Potassium for Subterranean clover

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There are a number of areas in the south-western portion of the State where, although adequate quantities of superphosphate and trace elements have been applied, the growth of pasture species, particularly subterranean clover, has declined. In some cases, subterranean clover has disappeared completely. Investigations have shown that in many instances the decreased production is due to potassium deficiency.

Improvement in the growth of pasture plants was obtained by using fertiliser containing potassium on the south coast at Quarram and Denmark in 1932, but no benefits from potash manuring were noted in experiments conducted in the lower South-West. Many years later (1947), considerable improvement in clover growth followed the use of potash fertiliser on a property at Margaret River. A heavy dressing of cow manure, presumably because of the potassium it contained, was also beneficial.

Experiments during the next few years were aimed at determining the minimum amount of potash fertiliser needed to rejuvenate declining pastures. With a view to economy, the rates of application included some very low ones.

In some cases, definite improvement in growth was obtained but the responses were erratic and often did not persist into the second season.

A typical result is shown in Table 1 below.

<table>
<thead>
<tr>
<th>Muriate of Potash Per Acre</th>
<th>Total Yield Per Acre</th>
<th>Clover Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>20.7</td>
<td>4.4</td>
</tr>
<tr>
<td>25 lb.</td>
<td>25.0</td>
<td>8.2</td>
</tr>
<tr>
<td>50 lb.</td>
<td>27.0</td>
<td>8.6</td>
</tr>
<tr>
<td>100 lb.</td>
<td>29.4</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Because of the persistence of potassium deficiency in the experimental areas and the low potassium contents of clover, even on plots to which some potassium had been added, a preliminary trial with a dressing of muriate of potash (60 per cent. K₂O) at 200 lb. per acre was made in 1953. The improvement in growth was so marked that trials using a more extensive
range of rates were begun in 1954. To ensure that there were sufficient clover plants present to respond to manuring treatments, the areas were reseeded. The data obtained from an area where an outstanding response was obtained is shown in Table 2 below.

**TABLE 2.**

Vasse (Mr. R. Reading's property).

Yields—cwt. per acre dry weight.

<table>
<thead>
<tr>
<th>Muriate of Potash per Acre</th>
<th>Total Yield</th>
<th>Clover Yield</th>
<th>Protein Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>23.8</td>
<td>0.1</td>
<td>2.1</td>
</tr>
<tr>
<td>112lb.</td>
<td>34.1</td>
<td>15.6</td>
<td>4.8</td>
</tr>
<tr>
<td>224lb.</td>
<td>43.2</td>
<td>28.3</td>
<td>7.2</td>
</tr>
<tr>
<td>336lb.</td>
<td>43.2</td>
<td>30.4</td>
<td>7.4</td>
</tr>
<tr>
<td>448lb.</td>
<td>41.0</td>
<td>30.7</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Taking the 224 lb. per acre of muriate of potash as giving the maximum yield, the outstanding points of the results are—

(1) The disappearance of clover from the no potassium plots even though they were reseeded.

(2) An increase of 19.4 cwt. per acre of hay.

(3) An increase of 28.2 cwt. per acre of clover.

(4) As a result of the clover increase, an increase of 5.1 cwt. per acre of protein.

The importance of the clover increase is apparent in that it provides added protein in the feed and hay. In addition, vigorous clover causes increased soil nitrogen and consequently increased production of associated annual grasses.

Similar trials were conducted at Elgin (Mr. C. B. Wells' property) and at Margaret River (Mr. N. L. Smith's property). The results obtained from these trials are shown in Table 3.

**TABLE 3.**

Yields—cwt. per acre dry weight.

<table>
<thead>
<tr>
<th>Muriate of Potash per Acre</th>
<th>Margaret River</th>
<th>Elgin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Yield</td>
<td>Clover Yield</td>
<td>Total Yield</td>
</tr>
<tr>
<td>Nil</td>
<td>24.2</td>
<td>8.0</td>
</tr>
<tr>
<td>224lb.</td>
<td>34.3</td>
<td>25.9</td>
</tr>
</tbody>
</table>
The clover increases are obvious. The response at Margaret River is shown in Fig. 2 and that at Elgin in Fig. 3.

