

Copper Sequestration Using Local Waste Products

Jim Ippolito¹

¹USDA-ARS-Northwest Irrigation and Soils Research Laboratory, Kimberly, Idaho

ABSTRACT

Dairies utilize copper sulfate (CuSO_4) foot baths to control hoof infections. Typical solutions are 5 or 10% CuSO_4 (pH ~6), equal to 12,500 or 25,000 ppm Cu, respectively. When spent, hoof bath solutions are usually disposed of in waste lagoons and subsequently utilized for irrigation. In the Magic Valley, this practice appears to be causing soil Cu concentrations to increase. The goal of our research was to use local waste products to sequester Cu from a simulated hoof bath solution and to use waste products to adsorb excessive Cu from Cu-affected soils.

We utilized lime waste and fly ash from the Amalgamated Sugar Company, LLC (Twin Falls, ID) to identify Cu sorption maximum as a function of pH. In triplicate, solutions containing one gram of material and increasing Cu concentrations (0, 2500, 5000, 12500, 25000 ppm Cu) were shaken for one month buffered at either pH 6, 7, 8, or 9. Materials shaken at pH 6 adsorbed the greatest amount of Cu, but concentrations up to 25000 ppm did not maximize all adsorption sites. Thus, additional solutions containing waste materials and Cu concentrations of 75000 and 100000 ppm Cu were shaken for one month at pH 6. Results showed that at pH 6 lime waste and fly ash adsorbed a maximum of ~ 45000 and 26000 ppm of Cu. The use of lime waste to sequester Cu from spent dairy CuSO_4 hoof baths appears to be a viable option.

Because lime waste adsorbed a greater quantity of Cu as compared to fly ash, we investigated the ability of lime waste to sequester Cu from Cu-affected soils. A soil from the Logan Soil Series (Typic Calciaquoll; pH 8.0; CEC = 14 meq/100g; % lime = 50%) which had received 0, 250, 500, or 1000 ppm Cu approximately one year earlier was utilized. Using a completely randomized design with four replicates, lime waste was applied at 0, 0.5, 1, and 2% by weight (~0, 10, 20, and 40 tons/acre), thoroughly incorporated, and allowed to incubate at 90% of field capacity for 3 months, after which 15 alfalfa (*Medicago sativa* L.) seeds were planted in each pot. Plants were allowed to grow for 2.5 months, and then were harvested at ½" above the soil surface, oven dried at 60°C for 72 hours, ground, weighed, and analyzed for total Cu content. Soils were air-dried, ground to pass a 1/16" screen, and then diethylenetriaminepentaacetic acid (DTPA; a measure of plant-availability) extractable Cu was measured. Soils were also subjected to a sequential metal extraction procedure which identified Cu associated with a) soluble species, carbonates, and cation exchange sites, b) iron and manganese oxyhydroxides, c) organic matter and sulfides, and d) residual phases. Increasing soil Cu application rate decreased alfalfa yield, but increasing lime waste application rate had no effect on improving alfalfa yield. Increasing soil Cu application also increased plant Cu concentration, while increasing lime application rate caused a decrease in plant Cu concentration. Increasing soil Cu application increased DTPA extractable Cu content, while increasing lime application rate did not affect extractable soil Cu content. Increasing Cu application rate increased Cu bound in all soil phases. Lime waste significantly affected Cu associated with most soil metal phases, but the changes were not large enough to help decrease soil Cu concentrations to below levels that would affect alfalfa growth and Cu accumulation. The use of lime waste to

sequester Cu from Cu-affected soils, unlike from solution, does not appear to be a viable treatment process. Results of these studies will be published in a peer reviewed journal later this year.