SOME ASPECTS OF PASTURE ESTABLISHMENT ON WAIKATO PEATS

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In considering this problem, it is necessary to define the conditions under discussion. Reference will be made in this paper to raw peat, decomposed peat, and overdrained peat, and in order to clarify the position the following descriptions will apply.

(1) Raw Peat: Most, raw peat is deep under Waikato conditions. It is undrained and carries a good deal of the original peat-forming vegetation such as rushes, sedges, umbrella fern, and sphagnum moss. On being drained the swamp changes to an almost pure association of manuka. It is normally waterlogged in the winter. It is extremely acid and tends to become more so at increasing depths up to 12in from the surface and contains a large amount of undecomposed vegetable matter. It is highly fibrous.

(2) Decomposed Peat: Decomposition takes place with aeration consequent upon drainage and working: It becomes more consolidated, less fibrous, and less acid, and ma.y or may not suffer from water-logging in winter and overdrainage in the summer. Depending upon the degree'of decomposition, it is capable of supporting fair pasture.

(3) Overdrained Peat is really a phase of (2), but one where drainage has proceeded to such an extent that pasture growth is limited for long periods of the summer through inadequate soil moisture.

It is not proposed in this paper to cover the whole of the problems encountered in establishing pastures on peat, as reasonably comprehensive reviews have already been published in the Journal of Agriculture, Journal of Science and Technology, and in the proceedings of the last two Science Congresses. It will there-

fore be assumed that the following points will be familiar to the reader:—

1. That most peats have plenty of total nitrogen, but the speed of release during the active phases of decomposition is too low for plants. They are therefore highly responsive to applications of artificial nitrogen.
2. The cheapest way to supply nitrogen to grasses is through legumes. Therefore conditions must be made suitable for them to grow.
3. Legumes can be grown vigorously by suitable applications of lime, phosphate, and potash. Failure to have present the correct quantities of all these materials leads to failure in pasture establishment.
4. Special considerations exist in peat soils which make it highly imperative that close attention be paid to water relationships.
5. Careful attention to grazing management and paddock size are of particular importance in establishing and maintaining good pasture on peat.

USE OF ARTIFICIAL NITROGEN

It has already been stated that peat is highly deficient in available nitrogen and that spectacular results can be expected from its application. This is particularly noticeable in the first year of pasture establishment on raw peat, when all newly sown areas make little winter growth and take on the characteristic yellow symptoms associated with nitrogen deficiency. This is not merely associated with waterlogging at that time of the year, because the same effect takes place to a smaller extent, even where the peat is well-drained.

In common with other large areas of marginal land, young peat pastures tend to become clover dominant even under carefully controlled grazing, and provided adequate lime phosphate and potash are applied there is little difficulty in developing vigorous clover growth. The big problem seems to be to maintain the clover-grass relationship and to so thicken up the grasses that they become knit into a dense sward and avoid the tufty habit of growth so frequently noted in this type of pasture.

Both these conditions-the fact that peat pastures are always highly nitrogen-deficient in winter, and also tend to become clover-dominant very easily-argue that artificial nitrogen should be of very material benefit at least during the first year of establishment and possibly as a normal part of the manurial programme for producing winter feed.

On a small scale this has been attempted several times at the Rukuhia Station and large increases in growth have been noted. Although the most spectacular effect of the nitrogen has been on the grass, it has also increased the size and vigour of the clover plants, thus indicating that the clover itself suffers just as severely from nitrogen lack as the grass.

There seem to be several factors to be borne carefully in mind when using nitrogen under conditions such as these. The first one is that it is easy to stimulate growth with nitrogen to such an extent that deficiency of phosphate or. potash is easily induced. It must be remembered that when working with raw peat the amounts of mineral nutrients present in the soil are so small that the provision of added nitrogen can easily result in their becoming limiting factors to growth. It is therefore necessary to consider balance in fertiliser applications as well as type of nutrient.

In order to minimise possible damage from the use of nitrogen grazing must be concentrated and rotational to secure maximum return of dung and urine to the areas treated.

Last year an area of about $\frac{1}{2}$ acre was given the equivalent of' 2cwt. of sulphate of ammonia in the form of ammonium nitrate. Part of this area was spray irrigated, part was under sub-surface water-table control and part received no attention except the drainage provisions which were common to the whole area. It was noted that on that part of the plot receiving no added moisture in the summer the pasture showed evidence of deterioration, mainly from the point of view of less clover and more fog. The watered areas, on the other hand, failed to show any deleterious effects from the use of nitrogen.

To sum up, then, it is felt that nitrogen has more than usual value on peat soils and further studies of its use and limitations will be undertaken at the Station.

THE OCCURRENCE AND CAUSE OF PATCHY PASTURE GROWTH

In an early attempt to establish pasture on deep peat, it was noted that the strike, though poor, was initially even and that as the winter progressed good and bad patches became more and more obvious. This state of affairs is very common on new pastures on peat and unless steps are taken to avoid the trouble from the -outset, the poor patches get progressively worse and manuka and rushes become firmly established.