On another property at Margaret River (Mr. A. Zanni's), where potassium deficiency was not so acute, near maximum results were obtained with 112 lb. per acre of muriate of potash and there was a substantial improvement with 56 lb. per acre. The data obtained is shown in Table 4.

TABLE 4.
Margaret River (Mr. A. Zanni).
Yields—cwt. per acre dry weight.

<table>
<thead>
<tr>
<th>Muriate of Potash Per Acre.</th>
<th>Total Yield.</th>
<th>Clover Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>21.9</td>
<td>13.3</td>
</tr>
<tr>
<td>56 lb</td>
<td>32.7</td>
<td>23.1</td>
</tr>
<tr>
<td>112 lb</td>
<td>34.4</td>
<td>27.7</td>
</tr>
<tr>
<td>168 lb</td>
<td>36.5</td>
<td>28.4</td>
</tr>
<tr>
<td>224 lb</td>
<td>38.7</td>
<td>31.4</td>
</tr>
</tbody>
</table>

WHY POTASSIUM DEFICIENCY DEVELOPS

It has been known for many years that the potassium content of many of the soils in the south-western part of the State is very low. Chemical data obtained from soil surveys in recent years has shown that it was inevitable that potassium deficiency would develop under any system of farming which involved the removal of substantial quantities of potassium.

The potassium content of pasture plants is such that the removal of meadow hay from a paddock robs the area of a substantial amount of potassium. Dairying in Western Australia does, of necessity, entail the making of meadow hay and its removal from paddocks. As the hay is seldom fed back on the area from which it came, the potassium it contains is usually permanently lost.

The quantity lost varies of course with the tonnage and potassium content of the hay, but a two ton crop of clover hay can contain from 35 lb. to 75 lb. of potassium (equivalent to 70 lb. to 150 lb. of muriate of potash).

The potassium in the soil which is available to plants cannot be accurately determined but a chemical analysis for that portion known as "exchangeable" potassium is quite a good guide. Data obtained from soil surveys and other sources show that the "exchangeable" potassium in the top nine inches of the soils which predominate in the Elgin, Vasse and Margaret River areas is low and varies from 80 lb. to 500 lb. per acre.
Not all of this “exchangeable” potassium is necessarily available to plants. It becomes obvious that a succession of hay crops each of which might remove 35 lb. to 75 lb. of potassium per acre would soon reduce the soil content to a level where the growth of healthy pastures would no longer be possible.

SYMPTOMS OF POTASSIUM DEFICIENCY OF SUBTERRANEAN CLOVER

Potassium deficiency of subterranean clover is most readily diagnosed in the late spring, at the time of rapid clover growth. While clover is still present in the sward, a mild deficiency may show up as patchy growth—with some areas growing normally while others grow slowly if at all—giving a wavy appearance to the pasture.

In instances of more severe deficiency, the clover plants may be only sparsely scattered throughout the pasture. In such cases, the only healthy clover is usually associated with dung patches from which it derives sufficient potassium for normal growth. The typical appearance of such an area is shown in Fig. 1.

The leaves of affected clover plants show variable but nevertheless recognisable symptoms. On the Mt. Barker strain (the common midseason strain grown in the lower South-West) the older leaves pale from the edges and turn a dull yellow. A fine spotting then develops on the leaf surface and these spots later join together to give dead areas which can often be mistaken for insect damage. Subsequently the edges of the leaves scorch and the whole leaf dies rapidly.

Where the deficiency is severe the plants are poorly grown and the leaves a dull yellow or putty colour so that they resemble the leaves of zinc-deficient clover plants. Where the deficiency is so acute, however, the areas soon reach a stage where the clover disappears from the sward completely and the remaining pasture consists of annual grasses of low value such as silver grass.

Typically in the paddock, leaves are seen exhibiting various stages of potassium deficiency. A poorly-grown patch in a potassium deficient clover stand will contain

Fig. 4.—Subterranean clover showing potassium deficiency symptoms—leaf scorch prominent

Fig. 5.—Potassium deficiency symptoms developed in pot trial. Similar symptoms are frequently seen in the field
many dull yellow leaves; some leaves showing marginal scorching; and some completely withered.

