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***Boletim de Pesquisa e Desenvolvimento*** **44**  
ISSN 1678-1961  
Outubro, 2009

**Comparison of Resin, Mehlich-1 and  
Mehlich-3 extractants for phosphorus,  
in Coastal Tableland soils**



ISSN 1678-1961

Outubro, 2009

*Empresa Brasileira de Pesquisa Agropecuária  
Centro de Pesquisa Agropecuária dos Tabuleiros Costeiros  
Ministério da Agricultura, Pecuária e Abastecimento*

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Aracaju, SE  
2009

Disponível em: <http://www.cpatc.embrapa.br/index.php?idpagina=fixas&pagina=publicacoesonline>

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Sobral, Lafayette Franco

Comparison of resin, Mehlich-1 and Mehlich-w extractants for phosphorus, in coastal tableland / Lafayette Franco Sobral. -- Aracaju : Embrapa Coastal Tableland, 2009.

12 p. - (Research Development Bulletin / Embrapa Coastal Tableland, ISSN1678-1961; 44).

Access: <http://www.cpatc.embrapa.br/index.php?idpagina=fixas&pagina=publicacoesonline>

1. Soils. 2. Chemical analysis. 3. Coastal Tableland.I. Title. II. Series.

CDD 631.4

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# Comparison of Resin, Mehlich-1 and Mehlich-3 extractants for phosphorus, in Coastal Tableland soils

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*Lafayette Franco Sobral*

## Abstract

Assessment of P availability by Mehlich-1, currently used in the coastal tableland, was compared with that of the Mehlich-3 and resin. Twenty soil samples (0-20 cm depth) were collected from representative Oxisols, Ultisols and Spodosols in five States throughout the coastal tableland region. In order to evaluate P uptake by corn, an experiment was carried out in the greenhouse with 20 soils, and three replications. Correlation coefficients between corn P uptake and P extracted by Mehlich-1, Mehlich-3 and resin at corn harvest, were 0.61 e 0.56 e 0.72 for all soils and 0.85, 0.81 and 0.87 for soils with P lower than 40 mg dm<sup>-3</sup>. Comparisons between data obtained with Mehlich-1, Mehlich-3 and resin extractants, suggest that the Mehlich-1 is reliable for assessing soil P in the coastal tablelands soils.

Index terms: Soil fertility, soil testing, methods,

## **Comparação entre a resina, Mehlich-1 e Mehlich-3, para fósforo, em solos dos tabuleiros costeiros**

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### **Resumo**

Resumo: Nos solos dos tabuleiros costeiros, a análise de P é feita pelo extrator Mehlich-1, o qual foi comparado, à resina e ao Mehlich-3. Vinte amostras de solo foram coletadas na profundidade 0-20 cm em cinco Estados do Nordeste do Brasil em perfis descritos de Latossolos, Argissolos e Espodosolos, os quais são os mais representativos dos tabuleiros costeiros. Para obter a absorção de fósforo pelo milho, foi conduzido um experimento em casa de vegetação com vinte solos e três repetições. Os coeficientes de correlação entre o P absorvido pelo milho e o P extraído pelo Mehlich-1, Mehlich-3 e resina após o cultivo do milho foram 0,61 e 0,56 e 0,72 para todos os solos e 0,85, 0,81 e 0,87 para os solos com P menor que  $40 \text{ mg dm}^{-3}$ . Os dados comparativos entre os extratores Mehlich-1, Mehlich-3 e o método da resina, sugerem que o Mehlich-1 é um extrator adequado para os solos dos tabuleiros costeiros.

Termos para indexação: Fertilidade do solo, análise de solo, métodos.