An intensive survey was therefore made in an attempt to sort out the differences between the good and bad patches. It was found that without exception the bad patches were about 1 pH unit more acid and the calcium status was correspondingly lower.

However, the bad patches are not only associated with lack of lime, but may be caused through insufficiency of any of the prime nutrient deficiencies, lime, phosphate, or potash.

Again it must be remembered that as, initially, peat is so intensely deficient in minerals, evenness of distribution is of prime importance.

Our experience on several occasions has led us to the conclusion that the rotary type of topdresser so frequently employed by farmers and contractors for applying lime and fertilisers is an unsatisfactory implement for use in developing low fertility areas. It has always given very irregular distribution with the heaviest application immediately behind the machine and then tailing off to lighter applications on the outsides of the strip. A further point is that in the handling of aggregates of variable particle size, a distributor depending upon centrifugal force has the effect of throwing the coarse particles further than the fine ones.

As these patches almost invariably developed on young pastures, it was argued that the differences causing the patches should be present before sowing the pasture. An area was therefore selected and carefully sampled on the basis of changes of herbage visible on the surface. Sampling on this basis failed to reveal any differences of sufficient magnitude to explain why these patches developed.

It was also suggested that the patches were related to the presence of hummocks and hollows, and accord-

ingly a careful study was conducted on a number of pegged squares, an equal number being situated on both hummocks and hollows. The pasture concerned was sown with the following mixture on April 24 1950 at the rate of 351b. per acre:-

Perennial Ryegrass	25
H.I.	8
Cocksfoot	8
Paspalum	5
Yorkshire Fog	3
White Clover	2
Montgomery Red	2
Lotus major	½
	53½lb.

Previous treatment of the area consisted of ploughing about 9in. deep after an application to the surface of 2 tons of lime. Later it was rolled, disced, and harrowed, and a further 2 tons of lime applied and lightly disced in. After further working to provide a seed-bed, the pasture was sown with 2cwt. of superphosphate and lcwt. of potash.

The following table sets out the counts of both grasses and clovers on the hummocks and hollows:—

SEEDLING COUNTS ON HUMMOCKS AND HOLLOWS

Average **count per sq. yd.** (Legumes, Grasses)

	5.5.50		26.5.50		16.6.50		10.7.50		23.8.50	
	Legs.	Grs.	Legs.	Grs.	Legs.	Grs.	Legs.	Grs.	Legs.	Grs.
Hummock	3 1	22	314	513	130	345	132	463	114	366
Hollow	45	46	162	430	122	305	134	500	93	365
Mean	38	34	238	472	127	328	162	479	105	365

It will be noted from the above table that there was no very significant difference in terms of early establishment between the hummocks and hollows, and, the position remains substantially the same at the present time some 18 months after sowing.

It is therefore concluded that the main cause of patchiness in newly established pastures on peat is related principally to unevenness of distribution of lime or other plant nutrients. However, it is-felt that if the final brushing in of seed is carried out with too heavy an implement seed and topsoil with the incorporated fertilisers may be dragged- off the hummocks and lodged in the hollows.

ACIDITY AND LIMING

In considering raw peat areas it must be borne in mind that the acidity of the surface layers, although high, is lower than those further from the surface. Thus the pH of the surface 3in. may be 4.5, while the 3in. to 6in. layer may be 4.2 and the lower layers about 3.8. After observations spreading over several years it is the author's opinion that most pasture failures are to be attributed to shallow rooting of established plants, This is believed to result from a combination of two main factors.

1. Inability of the roots to penetrate into these highly acid layers.
2. High water tables and lack of effective aeration in winter.

Both the use of lime and thorough cultivation are important in overcoming these effects. Lime is important from the viewpoint of its capacity to neutralise acidity and also to supply that very necessary plant food-calcium. Cultivation is also considered beneficial because the improved aeration facilitates oxidation of the acid organic materials and so contributes to the work of the lime in eliminating the extremely acid conditions.

From a careful study now extending over several years, it is interesting to note that the downward movement of lime is for all practical purposes negligible when this material is applied to the surface of an established pasture. By this it is not meant to suggest that absolutely no lime moves downwards—it does, but insufficient movement takes place to have any material effect on soil conditions at the lower levels. This is clearly shown in the following table:—

Effect of Lime on pH and Calcium of Peat Three Years after Topdressing

Depth of Sample	Lime applied					
	pH	Ca	pH	Ca	pH	Ca
Inches	Nil		2 tons		4 tons	
0.2	4.8	0	5.0	6	6.0	14
2.4	4.0	0	4.0	0	4.3	
4.6	3.8	0	3.8	0	4.1	8

For this reason and because it has already been clearly demonstrated how important lime is in the establishment of pasture plants and how high acidity will prevent root development in depth, it is believed

to be important to incorporate the lime as deeply as possible into the top layers of the peat before any attempt is made at pasture establishment. Failure to do this will militate against deep rooting and the pasture will suffer accordingly during dry summer spells.

This obviously opens up a further avenue for consideration. In some of our early work we ignored the necessity for incorporating lime in depth and added lime sufficient to meet the requirements of say, the top 3 in. Now if it is proposed to work the soil 10in. deep and incorporate lime, then obviously something approaching three times the quantity of lime must be used.

