Factors related to potato productivity

Henry Sako[1*]; Carlos Francisco Ragassi[1]; Leandro Eiji Hashimoto[1]; Murillo Grespan da Rocha[1]; José Laércio Favarin[1]; Paulo César Tavares de Melo[1].

[1]ESALQ/USP – Departamento de Produção Vegetal. CP-9, 13.418-900, Piracicaba – SP: henrysk@uol.com.br (*author for correspondence), cragassi@gmail.com.br, lehazuki@hotmail.com; mgrocha@esalq.usp.br; jlfavari@esalq.usp.br; pctmelo@esalq.usp.br

Abstract

Potato is the fourth most important crop in the world and it is an essential food resource worldwide. Phosphorus uptake, which is closely related to the potato crop yield, is both influenced by the soil nutrient concentration and the oxygen supply to roots. To evaluate the factors associated to phosphorus uptake, it was conduced a complete randomized blocks experiment in factorial (3x4) scheme with three grass crops (*Brachiaria brizantha* cv Marandu, *Panicum maximum* cv Tanzania and *Zea mays*), cultivated prior to potato cv. Atlantic, and four levels of phosphorus (100, 400, 700, 1000 kg.ha^{-1} of P_2O_5) applied to soil before the sowing of the grasses. The residual phosphorus affected significantly the potato productivity, which was not influenced by the previous crop.

Keywords: Crop rotation, organic material, phosphorus uptake.

Introduction

Potato is the fourth most important crop in the world and it is an essential food resource worldwide. The potato protein production per unit of area is 52% and 78% higher in comparison to wheat and rice, respectively. Few crops can produce that quantity of proteins and carbohydrates in the same area (Stevenson *et al*., 2001). For the food security, the establishment of efficient production methods is essential, such as the crop rotation and the phosphorus (P) application. Phosphorus is an essential element to the starch synthesis and, consequently, to the potato productivity (Marschner, 1995). The potato P absortion efficience is lower in comparison to other crops, such as cassava and pumpkin (Dechassa *et al*, 2003; Vander Zaag *et al* 1979). Pursglove & Sanders (1981) observed that the potato crop recovered only 4% of the applied phosphorus, which makes potato a crop highly sensible to the factors associated to the absorption of that nutrient. Both the soil nutrient concentration and the plant metabolic activity affect the nutrient absorption (Marschner, 1995), which relies on the oxygen supply to the generation of energy and to support the cell activity. The adequate oxygen supply relies on the establishment of soil macropores and water stable aggregates formation. Crop rotation affects the soil physical properties by the roots action, which releases organic material to the system. Silva & Mielniczuk (1998) observed that grasses affect positively to the soil aggregation, which is due to its high root production. Towards the root system production capacity, *Brachiaria brizantha* cv. Marandu is enhanced among the grasses (Kanno *et al*, 1999), while *Panicum maximum* cv. Tanzania presents the highest shoot biomass production. Considering the importance of the soil physical, chemical and biological attributes, this research was conducted to evaluate the influence of the previus crop, associated to different phosphorus levels, on the potato crop productivity.

Material and methods

The experiment was a fatorial (3x4) scheme arranged in complete randomized blocks with six replicates. The treatments were combinations among three grasses (*Brachiaria brizantha* cv Marandu, *Panicum maximum* cv Tanzania and *Zea mays* L.), cultivated prior to potato cv. Atlantic, and four P levels (100, 400, 700 e 1000 kg . ha^{-1} P_2O_5). On November, 2007, just before the sowing of the grasses, a deep soil tillage was proceeded up to 80 cm. On April, 2008, the grasses were cut and milled and the straw remained on the soil surface for 30 days. Then, the soil was prepared and, on May, the potato crop was installed. On September, productivity was evaluated by F and Duncan tests at 5%.

Results and discussion

The residual phosphorus affected significantly the potato productivity and the highest yield was obtained with 700 kg.ha^{-1} P_2O_5 (Figure 1).

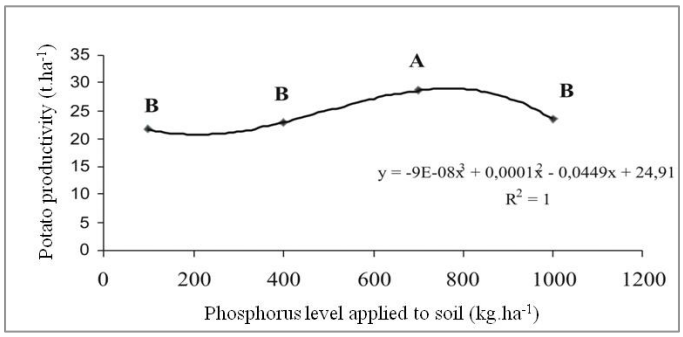

Figure 1. Potato yield affected by different levels of phosphorus applied to soil. Different letters mean significant difference (Duncan test at 5%) among treatments. Variation coefficient: 26.3%

The P absorption efficiency ranges among the potato varieties, due to the plant physiology and its interaction with the environment (Sattelmacher et al, 1990; Harris, 1992). The level of P which proportioned the highest potato cv. Atlantic yield (700 kg.ha^{-1} P_2O_5) resulted in a leaf P content of 4,8 g of P per kg of dry leaf tissue (Figure 2), which is higher than the optimum P leaf content determined to the potato cv. Aquila, which ranged from 2,5 to 2,7 g.kg^{-1} (Gallo et al, 1970); it is, also, higher than the standard value of 3,5 g.kg^{-1} suggested by Malavolta (2006). It indicates the potato cv. Atlantic is highly dependent on phosphorus. The P_2O_5 level of 1.000 kg.ha^{-1} led to a reduction of the leaf zinc content in comparison to the P level of 700 kg.ha^{-1} (Figure 2), possibly due to the competition between those nutrients during the uptake process (Malavolta, 2006), which may have let to the observed decrease in potato yield.

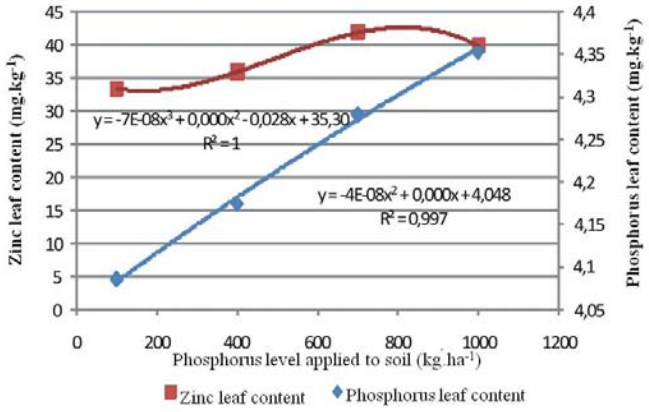

Figure 2. Relationship among levels of phosphorus applied to soil on foliar contents of phosphorus and zinc

The effect of the grasses cultivated prior to the potato crop were not detected but, nevertheless, Bishop & Grimes (1978) obtained increases in the potato productivity due to the improvement of soil macroporosity, achieved by the adoption of deep tillage and zero traffic systems. In this work, the cultivation of grasses with different characteristics of shoot and root production proportioned distinct effects to the soil macroporosity (Rocha et al, 2008), but, instead of it, the potato yield was not affected.

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