## Introduction

Oxisols, Ultisols, Spodosols, and Entisols are the predominant soils in the Brazilian coastal tableland. These soils have low CEC and kaolinite is the primary clay mineral. Soil laboratories in the region extract P with the Mehlich-1. The resin procedure (Raij et al., 1986) and the Mehlich-3 (Mehlich, 1984) are potential alternatives to the Mehlich-1. The Mehlich-1 solution is a mixture of two acids which extracts portions of complexed and strongly adsorbed nutrients through a dissolution process. In the Mehlich-3 solution (Mehlich, 1984) the acetic acid buffers the solutions to a pH 2,5 and the nitric acid dissolves calcium phosphates. In addition, the ammonium fluoride extracts P related to iron and aluminum. Miranda et al. (2002) observed that Mehlich-1, Mehlich-3 and resin correlated well and both solutions showed a good prediction of available P in cerrado soils. The amount of P extracted was in the following order: resin > Mehlich-3 > Mehlich-1. Mylavarapu et al., (2002) obtained good correlation coefficients between Mehlich-1 and Mehlich-3 and the Mehlich-3 extracted more P than the Mehlich-1. The resin method is based on anion and cation exchange. Raij et al., (1986, 2001) improved this technique decreasing the time of analysis, making it feasible for routine work. Bissani et al. (2002) concluded that the resin removed more P than the Mehlich-1 and the difference was greater in soils with more than 400 g kg<sup>-1</sup> of clay content

The objective of this investigation was to compare soil phosphorus extractions with the Mehlich-1, the resin and the Mehlich-3 methods, in soils from the Brazilian Coastal Tablelands.

## Materials and Methods

Twenty soil samples (0-20 cm depth), were collected from representative Ultisols, Oxisols and Spodosols in the Brazilian coastal tablelands, where soil profiles had been described. Soil organic matter, clay content, and pH in water were determined according with procedures described in Silva (1999) . Mehlich-

1-, Mehlich-3- and resin-extractable P contents were determined according with Silva (1999), Mehlich (1984) and Rajj et al., (1986), respectively.

In order to evaluate P uptake by corn, an experiment was carried out in the greenhouse with 20 soils, and three replications. Each pot contained 2 L of soil, limed with  $\text{Ca(OH)}_2$  based on its aluminum content, with a lime factor of 2 and, subsequently, incubated moist for 30 days. Final pH values in water ranged from 4.1 to 6.2 among the 20 soils. Eight corn seeds were sown to each pot. All pots received weekly additions of 0.1 L of a nutrient solution containing  $\text{KNO}_3$ ,  $\text{Ca(NO}_3)_2$ ,  $\text{MgSO}_4$ ,  $\text{H}_3\text{BO}_3$ ,  $\text{MnCl}_2$ ,  $\text{ZnSO}_4$ ,  $\text{CuSO}_4$  and  $\text{H}_2\text{MoO}_4$ . Pots were weighed daily and water was added to approximate water holding capacity, previously estimated as water retained at 0.10 atm tension. After 40 days, aboveground plant material was harvested, dried digested with a mixture of perchloric and nitric acids and analyzed for P. Soils were removed from the pots, mixed, and soil phosphorus analyses were accomplished with the Mehlich-1 (Silva, 1999), the Mehlich-3 (Mehlich-1984), and the resin procedure according to Rajj et al. (1986). Analysis of variance and regressions were performed with the Statistical Analysis System software (SAS, 1994).

## Results and Discussion

Correlation coefficients between P uptake by corn and P extracted by Mehlich-1, Mehlich-3 and resin at corn harvest for all samples were 0,61 e 0,56 e 0,72 respectively and samples with P higher than  $40 \text{ mg dm}^{-3}$ , moved away from the regression line. As phosphorus content in the great majority of soil samples in coastal tableland soils is lower than  $40 \text{ mg dm}^{-3}$ , correlation coefficients were also calculated for samples with P Mehlich-1 lower than  $40 \text{ mg dm}^{-3}$  and they increased to 0,85, 0,81 e 0,87 for Mehlich-1, Mehlich-3 and resin respectively (Figure 1). Even though the mechanisms of P removal are different for the three methods and according to Rajj et al. (2001) the resin is less influenced by clay content than the Mehlich-1, correlation coefficients between P uptake and P extracted by them are close. At the sampling depth of (0–20 cm) coastal tableland soils are low in clay content and kaolinite is the predominant clay mineral, making them alike. The correlation coefficients between P uptake and



