

Influences of Phosphorus Fertilization on Zinc Status in Maize

V. Kovacevic¹, I. Komljenovic², M. Markovic²

¹ University J. J. Strossmayer in Osijek, Faculty of Agriculture, Trg Sv. Trojstva 3, HR-31000 Osijek, CROATIA (vladok@pfos.hr)

² Faculty of Agriculture, University of Banja Luka, Trg Vojvoda Bojovic bb, 78000 Banja Luka, REPUBLIC OF SRPSKA, BOSNIA AND HERZEGOVINA

INTRODUCTION

Low levels of plant-available P are a limiting soil-fertility factor under the conditions of Northern Bosnia. Increased P fertilization is usually recommended to improve these soils. As application of high P quantities could affect the Zn uptake in plants, the aim of this study was to test the effects of an ameliorative P fertilization on the Zn status in corn with emphasis on the P:Zn ratio.

METHODS

The field experiment was conducted in calcareic soil in the Knespolje area (Republic of Srpska, Bosnia and Herzegovina). Preliminary soil test (autumn 2003) values were: pH in KCl = 6.84; humus = 4.24 %; NH₄-Acetate + EDTA (pH 4.65) extractable P and Ca = 10 and 22559 mg kg⁻¹, respectively. Four rates of P fertilization were applied on May 7, 2004 (in kg ha⁻¹): a) ordinary fertilization (200 N + 80 P₂O₅ + 120 K₂O); b) a + 500 P₂O₅; c) a + 1000 P₂O₅; and d) a + 1500 P₂O₅. Triplephosphate enriched with S and Zn (45% P₂O₅ + 1, 2% S + 0.06% Zn) was used for fertilization. Maize hybrids Bc5984 and OsSK494 (2004 and 2005, respectively) were grown on the experimental plots. In the following year, residual effects of P fertilization were studied, and the experimental plots were fertilized uniformly (in kg ha⁻¹): 200 N + 80 P₂O₅ + 120 K₂O. The experiment was conducted in four 32 m² blocks. Four replicates were harvested manually in each block.

The ear-leaves of maize were sampled at the beginning of silking (25 leaves in the mean sample, total of 16 samples). The total concentrations of elements in the leaf samples were measured after microwave digestion with concentrated HNO₃+H₂O₂ by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES).

Statistical data analysis (analysis of variance and correlations) were performed according to Mead et al. (1996).

RESULTS AND DISCUSSION

Adequate quantities of Zn in corn leaves at flowering stage range from 20 to 70 mg Zn kg⁻¹ dry weight (Mengel and Kirkby 2001). The P:Zn ratios are also important for a balanced Zn nutrition in plants. Blasl and Mayr (1978) reported an optimal P:Zn ratio of 65 and an acceptable range from 15 to 180. Based on these criteria, a normal Zn status of corn was found in our study (Table 1).

Applied fertilization resulted in increases of grain yield up to 32% and 17% compared to the control, for 2004 and 2005, respectively. In our study, P fertilization significantly decreased the Zn level in leaves by 48% compared to the control but only in the first year of testing. Residual influences of ameliorative P fertilization on the Zn status of corn leaves were not found in the following year. However, the Zn status in corn grain was independent of P fertilization in 2004, but Zn contents decreased with ameliorative P treatments by 40% compared to the control in the following year. This phenomenon is impossible to explain given the available data.

Table 1. Results of Knespolje field experiment

P ₂ O ₅ kg ha ⁻¹	Yield, P (%) and Zn (mg kg ⁻¹) in grain and leaf							Soil (0-30 cm depth)		
	Yield t ha ⁻¹	Grain at maturity			Ear-leaf at silking			pH (KCl)	P ₂ O ₅ mg kg ⁻¹	CaCO ₃ %
The growing season 2004										
80	7.90	0.27	21.8	125.7	0.33	45.2	73.7	Soil sampling (August 11, 2005)		
580	9.18	0.30	21.3	139.5	0.30	37.3	81.2			
1080	9.85	0.30	19.9	150.3	0.32	28.2	113.8			
1580	10.40	0.32	19.0	167.9	0.31	23.7	131.2			
LSD 5%	0.37	0.02	n.s.		n.s.	9.4		Soil P ₂ O ₅ status: AL-method		
LSD 1%	0.53	n.s.				14.3				
The growing season 2005										
80	7.27	0.28	31.3	90.1	0.33	44.5	75.3	6.73	71	1.66
80	8.53	0.29	21.5	132.6	0.36	39.1	92.1	6.65	115	1.36
80	8.38	0.29	17.4	168.4	0.35	40.9	85.8	6.60	260	1.27
80	8.42	0.29	18.5	154.1	0.35	41.0	85.1	6.85	444	1.38
LSD 5%	0.29	n.s.	2.4		n.s.	n.s.				
LSD 1%	0.42		3.6							

Zinc deficiency occurs mainly in soils with high pH, especially calcareous soils (Lukac and Knezek 1972, Kovacevic et al. 1988).

Bogdanovic et al. (2003) applied increased rates of P fertilizer (control (0) and 1000 kg P₂O₅ ha⁻¹) on chernozem soil, and the nutritional status of corn (dry matter at 5-7 leaves stage) was reported with 0.24 and 0.79% P, 17.2 and 12.5 mg Zn kg⁻¹, and P:Zn ratios of 142 and 631, respectively. At same time, the available Zn in the soil was drastically reduced by P fertilization (3, 67 and 0.79 mg Zn kg⁻¹, respectively). In our study, P application did not harm the Zn status of plants, probably due to using Zn-enriched P fertilizer and the high organic matter content of the soil.

REFERENCES

- Blasl, S. and Mayr H.H. (1978) Der Einfluss von Zink auf die Ernaehrung der Maispflanze und seine Wechselbeziehungen mit Phosphor und Eisen. *Bodenkultur* 29:253-269.
- Bogdanovic, D., Cuvardic, M. and Miladinovic, F. (2003) Effect of phosphorus fertilization on phosphorus and zinc contents in soil and plants. In: Schnug, E., Nagy, J., Nemeth T., Kovacs, Z. and Dovenyi-Nagy, T. (eds.): *Fertilizers in context with resource management in agriculture, Volume II, International Scientific Centre of fertilizers (CIEC) Braunschweig - Budapest - Vienna*, p.506-512.
- Kovačević, V., Žugec, I. and Katušić, V. (1988): Growth retardation and chlorosis of maize due to zinc deficiency under the conditions of Eastern Croatia. *Tagung Bericht Nr 267. Akademie der Landwirtschaftswissenschaften der DDR, Berlin*. S. 219-224.
- Lucas, R.E. and Knezek, B.D. (1972) Climatic and soil conditions promoting micronutrient deficiencies in plants. In: Mortvedt, J.J., Giordano, P.M. and Lindsay, W.L. (eds) *Micronutrients in Agriculture. Soil Sci. Soc. America, Madison*, p. 265-288.
- Mead R., Curnow R. N., Hasted A.M. (1996) *Statistical methods in agriculture and experimental biology*. Chapman & Hall, London.
- Mengel, K. And Kirkby, E.A. (2001) *Principles of plant nutrition*. Kluwer Academic Publishers Dordrecht/Boston/London.