

# Studies Regarding the Establishment of the Optimum Conditions of Obtaining Process of NP Fertilizers with Micronutrients

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**Abstract:** The fertilizers play a very important role in the plant growing and development. The fertilizers with micro-nutrients supply to the plant the needed nutritive substances, which doesn't exist or are insufficient in soil. In the present paper were established the optimum conditions for the obtaining process of some NP fertilizers with zinc and copper as micronutrients. The zinc and copper-ammonium phosphates were synthesized using diammonium monohydrogen phosphate, zinc sulphate and copper sulphate solutions mixed at various molar ratios (Zn:Cu:P = 1:0:1; 0.8:0.2:1; 0.6:0.4:1; 0.4:0.6:1; 0.2:0.8:1; 0:1:1) and at various pH values of the reaction mass (4; 5; 6; 7). In order to find the optimum conditions for the fertilizers obtaining process, it was determined the dependence of the zinc and copper residual concentrations on the pH of the reaction mass at the studied molar ratios. We found that the optimum conditions of the obtaining process of NP fertilizers with zinc and copper micro-nutrients are: a value of the pH of the reaction mass between 6 and 7 and a molar ratio Zn:Cu:P = 0.6:0.4:1 or Zn:Cu:P = 0.4:0.6:1.

**Keywords:** fertilizer, micro-nutrient, copper, zinc

## 1. Introduction

The plants take the primary macro-nutrients (nitrogen, phosphorus and potassium), the secondary macro-nutrients (Ca, Mg and S) and the micro-nutrients (Zn, Fe, Co, Cu, Mn, B, Mo and Cl) from the soil. The lack or the insufficiency of the nutritive elements in soil can cause plant diseases and as result the quantitative and qualitative decreasing of the crops. In this situation the use of fertilizers becomes essential.

Although the plants use the micro-nutrients in very small quantities, they are very important for the growth and the development of plants. They are protecting the plants from diseases and improve the assimilation of the other nutritive elements.

Zinc is assimilated by plants as  $Zn^{2+}$  and it is component of some enzymes with an important role in respiration and in growth processes. It also has an important role in chlorophyll synthesis. Zinc favors the synthesis of B, C and P vitamins. Plants assimilate copper as  $Cu^{2+}$  which increases their resistance at drought and diseases caused by fungus. Copper is also very important for chlorophyll synthesis and it is component of the enzymes involved in seed and fruit formation [1-11].

Zinc-ammonium phosphate and may be used as primary complex fertilizer with zinc micronutrient, as technical phosphate or for the obtaining basic solid fertilizers with zinc. The product is thermally stable up to 200°C [2, 7].

Copper-ammonium phosphate may be used as primary complex fertilizer with copper micronutrient, as technical phosphate or for the obtaining basic solid fertilizers with

copper. When heated, the product is stable up to 205°C [2,7].

In the copper-ammonium phosphate respectively zinc-ammonium phosphate, copper and respectively zinc are chemically bonded by nitrogen and phosphorus macro-nutrients, which bring increased efficiency to the assimilation process in plants.

The paper presents studies carried out in order to establish the optimum conditions for the obtaining process of some NP fertilizers containing zinc and copper as micronutrients.

## 2. Experimental

The zinc and copper-ammonium phosphates were synthesized using 1 M diammonium monohydrogen phosphate solution and zinc sulphate solution, respectively copper sulphate solution mixed at various molar ratios (Zn:Cu:P = 1:0:1; 0.8:0.2:1; 0.6:0.4:1; 0.4:0.6:1; 0.2:0.8:1; 0:1:1) and at various pH values of the reaction mass (4; 5; 6; 7). The pH value of the reaction mass was adjusted using a 25% ammonia solution.

Volumes of diammonium monohydrogen phosphate, zinc sulphate and copper sulphate solutions corresponding to the studied molar ratios were mixed and stirred. The ammonia solution was added until the desired value of the pH was reached. The pH of the reaction mass was determined using a Denver Instrument 250 pH-meter.

The precipitates were filtered and the residual concentrations of copper and zinc in the solutions were determined by atomic absorption spectrophotometry using a VARIAN SpectrAA 110 spectrophotometer.

### 3. Results and discussion

In order to find the optimum conditions for the fertilizers obtaining process, it was determined the dependence of the zinc and copper residual concentration on the pH of the reaction mass at the studied molar ratio.

From the experimental data presented in Figures 1-6 one can observe that at each studied molar ratio, the zinc and copper residual concentrations decrease abruptly as the value of the pH increases from 4 to 5. At higher values of the pH, zinc and copper residual concentrations are changing within a narrow range. Between 6 and 7, zinc residual concentrations slightly decrease or remain the same and copper residual concentration slightly increases. One can conclude that for each studied molar ratio the optimum value of the pH is between 6 and 7, since in this range the lowest residual concentrations are reached.

