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Zinc and Phosphorus Interaction in Phosphorus-Efficient and Inefficient Wheat Cultivars

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INTRODUCTION

Wheat (*Triticum aestivum*) is an important food crops worldwide. Phosphorus is one of most yield-limiting factor in highly weathered acidic soils; consequently, successful crop production depends on the use of P fertilizers. It has been documented that large application of P fertilizers can reduce plant Zn uptake and, in some cases, induce Zn deficiency (Singh et al. 1988; Buerkert et al. 1998). However, although interaction between Zn and P has been widely investigated, its relationship remains unknown (Loneragan and Webb 1993). The aim of this study was to investigate the Zn and P interaction at high P availability in the soil by wheat cultivars with different P uptake efficiency.

METHODS

The cultivars evaluated were previously selected from an experiment with 42 wheat cultivars, carried out in pots holding 2.0 dm^3 of soil with 120 mg dm^{-3} of P_2O_5. The soil was labeled with ^{32}P and the activity of ^{32}P was determined by Cherenkov counting. The L value was calculated according Larsen (1952). Six cultivars were selected from the previous experiment, three with high P uptake efficiency (IPR 136, CD 116, CD 120) and three with low P uptake efficiency (BR 17 Caiuá, CD 113 and IAPAR 78).

The experiment was carried out in pots holding 3.0 dm^3 of an Oxisol, which had the following chemical characteristics: pH 4.2, P 4.0 mg dm^{-3} (extracted by anionic resin) and Zn 0.3 mg dm^{-3} (DTPA). The experiment was a completely randomized design in a 2 × 2 factorial arrangement of treatments. The factors were two P levels: optimum P (high P) and suboptimal P (low P), and two groups of cultivars: high P uptake efficiency (HE) and with low P uptake efficiency (LE), with four replications. Phosphorus fertilization was accomplished by applying triple superphosphate in two levels: 45 mg dm^{-3} of P_2O_5 (low P) and 200 mg dm^{-3} (high P). The treatment with 200 mg dm^{-3} of P_2O_5 was divided into two applications (at sowing and 30 days after sowing). After 78 days of emergence shoots were harvested to determine shoot dry matter (SDM). The P and Zn accumulation in SDM (PA and ZnA) was determined by colorimetric method and atomic absorption, respectively. The means of the SDM, PA and ZnA of the three cultivars with high P uptake efficiency were compared with the three cultivars with low P uptake efficiency (T-student).

RESULTS AND DISCUSSION

The cultivars with high P uptake efficiency had SDM significantly greater than cultivars with low P uptake efficiency when P available in the soil was low. But, when was applied P fertilizer, the cultivars with high or low P uptake efficiency showed the same SDM (Fig. 1). Although cultivars with

high P uptake efficiency had greater capacity to produce SDM in the treatment with low P, the total accumulated P (PA) in plants was the same as the cultivars with low P uptake efficiency. However, when 200 mg dm^{-3} was provided, the cultivars with high P uptake efficiency accumulated more P (Fig. 1), indicating that the greatest P uptake efficiency shown by the cultivars with higher L value is verified only when P levels in the soil are high. In relation to the total Zn accumulation in plants (ZnA), the groups of the cultivars with low or high P uptake efficiency did not differ, even when was increased P in the soil, from 45 mg dm^{-3} to 200 mg dm^{-3} of P_2O_5, which did not affected significantly Zn accumulation in plant.

It has been well documented that large application of P fertilizers can reduce plant Zn uptake and, in some cases, induce Zn deficiency (Singh et al. 1988; Buerkert et al. 1998). One of the reasons for this interaction is verified when both nutrients are limited in the soil. Application of high amounts of P fertilizers can also cause Zn deficiency through a dilution effect, stimulated by plant growth (Singh et al. 1988; Loneragan and Webb 1993). Nevertheless, the low P and Zn concentration in the soil, 4.0 mg dm^{-3} and 0.3 mg dm^{-3} respectively, and the application of high amounts of P fertilizer did not promote differences in Zn accumulation for any groups of cultivars tested in this study.

This lack of significant differences found in this study for Zn accumulation in the SDM allows concluding that the relationship between P uptake efficiency and Zn accumulation was not inherent of the cultivars, neither influenced by management of P fertilization.

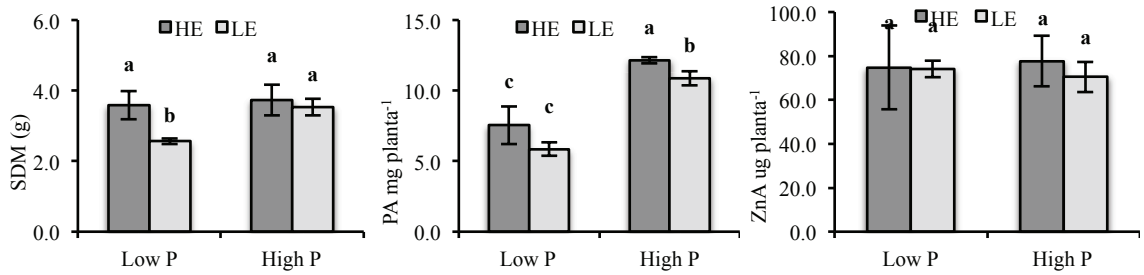

Fig. 1. Shoot dry matter (SDM), P accumulation (PA) and Zn accumulation (ZnA) on SDM for group of cultivars with high P uptake efficiency (HE) and low P uptake efficiency (LE) in soil fertilized with 45 mg dm^{-3} of P_2O_5 (Low P) and 200 mg dm^{-3} (High P). Different letters represent significant differences ($p<0.05$)

CONCLUSION

The application of high amounts of P fertilizers did not cause differences in Zn accumulation for both groups of cultivars, high and low P uptake efficiency.

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