THE INFLUENCE OF ZINC AND COPPER FERTILIZER APPLICATION ON ZINC, COPPER AND CADMIUM CONCENTRATION IN MIXED PASTURE

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ABSTRACT

There has been considerable debate about the accumulation of cadmium (Cd) in agricultural soils and its subsequent uptake by pasture plants due to phosphate fertilizer application. Ruminants grazing pastures absorb a small fraction of this Cd, and some of this is subsequently accumulated in the liver and kidney. Although tissue accumulation of Cd in grazing livestock is generally small (< 1 mg Cd kg^{-1} fresh tissue), but any reduction in plant uptake is beneficial in reducing such accumulation further, especially in the kidneys. Uptake of Cd by pasture may be affected by the concentration of other nutrient cations, such as zinc (Zn) and copper (Cu). In addition, since Zn and Cu are complexed by the same metal binding protein (metallothionein) as Cd, a change in the ratio of these nutrients in pasture may also reduce Cd accumulation rates by interfering with Cd accumulation.

In order to assess the effects of Zn and Cu on Cd uptake by pasture, a field experiment was conducted, using three pairs of pasture plots with low (0.2 mg Cd kg^{-1}) and high (0.6 mg Cd kg^{-1}) background Cd status. Twelve sub-plots (1.44 m^2) were laid out in each plot and increasing levels of Zn (0, 5, 15 and 40 kg ha^{-1}) and Cu (0, 2, 5 and 10 kg ha^{-1}) were added as $ZnSO_4.7H_2O$ and $CuSO_4.5H_2O$ respectively. Pasture samples were collected at regular intervals and analysed for dry matter yield, botanical composition and Zn, Cu and Cd uptake. Soil samples were extracted with 0.01M $CaCl_2$ and 0.1M HCl solution to measure the plant available Zn, Cu and Cd.

It was found that the plots with a high background Cd status in the soil resulted in a higher Cd concentration in mixed pasture (0.22 mg Cd kg^{-1} DM) than those with a low background Cd status (0.10 mg Cd kg^{-1} DM) at the first harvest (after 73 days). The Cd concentration in the mixed pasture was higher during the summer (December) period than in the early spring (September).

Application of Zn fertilizer increased the Zn concentration in pasture from 37 to 150 mg kg^{-1} DM at the first harvest. Excessive amounts of Zn lead to a decrease in DM yield. The growth of pasture was controlled principally by the amount of plant available Zn,

which depended on the amount of both added Zn and added Cu. The effect of the added Cu was to increase the toxicity of the added Zn.

Application Cu fertilizer increased the Cu levels from 9 to 16 mg kg^{-1} DM at the first harvest. The Cu concentration in pasture continued to decrease with time following the addition of fertilizers. The legumes are more tolerant of Cu than grass. The Cu concentration in harvest 4 (after 159 days) ranged from 6.9 to 7.0 mg kg^{-1} DM in grass and 8.9 to 9.9 mg kg^{-1} DM in legumes.

The Cd concentration in the pasture decreased with increasing Zn concentration in the pasture at the first harvest. The effect of Zn on Cd uptake was more pronounced on plots with a high background Cd status in the soil. The effect of Zn on Cd concentration depends on the external Zn concentration levels.

There was no consistent effect of Cu concentration on Cd concentration. The effect of the addition of Cu and Zn in fertilizer was to lower the Cd:Cu and Cd:Zn ratios in the herbage.

There was a good relationship between soil available Zn as extracted by 0.1M HCl and Zn concentration in the herbage. A similar observation was obtained for Cu. But there was no consistent relationship between 0.01M $CaCl_2$ extractable Cd and the Cd concentration in pasture.

The results indicated that pasture and soil analysis for Cd and Zn may provide useful guides to situations where Cd concentrations in pasture may be decreased by Zn applications.

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DEDICATED

TO MY

BELOVED PARENTS

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