# SOME REQUIREMENTS OF PLANT GROWTH*

THE food of plants is naturally the first requirement to be considered in connection with plant growth.

Plants are composed of many compounds, these compounds being built up with chemical elements. The following elements are found in plants: Carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, calcium, potassium, magnesium, iron, sodium, silicon, manganese. Other elements are found in plants, some of which are now also considered as possibly being essential to plant growth.

Water, in so far as quantity is concerned, is the most important factor in plant production. The amount of water which enters the roots of plants and transpired through the leaves during growth is enormous. The amount will be realised when it is stated that for every pound of dry material manufactured by plant processes, from 300 to 800 lb. of water have been required. Of course, this amount of water represents the water that has circulated continuously through the plant carrying fresh amounts of dissolved food from the soil to meet the needs of the growing plant. In different crops the water required to produce one pound of dry matter varies considerably, thus it is stated wheat requires 500 lb., oats 600 lb., and clover 800 lb. of water to produce 1 lb. of dry plant material. Though the amount of water in the plant at any one time is large compared with other material composing the plant, it is relatively small when compared with the amount of water transpired.

Briefly, we may consider the composition of some crop — paspalum, for example—water, 75 per cent.; organic matter, 22 per cent.; ash, 3 per cent.

Now practically one-half of the organic matter of plants consists of carbon, the rest of the organic matter being composed mostly of oxygen and hydrogen, and a small amount of nitrogen — about 0·4 per cent. The plants by means of the green colouring matter — chlorophyll — in their leaves have the power in sunlight of assimilating the carbon contained in the carbonic acid of the air. The air contains on the average 0·033 per cent., or one hundred of 1 per cent. of carbonic acid gas, and it is certainly very wonderful that about one-half of the dry matter of all green plant growth and coal in the world is the result of the assimilation by chlorophyll mentioned above.

## ESSENTIALS OF SUCCESSFUL PLANT DEVELOPMENT

With this brief review of plant composition consideration can be given to means that may be employed to enable plants to obtain the requirements necessary for their most successful growth.

---

* By E. H. Gurney, Agricultural Chemist in the *Queensland Agricultural Journal*, Vol. XLII, Part 5, November 1, 1934.

Plant life is assisted in connection with carbon assimilation in being situated in locations which permit of their receiving suitable exposure to sunlight, and this is one of the reasons that certain situations are more suitable than others, for some crops.

Here it may be mentioned that iron is necessary in plant life as it controls the formation of chlorophyll, and in some cases a deficiency of iron has caused a plant trouble termed "chlorosis." There is usually an abundant supply of iron in most soils, but in some cases where plant chlorosis has occurred owing to iron deficiency, the trouble has been rectified by the application of iron sulphate, either as a spray or to the soil.

Regarding the water requirement of plants, means are available for assisting plant growth in this requirement, and the first measure to be undertaken is to prepare the soil as far as possible into a suitable condition for the reception and retaining of rain. Rain falling upon a soil with its surface in a hard crust-like condition will be unable to penetrate the soil to the extent it would if soil surface was in a friable condition.

Some soils are able to retain the rain falling upon them better than others, and this is due to the fact that soils are composed of variable amounts of different materials. These various soil ingredients have very different power of absorbing and retaining water, thus soils having a high humus content and clayey soils have a much greater capacity of absorbing and retaining water than sandy soils. It has been found that a more or less pure sandy soil will only retain about 25 per cent. of its weight of water, whilst a sand clay may absorb as much as 50 per cent., and a soil with high humus content may absorb 85 per cent. or more.

It is considered that the most successful plant growth is obtained when the water content of the soil ranges from 40 to 50 per cent. of the total water-holding capacity of the soil.

Therefore, plants may be assisted in obtaining their suitable water requirements, first, by improving the condition of soil by converting it into a more open and friable condition by cultivation and liming, and in the second place by increasing the humus content of the soil.

Humus can be added to the soil by the addition of farmyard manure and by ploughing in green manure crops and all vegetable residues. In our climate, with at times long spells of dry weather, the necessity of increasing the humus content of soils for the purpose of retaining the soil moisture as long as possible is gradually becoming recognised, though not to the extent that its importance deserves, but as farmyard manure is not available in large quantity, the ploughing in of green manure crops should be a regular procedure in our cultural system.

It was mentioned that the organic matter of the paspalum contained a certain amount of nitrogen; similarly all plant life contains nitrogen, the percentage of nitrogen being much higher in the younger stages of plant growth than in the matured plant. Some plants contain more nitrogen than others. Thus leguminous crops have a high nitrogen content, and what is of particular importance is that the nitrogen of these crops is

derived from the air, and thus the growth of a leguminous crop does not lessen the soil's nitrogen content, but increases it. This valuable property of the legumes is due to the fact that the various leguminous crops have different bacteria growing in "symbiosis" with them (symbiosis means the living together of two organisms for their mutual benefit).

