CADMIUM MANAGEMENT IN NEW ZEALAND'S HORTICULTURAL SOILS

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Abstract

Cadmium (Cd) is a heavy metal trace element which presents risks for the horticultural industry in New Zealand (NZ). This element is added to soils through phosphate fertiliser application, and once there may be available for plant uptake and food chain transfer. When food products exceed international standards for Cd concentrations, these products may be excluded from international markets upon which NZ relies to maintain its economy. This presents a reputational risk for NZ's horticultural exports. Soil pH and organic matter (OM) content are the two key drivers influencing Cd's bioavailability, and field trials are currently being undertaken in four horticultural sites throughout NZ – Pukekawa, Manawatu, and two adjacent sites at Lincoln – to test the efficacy of the use of lime and compost amendments to influence these soil variables and thus reduce Cd plant uptake from soils. Potatoes are grown at all sites while Lincoln also includes wheat. This research aimed to characterise these soils, including total and plant-exchangeable Cd concentrations, pH, OM content, cation exchange capacity, total and plant-exchangeable Zn concentrations, aluminium and iron oxide content, total phosphorus and total nitrogen content. Findings indicated that total Cd concentrations varied among sites, with the highest (0.52 mg kg^{-1}) at Pukekawa, followed by Manawatu (0.26 mg kg^{-1}) and Lincoln Wheat and Potato sites (both 0.13 mg kg^{-1}). Exchangeable Cd concentrations were low at all sites (0.01-0.02 mg kg^{-1}) indicating little risk of plant uptake from these soils.

The mitigation strategy tested in this work focuses on pH as a key soil variable that can be readily changed to restrict Cd uptake. However, the effectiveness of amendment rates to effect target pH values is dependent on soil chemistry and rates will vary across sites. Incubation experiments were conducted to determine amendment rates for lime and sulphur, and to compare the pH of amended soil in a laboratory situation with the in-field situation. Incubation and field situations were found to be similar, with no significant differences between pH values after a period of 274 days in the incubator and 169 days in the field. The accuracy of the calculated amendment rates at achieving target pH values was assessed with extended incubation experiments. The results here varied between soils, with the sulphur application rate proving more accurate in the Pukekawa soil, however too high for the Manawatu and Lincoln potato soils. The calculated liming application rate similarly resulted in a higher-than-target pH, however after a period of 231-274 days the pH reduced and approached the target value.

A cost-benefit analysis was undertaken to determine the economic viability of the proposed mitigation strategy at each potato site. Results proved the strategy to be a viable option, which would remain viable in the face of varying uncertainty and reductions in potato yields. Practical considerations including timing and weather conditions, and compost availability were considered. Implementation of this strategy within NZ's current framework of the Tiered

Fertiliser Management System, which focuses on total rather than exchangeable Cd concentrations, may present difficulties, and thus there is a clear need for risk-based, soil and crop specific guidelines for Cd management within a NZ context.

Considering the apparent difficulties in designing pH amendments strategies, a model to convert pH buffer curve-generated lime application rates which can be derived in as little as 24 hours, to field applicable application rates which target a specific soil pH was developed for the Pukekawa soil. A similar model was not achieved for the Lincoln Wheat soil, and thus the development of such a model is not possible for all soil types. Where possible, the development of this model would be an innovative and useful tool for farmers with which to accurately and quickly determine required lime application rates to achieve a targeted soil pH. This would be of great benefit in the implementation of a Cd mitigation strategy using lime amendments, and would allow greater control over, and management of, soil pH in a horticultural context.

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