GROWTH AND ACCUMULATION OF PHOSPHORUS IN MUNG-BEANS CULTIVATED IN INCEPTISOL FERTILIZER WITH DIFFERENT SOURCES AND DOSES OF PHOSPHORUS

Fabio Martins de Queiroga
Eng. Agro e Mestrando em Ciências do Solo da UFERSA – Universidade Federal Rural do Semi Árido. Mossoró, RN.
E-mail: fmartinsubi@gmail.com

Samuel Ângelo Diógenes da Costa
Mestre e Eng. Agro da Del Monte Fresh. Quixeré, CE. E-mail: teologosamuel@gmail.com

Francisco Hevilásio Freira Pereira
Prof. D. Sc., Professor da UFCG - CCTA – Campus Pombal, Rua João Leite, 517 – Centro, 58840-000 – Pombal - PB; Tel.: (83) 3431-2211, fhfpereira@hotmail.com

Patrício Borges Maracajá
Prof. D. Sc., Professor da UFCG - CCTA – Campus Pombal, Rua João Leite, 517 – Centro, 58840-000 – Pombal - PB; Tel.: (83) 3431-2211, patriciomaracaja@gmail.com

ABSTRACT: This study aimed to evaluate the response of mung-bean cultivated in inceptisol fertilized with different sources and levels of phosphorus and its correlation with the extraction of P from the soil using the extractor Mehlich-1. The experiment was conducted in a greenhouse belonging to the Federal Rural University of Semiarid (UFERSA) Mossoro-RN, in the period of 15/09/2000 to 20/10/2000, using a variety of mung-bean 'Green Mungo'. The treatments were consisted of two sources of phosphorus (phosphoric acid and phosphate monopotassium) and five doses of P_2O_5 (0, 200, 400, 600 and 800 kg ha^{-1}). The experimental design was completely randomized in a factorial 2 x 5 with four replications. The source and P levels provided changes in height and levels of phosphorus in plant and soil and exchangeable potassium in soil. The extractor Mehlich-1 has a greater capacity for recovery of phosphorus from the soil fertilized with phosphoric acid. The higher concentration of K in soil fertilized with KH_2PO_4, corroborate with the hypothesis that this fertilizer has problems of precipitation and release of exchangeable potassium in contact with the ground.

Keywords: Vigna radiculata L., phosphorus, phosphorus adsorption, mineral nutrition

CRECIMIENTO Y ACUMULO DE FOSFORO EN FRIJOL MUNGO CULTIVADO EN CAMBISOL FERTILIZADO CON DIFERENTES FUENTES Y DOSIS DE FOSFORO

RESUMEM: El presente trabajo objetivó evaluar la respuesta del frijol mungo cultivado en cambissol fertilizado con diferentes fuentes y dosis de fosforo y su interacción con la extracción de P del suelo utilizando el extractor Mehlich-1. El experimento fue desarrollado en un invernadero de la Universidad Federal Rural del Semi Árido (UFERSA), Mossoró-RN, entre 15/09/2000 y 20/10/2000, utilizando la variedad de frijol mungo 'Mungo Verde'. Los tratamientos fueran constituidos por dos fuentes de P (acido fosfórico y fosfato mono potásico) y cinco dosis de P_2O_5 (0, 200, 400, 600 e 800 kg ha^{-1}). Fue empleado el DIC, con arreglo factorial 2 x 5, con cuatro repeticiones. La fuente y las dosis de P proporcionaran cambios en la altura de plantas y en los contenidos de P en la planta y en el suelo y de potasio intercambiable en el suelo. El extractor Mehlich-1 tiene mayor capacidad de recuperación de P del suelo fertilizado con acido fosfórico. Los mayores contenidos de K en el suelo fertilizado con KH_2PO_4 se acuerdan con la hipótesis que dicho fertilizante presenta problemas de precipitación y liberación de potasio intercambiable cuando en contacto con el suelo.

