A DIFFICULT PAKIHI -WASTELAND OR FARMS ?

Investigations at Bald Hill, Westport

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THE ADDISON SOIL at Bald Hill consists of a top layer high in coarse roots, which when dry is light and porous. It will be called the sponge layer. It is of variable thickness (0 to 6 in.) and its boundary with the underlying denser, rather structureless soil is not well defined. This underlying layer is by no means without roots, but often it is drier than either the sponge above or the grit layer below. For the sake of brevity it will be called the pug layer. The grit layer consists of humus-stained quartz grit overlying deeply cemented boulders. The whole soil — sponge, pug and grit -is 10 in. to 2 ft deep.

The mean annual rainfall at Bald Hill is probably about 90 in., and the vegetation, typical of the true pakihi, is dominantly stunted umbrella fern and rushes. The general condition is wetness. Puddles are common where the sponge has been eroded. Squeezing the sponge itself will produce water at almost any time. There are no self-contained farms on this area and, by standards accepted on more fertile soils, no reasonably good pastures seem to exist.

Three possible reasons for this situation can be put forward :

(1) The nutrient requirements of clovers and grasses in this environment are not fully known.

(2) The soil is too waterlogged to grow good pasture.

(3) The soil, although not too waterlogged to grow good pasture, is too wet for good pasture to persist under grazing.

The writers have so far had only one year in which to begin to examine these three assumptions. Before this could be done, it was necessary to decide what approximate level of farming was best suited to the Addison soil and other difficult pakihis. Considering the cost- of developing a farm, erecting buildings and fences, forming tracks, buying machinery and using a fair amount of concrete, and also considering the high transport costs and the likelihood of low land values in relation to carrying capacity, it was felt that 4 breeding ewes per acre would be a reasonable carrying capacity to aim for. This means fairly good pastures of which white clover and ryegrass or other high fertility-demanding grasses are expected to form an important component. At the same time it was realized that a *Lotus pedunculatus* based pasture, with Yorkshire fog as the dominant companion grass, has several important advantages. It would be best suited to the environment, it would be cheaper to maintain, and it would probably form a firm surface mat resistant to pugging. With new strains of *Lotus pedunculatus* and Yorkshire fog becoming available, the carrying capacity of lotus-fog pastures might be surprisingly high. For this reason, some investigational work with lotus was carried out, and more is needed.

Nutrient Requirements of Pastures

DEFICIENCIES

The first series of trials, laid down by J. R. Bruce-Smith, showed that more than lime, phosphate and potash was needed to grow white clover in competition with lotus. Chemical analyses suggested copper, sulphur, and possibly molybdenum as additional deficiencies. The stage was now set for a series of interlocking trials to examine the requirements of white clover for major and trace elements. These trials were begun in late September, 1963.

TRACE ELEMENTS

Copper was found to be very deficient. Only 5 lb copper sulphate per acre was used and care taken to apply it a day before surface-sowing white clover. Two months after sowing, when the seedlings were up to 3 in. high, copper had already reduced the number of dead and dying plants and increased the general vigour. It had also significantly increased the number of seedlings with yellow cotyledons, a symptom commonly associated with lack of nodules or delayed nodulation. Later in the season very large yield differences due to copper occurred. During the first year a slight initial deficiency of iron changed to sufficiency, whereas zinc at first in adequate supply later produced highly significant growth responses in white clover.

It seems therefore that copper at about 10 lb bluestone per acre will be needed and iron sulphate would probably be of benefit. Although superphosphate contains much zinc, this element at about 5 lb of the sulphate per acre should be included in the initial topdressing. So far there is no evidence that the addition of molybdenum is necessary.

LIME AND MAJOR ELEMENTS

Of particular interest was the relative requirements of white clover and an improved *Lotus pedunculatus* for lime and major elements. Unfortunately, however, knowledge on this point, to be of practical value, also involves the associated grasses. Time and manpower have limited this investigation to a very rudimentary stage. From small-scale trials with rates of lime, phosphate and potassium, it has been found that, with an initial pH of 4.4 to 4.5, very few white clover plants will survive without lime, and that vigour will be only moderate with 15 cwt per acre, quite good at 30 cwt per acre, and even better at 60 cwt per acre. At these two higher rates, the lime response in the associated ryegrass is better than the response in white clover. Lotus, on the other hand, appears quite happy with 15 cwt of lime or less. Similar results have been obtained on the deep acid peats by Rukuhia workers.

There is less difference in the initial requirements for phosphorus between lotus and white clover. In the first year, lotus needs 5 to 6 cwt superphosphate per acre for satisfactory growth, and white clover probably 8 to 12 cwt.

For white clover a lack of potash is crippling. Because muriate of potash might depress germination or damage the inoculum, it was not applied at time of sowing. Three months later, in December, white clover had the most severe potassium deficiency symptoms ever seen outside a text book. But as soon as potash was applied growth shot away.

Lotus did not prove nearly as deficient in potassium as white clover.

