH</th>
<th>P</th>
<th>S</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Al</th>
<th>H+Al</th>
<th>SB</th>
<th>CTC</th>
<th>V</th>
<th>m</th>
<th>B</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCl(_2) mg dm(^{-3})</td>
<td>4.9</td>
<td>10</td>
<td>4</td>
<td>0.4</td>
<td>27</td>
<td>18</td>
<td>1</td>
<td>52</td>
<td>45.6</td>
<td>97.8</td>
<td>47</td>
<td>1</td>
<td>0.16</td>
<td>0.4</td>
<td>50</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Overview
Commercial SSP-based fertilizer → **LAGAMAR PR** (Northeast Brazil)

**But, why Lagamar PR?**

- High level of impurities
- Very difficult beneficiation
- Limited information available

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>PR</th>
<th>( \text{P}_2\text{O}_5 )</th>
<th>( \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3 )</th>
<th>( \text{Fi} ) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSP-(60%)</td>
<td>Lagamar</td>
<td>18</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Citrate + H(_2)O</td>
<td>H(_2)O</td>
</tr>
<tr>
<td>SSP-(86%)</td>
<td>Catalão</td>
<td>22</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>

**Well-known = Reference**
Methods

Fertilizers treatments

Standard source

Marginal sources (legislation requirements not met)

Fi 85%

Fi 70%  ←  Fi 60%  →  Fi 50%

MCP

↑ Fe

Available P

WSP

%
Methods

Design & Experimental units

[Year 1]

Fertilizer application

[Year 2]

→ Residual effect ←

→ Reapplication ←

[Year 3]

Evaluations

[i] Soybean Yield  [ii] Soil available P
Results

Year 2

Control  Residual effect  Reapplication
Results

Soybean Yield

Annual evaluation

Fresh fertilizer application to new plots

Soybean yield, kg ha$^{-1}$

Year 1: a, a, a
Year 2: a, a, a
Year 3: a, a, a

Legend:
- no P
- SSP-50
- SSP-60
- SSP-70
- SSP-85
Results

Soybean Yield

Evaluation - year 3

Fresh application Vs residual effect

Soybean yield, kg ha\(^{-1}\)

<table>
<thead>
<tr>
<th>Fertilizer application</th>
<th>Year 1 + Year 2 + Year 3</th>
<th>Year 1 + Year 2</th>
<th>Year 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>no P</td>
<td>a</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>SSP-50</td>
<td>b</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>SSP-60</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>SSP-70</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>SSP-85</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>

IPNI International Plant Nutrition Institute
Results

**Soil available P**

**Resin P**

- Y-axis: Resin-Available P, mg kg\(^{-1}\)
- X-axis: no P, SSP-50, SSP-60, SSP-70, SSP-85
- Year 1, Year 1 + Year 2, Year 1 + Year 2 + Year 3

**Mehlich P**

- Y-axis: Mehlich-Available P, mg kg\(^{-1}\)
- X-axis: no P, SSP-50, SSP-60, SSP-70, SSP-85
- Year 1, Year 1 + Year 2, Year 1 + Year 2 + Year 3
Implication

Fertilizer industry will be forced to process marginal PR resources.

- To the best of our knowledge, lower grade SSP-based has not been evaluated yet in long term under field conditions to validate previous findings of incubation and pot experiments.

Silva et al. (unpublished)

- Results indicate the possibility of legislation revision in order to reduce the “Fi index” requirement, which would **optimize the use of marginal grade PR**.
Conclusions

- The agronomic performance of SSP-based fertilizers is unlikely to be affected by insoluble P impurities (~Fi 60%), despite the legislation requirements;

- SSP-based fertilizers with Fi as low as 60% can be agronomically as efficient as fertilizers with Fi ≥ 85%, even in a highly P fixing Oxisol;

- Acidulation of low grade PR is a reasonable option to obtain SSP-based fertilizers (even low Fi), mainly in countries that strongly depend on low grade phosphate resources. 🇧🇷
Acknowledgements
Thank you!