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Soil-plant Relationships of
Magnesium in Selected Taranaki Yellow-brown Loams

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Abstract

The exchangeable Mg contents of soils in the Inglewood - New Plymouth area of Taranaki are primarily determined by Mg contents of parent materials. Inglewood coarse sandy loams, formed from Inglewood Tephra contained the lowest, and New Plymouth black loams formed from Oakura Tephra the highest, exchangeable Mg contents. Exchangeable Mg contents of soils formed from Inglewood and Oakura Tephra declined with increasing altitude. The exchangeable Mg contents of Taranaki yellow-brown loams formed from pumiceous parent materials under high rainfall conditions are more similar to those of yellow-brown pumice soils than of Central yellow-brown loams.

In a pot experiment, the Mg concentrations of ryegrass plants grown on Burrell gravelly sandy loam (0.24 m.e.% exchangeable Mg) or Inglewood coarse sandy loam (0.22 m.e.% exchangeable Mg) were lower than those of plants grown on Egmont black loam (1.22 m.e.% exchangeable Mg) or New Plymouth black loam (1.44 m.e.% exchangeable Mg). Only on the two soils of lower exchangeable Mg content did Mg additions of from 9 to 36 kg Mg ha⁻¹ result in increased dry matter yields of ryegrass plants. Increases in ryegrass Mg concentrations and total Mg uptakes in response to Mg additions were also more marked on the soils of low exchangeable Mg content than on the soils of high exchangeable Mg content. Ryegrass dry matter yields increased with increasing temperature on all soils, as did plant Mg concentration and uptake, although the latter increases were greater on the soils of low Mg content and did not occur until after an apparent critical minimum temperature of ca. 14 C had been reached. Mg additions had no major effect on plant Ca or K concentrations.

The results of the field survey and the pot experiment are discussed in relation to the possible occurrence of Mg deficiency in plants and animals in Taranaki and the possibility of correcting these deficiencies using Mg-containing fertilizers.

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CHAPTER I

Introduction

Magnesium is an essential nutrient element for both plants and animals. In plants, Mg forms part of the chlorophyll molecule and is believed to participate in several other processes, which may include functioning as an enzyme co-factor in the processes of carbohydrate metabolism phosphate metabolism nitrogen metabolism and lipid metabolism (Gauch and Krauss, 1959); the regulation of cell osmotic potential (Sutcliffe, 1967) and the transport of phosphates within the plant (Jacob, 1958; Gauch and Krauss, 1959; Sutcliffe, 1967).

In animals, Mg is believed to act as an enzyme co-factor in many processes similar to those described above for plant cells. Further, the normal functioning of nerve cells is dependent upon the presence of adequate levels of Mg. When Mg is deficient, the nerve cells become more irritable, possibly resulting in the onset of a tetanic state in the affected animal. (Grunes et al, 1970). This disease is known as hypomagnasaemia (hypomagnasaemic tetany; grass staggers), and is of major practical importance, particularly in dairy or beef cows early in the post-parturition period. Over the July-September period, hypomagnasaemia may affect up to 2% of the cattle population in New Zealand. The economic importance of the disease arises from the fact that, in many cases, the affected animals die (Butler and Metson, 1967). It has been suggested that in order to ensure adequate animal intakes of Mg to prevent hypomagnasaemia, pasture herbage needs to contain at least 0.2% Mg (Kemp and T'Hart, 1957). Deficient levels for plants are commonly considered to be within the range of 0.1-0.15% Mg (McNaught, 1970). As there are few areas of soils in New Zealand which are Mg deficient with regard to plant

requirements (Metson, 1974), the present Mg problem is more one of maintaining adequate contents in herbage to meet animal requirements. This problem is accentuated by seasonal fluctuations in plant Mg concentrations, with lowest contents generally occurring over the late winter-early spring period.

In the past, scant attention has been paid to the relationships between soil parent materials and soil types, and soil exchangeable Mg status, in Taranaki. In an early study, Grange and Taylor (1932) mapped the main soil series in Taranaki but presented what proved to be an over-simplification of the occurrence of different soil parent materials and the relationships between them and the various soil types. In a recent study, Neall (1972) mapped a large number of soil parent materials and thus enabled the relationships between soil parent materials and the various soil types in Taranaki to be better defined. This, in turn, has made possible this study of the relationships between soil parent materials, soil types, and soil exchangeable Mg contents in several areas of Taranaki. In this study, several factors known, or suspected, to affect the Mg content of soils, and the Mg supply to plants, were investigated.