Maize (*Zea mays* L.) Protein Nitrogen Response to Zinc Fertilization

Vasile Cerven

Texas A&M AgriLife Research and Extension Center, Texas A&M University, Uvalde, TX 78801

vasile.cerven@ag.tamu.edu

Abstract

A field experiment with zinc sulfate supplements was conducted in Moldova to study protein nitrogen of maize (Zea mays L.) during years 13 through 15 of systematic application of mineral fertilizers (No fertilizer control, P60, N60K60, N60P60K60, N90P60K60 and N60P90K60. 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 carbonate chernozem, containing humus 4.3%, total nitrogen 0.29%, CaCO3 1.7%, plant available phosphorus and potassium average 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. The results revealed that long term phosphorus application induced zinc deficiency in plants and stunted growth. Applied zinc increased its concentration in leaves from 27.7-29.5 (P60, N60P90K60) to 36.6-38.2 $mg.kg^{-1}$ (P60Zn10, N60P90K60Zn10) in the 8-10 leaf stage averaged over three years. These changes were positively reflected on plant growth and development, and maize protein metabolism. Although, there was not a large difference in protein nitrogen concentration in maize leaves at the 8-10 leaf stage, combined macro and microelements application increased protein nitrogen accumulation in leaves 112.7-229.1 and in stems 37.6-155.6 $mg.plant^{-1}$at physiological maize maturity. There were strong positive correlations between zinc concentration in leaves and yield of maize. Hence, combined application of micro-and macroelements following systematic application of phosphorus fertilizers to carbonate chernosem soil is important to improve maize protein nitrogen content and accumulation on a long term basis in cropping system.

Introduction

In the field experiment, maize (*Zea mays* L.) zinc deficiency was observed with prolonged phosphorus fertilizer applications to carbonate chernozem. This led to maize stunted growth, interveinal chlorosis and necrosis, which effected on plant nitrogen metabolism. Micronutrient zinc is important in maize protein metabolism, however, there is little information on maize protein nitrogen content and accumulation as function of combined application macro-and microelements to carbonate chernozem soil. In maize, balanced nutrition with macro-and microelements is important to grain quality and quantity. Therefore, the objective of this study was to determine maize protein nitrogen content and its accumulation as influenced by macro- and microelements applied to carbonate chernozem soil.

Materials and Methods

Field experiment on the response of maize protein nitrogen to zinc fertilization was carried out at the Central Agricultural Research Station of the Moldavian Scientific-Research Institute for Soil Science and Agricultural Chemistry. The soil at the experimental field was a carbonate 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/100 g respectively, extractable cations Ca^{2+} and Mg^{2+} 31 and 2.9 meq/100 g respectively, with pH_{H2O} value of 7.9 at the 0-20 cm soil depth. Corn hybrid 'Chisinau 167' was used as planting material. Protein nitrogen concentration was determined by Kjeldahl method (Pleshkov, 1976), and zinc was measured by atom-absorption spectrometer. The experiment was laid out in a completely randomized design with four replications.

Results and Discussion

The results (Fig. 1, 2) revealed that protein nitrogen in maize leaves was higher (1.28–1.49%) than non-protein nitrogen (0.38-0.63%) at physiological maize maturity. Similarly, protein nitrogen in stems also was higher (0.37-0.56% than non-protein nitrogen (0.22-0.34%) at physiological maturity stage. There were not large differences in either protein or non-protein concentration between the treatments, however combined macro- and microelements application (Fig. 3, 4) increased protein nitrogen accumulation in leaves 112.7-229.1 and in stems 37.6-155.6 $mg.plant^{-1}$ at physiological maize maturity compare with no zinc application treatment.