Mehlich-1, Mehlich-3 and resin after adding soil attributes such pH,  $Al^{+3}$ , soil organic matter and clay contents into the regression model for all soils, were 0,74, 0,71 and 0,78 for the Mehlich-1, the Mehlich-3 and the resin respectively. Therefore, addition of these soil properties as explanatory variables did not contribute to improve the correlation coefficients between P uptake and P extracted by the three methods.

## Conclusions

1. Correlation coefficients between corn P uptake and P extracted by Mehlich-1, Mehlich-3 and resin at corn harvest, were 0.61 e 0.56 e 0.72 for all soils and 0,85, 0,81 and 0,87 for soils with P lower than  $40 \text{ mg dm}^{-3}$ .
2. Comparisons between data obtained with Mehlich-1, Mehlich-3 and resin extractants, suggest that the Mehlich-1 is reliable for assessing soil P in the coastal tablelands soils.

Table 1. Range, means and standard deviations for initial values of pH, clay and organic matter and P by Mehlich-1 of the twenty 20 soil samples.

	Range		Mean	Standard Deviation
	Minimum	Maximum		
pH in water	4.1	5.9	5.1	0.5
Organic matter, g kg <sup>-1</sup>	12.1	75.9	42.4	18.0
Clay, g kg <sup>-1</sup>	10.0	272.6	120.5	79.4
P Mehlich-1, mg dm <sup>-3</sup>	2.3	120.9	28.7	36.1

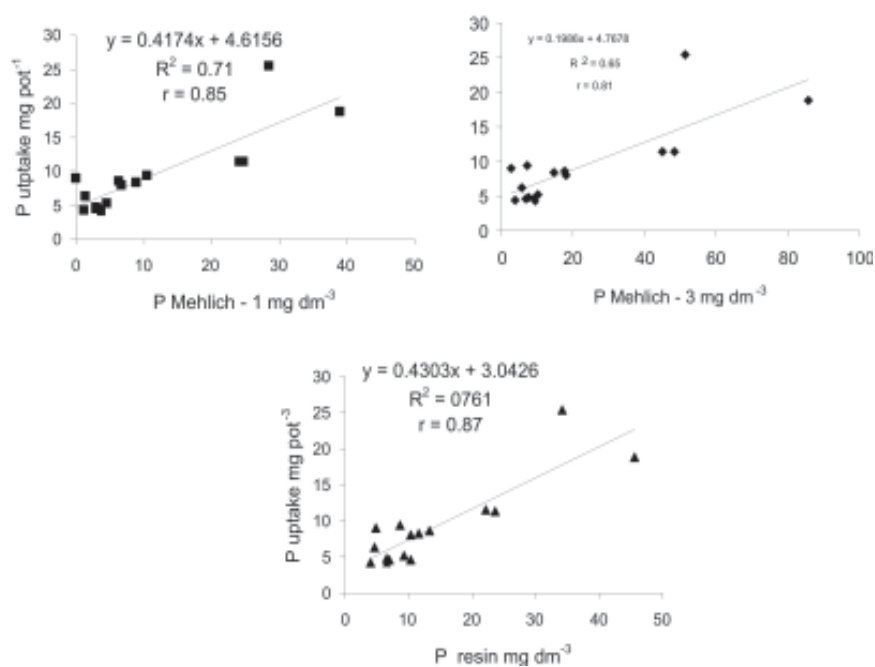


Figure 1. Linear regressions and correlation coefficients between P by Mehlich-1, Mehlich-3 and resin and P uptake by corn, for samples with P Mehlich - 1 lower than 40 mg dm<sup>-3</sup>.

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