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Residual zinc forms in weakly acidic and calcareous soils after an oilseed flax crop

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The different chemical forms of Zn found in soils exhibit different levels of reactivity, solubility and availability to plants. Sequential extraction procedures (SEP) are applied in soils to partition metal into operationally-defined geochemical fractions. The bioavailability of metals in soils is related to these chemical fractions and not to total metal content. Furthermore, single extraction methods, such as DTPA or Mehlich-3, are commonly used to predict Zn availability to plants. Other, more recently developed, method that try to simulate the conditions of the soil rhizosphere use a mixture of low-molecular-weight organic acids (LMWOAs) as extractants. According to various researchers, the $BaCl_2$ reagent only extracts elements which are physically adsorbed on particles and it can be used to estimate the easily leachable Zn portion. Flax (*Linum usitatisimum* L.) is a major oilseed meadow crop grown throughout the world and is more sensitive to Zn deficiency than cereal crops such is wheat. The objectives of this study were to determine soil chemical Zn pools, potential Zn availability and easily leachable Zn in two residual soils after a flax harvest.

A greenhouse experiment was conducted with 50 flax plants in 14 kg pots containing two different original soils (Soil 1: Typic Haploxeralf, pH_w (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%. Soil 2: Typic Calcixerept; pH_w (1/2.5, w/v), 8.1; texture USDA, loamy sand, with esmectite as the predominant clay; oxidizable organic carbon 0.75%; available P, 1.

In soil 1, the order (from highest to lowest amounts) of the Zn fractions (mg/kg)

was: OM, 2.74 (29.03%); FeOX, 2.35 (24.89%); EXC, 1.71 (18.12%); MnOX, 1.34 (14.19%); RES, 1.00 (10.59%); WS, 0.30 (3.18%). Levels of DTPA- and Mehlich-3-extractable Zn (mg/kg) in this soil were 1.24 (13.14%) and 4.21 (44.60%) respectively, and the amount of Zn extracted with the mixture of LMWOAs was 1.37 mg/kg (14.51%). The quantity of Zn estimated as easily leachable was 1.63 mg/kg (17.27%). In soil 2, the order of Zn distribution in the different fractions (mg/kg) was: RES, 31.46 (71.76%); FeOX, 7.88 (17.98%); OM, 3.03 (6.91%); CAR, 0.98 (2.24%); EXC, 0.22 (0.50%); MnOX, 0.15 (0.34%); WS, 0.12 (0.27%). Levels of DTPA- and Mehlich-3-extractable Zn (mg/kg) in this soil were 0.71 (1.62%) and 2.87 (6.55%) respectively, and the amount of Zn extracted with the mixture of LMWOAs was 0.05 mg/kg (0.11%). The quantity of Zn estimated as easily leachable was 0.29 mg/kg (0.66%). The different physical-chemical properties of the original soils and their total Zn contents therefore notably influenced the distribution of Zn in fractions in residual soils after the crop was harvested. The three methods used to estimate available Zn produced very different results. The extraction order was: Mehlich-3 $>$ DTPA-TEA $>$ LMWOAs. The concentration of easily leachable Zn in the acidic soil was 5.6 times greater than in the calcareous soil.