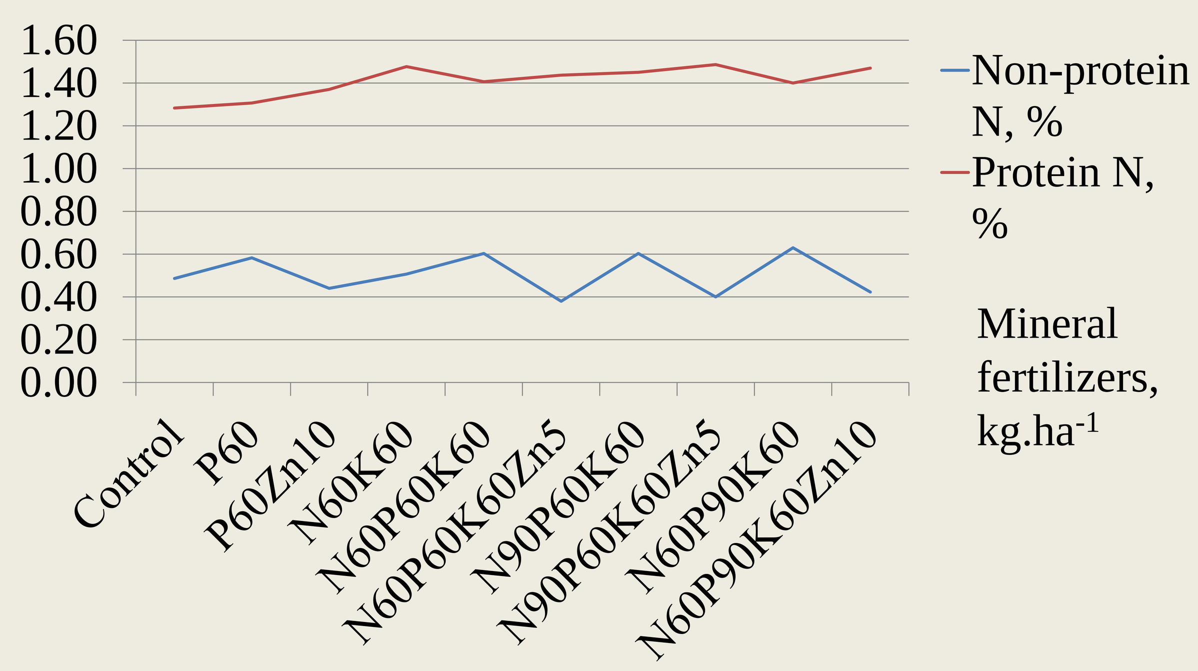

Fig. 1. Leaves' non-protein and protein nitrogen response to macro-and microelements at physiological maize maturity.