Palabras-llave: Vigna radiculata L., fertilización fosfatada, adsorción de fosforo, nutrición mineral

CRESCIMENTO E ACÚMULO DE FÓSFORO EM FEIJÃO-MUNGO CULTIVADO EM CAMBISSOLO ADUBADO COM DIFERENTES FONTES E DOSES DE FÓSFORO

RESUMO: O trabalho teve como objetivo avaliar a resposta do feijão-mungo cultivado em cambissolo adubado com diferentes fontes e doses de fósforo e sua correlação com a extração de P do solo utilizando o extrator Mehlich-1. O experimento foi desenvolvido em casa de vegetação pertencente a Universidade Federal Rural do Semiárido (UFERSA), Mossoró-RN, no período de 15/09/2000 a 20/10/2000, utilizando a variedade de feijão mungo 'Mungo Verde'. Os tratamentos foram constituídos por duas fontes de fósforo (ácido fosfórico e fosfato monopotássico) e cinco doses de P_2O_5 (0, 200, 400, 600 e 800 kg ha^{-1}). O delineamento experimental utilizado foi o inteiramente casualizado, no esquema fatorial 2 x 5, com quatro repetições. A fonte e as doses de P proporcionaram alterações na altura de plantas e nos teores de fósforo na planta e no solo e de potássio trocável no solo. O extrator Mehlich-1 possui maior capacidade de recuperação do fósforo do solo adubado com ácido fosfórico. Os maiores teores de K no solo adubado com KH_2PO_4 corroboram com a hipótese de que esse adubo apresenta problemas de precipitação e liberação de potássio trocável quando em contato com o solo.

Palavras-chave: Vigna radiculata L., adubação fosfatada, adsorção de fósforo, nutrição mineral

INTRODUCTION

The mung-bean (Vigna radiculata L.) is an annual legume of upright and of easy adaptation to tropical and subtropical conditions. Its cultivars can produce up to 10 tons of green beans or 2 tons of dry beans per hectare. Of Indian origin and an average height of 0.60 m is much appreciated by the oriental people where the use of newly germinated seeds in the form of sprouts, is widespread. Moreover, it can also be consumed as string beans, grains in salads and stews. Most varieties grown in Brazil presents small seeds of green coloration, therefore, also known as Mungo-green (VIEIRA & VIEIRA, 2007).

Phosphorus is an element known for its high susceptibility to soil adsorption. This phenomenon may be amenable to the use of P by plants, but can also be harmful in step that the "aging" of soil cause their attachment in the P form of non-labile, by precipitation in solution with ionic forms of Fe, Al and Ca (NOVAIS & SMITH, 1999). Due to the high content of calcium present in soils derived from limestone, like the Cambisol in study that is rich in $CaCO_3$, the availability of P is committed to the exchange complex, making it unavailable for the formation of P-Ca at alkaline pH (MOREIRA et al., 2006, CHAVES et al., 2007). Aiming to reduce this inconvenience has been suggested the application of P in localized or use of phosphorus sources that, by enhancing soil acidification; reduce the formation of P-Ca. Despite this problem, the P is adsorbed by $CaCO^3$ in a lesser extent and with less energy than in oxidroxidos of Fe and Al as they occur in acidic soils (CHAVES et al., 2009).

Novais et al. (2007) observed in experiments with nine successive crops in different soil types in the United States that the way that more releases between P adsorption complexes of P is the P-Al, followed at a distance of P-Fe and, for your time P-Ca, with a contribution of only 3.2% only of P total absorbed by plants. In the plant P is particularly involved in the transfer of energy, because the ATP compound that contains P in its structure, is required for CO_2 assimilation in photosynthesis process and many other metabolic reactions of relevance in the plant (TAIZ & ZEIGER, 2004). In its inorganic form, Pi is a substrate or end product in many important enzymatic reactions, including those of carbohydrate metabolism and it's been essential for regulation of metabolic pathways in the cytoplasm, synthesis of starch and sucrose, the transport of phosphate-triosis and synthesis and synthese of hexoses (MITRA et al., 1993).

