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Soil bioactivator in the development of corn plants

Bioativador de solo no desenvolvimento da planta de milho

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Abstract: Corn is a plant that requires significant concentrations of phosphorus (P) to complete its development. The objective of this work was to verify the efficiency of soil bioactivator (Penergetic K®) associated with simple super phosphate applications in the phosphorus release adsorbed to corn plants. The research was conducted in a greenhouse, in a randomized block design with three replications, arranged in a 4 x 2 factorial scheme, with four doses, with and without bioactivator addition (600g ha-1), totaling eight treatments in 24 hours. Plots: 0% single superphosphate (with and without bioactivator), 25% single superphosphate (with and without bioactivator), 50% single superphosphate (with and without bioactivator) and 100% single superphosphate without bioactivator. The plots consisted of 10 dm3 pots with two plants per pot (Biomatrix 2b655 hybrid). The parameters related to the characteristics of vegetative growth (plant height), root length, root dry weight and aerial part dry weight were evaluated. The results were subjected to analysis of variance using the 5% Scott-Knott test with the aid of SISVAR® software and then plotted on graphs for analysis of the results. The application of Pernergetic K® soil bioactivator did not interfere with the initial development of corn crop.
Keywords: Adsorption. Pernegetic K®. Phosphorus.

Resumo: O milho é uma planta que requer concentrações significativas de fósforo (P) para completar seu desenvolvimento. O objetivo deste trabalho foi verificar a eficiência do bioativador do solo (Penergetic K®) associado a aplicações de superfosfato simples na liberação de fósforo adsorvido a plantas de milho. A pesquisa foi conduzida em casa de vegetação, em delineamento de blocos casualizados, com três repetições, dispostos em esquema fatorial 4 x 2, com quatro doses, com e sem adição de bioativador (600g ha-1), totalizando oito tratamentos em 24 horas. Parcelas: 0% de superfosfato simples (com e sem bioativador), 25% de superfosfato simples (com e sem bioativador), 50% de superfosfato simples (com e sem bioativador) e 100% de superfosfato simples sem bioativador. As parcelas consistiram de vasos com capacidade de 10 dm3, com duas plantas por vaso (híbrido Biomatrix 2b655). Foram avaliados os parâmetros relacionados às características de crescimento vegetativo (altura das plantas), comprimento de

raiz, peso da massa seca da raiz e massa seca da parte aérea. Os resultados foram submetidos à análise de variância, usando o teste de Scott-Knott a 5% com auxílio do software SISVAR® e posteriormente plotados em gráfico para análise dos resultados. A aplicação do bioativador do solo Pernergetic K® não interferiu no desenvolvimento inicial da cultura do milho.
Palavras-chave: Adsorção. Pernegetic K®. Fósforo.

Introduction

The corn crop (*Zea mays* L.) is one of the most important in the world, cultivated areas, value of production and the main source of carbohydrates. In Brazil, corn has been grown in the most varied climatic and soil conditions, whose annual production is estimated at billions of tons, which requires a constant search for new technologies that provide greater stability, profitability, cost reduction and consequently greater profitability.

Crop productivity depends, among other factors, on the adequate supply of nutrients, and the supply of phosphorus (P) via fertilization is an essential practice in Brazilian soils (STAUFFER; SULEWSKI, 2003). Although phosphorus requirements are much lower than those in nitrogen and potassium, the normally recommended doses are high, due to the low efficiency (20 to 30%) of this nutrient used by the crop due to the phosphorus adsorption high capacity added to the soil, reducing its availability to the plants, since the occurrence of the adsorption sites of P in the soil by the organic matter, where the carboxylic and phenolic functional groups of the organic acids bind to the hydroxyls of the iron oxides and aluminum and complex the aluminum in solution (BASTOS et al., 2010).

The organic matter can also originate organic binders released during the mineralization process, which can form complexes with aluminum or soluble complexes with the P of the soil solution, avoiding that it is adsorbed. (CORRÊA et al., 2008). Phosphorus is crucial in plant metabolism, playing an important role in cell energy transfer, respiration and photosynthesis. The adequate supply of P is thus extremely important in the early stages of plant growth (GRANT et al., 2001). This element is an integral part of several chemical molecules, such as phosphate sugars, nucleotides, coenzymes, phospholipids, phytic acid, as well as being a structural part of adenosine diphosphate (ADP) and adenosine triphosphate (ATP). It is also related to root growth, fruit maturation, grain formation, fruit and fiber, and plant vigor. (VITTI; WIT; FERNANDES, 2004).