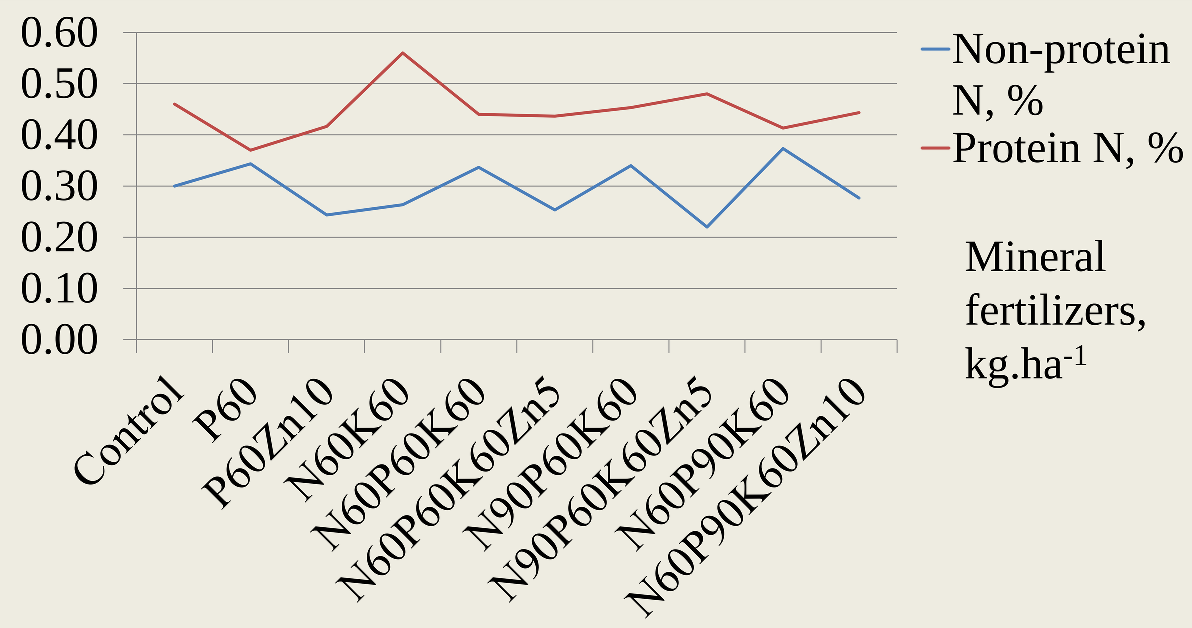

Fig. 3. Stem's non-protein and protein nitrogen response to macro-and microelements at physiological maize maturity.

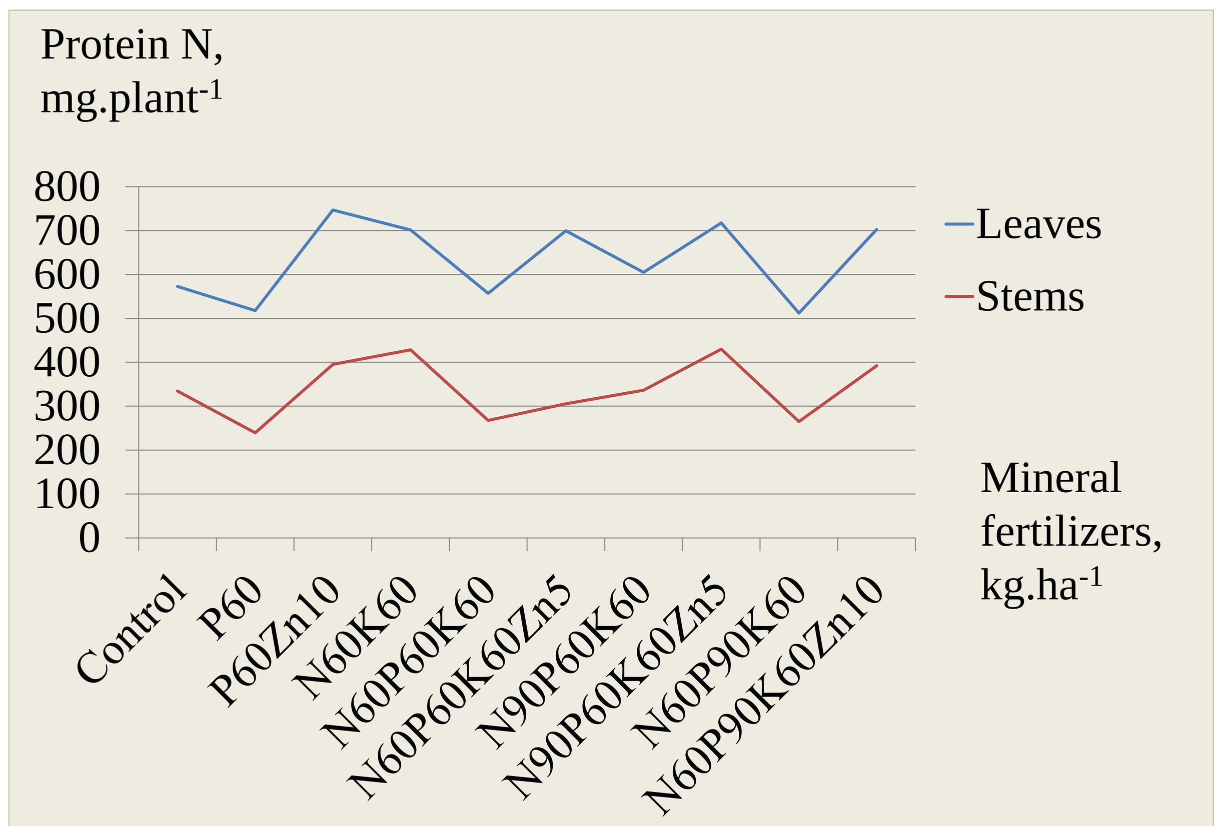

Fig..3. Protein nitrogen accumulation in maize leaves and stems at physiological maize maturity.