Both the Yarloop and Dwalganup strains of subterranean clover appear to show more marked scorching of the edges of the leaves than is the case with the Mt. Barker strain. In the Mt. Barker strain the dull yellowing of the older leaves and fine surface spotting is a far more common symptom than the marginal scorching.

Chemical analysis of plant material can be used to confirm suggested potassium deficiency. If the dried leaves contain less than 0.8 per cent. potassium, maximum growth cannot be expected.

Deficiency is, of course, best confirmed by obtaining in the field improved growth with a fertiliser containing potassium.

WHERE POTASSIUM DEFICIENCY MAY OCCUR

Potassium deficiency may be expected to occur on any of the light-textured soils of the higher rainfall areas which are utilised in such a way that there is a drain on the potassium reserves of the soil.

It may develop on the sandy loams of the south-western areas which originally carried marri (redgum) and on the light loams of the southern areas which originally supported karri forest.

On some of the very sandy soils along the west coast, south of Perth, and along the south coast, potassium deficiency may become obvious soon after seeding. This applies also to the peaty sands, of which many of the coastal swamps are constituted. These are also low in natural potassium reserves and exhibit deficiency even before any potassium has been removed.

The deficiency has occasionally developed on heavier soil types where removal of hay over a long period has seriously depleted the potassium reserves of the surface soil.

In all cases the practice of cutting and removing hay will hasten the onset of the deficiency. In many cases the deficiency appears to be more frequently related to farm practice than to soil type.

PRESENT RECOMMENDATIONS

The potassium supplies of sandy surfaced soils are usually found associated with the organic matter accumulated in the top few inches. Particularly where cultivation is practiced most of this potassium quickly becomes available to the pasture plants. However, following this initial release, leaching and removal of plant material reduce soil potassium to a very low level at which acute deficiency occurs and the clover disappears completely from the sward.

In those cases re-establishment can only be ensured by reseeding to clover, and by applying muriate of potash at a substantial rate—up to 200 lb. per acre. Excellent clover growth should be obtained, but if the area is cut for hay a dressing of potash should be applied in the following year. Until further information is available, it is suggested that, when hay is not cut, the superphosphate-potash mixture (5 parts of superphosphate to 1 part of muriate of potash) now available be used at the rate of 1 bag (186 lb.) per acre.

On areas where deficiency is less severe and clover persists but develops deficiency symptoms in the spring, a dressing of 1 cwt. per acre of muriate of potash should be sufficient to ensure satisfactory growth. Here again, the same dressing should be repeated should a hay crop be removed. Thereafter, under grazing conditions, the use of the superphosphate-potash mixture should be standard practice.

On the lighter-textured soils of the south-west where deficiency has not yet appeared, it is recommended that the superphosphate-potash mixture be used annually to prevent the development of deficiency. Admittedly under grazing conditions, practically all of the potassium taken up by animals is returned in the dung and urine. However, the application of small quantities of potash fertiliser annually to these lighter soils should ensure maximum growth and should so build up potassium supplies in the soil that hay crops can be taken once every few years without seriously depleting potassium reserves.

It must be realised that the maximum benefit from potash fertiliser can only be
obtained if the plant requirements for superphosphate, copper, zinc and sometimes molybdenum have been met.

When applying heavy dressing of muriate of potash there is a danger of severe injury to the young plants. To avoid this danger every attempt should be made to topdress with potash fertiliser during the dry months. If, however, it is essential that the area be topdressed after germination, mornings when there is dew on the plants or days when very light rain is falling should be avoided. It is the formation of a concentrated solution, due to the fertiliser being dissolved in a small amount of water, that causes injury which is evidenced by a scorched appearance of the leaves. Heavy rain or even a strong wind will remove the fertiliser from the leaves and so reduce the danger of injury.

FURTHER EXPERIMENTS

Additional experiments are in progress on soils where potassium deficiency has occurred, and has been overcome by manuring, to determine the quantities of muriate of potash which are needed in the years following the initial heavy dressings. It is hoped to ascertain the potassium requirements under varying conditions of management including—

1. Grazing only.
2. Grazing with hay cut and removed every year.
3. Grazing with hay cut and removed every second year.
4. Grazing with hay cut and removed every fourth year.

This information will enable more accurate recommendations to be made for manuring with potash fertiliser to ensure permanent productive pastures.
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