Effect of Phosphorus and Zinc Fertilizers on Protein Nitrogen of Maize (Zea mays L.) on Carbonate Chernozem Soil

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Abstract

A three year field experiment with zinc sulfate supplements was conducted in Moldova to study nitrogen metabolism of maize (*Zea mays* L.) in years 13 through 15 of systematic application of mineral fertilizers (no-fertilizer control, P60, N60K60, N60P60K60, N90P60K60, N60P90K60, kg ha^{-1}) to carbonate chernozem soil. Zinc treatments for three years were P60Zn10, N60P60K60Zn5, N90P60K60Zn5 and N60P90K60Zn10 on half of each long-term treatment. The soil at the experiment site was a carbonate chernozem, containing: humus 4.3%, total nitrogen 0.29%, CaCO3 1.7%, plant available phosphorus and potassium averaging 0.88 and 34.5 mg/100g respectively, extractable cations Ca^{2+} and Mg^{2+} 31 and 2.9 meq/100g respectively, with pH_{H2O} value of 7.9 at the 0-20 cm soil depth. Long term phosphorus (P60, N60P90K60) application increased available phosphorus from 0.88 to 2.7-3.22 mg/100g at the 0-20 cm soil depth, induced zinc deficiency and decreased protein synthesis in maize. The results revealed that the combined phosphorus and zinc fertilization increased total nitrogen in leaves from 201.4 to 526.6 and in stems from 91.3 to 316.2 mg $plant^{-1}$ dry weight at the 8-10 leaves stages. In addition, zinc treatments compared to no zinc application increased total protein nitrogen in leaves from 131.3-166.3 to 316.9-385.9 and in stems from 42.1-73.8 to 143-203.5 mg $plant^{-1}$ dry weight at the 8-10 leaves stage. Hence, the use of zinc sulfate following systematic application of phosphorus fertilizers to carbonate chernozem soil is essential to improving maze nitrogen metabolism and maize protein content. *The results were obtained in Moldavian Scientific-Research Institute of Soil Science and Agricultural Chemistry, Chisinau, Moldova.

Introduction

In the field experiment with maize (*Zea mays* L.) zinc deficiency was observed with systematic, repeated phosphorus fertilizer applications to carbonate chernozem soil, causing plant chlorosis and necrosis. This field experiment was conducted to evaluate the effects of different rates of phosphorus and zinc fertilizers on protein and non-protein nitrogen of maize (*Zea mays* L.) on carbonate chernozem soil. Long term phosphorus (P60, N60P90K60) application increased available phosphorus in soil, induced zinc deficiency and decreased protein synthesis in maize. Evaluation of protein metabolism provide new knowledge for macro-and microelement management to achieve maximum grain protein content in maize. However, there is little information on maize grain protein content as function of combined application macro-and microelements to carbonate chernozem soil. Therefore, the objective of this study was to determine maize protein and non-protein nitrogen levels as influenced by macro-and microelements fertilizers applied to carbonate chernozem soil.

Materials and methods

The field experiment was conducted at the Moldavian Scientific-Research Institute of Soil Science and Agricultural Chemistry's Central Agricultural Research Station. The soil at the experiment site was a calcareous chernozem, containing: humus 4.3%, total nitrogen 0.29%, $CaCO_3$ 1.7%, plant available phosphorus and potassium averaging 0.88 and 34.5 mg/100g respectively, extractable cations Ca^{2+} and Mg^{2+} were 31 and 2.9 meq/100g respectively, with pH_{H2O} value of 7.9 at the 0-20 cm soil depth. Maize hybrid 'Chisinau 167' was used as planting material. Nitrogen and phosphorus rates were 60 to 90, potassium 60 and zinc 5 to 10 kg ha^{-1}. Leaves and stem were separated from randomly selected plants, weighed, dried, and ground for chemical nutrient analysis. Protein nitrogen concentration were determined by Kjeldahl analysis (Pleshkov, 1976). The experiment was laid out in a completely randomized design with four replications. Grain from each plot was hand-harvested and weighed.

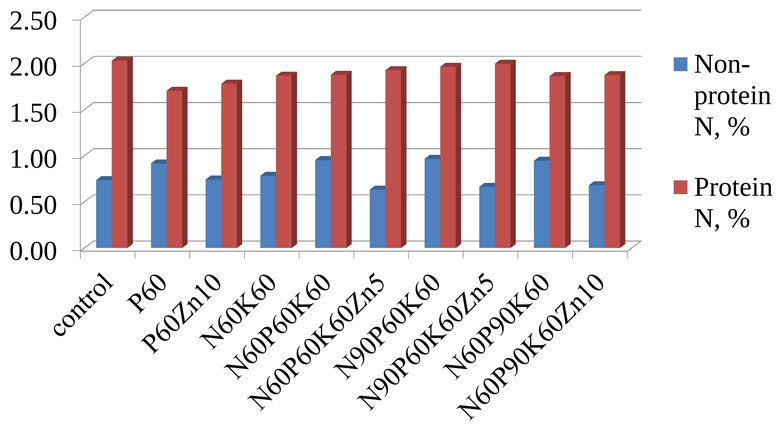

Fig. 1. Leaf protein and non-protein nitrogen response to macro-and microelements at the 8-10 leaves stage