The bacteria enter the roots of the plant, which results in the formation of nodules upon the roots, after which the bacteria obtaining energy from plant material converts the nitrogen of the air in the soil into compounds suitable for assimilation by the plant. For this reason legumes are particularly suitable as green manure crops, although other crop growths are valuable for this purpose.

## VALUE OF HUMUS

It may again be stated that it is considered that in Queensland one very important means of maintaining the fertility of agricultural fields or garden plots is by the continued application of material capable of forming humus. That this application of humus may not supply all the mineral plant-food requirements is admitted, but humus in the soil assists in rendering more quickly available to plants the mineral plant-food applied by means of fertilisers. That mineral plant-food material is required by plants is shown by the composition of plant growth previously mentioned and is represented by the ash.

For the most successful plant growth there are requirements besides a sufficiency of moisture and plant foods. Some crops, such as clover, peas, cherries, thrive on soils that are not of an acid nature, whereas other crops such as maize have been grown successfully on soils having at least some degree of acidity. Again the different types of soils are more suitable for different plant growth, sandy loams being more suitable for root development of some crops than soils of a more clayey nature.

That crops have not made successful growth does not necessarily mean that some plant food is wanting or is in too small quantities, though this is very frequently assumed, whereas the real reason of poor growth may be that the type of soil is not suitable for the crop sown in it, or that the soil requires proper drainage, or that the soil has not a suitable aspect for the crop in question.

Therefore, in conclusion, it may be said for all crop requirements it is necessary to have all soil conditions such as tilth, available plant food, and soil bacterial population in good condition to satisfy their requirements.

## FERTILIZERS AND MANURES

Crops obtain their mineral plant-food requirements from the soil water. Cultivated soils usually contain abundance of plant food for many successive crops, with the possible exception of three or four substances — *viz.*, nitrogen, phosphoric acid, potash, and lime. These substances in a fertile soil are not only present, but supplies are present in a form sufficiently available for the crop's need, whereas an infertile soil may contain the above-mentioned food materials in a form unavailable to crops. Fertilizers and manures are applied to the soil to provide a certain amount of these plant foods to crops.

Fertilizers, often spoken of as artificial fertilizers, is the name given to what may be termed manufactured materials used for the purpose of supplying plant food to crops, and the term manure is more used in reference to such material as farmyard manure, guanos, and bulky organic material, which manures, it may be mentioned, improve the physical and biological conditions of the soils as well as supplying plant food.

Soils become depleted of some portion of their plant food by incorrect systems of cultivation; the supply of some particular plant food is exhausted before others. What particular plant food is required to be supplemented with application of fertilizer can be determined by experimental plots with crop it is intended to grow. Different crops require varying proportions of the different plant foods, some requiring larger amounts of nitrogen, others demand more phosphoric acid or potash.

The general effect upon plant life of the different ingredients in fertilizers should be considered.

Nitrogen stimulates the growth of the stems and foliage of plants, and if excessive amounts of nitrogen are applied, particularly if a deficiency of phosphoric acid and potash exists, very vigorous plant growth occurs, but with poor development of flowers and fruit.

Phosphoric acid promotes the growth of roots, increases crop yields, and accelerates the ripening and maturity of crops.

Potash seems to be connected with the formation of starch and sugar in plants, and in some cases with increased crop yield. Potash deficiency causes plant growth to be less resistant to diseases.

Lime improves soil tilth, renders some unavailable soil plant food to become available, causes conditions favourable for bacterial growth, and neutralises soil acidity. As in most soils there is sufficient lime for plant-food requirements, lime is applied for the purposes just mentioned and not for plant food.

All plants make use of the same plant foods, but different plants require different proportions of these food ingredients.

These plant foods ingredients are contained in different commercial fertilizers. Among what may be termed simple (that is containing only one food ingredient) nitrogenous fertilizers are nitrate of soda, containing 15 per cent. nitrogen, ammonium sulphate, with 21 per cent. nitrogen. Both of these fertilizers being water-soluble are quick acting, the ammonium sulphate being somewhat slower than nitrate of soda. It is considered that plants when taking up nitrogen from the soil water assimilate the greater portion of their nitrogen in the form of nitrates, and, therefore, that the nitrogen in the ammonium sulphate is changed by reactions in the soil to the nitrate form before being utilised by the plant. Dried blood is another nitrogenous manure containing from 11 to 12 per cent. nitrogen. The nitrogen in this fertilizer is not so quickly available as the nitrogen in the two previously-mentioned fertilizers, still dried blood may be classed as a fairly quick-acting fertilizer.

Two simple phosphatic fertilizers are superphosphate and Nauru phosphate. Superphosphate containing from 20 to 21 per cent. phosphoric acid in a water soluble form is a quick-acting fertilizer, whereas Nauru phosphate containing from 37 to 38 per cent. of phosphoric acid in a form insoluble in water, is a slow-acting fertilizer, particularly if it is not ground to a fine state of division. In fact results from the application of Nauru phosphate are frequently not noticed during the first year, but appear in the second year.

Potash is contained in the two fertilizers sulphate and muriate of potash. Both these fertilizers being soluble in water are very quick acting. The sulphate contains 48 per cent. and the muriate 50 per cent. potash.

