Phosphate rock efficiency enhanced by granulation with water-soluble P fertilizer and elemental sulfur

Fábio Ricardo Coutinho Fontes César[1] and Takashi Muraoka[2]

[1]Dep. of Soil Science, ESALQ, University of São Paulo, Piracicaba, SP; [2]Center for Nuclear Energy in Agriculture, University of Sao Paulo[2].
E-mail: fabio.cesar@usp.br; muraoka@cena.usp.br

Introduction

✓ More than 90% of the P sources used worldwide in agriculture is fully soluble;

✓ Weathered tropical soils → High P "fixing" → These sources may not be the most appropriated;

✓ Phosphate rock (PR) is an alternative → However, PRs have low agronomic effectiveness.

The manufacture of a fertilizer by mixing PR with monoammonium phosphate (MAP) and elemental sulfur (S^0) can increase the solubility of the PR, obtaining a fertilizer with "synchronized" P releasing .

Objectives

1. Assess the agronomic performance of phosphate fertilizers produced by mixture of PR+MAP+S^0 in the same granule;
2. Quantify the effect of S^0 addition to mixture on P uptake through the **^{32}P isotopic dilution method.**

Material and Methods

✓ A Typic Haplustox "sandy clay loam" was used to grow corn in a pot trial.

Treatments

(i) MAP (control)
(ii) MAP+S^0
(iii) Bayóvar PR
(iv) PR+S^0
(v) MAP[50%]+PR[50%]
(vi) MAP[50%]+PR[50%]+S^0
(vii) MAP[25%]+PR[75%]
(viii) MAP[25%]+PR[75%]+S^0

The fertilizers were granulated based on the total P. The amount of S was applied aiming a P:S relation in the granule corresponding to 2:1.

✓ Four P rates applied (0, 15, 30 and 60 mg kg^{-1} P);

✓ Plants were harvested at 45 days after planting.

Data Analysis

✓ Response functions: linear, semilog, and exponential, were tested to describe the relation-ship between of the dry matter and P uptake;

✓ To determine difference between two P sources in the range of P rates, the F value (t^2) was calculated.

