# MICRONUTRIENT AND HEAVY METAL EXCESS AND TOXICITY IN SOUTHERN AFRICAN SOILS

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## ABSTRACT

Examples of naturally occurring, high or toxic levels of micronutrients and the heavy metals Ni and Cr are discussed. Al, Fe and Mn are excluded, as toxicity is generally associated with wet or acidic soils that can be rectified by drainage or liming. Anthropogenic causes such as (inadvertent) over-application of micronutrients and pollution are also considered.

Naturally occurring copper toxicity occurs near copper ore outcrops in areas where copper is mined. Plant and soil levels associated with one such anomaly are given for maize and the mechanism of toxicity appears to be suppression of manganese uptake. Copper applied for wheat on granite sands generally low in copper, easily reaches toxic levels when applied at too high a rate or where the soil is in fact not deficient in the first place. In these cases leaves may have the appearance of iron deficiency induced by high copper.

Boron toxicity occurs where B weathered from parent materials of marine origin accumulates in dry climates. The leaf edge yellowing/browning symptoms are well known even though boron toxicity is not common in cropping areas of Southern Africa. Deficiency is more widespread and is often associated with sandy or calcareous soils; here inadvertent over-application of boron to soil will give classic symptoms of toxicity. Over-application via leaf sprays can just as easily occur and an example for sweet corn is described, where quite different symptoms of leaf and stem distortion and twisting, more associated with interference of calcium uptake, occurred.

High zinc occurs near zinc mining operations and toxic levels have been recorded which may be toxic to grazing animals. Levels in agricultural soils, even when high, are generally considered not to be high enough to be toxic. The interference of zinc with the uptake and utilisation of other nutrients such as copper and iron is considered.

That nickel is a universal essential plant nutrient element has yet to be demonstrated, but amongst other things there is evidence that it is an essential component of urease, thus affecting nitrogen transformation reactions in certain legumes and micro organisms. Ni along with Fe, Mn, Cr and sometimes Co is concentrated in ultramafic rocks and its toxicity is well known in soils derived from such parent materials. Ni in soil is associated with oxides of Fe and Mn and with organic matter in surface horizons and is easily assimilable by plants and thus easily extractable. Ni causes stunting and an interveinal chlorosis similar to iron deficiency in most crops. In fact, the cause of nickel chlorosis in maize is demonstrated to be low ferrous iron ($Fe^{2+}$) concentration but masked by normal or high total iron in the leaves.

Chromium is essential in animal and human nutrition but so far has been shown to only “enhance” growth of certain plants in soils very low in Cr. Small amounts of Cr either as soluble $Cr^{3+}$ or $Cr^{6+}$ are extremely toxic to plants especially roots. Total Cr is often high in ultramafic rocks but as $Cr^{3+}$ in the refractory mineral chromite is very insoluble, toxicity is rare and difficult to demonstrate. Chromium toxicity in field ultramafic soil and in hydroponic culture is demonstrated to harm flowering (tasseling) of maize. It is further shown that an ultramafic soil high in total Cr became very toxic to maize after years in storage. The soil was high in easily reducible manganese oxides that were capable of oxidizing bound $Cr^{3+}$ to soluble, toxic $Cr^{6+}$.