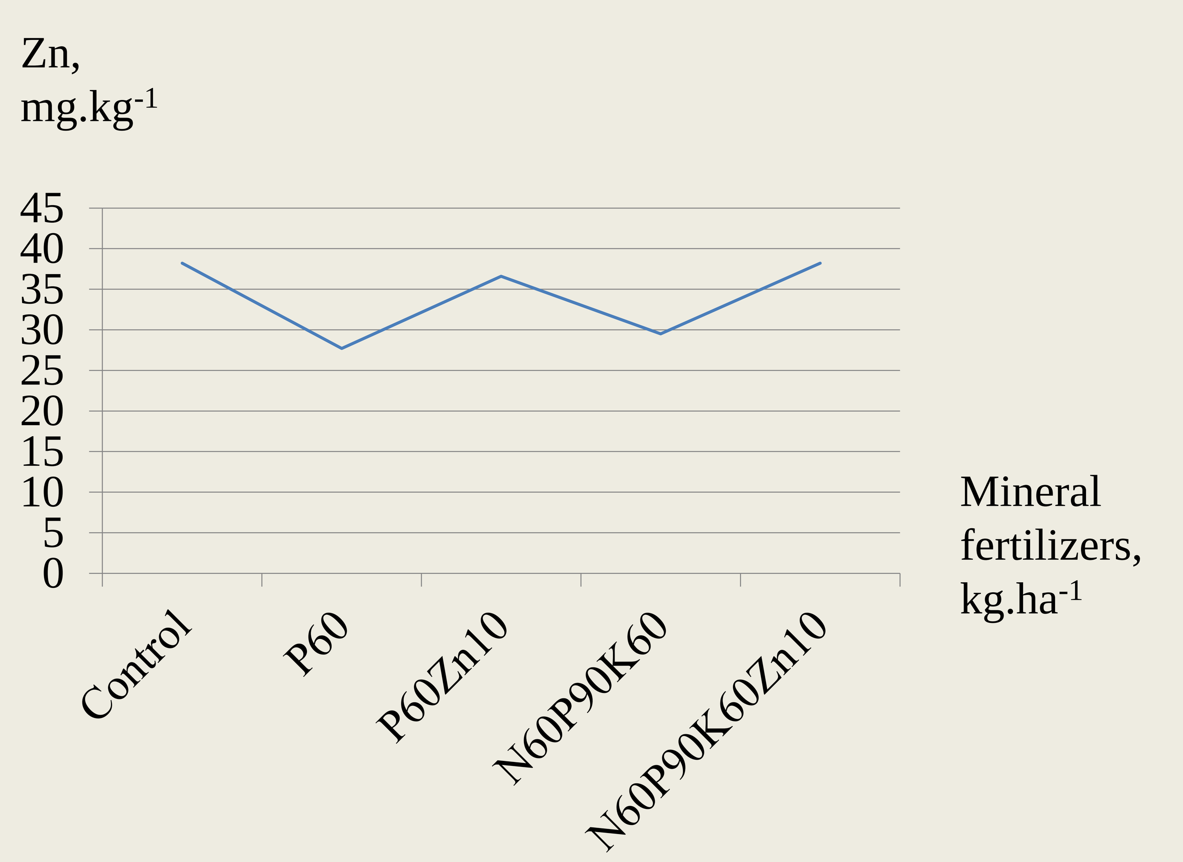

Fig. 4. Effect of macro-and microelements on zinc content in maize leaves at 8-10 leaves stages.