To supply the demand for P in the corn crop, after several studies, the technology of soil bioactivators (Penergetic K®) was developed, based both on the methods and practices of the classical natural sciences and on phenomena that were object of extensive experimentation and observation, but whose mechanisms cannot yet be exhaustively described in terms of traditional theoretical models. Penergetic K®, developed in Europe, aims to improve and accelerate the process of decomposition and mineralization of straw, establishing a better balance of soil microorganisms, promoting a better rooting and microbial symbiosis, increasing the surface area of soil radicular, mineralize and solubilize phosphorus (P) immobilized in the soil, leading to the economic and sustainable use of fertilizers (FERNANDES; SANTINATO; SILVA, 2014). In addition, Penergetic K® has an action on soil bacteria, increasing its activity, resulting in an improvement and acceleration of the organic matter decomposition process, which establishes a better balance of soil microorganisms, mineralizing and solubilizing immobilized phosphorus in the soil, these are some of the benefits of the product (FERNANDES; SANTINATO; SILVA, 2014). Its composition presents SiO_2 (560g kg^{-1}) and other nutrients such as Al_2O_3 (160 g kg^{-1}), Fe_2O_3 (40 g kg^{-1}), MgO (40 g kg^{-1}), K_2O (20 g kg^{-1}) and Na_2O (4 g kg^{-1}). The corn crop is 250 to 300 g ha^{-1}(COBUCCI; NASCENTE; LIMA, 2015).

Several studies have demonstrated the benefits of Si in several crops, such as: low transpiration coefficient with better water use, higher chlorophyll content, greater tissue structural rigidity with more upright increased mechanical resistance of the leaves, larger photosynthetic area and greater absorption of CO_2. In the present study, it is suggested that soil bio-activators preserve and stimulate the ability of plants to tolerate adversities, since they increase the biological, physiological and energetic balance of the cultivated plants. The objective of this study was to verify the efficiency of soil bioactivator (Penergetic K®) for single super phosphate applications in the release of phosphorus adsorbed to corn plants.

Material and Methods

The research was carried out in September 2016 in the municipality of Carvalhópolis - MG, located at approximately 860 m above sea level, average rainfall of 1500 mm per year. The climate was classified as Cwa, according to the international classification of Köppen (CUNHA; MARTINS, 2009). The predominant vegetation type in the region is forest type and the topography of the place is flat.

The corn cycle (Biomatrix 2b655), of precocious cycle, with medium size, presenting protandria, was used. Its characteristics are semi-red grains of orange-red color, requiring 840 degrees days to bloom.

Penegetic K®, in a single dose of 600 g ha^{-1}, was applied as a soil bioactivator and the phosphorus source used was the single super phosphate containing 18% P_2O_5. The experiment was carried out in a randomized block design with three replicates, arranged in a 4 x 2 factorial scheme, with four doses, with and without the addition of a bioactivator, totaling eight treatments in 24 plots: 0 % of single super phosphate, 50 % of single super phosphate and 100 % of single super phosphate, with and without bioactivator, with the standardization of single super phosphate 250 kg ha^{-1}. In this study, the soil was classified as an Oxisol (dysphric red oxisol), presenting characteristics of high or low clay activity, being generally moderately acidic soils (EMBRAPA, 2006).

The soil used in the study was classified as Oxisol, with a clay texture, with the following chemical properties analyzed in the upper layer 0-20 cm (SILVA, 1999): pH (H_2O) = 5,5; P-Mehlich = 8,2 mg dm^{-3}; K^+ = 275 (mg dm^{-3}); Mg^{2+} = 1,0 $cmol_c$ dm^{-3}; Ca^{2+} = 3,4 $cmol_c$ dm^{-3}; Al^{3+} = 0 $cmol_c$. dm^{-3}; H + Al = 4,7 cmol / dm^{-3}; sum of bases = 5,1 $cmol_c$ / dm^{-3} base saturation (V%) = 52; organic matter (OM) = 3,2 dag kg^{-1}; t = 5,1 $cmol_c$ / dm^{-3}; T = 9,8 $cmol_c$ / dm^{-3}.

Liming was performed aiming to raise the saturation value by 70 %, with the need for liming calculated by the method of base saturation in which dolomitic limestone was used with 45 % Ca, 9 % Mg and 95 % PRNT (ALVAREZ; RIBEIRO, 1999). All treatments received the same basic fertilization for macros and micronutrients (except phosphorus element), which doses were varied and tested for potted cultures (ALVES et al., 1999).

