T H E S I S.

Submitted for M. Agr. Sc. Degree.

"A STUDY OF THE YIELDS OF VARIOUS SPECIES OF PASTURE PLANTS, AND SOME OF THEIR STRAINS, WHEN GROWING IN A SOIL BROUGHT TO VARIOUS LEVELS OF HYDROGEN-ION CONCENTRATION."

by

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Photo. 18th Dec. 1946.

This shows a general view of the experimental area. The most acid treatment is at the extreme left and the neutral treatment on the right. White clovers are in the foreground, Montgomery red clover shows black just behind, while the grass series are further back still.

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INTRODUCTION.

1. General.

During the past few decades, our country, along with other important primary producers, has come to realise with increasing force the real importance of pasture production to mankind. In New Zealand over nine tenths of the value of our exports comes directly or indirectly from grasslands. This realisation has been reflected in the marked extension in research, not only towards the improvement of pasture species and strains, but also in an attempt to learn more of the conditions in the soil that are most ideal for maximum production.

As a plant can produce only as much as its inherent potential and its external environment will allow, it becomes all workers to consider both sides of the question of maximum production. As a result of work done by the Grasslands Division of the Plant Research Bureau since its inception, strains of new pasture species have been developed which will produce very highly under conditions favourable to their growth. Thus if these strains are used in agriculture and maximum production is not obtained, managemental and environmental factors must be the limiting ones. Of the environmental factors, five claim pride of place where pasture production is concerned:-

(a) Soil moisture
(b) Soil and air temperature
(c) Light intensity
(d) Soil fertility
(e) Soil acidity

In practice the first three factors are mainly dependent on climatic conditions, though by suitably controlled irrigation and drainage both soil moisture and soil temperature can be influenced and plant growth markedly increased.

The problem of light intensity needs research in this country, but it is known that some species, such as Prairie grass (Bromus catharticus) and Cocksfoot (Dactylis glomerata) thrive when a certain amount of shade is provided for their crown, while others such as Indian doub (Cynodon dactylon) or English hair-grass (Aira caryaphyllia) grow best under open sunny conditions. Thus although climate can play an important part in this factor, it is obvious that, as Nilsson-Leissner has said ".....if we know the special requirements of a certain strain or group of strains of pasture plants we can adapt our system of grazing management and of manuring and so on, in such a way that we favour or hamper that particular group....."

Soil fertility as usually considered includes all other factors of soil environment but here the term is used to mean the ability of the soil to supply the growing plant with all the nutrient requirements normally absorbed through the root system. It is well known that this is usually the most important factor limiting plant growth, but much can be done by manurial applications to counteract any deficiencies that may be limiting plant growth.

The fifth factor of soil acidity or Hydrogen-ion concentration is partially wrapped up in its effects with fertility, because it is known for instance that under acid conditions some nutrients - particularly calcium and magnesium are usually leached out while under alkaline conditions others like Potassium and iron may be held in forms unavailable to the plants. (Pettinger, 1935.) However apart from this indirect effect, the Hydrogen-ion seems to have a direct bearing on the growth of a plant, even when special measures have been taken to make all nutrients available. (Lundegardh, 1931).

Thus it would seem that the soil acidity, or soil reaction as it is often called, when combined with the resultant degree of nutrient availability, plays a very important part in regulating plant growth.

Soil acidity depends on the Hydrogen-ion concentration in the soil and this is usually measured and expressed as the pH value for that soil. The pH may be defined as "the negative index of ten which expresses the concentration of Hydrogen-ion in the solution of the acid". (Russell 1927.) A pH of 7 represents a neutral solution with equal amounts of Hydrogen-ions and Hydroxyl-ions, while a smaller number, e.g. pH 3 is more acid and pH 9 more alkaline. The natural pH of soils in New Zealand varies considerably from 4.1 to 8.1. (Annual Report D.S.& I.R.) but the more usual range in agricultural soils is between 5 and 7. (Lyon & Buckman 1943). It is of interest that the extremes of acidity recorded in the world are pH 1.7 in America on the acid side (Arrherius 1922), and pH 11 in Egypt, on the alkaline side (Lundegardh, 1931.)

2. Object of Present Work.

It is usually recognised that different plants thrive best at different levels of soil acidity, e.g. potatoes best at pH 4.8 to 5.4, asparagus at 6.0 to 6.7 etc. (Work, 1945), so the present work was undertaken in an attempt to throw light on the following points:-

(a) Is there one level of soil acidity optimum to all of the following species of pasture plants, and if not what level suits each species?

Perennial ryegrass	Lolium perenne
Italian ryegrass	Lolium multiflorum
Short Rotation ryegrass	L. perenne, L. multiflorum
Cocksfoot	Dactylis glomerata
Red clover	Trifolium pratense
White clover	Trifolium repens.

(b) Some of the above species have different strains, some more highly producing than others. Does the strain with the highest potential production still produce better than the poorer strain when the conditions are not optimum, or are the lower producers more tolerant of conditions less ideal as far as soil reaction is concerned?

(c) When any of these pasture species have different strains, do these have the same optimum pH or does each strain have a different level?

3. General Outline of Experiment.

It was planned to make a soil acid by artificial means till certain levels of Hydrogen-ion concentration were reached, then in each of these resultant soils to grow samples of all the pasture species under consideration. These plants could then be cut as required and the growth measured by weighing the herbage.

After much consideration it was decided that , although plant growth in pots may not always reproduce results "in the field", in this case soil in situ would not be satisfactory, as while the depth to which soil acidification can be controlled is limited, grass and clover roots extend to a very considerable depth under our conditions. (Jacques, 1941.)

Regarding the method of making the soil more acid. "Sulphur is sometimes used commercially for this purpose, and is changed by soil bacteria into sulphuric acid. Aluminium sulphate is sometimes applied, or fertilisers such as Ammonium sulphate which leaves an acid residue on the soil." (Work, 1945) As such methods would be slow in taking effect and final reaction could not be easily controlled, it was decided to use sulphuric acid directly instead of using another substance and waiting for it to be converted into this acid by natural forces. After this treatment had been carried out, it was discovered that straight acid applications had also been used by Reid (1932) and had been found quite effective.

It was decided that initially no attempt would be made to add any nutrients to the soil but to make the growth of the plants a measure of the reaction of the plant to the Hydrogen-ion concentration and to any other conditions resulting from the soil treatment.

The plants to be used in the experiment were some of the main pasture species, and the actual plants were to be selected from lines of known history, so that they were representative of the species or strains being tested. To aid in lessening variation between plants in any species, single known plants were to be broken into clones and these used, so that in effect one had the same plants growing under the conditions resulting from each individual treatment.

4. Time and Place of Work.

This work was carried out at the Station of the Grasslands Division, Plant Research Bureau, Department of Scientific and Industrial Research, situated in Fitzherbert West, Palmerston North. The preliminary work began in October, 1945 and the last measurements of the plants were taken in June, 1947.