Sulphur was of particular interest, because sulphur deficiency had been diagnosed in the herbage in spite of the fact that, three months earlier, quite large amounts of gypsum had been applied to the plots concerned. In a subsequent trial with white clover, no growth responses to either gypsum or flowers of sulphur, applied at varying rates, were obtained. Meanwhile D. **Hogg, Galloway Laboratory**, Ruakura, had found that the Addison soil did not retain sulphate against percolating water. In a leaching experiment, all the sulphate applied passed through the soil. The rapid movement of applied sulphate was confirmed in the field, using radioactive sulphur. Figure I gives an idea of the movement of sulphate eight days after the application of ^{35}S. About 2 in. of rain fell during these eight days. The presence of forms other than sulphate, some of which could be toxic to plants, still needs to be examined,

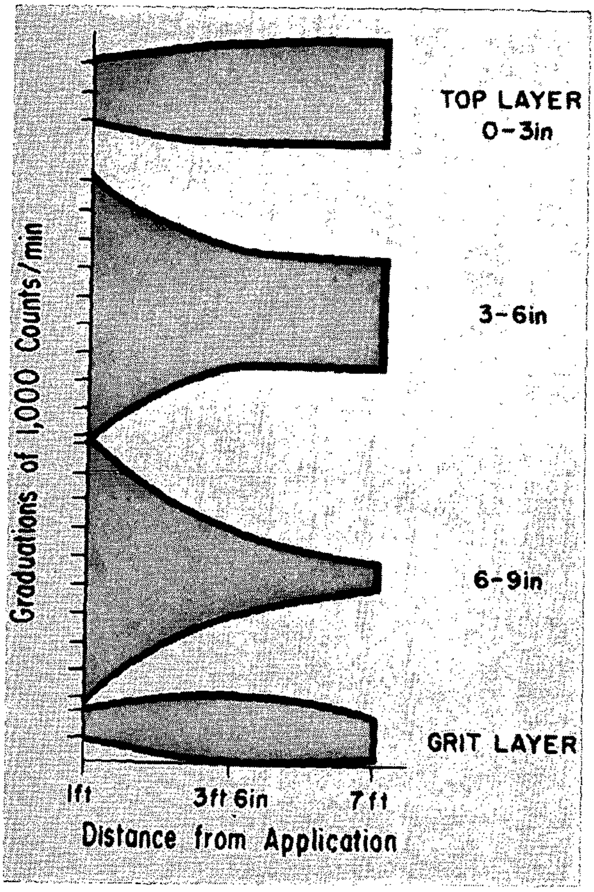

FIG. 1 : *Sulphate distribution eight days after application*

Is the Soil too Waterlogged to Grow Good Pasture?

It became obvious that white clover properly nourished grew well on the trial sites. But these sites generally were relatively dry. In wetter places clover survived for a surprisingly long time, but finally succumbed or became very weak. Also, wetness is expected to become more damaging with time, since, as the fertility of the soil is raised, its demand for oxygen will probably *increase*. Part of Bald Hill, therefore, may be too wet to grow good pasture. Drainage

There have always been differences of opinion about the efficacy of open drains on pakihi. Radioactive water was therefore used in two experiments on a site with a fall of about 1 in 30 to estimate where water movement took place and how it was affected by open drains. In the first experiment, shower-y weather with up to 0.7 in. of rain per day was experienced. Slightly less than 3 in. fell over ten days. Under these conditions, water moved mainly along the bottom of the sponge layer. Surface drains accelerated this movement.

In the second experiment, tritiated water was applied 7.5, 10 and 15 ft from a surface drain. The daily rainfall, beginning on the day of application, was 0.4, 0, 0.4, 2.1 and 0.3 in. Under this moderate rain intensity of the first three days, tritiated water appeared in appreciable quantity only in the nearest drains — 7 ft 6 in. from the point of application. In the drains placed 10 or 15 ft from the point of application, very little tritiated water was detected until the fourth day, after heavy rainfall. Evidence therefore suggests that fairly shallow drains could be effective if placed at close intervals of, say, 15 ft or preferably less. These drains may need renewing once a year. They should cut across the line of fall and yet join up with the natural streamlets. The latter will frequently need to be straightened and cleaned.

Is the Soil too Wet for Good Pasture to Persist under a High Stocking Rate?

Last autumn 40 acres were oversown to provide an area on which this assumption can be tested. It will take several years before useful information will become available. During this time it is expected that the sponge layer will be reduced or disappear, and that water movement will be closer to or at the surface and will become more rapid. This will be of great advantage.

On the other hand, as the original root mat disappears, the bearing strength of the surface may markedly decrease, particularly under high fertility. It may be wise, therefore, to aim for the strongest possible surface mat compatible with highly productive pasture. For this reason, the pakihis may be one place where casting worms could be harmful, and cheap means of keeping them out must be sought.

Conclusion

It has been shown that vigorous clover and good associated ryegrass can be established, provided many nutrients and adequate lime are supplied. The omission of any of the essential nutrients can be critical and could lead to a dominance of lotus.

The maintenance of soil fertility after establishment will need to be examined. The loss of nutrients in drainage water may pose a major problem.

Cheap drainage is now the key factor. In places with relative freedom from large roots and from boulders in the top foot of soil, and with moderate slope, this is probably not a difficult technical problem. Frequent shallow surface drains combined with vigorous legume growth will lead to a digestion of the sponge layer and will make it easier to construct humps and hollows formations later on if found desirable. Rate of stocking experiments, now in preparation, will, however, be the final test of the preliminary work. Provided staffing and finance for these experiments are adequate, a certain optimism about their outcome seems justified. The pakihi soils offer possibilities for new farm practices and should challenge the imagination of research workers. If this challenge is met, a new prosperous farming area could replace the present wasteland.

Acknowledgements

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