MOLYBDENUM RESPONSES IN NORTH OTAGO

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We have had some excellent papers on the development of poorly farmed rolling downlands and clay foothill farmlands. It has been indicated that if the pattern of knowledge already known were applied to farming in these areas, great strides could be made.

It seems to me that there is a series of problem soils on which our present knowledge of lime and fertiliser practice, even used in conjunction with suitable pasture mixtures of Certified seeds and with seemingly good rotational methods, does not give results. It is illogical to presume that progressive farming practices have not been applied to some' of the easy rolling arable areas of North Otago. That in many cases these have failed is certain. The answer to this may be found in the investigation of trace element deficiencies, about which we know so little. It is interesting therefore to discuss the results so far achieved with one of these trace elements in North Otago. This work was really a continuation of the work undertaken in collaboration with Messrs E. M. Lake of Hindon and J. 0. H. Tripp of Outram. It appeared from chemical and experimental work on these properties that something more than low soil pH and low soil phosphate was involved in the development of their tussock and browntop country. The possibility of molybdenum deficiency on this country was first suspected in 1946, but no obvious responses from the trials begun then were obtained.

In North Otago a similar set of soil problems seemed to occur in the browntop country 'on the foothills from Herbert to Kauru Hill. Experiments were begun on this block in February 1951 and responses were observed on a trial put down in June 1951 at Ngapara. Then the spectacular results from a series of trials over a wide area became apparent in the spring of 1951 and summer and spring of 1952.

I will describe the areas involved and the plant

nutrient status' of their soils from the, work undertaken by the Soil Research Station at Hamilton.

First it appeared that on the Herbert and Kauru Hill country' pastures containing good clovers were difficult to establish and maintain for any time. Crop failures with turnips and rape were reported as common and lucerne was almost unknown.

In both these areas, however, some highly improved farms' could be seen next to almost derelict farms. Heavy liming-and the use of fertilisers were features on the improved farms. The chemistry of these soils did not show a very high lime requirement. In general the pH was from 5.4 to 5.8, the calcium figure from 1 to 8, phosphates low, and potash mostly high but quite variable. The recommended lime dressings would be from 15cwt. to 1 ton (sometimes 30cwt.). Heavier dressings than these were common where good results had been secured. For instance, one. of the few good lucerne stands in the area had received 7 tons of lime per acre in its first five years. For good pastures 3 tons per acre was a common dressing. It was found on chemical analysis that all these soils had low available molybdenum figures. These ranged from 0.02 to 0.13 p.p.m.

The number of trials which gave responses in this initial series was recorded in the May 1952 "Journal of Agriculture," and their locations were as widely scattered as Herbert, Kauru Hill, Tapui, Windsor, Ngapara and Airedale. This area embraced several soil types, notably Opuha, Claremont, Kauru and Timaru silt loams. The Waiareka complex or the Oamaru "tarry" soils were also shown to be 'low in available molybdenum. These are the market garden soils of North Otago and molybdenum has been found necessary for the growing of cauliflowers on them, though we have not yet demonstrated any responses to application on pastures.

On the soil types previously mentioned it would appear that the problem of the Opuha, Claremont and Timaru siltloams may be quite logical as the chemistry is of the expected nature and the responses are as anticipated.

From more recent work,: however, it appears that the sandstone soils of the Kauru Hill series present a more complex' and less easily explained problem. On these soils the pH is variable and the molybdenum figure not always as low as anticipated. For instance,

a. trial area giving a' good response has a pH of 6.6 and a molybdenum figure of 0.17 p.p.m. Furthermore, good responses to boron have been recorded and suspected responses to several other trace elements are indicated.

The question of interaction of trace elements with varying pHs has been fully set out by Dr. Davies and the results of two trials here which fit the pattern should be noted. These are the suppression of molybdenum responses with liming and the occurence of boron responses on the limed areas.

It would appear from the above brief outline that there are three types of problems here:—

1. The tarry soils, which may have low molybdenum figures and give responses in cauliflowers, but which grow legumes quite well.
2. The clay soils, which respond to heavy dressings of lime and where badly farmed and depleted by cropping give spectacular responses to molybdenum.
3. The sandstone soils, which may in addition to being deficient in molybdenum involve a complicated trace element interaction problem.

On all these soils, however, there is one common feature and I think it may be found important. That is their deficiency in nitrogen, or at least the occurrence of nitrogen patches on them.

Mr Adams will discuss the part played by molybdenum in plant physiology and of the necessity for molybdenum in the functioning of the soil fauna. The question of the nitrogen cycle then may be found to be of some importance.

These so-called nitrogen patches are very characteristic of the uneven distribution of lime by bulk sowers.

The features which appear common to the areas of which I am speaking can be summarised as follows:

1. The failure to establish good clovers and the consequent running out of pastures.
2. The rapid ingress of browntop and sweet vernal.
3. The failure of lucerne stands.
4. The occurrence of so-called whiptail symptoms in crops of rape, swedes, turnips, kale and chou moellier.

5. The unevenness of the soil types.
6. The occurrence of so-called nitrogen patches.
7. The uneven green colour throughout crops of cereals, young grass and brassicas.

The range of crops on which responses have been obtained in North Otago are clovers, lucerne, young grass, rape, wheat and oats. A trial with a large number of different species and strains is at present under way and field trials with wheat, linseed and barley are being undertaken by farmers. Trials with chou moellier, kale and turnips have not given responses here, but Mr Stockdill, who is carrying on the work on Mr Lake's property where this work started in 1946, has obtained a response there on swedes.