Good results on raw peat at the station have been achieved from ploughing in 2 tons of lime to 9 or 10in., followed by a further surface application of 2 tons worked in.

BURNING OF PEAT

It is the belief of the authors that in most cases there is no virtue in burning peat, but. twor exceptions to this statement must be made:

1. Burning represents the only easily practical method of disposing of large quantities of rubbish on the surface of the peat, which, if left, would impede cultural operations, e.g., tall or, dense manuka. Under these conditions the initial operation should be to crush the manuka in the autumn and burn early the following summer, after the seedling manuka has become established. Burning should be done when the surface is dry, but the water-table high. If it is delayed until the water-table falls, then the peat itself will burn and holes and unevennesses will 'develop.

2. In cases where peat has been severely overdrained there seem logically only two approaches if any alterations in the moisture status of the peat is desired. The first is to bring the water-table up in the peat by surface or sub-surface irrigation, while the second is to attempt to lower the surface of the peat closer to the water-table by burning. It must, however, be remembered that this set of conditions most frequently arises where the peat has been farmed for some considerable time, and under these conditions the potential risk to fences, buildings, stock, and shelter belts is very considerable. The only true answer here, therefore, is to avoid these conditions ever developing by controlling drainage and water-tables.

The insistence on burning peat under all circumstances is submitted to be without any justification if a clean and satisfactory seed-bed can be produced without it. The burning of peat has the ultimate effect of leaving a layer of ash over raw acid peat. Burning without a high water-table leads to the formation of holes and involves further levelling. Burning when the water-table is low in the summer may take the surface down to a point where the whole area is badly waterlogged in winter. Frequently after burning and where a fire gets a good hold, a layer of peat below the burn is charred and becomes very impervious to water, thus still further making it even more difficult to sustain a good growth of pasture. But probably the main objection which we have against burning is that it makes it virtually impossible to work the lime into the surface as we consider is necessary.

CONCLUSIONS

1. The suggestion is advanced that the main cause of good and bad patches in peat pastures is uneven distribution of the main plant food materials and that the type of implement used is an important consideration.

2. Because lime fails to move downward in adequate quantity in peats, it is believed to be important to incorporate the lime through a considerable depth of soil before sowing down. Surface applications after establishment will not achieve the desired result.

3. Because of considerations of acidity and moisture requirements, it is believed to be important to encourage deep rooting of pasture plants. This cannot be done without adequate lime being worked in.

4. The viewpoint is advanced that except, first, where the disposal of surface rubbish can only be accomplished by burning and, secondly, where burning is the only possible means of lowering the surface closer to the water table, the routine burning of peat cannot be justified. It is further suggested that in the long run any possible advantage from burning is more than overshadowed by its drawbacks.

DISCUSSION

Q. What quantity of lime should be used and how deep should it be worked in when breaking in raw peat?

A. This will be variable, depending upon the type of peat, its stage of decomposition, and the depths to which it is worked. The aim is to produce a layer of peat with adequate lime-through it so that ulants can establish a nood root system. At the Rukuhia Station 2 tons of lime were-applied and then ploughed down. A further 2 tons was then applied to the ploughed surface and worked in.

Q. Would the speaker elaborate on drainage methods and control of water-table? How far apart should open drains be placed?

A. The full story. of drainage for peat is too long to go into in detail. What is necessary is to avoid open drains which are too deep and to supply an adequate internal drainage system. In many cases moles can be used effectively. We do not know how close the water-table must be kept to the surface but suspect it would be lft. to 18in. In the more fibrous peats drainage can be reasonably effective with open drains, but for the most part they are inefficient.

Q. Are there any bad effects on young clover from the application of nitrogen?

A. Not in our experience. Actually the clover was stimulated as well as the grass. There was some depression in clover the following dry summer, after an application of 2cwt. of sulphate of ammonia. This did not take place, however, when irrigation was applied and where the pasture did not dry out in the summer.

Q. What was the dry-matter production from your best plot?

A. I do not recall the actual figure, but it was approximately equal during mid-summer to the production from a good pasture on Hamilton clay loam under spray irrigation.

Q. Did you try out different forms of nitrogen ? If so what were the results ?

A.. None of the more recent forms of nitrogenous fertilisers have been compared, but in earlier trials there was no difference when nitrogen was added in either the nitrate or the ammoniacal form.

Q. Do you Consider cattle useful for consolidation?

A. Yes, certainly, but we feel it is better to carry out the initial grazing for, say, the first year with sheep. At the station we have no cattle and grazing so far has been done entirely with sheep.

Q. How much nitrogenous fertiliser would you recommend on, peat?

A. We have not yet gone sufficiently into the question and in the meantime it is best to consult the local Instructor in Agriculture about types and quantities to be used.

Q. How much potash should be used on peat?

A. This will vary from place to place. In our own work we normally use 2cwt. of super and 1cwt. of potash at time of sowing and repeat in the following spring. Thereafter annual spring topdressings of the same order are given. In the meantime it is wise to refer this type of query to your Instructor in Agriculture who will know your local conditions.