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Residual effect of natural and synthetic zinc chelates on zinc in a soil solution of a waterlogged acidic soil. Evolution of the pH and redox potential

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Zinc chelates have been widely used to correct deficiencies in this micronutrient in different soil types and under different moisture conditions. The aging of the metal in soil could cause a change in its availability. Over time the most labile forms of Zn could decrease in activity and extractability and change to more stable forms. Various soil parameters, such as redox conditions, time, soil type and moisture conditions, affect the aging process and modify the solubility of the metal. In general, redox conditions influence pH and also the chemical forms dissolved in the soil solution. Soil pH also affects Zn solubility; at high pH values, most of the Zn is present in forms that are not bioavailable to plants. The objective of this study was to determine the changes in Zn over time in a soil solution in a waterlogged acidic soil to which synthetic and natural chelates were applied.

An experiment was conducted under controlled laboratory conditions (at 5 times field capacity) in an acidic soil [Typic Haploxeralf; field capacity, 6.5 g H_2O/100 g soil; pHw (1/2.5, w/v), 6.1; texture USDA, sandy loam, with illite as the predominant clay; oxidizable organic carbon 0.29%; available P, 2%] under two years of flax crops. Before the first flax crop, this soil was treated with a natural chelate, Zn-aminelignosulphonate (Zn-AML) and a synthetic chelate, Zn-ethylenediaminetetraacetate (Zn-EDTA), at different rates of application [0 (control), 5 and 10 mg Zn kg^{-1} soil].

The results obtained showed the evolution of concentrations of Zn in soil solution, pH and redox potential for three experimental times (15, 45 and 75 d after waterlogging conditions) for each treatment. The zinc in the soil solution showed significant differences between treatments, but not between the experimental times for each treatment. Zn-EDTA applied at the rate of 10 mg Zn kg^{-1} was the treatment that produced the highest Zn concentration in the soil solution (values ranged from 13 to 14 mg Zn L^{-1}). Zn-EDTA at the lowest rate of application and Zn-AML at the highest rate produced similar values (ranging between 1.8 and 3.1 mg Zn L^{-1}). The values of Zn in the soil solution with Zn-AML-5 ranged between 1 and 1.5 mg Zn L^{-1} and in the control treatment they ranged between 0.4 and 0.5 mg Zn L^{-1}.The pH parameter showed a slight increase over time with the Zn-EDTA treatments (values ranged between 5.1 and 5.6), though the control and Zn-AML treatments showed the stability of this parameter over time (values ranged between 4.9 and 5.3). The Eh parameter ranged between 290 and 390 mV with a slight decrease over time. The lowest Eh value corresponded to the Zn-EDTA treatment for each experimental time. In general, pH + pe values [pe=Eh(mV)/59.2] showed a slight decrease with time (values ranged from 10.4 to 11.7). These values of pH and Eh corresponded to soils classified as waterlogged or semi-permanently saturated. Significant statistical correlations were observed between pH and Eh parameters ($r=-0.525$, $P<0.05$) and between pH and Zn in soil solution ($r=0.5567$, $P<0.05$).

Although the aging effect produced a change in Zn availability, from more to less available forms, or non water soluble Zn forms. In this study we obtained greater amounts of Zn in soil solutions with synthetic than with natural sources.