Phosphorus deficiency not only limits plant growth by direct effects but also by indirect ones too, by affecting the supply of nitrogen to the plant. Araujo & Machado (2006) points at least three kinds of general effects of the limited supply of P on N assimilation: a reduction in the absorption and translocation of NO_{-3} to the shoot apparently due to restriction by the symplast transport and accumulation of amino acids in leaves and roots as a result of inhibition of synthesis or degradation of proteins.

Leguminous species in most of them, depend on the biological fixation of N_2. As a consequence presents a higher P requirement for obtaining optimal growth than plants supplied with NO_3-. This is because the processes associated with N_2 respond more strongly to P supply than the actual plant growth (ARAUJO & MACHADO, 2006). The reduction of atmospheric N_2 that occurs in bacteroids and the incorporation of NH_4^+ into amino acids and ureides that occurs in the plant fraction of nodules they are consumed processes of energy dependent on the availability of ATP (LARCHER, 2000).

Given the above, the study aimed to evaluate the response of mung-bean grown in Cambisol fertilized with different sources and levels of phosphorus and its correlation with the extraction of P from the soil using the extractor Mehlich-1.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse belonging to the Federal University of Semi Arid (UFERSA) Mossoro-RN, in the period of 15/09/2000 to 20/10/2000. It was used a variety of mung-bean 'Mungo Green'. Cultures were grown in pots with a capacity of 20 L filled with sieved soil (sieve No. 2) and dry shadow for a period of 10 days. The soil was collected in the Apodi Plateau, municipality of Baraunas-RN. Here the soil is classified as Cambisol, derived from limestone and clay texture (coarse sand = 38.4, 17.6 = fine sand, silt = 13.3 = and clay 30.7 g kg^{-1}), whose average results of chemical analysis before the experiment installation were: pH in H_2O (1:2.5) = 6.5, P = 7.2 and K = 385.1 mg dm^{-3}, Ca = 9.0 , Mg = 1.5, Al = 0.0, H + Al = 0.83, SB = 11.56; CTC = 12.39 cmolc dm^{-3} and MO = 1.19 g kg^{-1}.

The treatments were consisted of two sources of phosphorus (phosphoric acid and phosphate monopotassium) and five doses of P_2O_5 (0, 200, 400, 600 and 800 kg ha^{-1}). The experimental design was completely randomized in a factorial 2 x 5 with four repetitions. The experimental unit consisted of one pot containing one plant. The pots were arranged in a spacing of 0.30 x 0.20 m. The fertilizers were homogenized and irrigated with 70% of field capacity during eight days before planting.

The seed was doing on 15/09/2000, directly into the soil to a depth of approximately 2.0 cm, placing five seeds per pot. Five days after emergence plants were thinned out leaving only one plant per pot. The amount of nutrient applied in coverage during the experiment was 40 kg N ha^{-1}. Irrigation was done by keeping the soil with 70% of field capacity.

