# SOUTH AUSTRALIAN EXPERIENCE WITH INORGANIC FERTILIZERS.

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The outlook towards fertilizers in Australian agriculture is determined by two main factors—the low density of population and the relative poverty of many of the virgin soils in the elements required for plant nutrition.

The first determines the low availability in quantity of any form of organic manure and the second determines the actual volume of production of organic matter as plant material by the soil under natural conditions.

The mild winters also mean that few stock are housed and this is accentuated by the increasing mechanization of transport and farm operations.

Under the conditions prevailing in southern Australia, where the problem has been most closely studied, for each particular level of soil phosphate there is a sequence of vegetation associations starting with the most arid and finishing with the most humid. In South Australia with a rainfall of 20 inches per annum, principally effective in winter, there may occur either, savannah woodland, a sclerophyll woodland or a sclerophyll heath or scrub depending on the phosphate content of the soil. Some of these soils have never been used for agricultural purposes and have a very low carrying capacity for livestock.

The amount of organic matter present in the virgin soil is strictly proportional in these cases to the level of inorganic plant nutrients measured as phosphate. In one locality (Keith: annual rainfall 17·9 inches) the amount of nitrogen in the top two inches of virgin soil was found to be six times the amount of acid soluble $P_2O_5$ present over the range 0·002% to 0·025% of $P_2O_5$. Such soils are exceptionally poor in phosphate, particularly when one considers that soil derived from basaltic parent material may contain up to 0·50% of $P_2O_5$.

These soils, although deficient in phosphate are not necessarily deficient in potassium but the first deficiency carries with it other deficiencies, particularly among the micro-elements and the improvement and economic utilization of these lands has in fact had to await the discovery of the importance of these microelements for agriculture.

The most logical explanation of the low values for mineral nutrients in these soils is that the parent materials from which they are derived have undergone a number of cycles of weathering, losing something in each cycle. Thus it is estimated that in each cycle of weathering of a rock about 35 per cent of the phosphate is lost in the drainage waters and finds its way to the oceans. If at each cycle of weathering of the resulting sediments the proportion of loss remains the same then the amount of phosphate present in the end product can be estimated from the following expression:

$$x = a(1-0{\cdot}35)^y$$

where $x$ is the amount of phosphate in the end product,

$a$ is the amount of phosphate present in the original parent rock, and

$y$ is the number of cycles of weathering.

It is probable that in South Australia most soils are derived from sediments that have undergone from three to six or more such cycles.

Before we can consider therefore the relative importance of organic or inorganic manures in these soils it is important to build up the level of inorganic nutrients so

that biological activity of all kinds can proceed at a much higher level than is occurring naturally.

Another feature of importance in parts of Australia is that the soils are relict from wetter climatic periods occurring probably in Pliocene times. These soils are often associated with formations of laterite. Not only are they depleted, by leaching, of mineral nutrients but some of these latter may be locked up in the laterite itself, by combination or association with the iron oxide.

At the present time the Department of Agricultural Chemistry at this Institute is engaged in the detailed study of the plant responses to inorganic fertilizers on one such soil: the *Seddon gravelly sandy loam*. This soil is grossly deficient in both phosphate and nitrogen and remarkable responses are obtained to both these fertilizers in the very first year of development from the native heath vegetation.

Plants grown on this soil also show responses to potassium and copper and micro-elements other than copper may also be concerned.

One remarkable feature of the soil is its low microbiological activity—such processes as nitrification are exceedingly slow and presumably before any decomposition of organic matter can take place it will be first necessary to build up the level of inorganic plant nutrients.

The practical method of land improvement on these soils when once the mechanical operations of clearing are completed is the growth of pastures containing as the dominant legume *Trifolium subterranium*. The symbiotic fixation of nitrogen by *Rhizobium* which is the basis of this improvement may itself be limited by inorganic nutrients of which the most important so far has proved to be molybdenum. There is still scope, however, for study of the possible effects of organic substances on these microbiological processes in the soil and it is proposed to include these in the study of the fertility problems of the *Seddon* soils in due course.

In South Australia generally phosphatic fertilizers have proved to be all important for both cereal and pasture production.

Leguminous crops and pasture components are used for the maintenance and building up of nitrogen levels and in addition in certain areas micro-elements have found a place. These include, copper, zinc, manganese and molybdenum. The first three are usually used in quantities of the order of 10 lbs. of appropriate salt per acre and salts of the latter may only be needed in ounces per acre.

The micro-element which has received most attention scientifically is manganese because it has been studied the longest and because it presents special problems of availability in terms of hydrogen ion concentration and oxidation-reduction equilibrium.

The problems associated with the availability of copper and zinc are not so fully understood.

The availability and functions of molybdenum have proved to be of great interest. This element is made more available by reducing the acidity of the soil and plays an important part in symbiotic nitrogen fixation by *Rhizobium*. In other parts of Australia, however, it has been shown to be directly concerned with the nutrition of the higher plants.

In brief then, in South Australia, inorganic fertilizers have played a very important rôle in building soil fertility. They are not only concerned in the nutrition of the crop plants but may be found to play an important part in the decomposition of organic matter that may be added to the soil.

At this stage in our experience we would be inclined to regard organic manures primarily as sources of inorganic nutrients, providing both the known and unknown elements of biological importance.

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