The time and method of application have been studied. Responses have been secured with molybdenum in fertiliser mixtures, as a seed dust, and sprayed on the ground crop. As most of the initial trials were as sprays on crops and pastures in the spring, a series of plots were conducted month by month to test if the time of application was important. From this trial, it would seem that all applications from February to November have so far responded, though the quicker responses were those applied in the growing season. This then means that it will be possible to apply the molybdenum in the autumn and winter topdressings of phosphates which are the regular times of topdressing in this district.

Rates of 'application have also been investigated and on some soils low amounts ($\frac{1}{8}$oz. per acre) are as satisfactory as the dressings of $2\frac{1}{2}$oz. used in most of the early trials. It appears that higher rates are better on the Kauru Hill soil types and here even $2\frac{1}{2}$oz. may not be the optimum. 'Evidence now accumulating indicates a definite. trend in favour of amounts up to $2\frac{1}{2}$oz. and that considerably higher amounts may be needed especially on lucerne in some soil types.

Some work on soil bacterial counts and pasture uptake of molybdenum is now under way. I would like to emphasise that molybdenum is not a substitute for any other essential plant food, that there is some risk of misuse of the material, and that molybdenum will not give responses everywhere it *is* tried. We have some 40-50 trials in North Otago- showing no responses and I personally know far more farmers on these very soils who have not had responses than those who have.

CONCLUSION

There are many things about the results we are getting which still have to be explained. For instance, contrary to the general pattern of responses elsewhere, a good response has occurred on a lucerne stand which has been well treated. It has had 7 tons of lime per acre in 5 years and has been well treated with phosphate. Other responses have occurred following reasonable fertiliser practices. Rates of application require further investigation and climatic influences may be important. The role of molybdenum, without phosphates on marginal land has still to be investigated.

It appears a sad commentary on the economic structure of, New Zealand's farming that so many are prepared to pin their faith on achieving so much for so little so quickly that they are not prepared to apply the proven methods, of which we have heard so much, to develop their land and increase production. Beyond all this however, there still remain new problems to be solved and one of these is unquestionably that of molybdenum deficiency.

APPENDIX I.

French Bros.' Trial.

Yields of Green Material in lb. per acre.

	Period 4/10/51-19/11/51		Period 19/11/51-19/12/51		
	A	B	A	B	Mean of 4 cuttings
Control	1522.4	1187.2	795.8	653.6	994.75
Lime only	2387.4	1453.2	1107.2	761.2	1427.25
Mo only	2387.4	1176.4	1384.0	1072.6	1606.10
Mo + lime	2975.6	1453.2	1868.4	1107.2	1851.10

McMann's Trial

Plot	20/11/51-8/1/52	20/11/51-27/3/52
Control	3300	2038.7
Mo	6232.5	9357.3
Lime	4312.	3930.7
Lime + Mo	7876	5822.7

Robert's Trial (Lucerne)

Control (Adjacent to Mo plot)	3060
Mo	13920
Mo + lime	4260
Mo + super	9300
Mo + super + lime	7980
Basic slag 1½cwt.	10920.
Basic slag 3cwt.	6600

Polson's Trial (Pasture)

	Plot 1	Plot 2
Mo	7028	2868
Control	4908	2080

Ruddenklau's Lucerne Trial

Mo	19,488
Control	13,664

Ruddenklau's Rape Trial

Mo	14,784
Control	8,288

APPENDIX II.

Soil Tests of Responsive Areas.

Farmer	Crop Response	pH	Ca	P_2O_5	K	Mo.	Req.
M. L. Roberts	Lucerne, Rape	5.9	10	7.6	V H	0.09	Maint.
French Bros.	Pasture						
	Pasture, Rape	5.5	4	2.5	H	0.03	1 ton
W. McMann	Pasture	5.2	3	8.3	L-M	0.05	1 ton
R. C. Ruddenklau	Lucerne, Rape Pasture	Not available.					
J. P. Rutherford	Pasture	5.5	4	Low	V H	0.07	1 ton
E. C. Ruddenklau	Pasture	5.5	3	Low	V H	0.13	1 ton
J. R. Polson	Pasture	5.4	3	8.3	V H	0.08	1 ton
J. C. McLean	Lucerne	6.0	8	12.2	H	0.12	Maint..
A. N. Woods	Lucerne	6.3	9	12.0	V H	0.04	Nil
J. Dalziel	Rape	5.3	6	4.5	V H	0.18	1 ton
J. M. Milmine	Lucerne	6.6	10+	5.0	V H	0.17	Nil
R. W. Hudson	Oats, Lucerne	6.7	10	4.7	V H		Nil
J. Clark	Lucerne	6.5	10	10.4	V H	0.11	Nil
J. Wedge	Lucerne	5.9	7	6.5	H	0.14	Maint.
A. R. Kininmont	Lucerne	6.4	10+	32.3	V H	0.14	Nil
S. J. Martin	Pasture Lucerne	5.6	6	6.5	VH		10cwt
B. R. Milmine	Cauliflower	6.4	10	53.0	H-V H		Nil
J. Spite	Typical Tar Soils	6.5	10+	25.9	H-V H		Nil
J. Newlands	Lucerne	Not available.					
J. A. Newlands	Wheat Lucerne	Not available.					