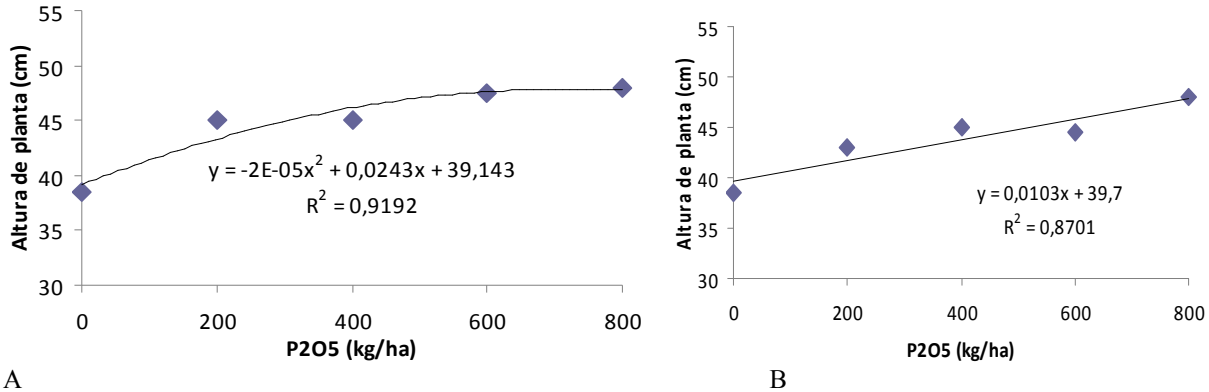
Evaluations were performed at 45 days after sowing (DAS), which corresponds to approximately 80% of vegetative growth. On this occasion were determined height (cm) and P content in dry matter (g/100g) of the plants and the EC (dS m^{-1}), P in Mehlich-1 (mg dm^{-3}) and exchangeable K (cmol dm^{-3}) in the soil.

Data were subjected to analysis of variance and regression performed the different equations in relation to the doses of P_2O_5 and tests an average of 5% probability for mean comparison between the sources of phosphorus. Analyses were performed using the software SISVAR.

RESULTS AND DISCUSSION

There was no significant interaction between P sources and rates of P_2O_5 for plant height and P in dry matter. Moreover, there was a significant effect on these traits alone for doses of P_2O_5 on each phosphorus source evaluated (Figure 1 and 2). For the height of plants fertilized with phosphoric acid was observed quadratic effect with maximum height of 46.50 cm at a dose of 605 kg P_2O_5ha-1 (Figure 1A). At fertilization with phosphate (KH2PO4) was observed with a linear increase of 2.06 cm in plant height for each 200 kg P_2O_5applied (Figure 1B).

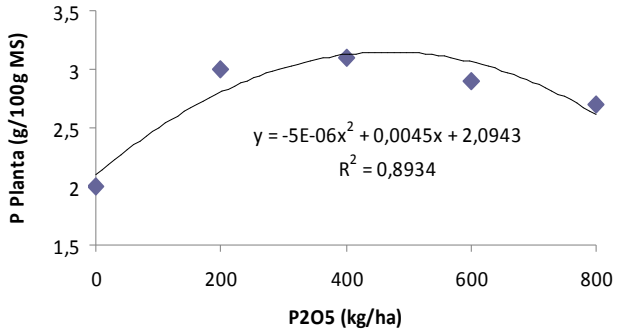
This linear behavior for KH_2PO_4 can be explained by the low solubility of fertilizer in an alkaline environment and rich in calcium. Part of the applied phosphorus may have been precipitated as Ca (H_2PO_4) or Ca_3 $(PO_4)_2$ and it was not enough to express the maximum potential height growth of mung-beans. Gargantini (1973) obtained in the cultivation of wheat equal response to fertilization with different sources of phosphorus in soil with acidity corrected.



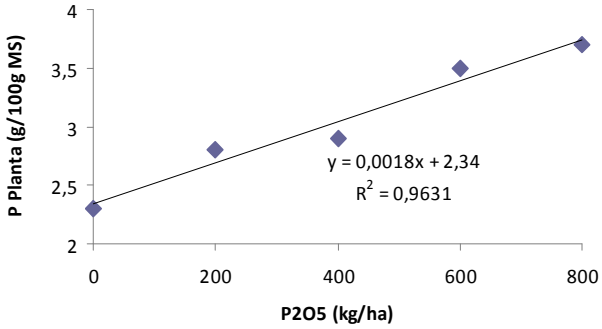
A B

Figure 1. Plant height in mung-bean subjected to doses of P_2O_5 kg ha-1 and fertilizer with phosphoric acid (A) and monopossium phosphate (B). Mossoro, UFERSA, 2000.

