

# Studies on the chemical forms of some micronutrients in soils and their relation to plant

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Studies on the chemical forms of some micronutrients in soils under consideration and their relation to plant, especially those bounded with organic and inorganic soil constituents, was the main purpose of this study. Three different soil types were selected to represent the Nile alluvial, calcareous and sand. Two experiments were carried out, the first was conducted to study the behaviour of Fe, Mn, Zn and Cu added separately to the studied soils under different incubation periods. The treatments were 5, 10 and 20 mg Fe/kg soil in the form of  $\text{FeSO}_4$ ; 2.5, 5 and 10 mg Mn/kg soil in the form of  $\text{MnSO}_4$ ; 2.5, 5 and 10 mg Zn/kg soil in the form of  $\text{ZnSO}_4$  and 0.5, 1.0 and 2.0 mg Cu/kg soil in the form of  $\text{CuSO}_4$ . The soils were watered with distilled water to field capacity and allowed to equilibrate at intervals 1, 15, 30 and 45 days. After each incubation period, the soils were fractionated for different forms of micronutrient fractions (exchangeable, carbonate, Fe-Mn oxides, organic and residual). The second experiment was conducted to study the effect of the previous treatments on the plant growth (dry matter yield) and the contents of micronutrients uptake by corn plants. The results could be summarized as follows:

1. Incubation experiment:
  - 1.1. Fe fractions:- Increasing the levels of Fe to the different soils was associated with a progressive increase in the chemical forms of Fe, i.e., exchangeable, carbonate, Fe-Mn oxides, organically bound and residual fractions at any incubation period. The maximum increase in Fe bounded with different fractions was detected at the highest level of Fe.- Fe in the sandy soil was detected in Fe-Mn oxides and exchangeable fractions, while in the calcareous soil was detected in carbonatic fraction. So, Fe in these two soils was potentially bioavailable because it presents as exchangeable and carbonates fractions, which was readily available for plant uptake. However, in the Nile alluvial soil an enrichment amount of Fe was found in organical and Fe-Mn oxide fractions.
  - 1.2. Mn fractions:- The amount of Mn bounded with Fe-Mn oxides and residual forms were greater than that bounded with exchangeable, carbonate and organic forms. However, Mn bounded with exchangeable, carbonate and organic fractions differed from soil to another.- In sandy soil Mn was detected in exchangeable fraction, while it was detected in carbonate and organic fractions in the calcareous and Nile alluvial, respectively. So, Mn in these soils was potentially bioavailable.
  - 1.3. Zn fractions:- The amount of Zn bounded with residual form was greater than that bounded with exchangeable, carbonate, Fe-Mn oxides and organic forms. However, Zn bounded with exchangeable, carbonate, Fe-Mn oxides and organic fractions differed from soil to another.- Zn was detected in exchangeable, carbonate and, organic fractions in the sandy, calcareous and Nile alluvial, respectively. So, Zn in sandy and calcareous soils was potentially bioavailable.
  - 1.4. Cu fractions:- The application of Cu was more effective for increasing the organic form of Cu in the Nile alluvial soil than the other soils.-The amount of Cu bounded with residual form was higher, compared to those bounded with exchangeable, carbonate, Fe-Mn oxides or organic forms.- The relative increase in Cu bounded with exchangeable form in sandy soil was higher than the other soils. While, carbonate fraction possessed the highest amount of Cu in calcareous soil.
2. Greenhouse experiment:-Application of the studied micronutrients to the Nile alluvial, calcareous and sandy soils had a markedly effect on the dry weight of corn.-The greatest growth of corn was recorded at 20, 10, 10 and 2 mg / kg soil for Fe, Mn, Zn and Cu, respectively.-Fe was more effective for increasing the corn yield and sandy soil was responded to micronutrients application more than

the Nile alluvial and calcareous ones.-The addition of the different levels of Fe, Mn, Zn and Cu to the Nile alluvial, calcareous and sandy soils caused a marked effect on the contents of Fe, Mn, Zn and Cu in corn plants.-The highest amounts of Fe, Mn, Zn and Cu were found in the Nile alluvial soil, while the lowest one was found in the calcareous soil.-The effects of chemical forms of micronutrients on their uptake by corn exhibited that organic, Fe-Mn oxides, exchangeable and carbonate forms were stronger influence on the uptake than the total concentration in soils.-The maximum increases in Fe, Mn, Zn and Cu bounded with different fractions (exchangeable, carbonate, Fe-Mn oxides, organic and residual fractions) were detected at the highest levels of micronutrients.- The sequential extraction used in this study is useful to indirectly assess the potential mobility and bioavailability of micronutrients in different soils. Assuming that bioavailability is related to solubility, then Fe, Mn, Zn and Cu bioavailability decreases in the order: exchangeable > carbonate > Fe-Mn oxides > organic > residual. Based on the above mentioned, it could be assumed that Fe, Mn, Zn and Cu in the non-residual fractions are more bioavailable than micronutrients associated with residual fraction.-The most important chemical forms influencing the uptake of Fe by corn plants in sandy soil were Fe-Mn oxides and exchangeable fractions. While, carbonate fraction in calcareous soil was the most important fraction for Fe uptake by corn plants.-The most important fractions influencing the uptake of Mn by corn plants in Nile alluvial, calcareous and sandy soils were organic and Fe-Mn oxides; carbonate; and Fe-Mn oxides and exchangeable fractions, respectively.-The most important chemical fractions influencing the uptake of Zn by corn plants in the Nile alluvial, calcareous and sandy soils were organic and Fe-Mn oxides; IFe-Mn oxides and carbonate; and exchangeable and Fe-Mn oxides, respectively.-The most important chemical fractions influencing the uptake of Cu by corn plants in Nile alluvial, calcareous and sandy soils were organic and Fe-Mn oxides; organic and carbonate; and exchangeable, respectively.