The experimental data also show that as the zinc quantity decreases, respectively the copper quantity increases, zinc residual concentration decreases. Beginning with a Zn:Cu:P molar ratio of 0.6:0.4:1, zinc residual concentration for the optimum pH lies under the detection limit and therefore one can conclude that zinc separation is complete. The copper residual concentration increases as the zinc quantity decreases respectively as the copper quantity increases. Consequently is not recommended to increase the Zn:Cu:P molar ratio at values higher than those minimum required for the complete separation of zinc (0.4:0.6:1).

Zinc separation is more efficient than copper separation, since for molar ratios  $\text{Zn:Cu:P} \geq 0.6:0.4:1$  in every situation when both copper and zinc were used, the residual concentrations of copper were higher than those of zinc.

Following the analysis of the experimental data we concluded that the optimum molar ratios are:  $\text{Zn:Cu:P} = 0.6:0.4:1$  or  $\text{Zn:Cu:P} = 0.4:0.6:1$ .

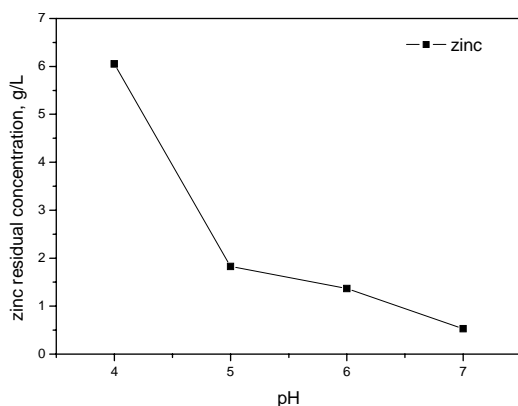


Figure 1. Dependence of zinc residual concentration on the pH value at the molar ratio Zn:Cu:P = 1:0:1

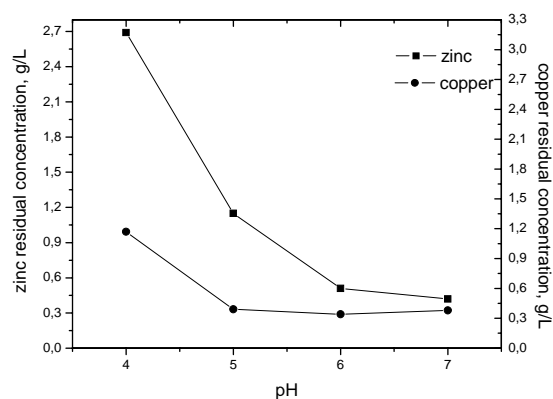


Figure 2. Dependence of zinc and copper residual concentrations on the pH value at the molar ratio Zn:Cu:P = 0.8:0.2:1

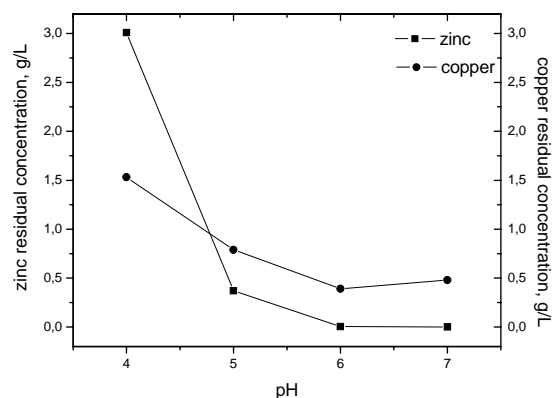


Figure 3. Dependence of zinc and copper residual concentrations on the pH value at the molar ratio Zn:Cu:P = 0.6:0.4:1

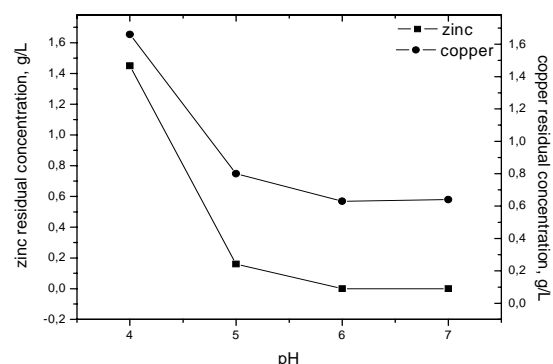


Figure 4. Dependence of zinc and copper residual concentrations on the pH value at the molar ratio Zn:Cu:P = 0.4:0.6:1