Results

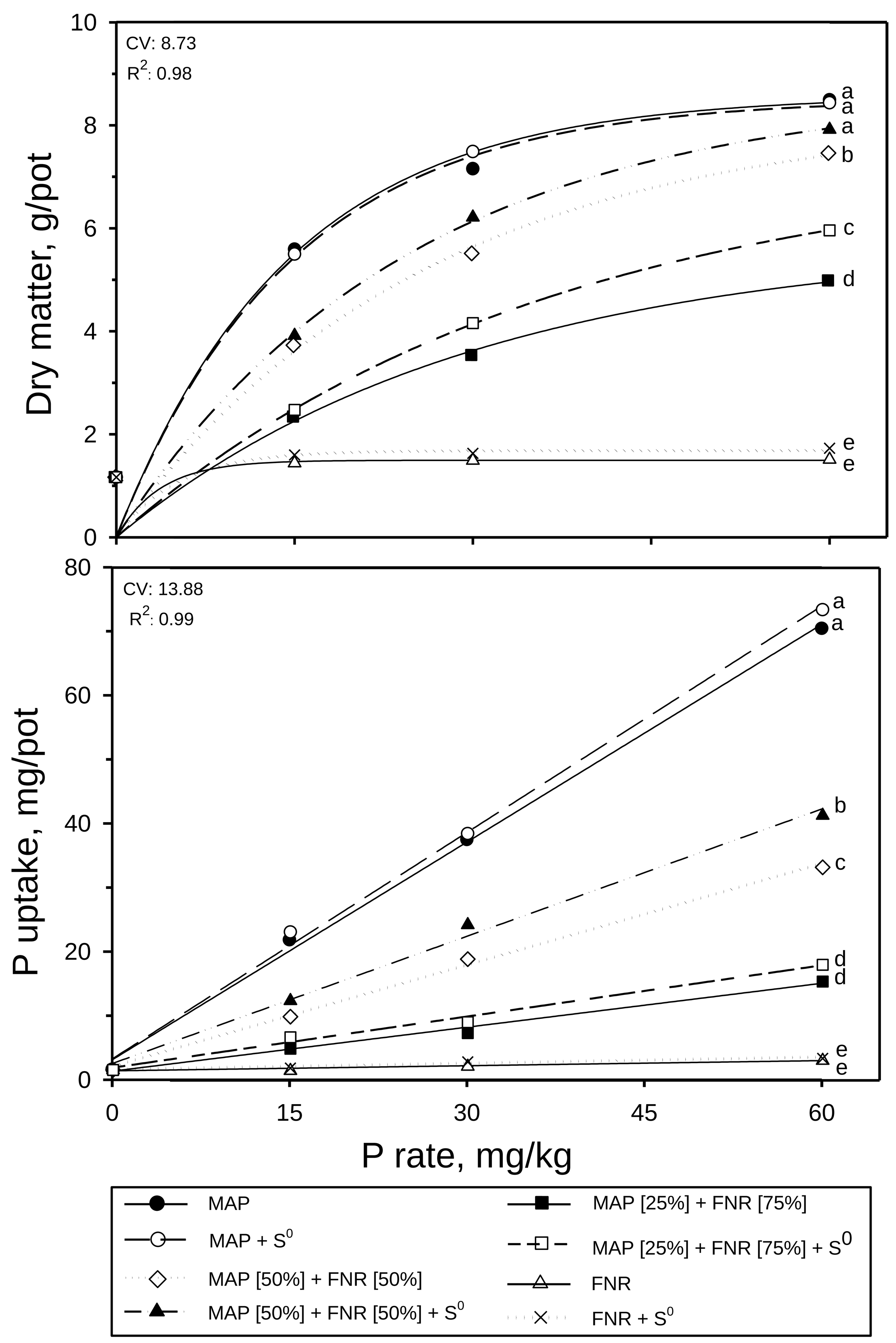

Figure 1. Models followed by the same letter are statistically not different from each other in the slope ($p \leq 0.05$).