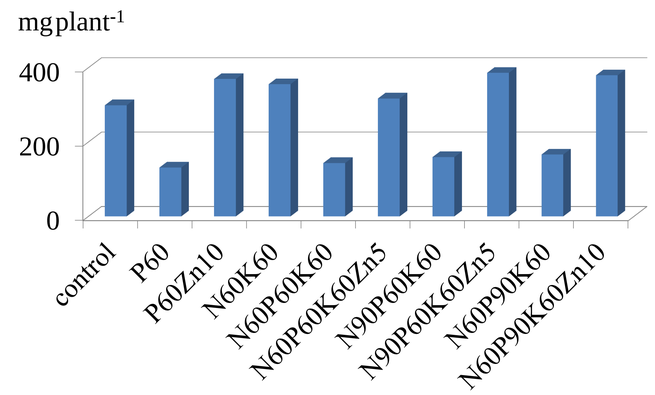

Fig. 2. Leaf total protein response to macro-and microelements at the 8-10 leaves stage

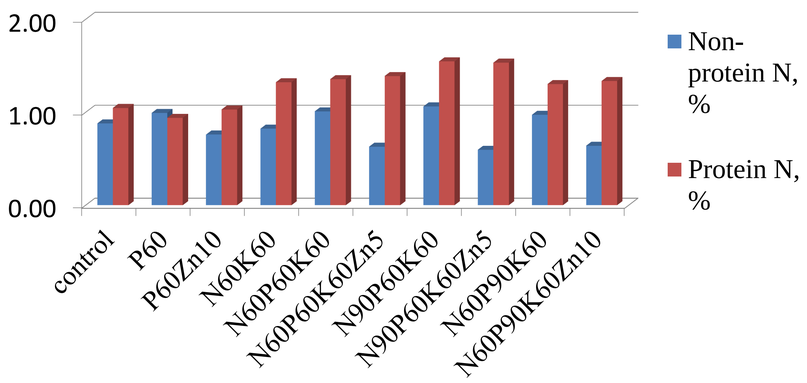

Fig. 3. Stem protein and non-protein response to Macro- and microelements at the 8-10 leaves stage

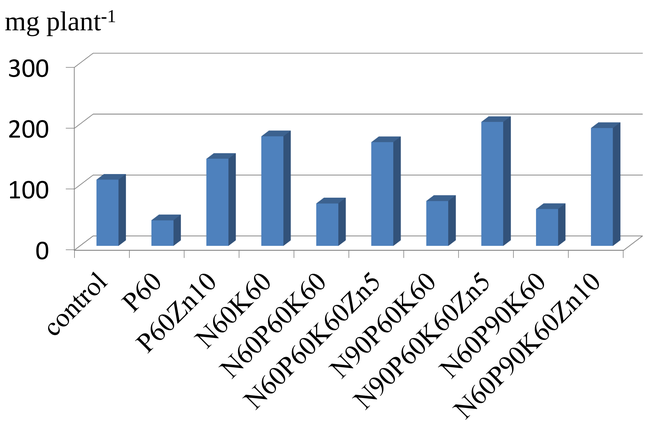

Fig. 4. Stem total protein response to macro-and microelements at the 8-10 leaves stage

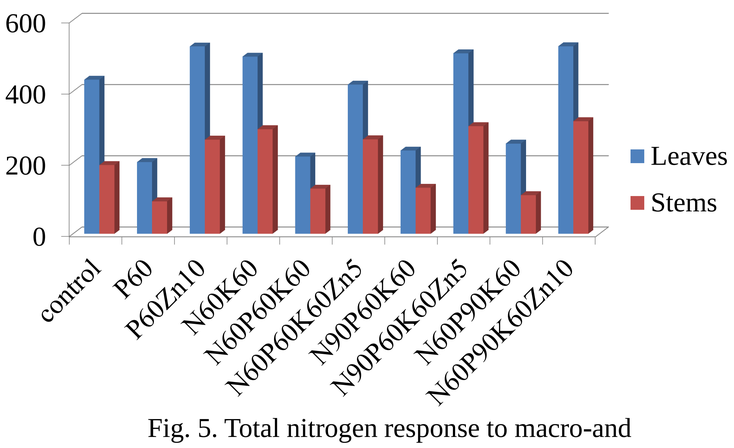

Fig. 5. Total nitrogen response to macro-and microelements at the 8-10 leaves stage

Results and discussion

The results revealed (Fig. 5) that combined phosphorus and zinc fertilization increased total nitrogen in leaves from 201.4 to 526.6 and in stem from 91.3 to 316.2 mg per dry weight plant at the 8-10 leaves stages. Zinc treatments compared to no zinc application increased total protein nitrogen in leaves from 131.3-166.3 to 316.9-386.9 and in stem from 42.1-73.8 to 143-203.5 mg per dry weight plant at the 8-10 leaves stage (Fig. 1, 2, 3, 4). Hence, the use of zinc sulfate following systematic application of phosphorus fertilizers to carbonate chernozem soil is essential to improving maize nitrogen metabolism and maize protein content.

Conclusion

The systematic, repeated application of phosphorus fertilizers to carbonate chernozem, led to maize zinc deficiency in maize. Combined nitrogen, phosphorus, potassium and zinc sulfate fertilizers application increased maize plant growth and nitrogen metabolism. The combined application of macro and microelements increased the total nitrogen in leaves and stem and consequently, the maize protein nitrogen at the 8-10 leaves stage on carbonate chernozem soil. Hence, the use of zinc sulfate following systematic, repeated application of phosphorus fertilizers to carbonate chernozem soil is important to increase maize protein nitrogen in dryland cropping system.

Literature Cited

1. Pleshkov B. P., 1976. The determination of protein nitrogen. In Methods of plants biochemistry, pp. 7-9. Moscow, 'Kolos' Press.

Acknowledgements

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