For the P content in dry matter in plants fertilized with phosphoric acid was observed quadratic effect with P content up to 3.1 g $100g^{-1}$ at a dose of 450 kg ha^{-1} P_2O_5 (Figure 2A). At fertilization with monopotassium phosphate was observed to increase linearly with 0.36 g 100 g^{-1} P content of each 200 kg of P_2O_5 applied (Figure 2B).



A



B

Working with the same Haplic Cambisol Amaro et al (1998) found in experiments with melon that the dose of phosphorus highest productivity was 130 kg ha^{-1} $P_2O_5$and that the extractor Mehlich-1 showed good correlation with the dose of P_2O_5 applied when it was used phosphoric acid simple superphosphate and triple as source of phosphorus. Menezes Junior et al. (2009) found significant accumulation of phosphorus in millet plants subjected to fertilization with H_3PO_4. There was significant interaction between P sources and rates of P_2O_5 for EC and P and isolated sources in relation to potassium concentration in soil (Table 1).

For both sources of P to soil electrical concentration decreased with increasing dose of P_2O_5 and remained constant from the dose of 200 kg ha^{-1} for phosphoric acid and 400 kg ha^{-1} to potassium phosphate. For the sources of P was found only significant difference between doses 0 and 200 kg ha^{-1} with phosphoric acid at a dose showing greater value 0 and monopotassium phosphate at a dose 200 kg ha^{-1} (Table 1).

The Mehlich-1 extractor has a greater capacity for recovery of phosphorus from the soil fertilized with phosphoric acid in relation to monopotassium phosphate (Table 1). Lima & Oliveira (1998) studied with several extractors of P in different samples of representative soils from Rio Grande do Norte, also found better rates of biological correlate with the Mehlich-1 extractor.

Table 1. Soil characteristics, assessed in the experimental plots with two phosphorus sources. LSD - least significant difference for P sources

	pH em H_20 (1:2,5)		CE (dS m^{-1})		P Mehlich-1 (mg dm^{-3})		K ($cmol_c$ dm^{-3})	
	H_3PO_4	KH_2PO_4	H_3PO_4	KH_2PO_4	H_3PO_4	KH_2PO_4	H_3PO_4	KH_2PO_4
0	8,1	8,1	0,15	0,14	7,7	7,3	0,50	0,54
200	8,2	8,2	0,13	0,14	6,0	6,0	0,47	0,54
400	8,2	8,2	0,13	0,13	11,0	5,7	0,49	0,52
600	8,2	8,1	0,13	0,13	18,7	6,3	0,48	0,54
800	8,1	8,1	0,13	0,13	13,7	7,3	0,47	0,50
DMS dose	0,12		0,01		5,97		0,05	
Average	8,16	8,14	0,13	0,13	11,42	6,52	0,48	0,53
DMS fonte	0,036		0,002		1,85		0,012	

DMS – least significant difference for sources of phosphorus.

For fertilization with phosphoric acid was found higher concentrations of soil P at doses 600 and 800 kg ha^{-1}. For fertilization with monopotassium phosphate was not observed significant effect between doses. Comparing the sources within each P level, a significant difference was found for doses 400, 600 and 800 kg ha^{-1} with higher values being observed at fertilization with phosphoric acid (Table 1). The increased concentration of P in soil fertilized with H_3PO_4 is due to higher solubility of this source in soils of alkaline reaction when compared to KH_2PO_4.

The concentration of potassium in the soil was greater when fertilized with monopotassium phosphate in depend of levels of P_2O_5 applied (Table 1). The highest values of exchangeable K in soil fertilized with KH_2PO_4 due to higher amount of K contained in this source of fertilizer.