Bonedust contains two fertilizing ingredients—*viz.*, from about 3 to 4 per cent. nitrogen, and from 20 to 25 per cent. phosphoric acid. Meatworks fertilizer also contains from 3 to 7 per cent. nitrogen and from 14 to 20 per cent. phosphoric acid, and as these fertilizers have to be first decomposed in the soil their nitrogen and phosphoric acid only slowly become available.

Mixed or complete fertilizers, of which there are many upon the market, are these fertilizers which are manufactured by mixing any two or more simple fertilizers together. These complete fertilizers are known and sold under trade names or number, or with formulae such as 6—14—10, which means the fertilizer contains 6 per cent. nitrogen, 14 per cent. phosphoric acid, and 10 per cent. potash, and other example 0—14—8 means that such a fertilizer contains no nitrogen, 14 per cent. phosphoric acid, and 8 per cent. potash.

## POINTS IN FERTILIZING PRACTICE

In connection with the fertilizers previously mentioned, it was stated that some were "quick acting" others again were "slow acting" and this difference in the time taken before the fertilizing ingredient is in a condition suitable for absorption by the plant is of particular practical value. In the case of crops that occupy the ground for more or less long periods it is advisable to apply fetilizers in which the fertilizing ingredients gradually become available to the plants or under some soil conditions it may be advisable to apply a fertilizer in which portion of the ingredients are quickly available and the other portion slowly available. For crops that come quickly to maturity quick-acting fertilizers are required in order that a plentiful supply of available food is provided. Again it is frequently required that at some particular stage of growth the crops are advantageously stimulated by some quick-acting fertilizing ingredient, and hence the practice of top-dressings. A very good example of the stimulating effect of a quick-acting fertilizer is seen in the modern practice of pasture cultivation, in which at first the pasture is fertilized with ammonium sulphate and superphosphate either without or with potash, then throughout the reason top-dressing with ammonium sulphate results in very definite increased grass growth.

Another point in connection with fertilizers is that some crops respond better to their application when their fertilizing ingredient is of organic nature and not mineral. In applying fertilizers to pineapples it is generally stated that it is preferable to apply the nitrogen required in the organic form—*viz.*, in blood and meatworks manure (blood and bone) and not in nitrate of soda (the mineral form). The nature of the fertilizing ingredients in the complete fertilizers sold can always be ascertained as it is stated in what form they exist—thus nitrogen as blood or as ammonium sulphate—phosphoric acid as bone or as superphosphate.

Lime, as stated before, is usually used for the purpose of improving tilth, neutralising acidity, and liberating otherwise insoluble plant foods. Lime can be used in different forms—*viz.*, as quick lime, agricultural lime, and pulverised limestone. Quick lime is recommended for use on stiff, heavy soils, whilst the use of pulverised limestone is preferable on lighter sandy soils with low humus content. The pulverised limestone to be effective must be in a very fine state of division. The degree of fineness is of importance in connection with such fertilizers as bone, Nauru phosphate, etc., for the finer the state of division of such fertilizers the quicker do they become available to plants.

It must be distinctly recognised that success from the application of fertilizers cannot be obtained, if the soil to which they are applied is in any manner of bad condition, such as bad tilth, poor drainage, or poor bacterial condition. This last condition is of particular importance in connection with the effect of fertilizers.

Fertilizers are always more effective if applied in conjunction with farmyard manure, even if with only small amounts of farmyard manure, as such manure encourages bacterial activity which in turn assists in converting more quickly the fertilizers into an available form for plants.

In connection with manures, such as farmyard manures, green manure crops, and composted vegetable matter, it may be said that they are used particularly for supplying humus to the soil and thus improving the physical and biological conditions of the soil, but such manures depending upon particular soil condition and crop requirement, may or may not be able to supply the particular amount of any mineral plant food required.

In connection with farmyard manure, it is considered that its importance is not properly recognised, as by not being collected and ploughed into the soil or stacked, a very great waste of valuable material results. The composition of farmyard manure varies considerably, but 1 ton of mixed farmyard manure contains from 450 to 700 lb. of organic matter, 10 to 15 lb. of nitrogen, 3 to 6 lb. of phosphoric acid, and from 8 to 16 lb. of potash. Then neglect of composting waste vegetable matter also ensures the loss of very valuable material which is of particular use in

orchards and market gardens. Regarding green manure crops, the composition of which varies very much according to the kind of crop used, but, besides a very large amount of organic matter which such crops return to the soil it must be remembered that the plant food material contained in such crops is in a very available condition. Of course it must not be overlooked that these plant foods, with the exception of the bulk of the organic matter, are taken from the soil and thus do not correspond to the actual addition of chemical manure, but, as previously stated, are of great value as they are in a very available form. Thus the amount of material returned to the soil by ploughing in a crop of cowpea from one acre was—organic matter, 5,462 lb.; nitrogen, 216 lb.; phosphoric acid, 61 lb.; potash, 123 lb.