Additive copper-zinc interaction affects toxic response in soybean

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Agricultural soils accumulate trace metals, particularly copper and zinc, as a result of their presence in wastes (sewage biosolids and manures) and fungicides that are applied over long periods of time. Regulations and guidelines for tolerable concentrations of these potentially plant-toxic elements in soils are based on the assumption that the toxic effects of the metals are substantially independent and not additive. However, additivity would imply that soil tolerance limits for each metal must be adjusted to compensate for the presence of another metal. There has been very little experimental work to date to provide a basis for determining the degree to which copper-zinc interaction in soils is additive as defined by the toxicity response in crops.

Researchers at Cornell University have investigated the copper-zinc interaction in two soils with different textures, using soybean growth and metal uptake into leaves to evaluate both toxicity and availability of these metals to the plants. Soybean crops were grown in pots in the field in two successive years after allowing copper and zinc sulfate-amended soils to age in the field for one year prior to the first planting. Copper and zinc were added to individual soils to provide 0, 50,100, 200, and 400 mg/kg of each metal as well as every possible combination of addition levels of the two metals. The results from the study are published in the November-December issue of *Journal of Environmental Quality*.

Interactive effects of copper and zinc were observed both in the soil as well as in the soybean toxic response. In the soil, high copper had a strong effect on inhibiting zinc adsorption on soil particles, thereby causing zinc to be more easily extractable and available. Conversely, there was only a moderate interactive effect of zinc on copper adsorption, probably explained by the higher affinity of copper for soil adsorption sites, particularly those associated with organic matter.

The toxic effects of copper and zinc on soybean growth was found to be additive to a large degree, as measures of both extractable copper and zinc in the soils were needed to adequately explain the inhibition of plant growth over all treatments. However, the toxic effect of copper was stronger than that of zinc, possibly explained by the observed severe impact of copper on soybean root development. Soil texture had a marked influence on the degree of copper and zinc toxicity and availability to soybeans, consistent with numerous studies that have shown coarse-textured soils to be more susceptible to the toxic effects of heavy metals on crops.

The results from the study indicate that guidelines for tolerable upper limits of copper and zinc concentrations in soils are likely to require allowance for the presence of a second toxic metal at elevated concentrations, which could lower the tolerable limit for either copper or zinc. Furthermore, tolerable limits for copper and zinc in soils are likely to be lower in coarse-textured soils.

More information: The full article is available for no charge for 30 days following the date of this summary. View the abstract at jeq.scijournals.org/cgi/content/abstract/38/6/2253

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