Nitrogen Sources and Soil-Root Interactions Affect the Phosphorus Pools

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INTRODUCTION

N sources can change the conditions at root-soil interface, P availability to plants and P levels in different pools. N-ammonium uptake increases proton release (H^+), the work of symporters $H^+/H_2PO_4^-$ and decreases rhizosphere pH, while N-nitrate induces H^+ uptake by a H^+ co-transport system and alkalizes the rhizosphere. These processes can affect the P solubilization and to change P forms in the soil.

OBJECTIVE

The aim of this work is to study the impact of different N sources (ammonium-N, nitric-N and both) on the different P fractions in rhizosphere soil.

MATERIALS AND METHODS

15 treatments: three N fertilizers (calcium nitrate, ammonium sulfate and both) were combined with five P doses (0, 40, 80, 120 and 160 mg kg^{-1}) like triple superphosphate . N dose applied: 240 mg kg^{-1} → **4 replicates → CRD**

Greenhouse → Pots of 12 L → 2 plants for pot **(** *Zea mays* L.) → One month after emergence (Dec 11 2013) the soils were collected

Soil samples:

Separation of rhizosphere soil by shaking and washing (Liu et al., 2004) → Fresh soil (10 g) were oven-dried at 60°C for 72 h

Analysis (Air Dried Soil):

pH ($CaCl_2$) (Raij et al., 2001) and P fractionation (Hedley et al.,1982; Condron et al., 1985)

RESULTS

Table 1: Labile, moderately labile and non-labile P in rhizosphere soil.

Labile P (mg kg^{-1})			
	Form of N		
Doses of P (mg kg^{-1})	NITRATE	AMMONIUM	NITRATE/ AMMONIUM
0	9.84 a	3.93 b	3.52 b
40	12.07 a	7.13 b	6.34 c
80	14.87 a	11.02 b	9.49 c
120	16.49 a	16.82 a	16.72 a
160	19.55 c	21.18 a	20.55 b
ED	L**	L**	L**
CV (%)	3.07		
Moderately Labile P (mg kg^{-1})			
0	64.18 a	58.48 b	57.33 b
40	66.10 a	54.23 b	50.65 b
80	70.31 a	53.43 b	44.48 c
120	71.29 a	72.18 a	44.27 b
160	73.21 b	82.84 a	36.57 c
ED	L**	Q**	L**
CV (%)	5.30		
Non-labile P (mg kg^{-1})			
0	9.84 a	3.93 b	3.52 b
40	12.07 a	7.13 b	6.34 c
80	14.87 a	11.02 b	9.49 c
120	16.49 a	16.82 a	16.72 a
160	19.55 c	21.18 a	20.55 b
ED	L**	L**	L**
CV (%)	3.37		

Letters on the lines denote significant difference by Tukey Test (p<0,05). ED (Effect of Doses) by regression: L (linear); Q (quadratic); NS (not significant); * (p<0,05); ** (p<0,01).

Table 2: Geochemical, biological and total P in rhizosphere soil.

Geochemical P (mg kg^{-1})			
	Form of N		
Doses of P (mg kg^{-1})	NITRATE	AMMONIUM	NITRATE/ AMMONIUM
0	854.11 b	786.69 c	990.04 a
40	921.27 b	849.00 c	979.99 a
80	1031.38 a	869.02 c	925.38 b
120	963.26 a	881.29 b	994.16 a
160	980.12 a	890.01 b	943.48 a
ED	Q**	L**	NS
CV (%)	4.31		
Biological P (mg kg^{-1})			
0	66.36 b	80.05 a	66.15 b
40	63.56 b	59.55 b	70.66 a
80	62.98 a	46.18 c	57.73 b
120	60.72 b	73.86 a	61.96 b
160	68.24 b	112.79 a	51.38 c
ED	Q**	Q**	NS
CV (%)	4.26		
Total P (mg kg^{-1})			
0	1009.67 a	1007.92 a	1013.51 a
40	958.82 c	1001.76 b	1026.73 a
80	846.68 c	971.05 b	1009.64 a
120	924.53 c	959.92 b	987.23 a
160	985.00 c	1025.58 b	1048.21 a
ED	Q**	Q**	NS
CV (%)	5.17		

Letters on the lines denote significant difference by Tukey Test (p<0,05). ED (Effect of Doses) by regression: L (linear); Q (quadratic); NS (not significant); * (p<0,05); ** (p<0,01).

Table 3: pH in rhizosphere soil.

pH (mg kg^{-1})			
	Form of N		
Doses of P (mg kg^{-1})	NITRATE	AMMONIUM	NITRATE/ AMMONIUM
0	5.29 a	5.06 b	5.11 b
40	5.35 a	4.85 c	4.98 b
80	5.37 a	4.79 b	4.73 c
120	5.44 a	4.62 c	4.82 b
160	5.78 a	4.59 c	4.84 b
ED	Q**	L**	Q**
CV (%)	2.05		

Letters on the lines denote significant difference by Tukey Test (p<0,05). ED (Effect of Doses) by regression: L (linear); Q (quadratic); NS (not significant); * (p<0,05); ** (p<0,01).

- **N-ammonium → Increasing dose of P promote lowering pH;**
- **N-nitrate → Increasing dose of P promote increasing pH;**
- **Lower doses of P → N-ammonium showed lower P levels in soil;**
- **Highest dose of P → N-ammonium showed higher P level in soil.**

CONCLUSIONS

N-ammonium promote solubilization even in non-labile P forms and this behavior enhance P uptake of all fractions.

N-nitrate promote less solubilization of P, less consumption in all fractions and higher levels of P in the soil after maize cultivation.

Different forms of N affect the pH, solubilization of P, P fractions and mineralization of P in distinct ways.

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