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EFFECT OF SOIL TYPE ON UPTAKE OF MAGNESIUM BY PASTURE PLANTS

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SUMMARY

Twenty-five to fifty lb magnesium per acre per annum (in 2 to 4 cwt dolomite or 4 to 8 cwt serpentine superphosphate applied to the soil as a topdressing on short pastures) have appreciably increased the magnesium contents of pastures on soils from pumice, but to date have failed to produce worthwhile effects on any of the other soils so far examined.

AN IMPORTANT FACTOR in the incidence of hypomagnesaemia and grass staggers is the magnesium content of the herbage consumed.

The pasture magnesium concentration can be increased by two methods: (1) Internally, through increasing root uptake of magnesium from the soil by use of magnesium fertilizers, or (2) Externally, by applying a coating of a magnesium material on the foliage by spraying or dusting. The present discussion is restricted to uptake through the roots, as obviously a dust coating will be unaffected by soil type.

McNaught (1964a, b) has reviewed evidence on effects of fertilizer and season on magnesium levels in New Zealand pastures. Results were quoted from three experiments with magnesium fertilizers on selected pumice soils of very low magnesium status and contrasted with findings in an experiment on Hamilton clay loam, a soil higher in magnesium, derived from andesitic ash showers. Detailed evidence was later reported (McNaught and Dorofaeff, 1965) from two of these trials on pumice soils.

On the low magnesium pumice soils there was no difficulty in demonstrating substantial increases in magnesium levels in the herbage from annual dressings of 4 cwt serpentine-superphosphate in place of 3 cwt normal superphosphate, or from the use of 2 cwt dolomite or Epsom salts, but in the experiment on Hamilton clay loam, increases were barely detectable using a single application at double these rates of magnesium.

Clearly, soil type has an important effect on uptake of magnesium from fertilizers applied to the soil.

Differences in uptake responses have also been found in Britain. Allcroft (1960) obtained good increases in magnesium uptake and succeeded in controlling hypomagnesaemia by applying 5 cwt calcined magnesite (equivalent in magnesium content to 1 ton dolomite) per acre on a light sandy soil at Weybridge, but in later work she and associates were forced to the conclusion that this did not prevent hypomagnesaemia on heavier soils, especially those of high pH derived from chalk. In a recent review, Todd (1966) concluded "soil treatments with magnesium compounds (300 lb Mg per acre, or more) are effective on light or sandy soils but are unlikely to be economical on heavy soils."

Todd's figure of 300 lb Mg per acre is equivalent to approximately 5½ cwt calcined magnesite or 24 cwt New Zealand dolomite per acre, a rate which would be considered quite uneconomic under New Zealand conditions. Dr Reith of Macaulay Institute, Aberdeen, has provided information that the Scottish farmer, because of subsidies, can purchase and apply 2 tons dolomite per acre on his farm at a net cost to him of only about £2 per acre, compared with more than £30 per acre in the North Island of New Zealand. Twenty-four hundredweight dolomite per acre could certainly be economic under British conditions but not here in New Zealand, unless it can be demonstrated that effects will last strongly for many years.

Kemp and Guerink (1962) obtained increases in pasture magnesium levels on sandy soils in the Netherlands with annual applications of as little as 1 cwt calcined magnesite per acre, equivalent to 4 cwt dolomite per acre per annum.

In view of all the above evidence, the good results obtained by Hogg and Karlovsky on a soil derived from pumice at Rotorua with only 2 cwt dolomite per acre per annum or with 4 cwt serpentine-superphosphate in place of 3 cwt normal superphosphate must be regarded as exceptional, and the results on Hamilton clay loam as more normal. Limited evidence from earlier trials also suggested that the magnesium component of serpentine-superphosphate had little effect on plant magnesium levels on "normal" soils—that is, soils not derived from pumice.

EXPERIMENTAL

To obtain more precise figures, and to extend present evidence, 15 field trials were laid down in June to July, 1966, on a range of soil types. In 13 of these trials, 4 cwt serpentine-superphosphate was compared with 3 cwt normal superphosphate, alone and in combination with 2 or 20 cwt dolomite or 20 cwt ground limestone. All these treatments were repeated with 3 cwt muriate of potash and there were 5 replicates of each of the 10 treatments. The other two trials were designed to test the value of New Zealand talc magnesite and of finely ground serpentine rock from Nelson on a soil from pumice and on a "normal" soil.