Six seeds were sown per pot of the Biomatrix 2b655 hybrid and, when emerged, thinning was performed where only two plants per pot were maintained, the most vigorous. Cover fertilization was carried out 19 and 35 days after emergence of the seedlings, using 155 kg ha $^{-1}$ of urea when the plants were 3 to 6 leaves, respectively, according to recommendation Francelli (2001).

In irrigation control, soil moisture characteristic curve data, determined by tensiometers installed at a depth of 0,15 m distance from the stem, were used. The water content in the soil / pot system was monitored and always maintained above 60 % of the soil field capacity.

On reaching the flowering stage, the parameters of vegetative growth characteristics were evaluated, such as: plant height, root length, dry root weight, and dry weight of shoot. It was used for drying the forced air greenhouse at 60 °C for 7 days to determine the root dry mass and area.

The results were submitted to analysis of variance, using the Scott-Knott test, with the aid of statistical software SISVAR (FERREIRA, 2014).

Results and Discussion

The present research evidences that the treatment with 100 % of P_2O_5 in corn crop was what promoted a better development when compared to the treatment where P_2O_5 was associated with bioactivator, that presented same result of the treatment where it was used only with P_2O_5, not differing statistically. The evaluated parameters were the characteristics related to plant height, shoot green weight, dry shoot weight, root dry weight, and are shown in Table 1.

Table 1. Results of plant height, green shoot weight, shoot dry matter weight and dry weight of the root system, Machado - MG, 2016.

TREATMENTS	Penergetic K®	PLANT HEIGHT (m)	GREEN WEIGHT GIVES AIR PART (g)	DRY WEIGHT FROM AIR PART (g)	DRY WEIGHT ROOT (g)
100 % P_2O_5	+	1.12Aa	194.33Aa	47.32Aa	19.85Aa
100 % P_2O_5	-	0.93Aa	189.03Aa	42.38Aa	19.82Aa
50 % P_2O_5	+	0.91Ba	85.50Bb	21.03Bb	16.78Aa
50 % P_2O_5	-	0.89Ba	84.53Bb	23.06Bb	20.33Aa
25 % P_2O_5	+	0.65Cb	28.73Cc	13.53Cc	12.16Bb
25 % P_2O_5	-	0.57Cb	35.93Cc	15.91 Cc	12.21Bb
0 % P_2O_5	+	0.41Dc	16.10Cd	11.47Cc	11. 43Bb
0 % P2O5	-	0.37Dc	20.63Cc	12.51Cc	11.01Bb
CV %		7.42 %	31.75 %	14. 32 %	9. 68 %

Equal capital letters in the column do not differ at the 5% significance level. Lower case letters on the same line do not differ at the 5% significance level.

For the characteristic plant height, the phosphorus dose interfered, conditioning the statistical differences between the dosages, and between the association with the use of the bioactivator. There were also differences between the associations with phosphorus doses, observed in the treatments with 25 % and 0 %.

In relation to the green and dry weight of the aerial part, the bioactivator action was observed in the 100 % dosage when compared to the others, the 100 % dosage of phosphorus was also superior to the other treatments.

In relation to root dry weight the P dosage had an influence on the results, where above 50 % of the dosage values were the best, and below this dose a statistical difference was observed, which was also observed in these dosages when associated with bioactivator.

As it can be observed, the treatment that received 100% of P_2O_5 had a satisfactory result compared to the other treatments, evidencing that the application of the soil bioactivator does not interfere with the growth and development of the corn plant. It can also be observed that as the dose of P_2O_5 was reduced, the performance was also reduced in the same proportion. According to Souza (2010), the application of soil bioactivator did not provide significant differences in the height parameter of plants in wheat crop, besides not having changed the values for a thousand grain weight.

According to the results found by Pádua (2010), it can be verified that the soil bioactivator has a positive effect on the productivity of the bean crop, being justified by the silicon-based composition, which acts at the adsorption sites of phosphorus. But according to the experiment conducted by Franzote et al. (2004), the application of silicon does not interfere in the increase of productivity. Therefore, the application of soil bioactivator has not been shown to promote statistically significant differences in corn crop.

Conclusions

According to the results obtained, the application of Pernergetic K® soil bioactivator in the present study did not interfere in the initial development of corn crop.

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