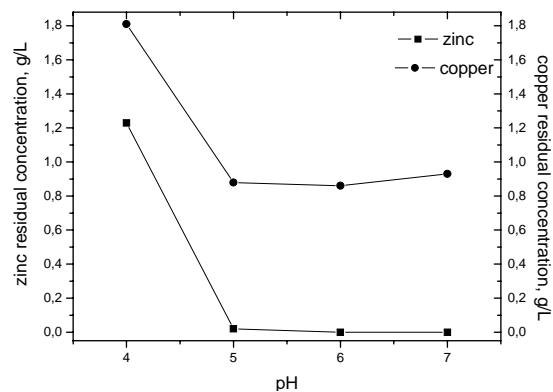


Figure 5. Dependence of zinc and copper residual concentrations on the pH value at the molar ratio Zn:Cu:P = 0.2:0.8:1

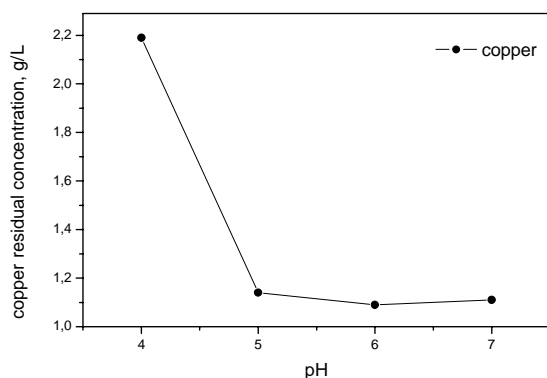


Figure 6. Dependence of copper residual concentration on the pH value at the molar ratio Zn:Cu:P = 0:1:1

#### 4. Conclusions

The fertilizers play a very important role in the plant growing and development. The fertilizers containing micro-nutrients such as copper and zinc supply to the plants the needed nutritive substances, which doesn't exist or are insufficient in soil.

In the present paper were established the optimum conditions for the obtaining process of some NP fertilizers containing zinc and copper as micro-nutrients.

The zinc and copper-ammonium phosphates were synthesized using diammonium monohydrogen phosphate, zinc sulphate and copper sulphate solutions mixed at various Zn:Cu:P molar ratios (Zn:Cu:P = 1:0:1; 0.8:0.2:1; 0.6:0.4:1; 0.4:0.6:1; 0.2:0.8:1; 0:1:1) and at various pH values (4; 5; 6; 7) of the reaction mass.

In order to find the optimum conditions for the fertilizers obtaining process, it was determined the dependence of the zinc and copper residual concentrations on the pH of the reaction mass at the studied molar ratio.

Following the analysis of the experimental data we concluded that the optimum conditions of the obtaining process of NP fertilizers with zinc and copper micro-nutrients are: a value of the pH of the reaction mass between 6 and 7 and a molar ratio Zn:Cu:P = 0.6:0.4:1 or Zn:Cu:P = 0.4:0.6:1.

#### REFERENCES

- Iovi A. and Iovi C., Tehnologii Ecologice - Chimia și Tehnologia Fosfaților Tehnici. Politehnica Publishing House. Timișoara. **2004**.
- Iovi A., Iovi C and Negrea P., Tehnologii ecologice - Chimia și tehnologia îngrășămintelor cu microelemente. Politehnica Publishing House. Timișoara. **2000**.
- x x x Fertilizers and their use, Food and Agriculture Organization of the United Nations International Fertilizer Industry Association. Rome. **2000**.
- Chandrasekaran A, Phosphorus Chemistry: Uses, University of Massachusetts. AMHERST. USA. **2003**.
- Penas E.J. and Sander D.H., Using Phosphorus fertilizers effectively. Published by Cooperative Extension. Institute of Agriculture and Natural Resources University of Nebraska. Lincoln. NebGuide. **1993**.
- Iovi C, Studii asupra proceselor de obținere a îngrășămintelor complexe primare cu microelemente de tipul fosfaților de metal-amoniu, PhD Thesis. Timișoara. **1995**.
- Pode R. and Iovi A., Tehnologii Ecologice - Tehnologii de valorificare a deșeurilor anorganice. Politehnica Publishing House. Timișoara. **2002**.
- Goudriaan J., Rob Groot J.J. and Uithol W.J.P., Productivity of Agroecosystems. *Terrestrial Global Productivity*. **2001**. pp. 301-313.
- von Wiren N., Improving fertilizer use efficiency in agro-ecosystems and nutrient efficiency in plants. *Developments in Plant Genetics and Breeding*. **2000**, Vol.6. pp. 225-233.
- Fageria N.K., Baligar C. and Clark R.B., Micronutrients in crop production. *Advances in Agronomy*. **2002**, Vol. 77, pp. 185-268.
- Lichtenberg E., Agriculture and the environment. Handbook of Agricultural Economics. Vol. 2. Part 1. **2002**. pp. 1249-1313.