Pasture samples were taken 8 to 20 weeks later when there was sufficient growth for sampling for yield. Samples were dissected at the Seed Testing Station, Palmerston North, into white clover and grasses and analysed at Ruakura Agricultural Research Centre for major elements, especially magnesium and potassium. Further samples will be taken this autumn and next spring.

RESULTS AND DISCUSSION

Results from the first sampling are now available from 13 of the 15 trials. The effects of the magnesium treatments during the period of 8 to 20 weeks were slight in most of the trials, the average uptake response to 1 ton dolomite in 10 trials on non-pumice soils being hardly detectable, of the order of only 4% in both grasses and clovers. The magnesium of serpentine-superphosphate at one-tenth this rate of magnesium increased the average magnesium level by only 2%.

In the three standard trials on soils from Taupo ash, the increases in magnesium levels were better than on the non-pumice soils, though smaller than were obtained in earlier trials on lower magnesium soils. One ton dolomite increased grass magnesium levels by 15% and clover levels by 26%.

Three cwt KCl per acre depressed Mg levels in grasses on the average by 8%, double the increase found so far from 1 ton dolomite on non-pumice soils, but had little or no effect on Mg levels in white clover.

One ton lime slightly depressed Mg levels in grasses by 2% and in clovers by 4% on non-pumice soils, but on soils from Taupo ash lowered the levels by 10 to 11%.

A further trial was laid down on Taupo sandy silt, on a farm with a past history of grass staggers, comparing talc magnesite with dolomite and serpentine-superphosphate at twice the magnesium rates used in the standard trials. Talc magnesite had very little effect. The magnesium of 8 cwt serpentine-superphosphate gave a clear uptake response, 12 weeks after application, of 24% over 6 cwt normal superphosphate and 18% in plots receiving in addition 4 cwt urea per acre. Dolomite at 4 cwt per acre gave smaller uptake responses, namely, 16% and 10%, respectively, on the no-N and plus-N plots. However, larger effects are expected later from the slower-acting dolomite.

A trial was laid down on Horotiu sandy loam comparing dolomite at the high rates of 8, 16 and 32 cwt per acre with equivalent magnesium in the form of ground serpentine rock and talc magnesite. Calcined magnesite was also included at 7.2 cwt per acre, equivalent to 32 cwt dolomite per acre. To date, the calcined magnesite is the only treatment which has given a large uptake response, namely, 76% in mixed herbage after 8 weeks, and 72% after 11 weeks. The fact that this treatment depressed calcium uptake in the herbage indicates that the increase in magnesium content was *not* due to surface dust contamination with the calcined magnesite. Talc magnesite had no detectable effect, while dolomite at 8, 16 and 32 cwt per acre raised the magnesium levels after 11 weeks by 9, 12 and 14% respectively, and ground serpentine rock at comparable magnesium rates by 4, 8 and 19%, respectively. These are relatively small uptake responses compared with the 16% response after the same time interval from only 4 cwt dolomite in the trial on the Taupo sandy silt from pumice.

To sum up, results to date substantially confirm previous evidence that magnesium fertilizers applied to the soil as a topdressing are very ineffective in raising herbage magnesium levels on most New Zealand soils so far examined. These include a yellow-grey earth, central and southern yellow-brown earths, yellow-brown loams from Hawke's Bay, Taranaki and Waikato, a brown-granular clay loam and a northern podzol.

Only on yellow-brown pumice soils have good uptake responses so far been observed from the application of magnesium fertilizers at rates which can be considered

to be economic for New Zealand conditions—that is, comparable in efficacy and cost to direct supplementary feeding with magnesium compounds.

The implications are that farmers are ill-advised to attempt to prevent grass staggers by application of magnesium fertilizers to any soils other than soils from pumice. On non-pumice soils, other methods should be used for increasing magnesium intake. Dusting of pasture or hay is one possible method which will be unaffected by soil type.

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