CONCLUSIONS

The source and P levels provided changes in height and levels of phosphorus in plant and soil and exchangeable potassium in soil; The Mehlich-1 extractor has a greater capacity for recovery of phosphorus from the soil fertilized with phosphoric acid ; The highest concentration of K in soil fertilized with KH_2PO_4 corroborate the hypothesis that this fertilizer has problems of precipitation and release of exchangeable potassium in contact with the ground.

REFERENCE

AMARO, K.M.M.; OLIVEIRA, M. de e LIMA, A.O. Recuperação de fósforo pelos extratores Mehlich-1 e Bray em solo calcário após adubação fosfatada. In **FERTBIO 98**. Caxambu, 11 a 16 de outubro de 1998. p. 207. RESUMOS.

ARAUJO, A.P.; MACHADO, C. T. T.; Fósforo. In: FERNANDES, M.S. Nutrição mineral de plantas. Viçosa: UFV, 2006. p.251-280.

CHAVES, L. H. G.; CHAVES, I. B.; MENDES, J. S. Adsorção de fósforo em materiais de latossolo e argissolo. Caatinga, v. 20, n.3, p. 104-111, 2007.

CHAVES, L. H. G.; CHAVES, I. B.; NASCIMENTO, A. K. S.; SOUSA, A. E. C. Características de adsorção de fósforo em argissolos, plintossolos e cambissolos do estado da Paraíba. Engenharia Ambiental – Espírito Santo do Pinhal, v. 6, n. 2, p. 130-139, 2009.

GARGANTINI, H.; SOARES, E. Efeitos de diversos fertilizantes fosfatados na produção de trigo cultivado em vasos. Bragantia, v.32, n.9, p.193-200, 1973.

LARCHER, W. Ecofisiologia Vegetal. Trad. Carlos Henrique B. A. Prado (3 ed.), São Carlos: Rima, 2000. 531 p.

LIMA, A. de O.; OLIVEIRA, M. Fósforo assimilável em solos representativos do Estado do Rio Grande do Norte. Caatinga, **v.** 11, n. 1/2, p. 65-70, 1998**.**

MENEZES JÚNIOR, J.C. et al. Nutrição do Milheto (Pennisetum glaucum) cultivado em solo salino-sódico submetido a dosagens de ácido fosfórico. In: XII Congresso Brasileiro de Fisiologia Vegetal. Fortaleza, 7 a 12 de setembro de 2009. p.156. RESUMOS.

MITRA, S.; BHARDWAJ, S. N. & SRIVASTAVA, G. C. Source and sink relationship. In: ABROL, Y.P.; MOHANTY, P. & GOVINDJEE (eds.) Phothosyntesis: photoreactions and plant productivity. Dordrecht: Kluwer Academic Press, 1993. p.361-387.

MOREIRA, F. L. M.; MOTA, F. O. B.; CLEMENTE, C. A.; AZEVEDO, B. M.; BOMFIM, G. V. Adsorção de fósforo em solos do Estado do Ceará. Revista Ciência Agronômica, v. 37, n. 1, p. 7-12, 2006.

NOVAIS, R. F.; SMYTH, T. J. Fósforo em solo e planta em condições tropicais. Viçosa: UFV, 1999. 399p.

NOVAIS, R.F.de; ALVAREZ V., V.H.; BARROS, N.F.de; FONTES,R.L.F.; et al. Fertilidade do solo. Viçosa: UFV, 2007. 1017 p.

TAIZ, L.; ZEIGER, E. Fisiologia Vegetal. Trad. Eliane Romanato Santarém et. al. (3 ed.), Porto Alegre: Artmed, 2004. 719 p.

VIEIRA, F. V.; VIEIRA, C. Feijão Mungo-Verde. In: PAULA JÚNIOR, T. J.; VENZON, M. (EdS.) 101 culturas: manual de tecnologias agrícolas. Belo Horizonte: EPAMIG, 2007, p. 355-358

Recebido em 10/12/2009
Aceito em 31/03/1010