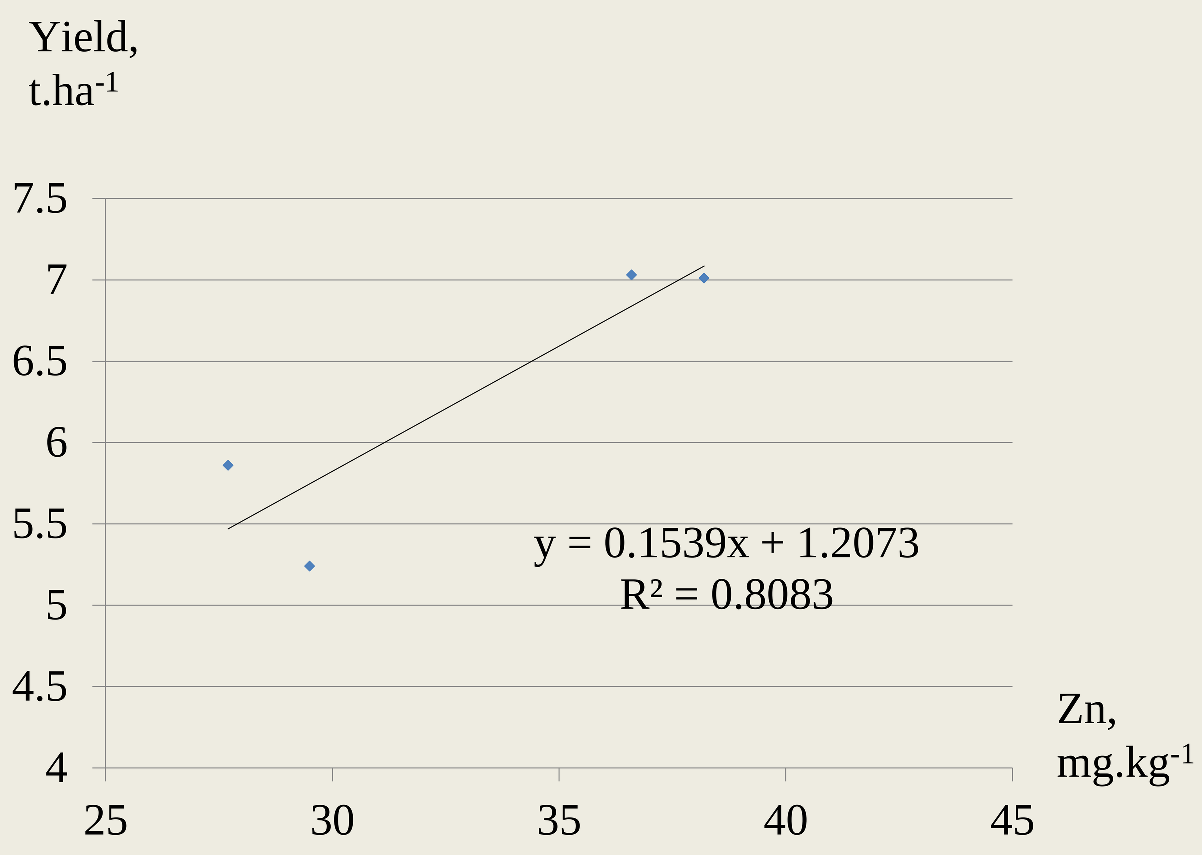

Fig. 5. Positive linear correlation between maize yield And zinc content in leaves at 8-10 leaves stages

Results from this study demonstrate that higher protein nitrogen accumulation in leaves and stems related to higher zinc uptake by maize plants at earlier stages of plant grow and development. So, combined application of micro- and macroelements increased zinc concentration in maize leaves from 27.7-29.5 (P60, N60P90K60) to 36.6-38.2 $mg.kg^{-1}$ (P60Zn10, N60P90K60Zn10) at the 8-10 leaf stage of development averaged over three years, which improved maize protein metabolism. Hence, long term phosphorus fertilization on carbonate chernozem soil can cause zinc maize deficiency, stunted growth, plant chloroses and as a result decrease maize yield. Therefore, the use of zinc sulfate following prolonged phosphorus application to carbonate chernozem soil is recommended to increase maize protein nitrogen accumulation as well as its yield in cropping system. The positive linear correlations (Fig. 5) was observed between maize yield and zinc concentration in maize leaves at 8-10 leaves plant stages.

Conclusion

The results revealed, that the use of zinc sulfate following prolonged application of phosphorus fertilizers to carbonate chernozem is necessary to increase maize protein metabolism. Phosphorus and zinc fertilization had significant effect on protein nitrogen accumulation in leaves and stems at the physiological maize maturity stage. Positive linear correlations were observed between maize yield and zinc content in leaves at the 8-10 leaf stage of development. Therefore, the use of zinc sulfate following prolonged application of phosphorus fertilizers to carbonate chernozem soil is recommended to increase maize protein nitrogen in leaves and stems as well as its yield in 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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