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Copper and Soil Functionality

Dasom Jeon, Nicholas Dickinson

Faculty of Agriculture and Life Sciences, Lincoln University, Lincoln 7647, Christchurch, New Zealand

som.jeon@lincolnuni.ac.nz

Abstract

Inorganic forms of copper (sulphate, hydroxide and oxychloride) continue to be widely applied as a largely effective and acceptable fungicide, as well as a defoliant and dessicant, in agriculture and horticulture. Application rates and regulatory standards in organic food production systems are lower nowadays, and often restricted to 3 – 4 kg ha^{-1} $annum^{-1}$, although much higher quantities have also been applied (up to 80 kg ha^{-1} $annum^{-1}$). Limited mobility of Cu in most soils and its very restricted uptake by plants means that the metals is not easily transferred to food products. Although liver storage and chronic copper poisoning of Cu in mammals is well known, it is assumed that the stability of this metal in soil largely alleviates concerns about its potential toxicity. Organic agrochemical formulations can be partially systemic in plants and more mobile and may raise concerns for different reasons. However, Cu mobility in soil is largely determined by pH and organic matter content, and uptake from the roots to above-ground edible parts of plants is generally negligible, leading to assumption there is less concern about toxicity. Surprisingly little is known of the biological and ecological impacts of elevated Cu in soil which is evaluated in this paper.

Experimental work is reported on Cu in different-aged orchard soil in New Zealand where historical Cu application rates have been well recorded. Vineyards and fruit trees have much shorter history of Cu inputs compared to Europe and elsewhere. It was considered these provided realistic routes of Cu into the urban environment thorough exposure from food or due to future urban expansion on to these peri-urban soils. Soil management (rotavation and ground cover) affected spatial dispersion of Cu, particularly with depth, and there was a strong correlation between soil copper concentrations and soil organic matter (SOM). Soil respiration was driven much more by SOM and temperature than by Cu below about 320 mg kg^{-1}. Earthworms had less sensitivity to Cu up to 260 mg kg^{-1} that to differences on SOM 4 – 12% (pH range 6.4 – 7.1). We find that the biological component of soil appears to have acclimated to enhanced copper. Functionality of soil appears to have adjusted to the gradual accumulation of Cu in these soils. We argue this should not be considered to lessen our concern about soil accumulation and possible exposure routes to this toxic metal.

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