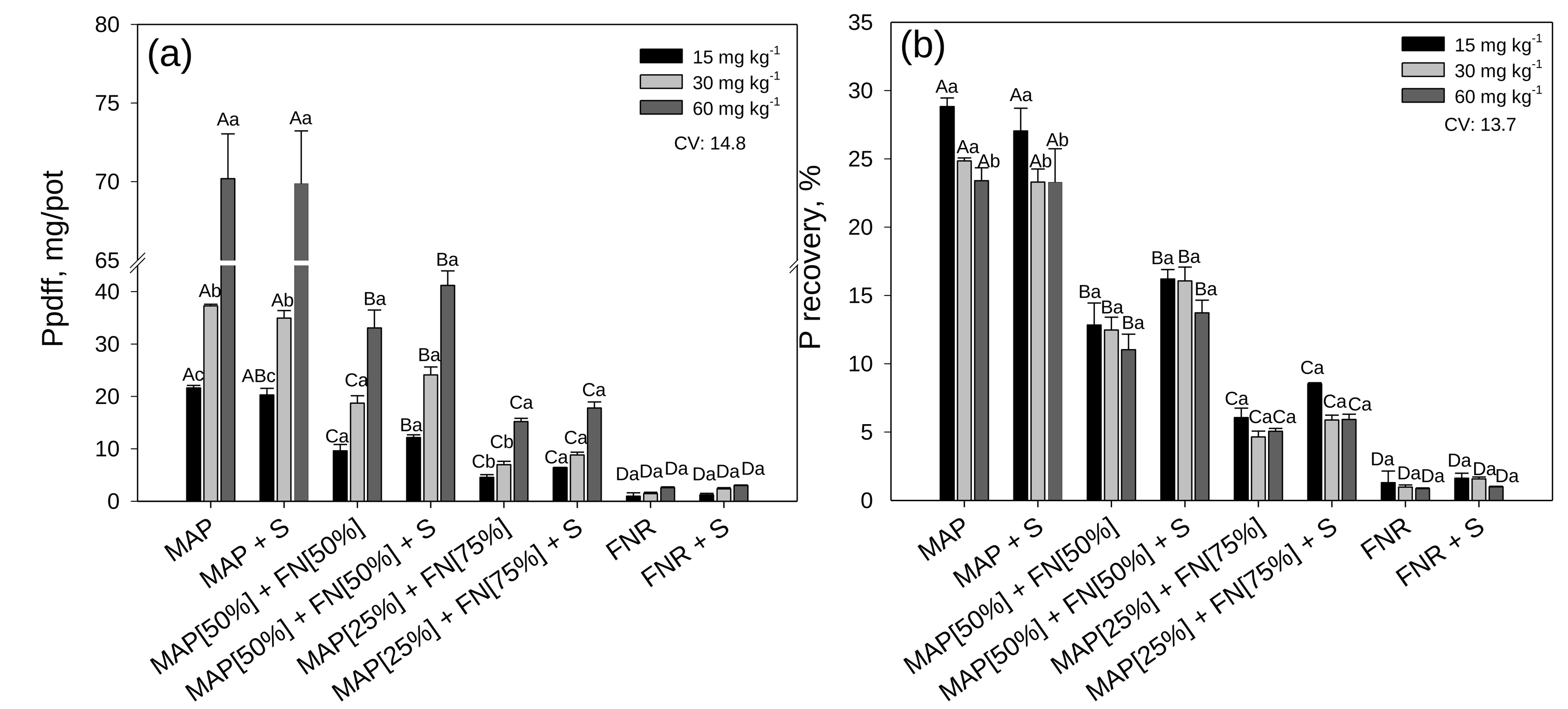

Figure 2. Phosphorus in the plant derived from P fertilizers (Ppdff) and (b) P fertilizer recovery. Values followed by the same letter are not significantly different (P<0.05) according to Tukey test. Capital letters compared different fertilizers with the same P rate, and lower case letters compared the P rate of application for the same fertilizer.

Table 1. Estimation of the increase in P uptake by corn from fertilizers as enhanced by elemental sulfur (S^0).

Sources compared	P rate (mg/kg)	With S^0	Without S^0	Difference	Increase (%)
		(mg/pot)	(mg/pot)	(mg/pot)	
MAP[50%] + FNR[50%] vs. MAP[50%] + FNR[50%] + S^0	15	12,15	9,63	2,52	26
	30	24,10	18,70	5,39	29
	60	41,18	33,08	8,10	24
MAP[25%] + FNR[75%] vs. MAP[25%] + FNR[75%] + S^0	15	6,40	4,55	1,85	41
	30	8,83	6,97	1,86	27
	60	17,78	15,20	2,58	17
FNR vs. FNR + S^0	15	1,22	0,97	0,25	26
	30	2,36	1,46	0,90	62
	60	2,98	2,59	0,39	15

✓ Dissolution of a PR (fluorapatite, e.g.) requires H^+:

$$Ca_{10}(PO_4)_6F_2 + \mathbf{12H^+} \rightarrow 10Ca^{2+} + 6H_2PO_4^- + 2F^-$$

✓ S^0 is oxidized to SO_4^{2-} by microorganisms, releasing H^+:

$$S^0 + 1.5O_2 + H_2O \rightarrow SO_4^{2-} + \mathbf{2H^+}$$

Conclusions

1. The agronomic performance of phosphate fertilizers followed: MAP = MAP+S^0 > MAP[50%]+PR[50%]+S^0 > MAP[50%]+PR[50%] > MAP[25%]+PR[75%]+S^0 > MAP[25%]+PR[75%] > PR+S^0 = PR;
2. The presence of S^0 in the fertilizers improved the corn P recovery from the PR present in the granule;
3. The oxidation and consequently benefits of S^0 on PR solubilization increases with time, thus, the residual effect of the fertilizers should be evaluated and also under field conditions.