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SELECTED ARTICLES

A new method for estimating the Fertilizer Requirements of Citrus Trees

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[The fertilizer requirements of crops are ascertained by (a) field experimentation and (b) soil analysis. The author has been experimenting with a new method promising to be cheaper and quicker than the field experiment and more accurate and reliable than soil analysis.

Field experiments are accurate but slow, and costly and beset with a number of limitations: (1) The field should be uniform, (2) The field should be large enough to accommodate the desired number of repetitions of the various treatments and (3) The experiment should be conducted for a number of years for eliminating residual effects of previous fertilization and seasonal effects and for studying the after effects of the treatments themselves.

Soil analysis is cheap and quick, but the results obtained are vague. Various methods of determining the soluble plant food in the soil are in vogue. The results obtained need not necessarily represent what actually the various crops could extract from the different soils. Abstract of the first part of the article. Ed.]

Plant Analysis: A new and promising method The idea of analysing a plant to determine its fertilizer requirements is not strictly speaking, a new one, since it was first suggested some sixty years ago. For various reasons, however, chiefly due to unreliable sampling methods, poor analytical methods, faulty methods of drawing conclusions, and lack of knowledge of basic principles governing plant growth, the method did not become popular. It may be of interest, however to quote briefly from a recent paper by two of America's leading plant physiologists, who recently received the annual thousand dollar award granted by the American Association for the Advancement of Science for a very notable contribution to science for the year 1940. The authors Drs. Hoagland and Arnon, state: 'The idea of analysing plant tissues in the study of nutrient deficiencies is a venerable one, but we gain the impression that there is a renewal of interest in this approach.....' In experiments with barley and tomato plants there was a high correlation between percentages of potassium in the dried vegetative tissues, and the response of the plant to potassium fertilization. The possibility also exists of sometimes obtaining useful indications of potassium supplying power of soils from analysis of samples of plant tissue taken at suitable stages of growth from plants growing in the field.

It is precisely this aspect, namely the relationship that has been found to exist between the amount of a certain plantfood found in a plant, and the response it will show to applications of that plantfood that is the basis on which the 'Plant Analysis Method' is founded. While in soil analysis we extract the plantfoods with water, acids, or other chemicals, we can never be sure that what we get out of a soil is the same as what the plant would get out of it. By analysing the plant however, we are taking a short cut as compared with soil analysis, since we use the plant itself as the means of removing the plantfoods from the soil Theoretically speaking, this method of approach should take us a big step nearer the heart of the problem. By making a large number of analyses, both of healthy plants and also of plants known to be suffering from definite shortages or excessive amounts of various plantfoods, we can eventually find out with

very fair accuracy how much of each of the essential plantfoods a healthy plant of any particular species should contain. This has actually been done in the case of various field crops over widely varying conditions in the U. S. A., Great Britain and Sweden, with encouraging results. To sum up the findings from these countries we may state that regardless of the climatic and soil conditions, the chemical composition of the healthy plants of a certain species varied only within a very small range, and also all plants containing less than normal quantities of any particular plantfood usually responded to fertilizers containing that plantfood. The evidence available suggests very strongly that it should be quite possible, by means of plant analysis, to predict the main fertilizer requirements of any plant, no matter what the soil and climatic conditions may be. This is something which soil analysis cannot do for neither the individual requirements of the plant, nor the plantfoods which it can actually take up, nor the prevailing climatic conditions are taken into account.

Predicting the fertilizer requirements of citrus During the past four or five years, the writer has laid down several large fertilizer experiments on citrus in various parts of the Union. The objects were twofold: firstly, to find out by trial and error the best fertilizers for Valencias under each of the different soil and climatic conditions, and secondly, to discover just how the amounts of the various important plantfoods in the trees were affected by the various soils and the fertilizers given. These experiments have now provided some valuable information which may be summarised as follows:—

In an orchard in the eastern Transvaal striking improvements in yield—two or three times the yield of unfertilized plots—followed annual applications of nitrogen in the form of sulphate of ammonia at the rate of 3 to 7 lb. per tree. This orchard has previously received practically nothing in the way of fertilizers or manures. In another orchard in the western Transvaal, receiving exactly the same treatments slight but definite *decreases* in yield resulted from the same applications of ammonium sulphate—the heaviest applications causing the greatest falling off in yields. This orchard had previously received about 150 lb. kraal manure per tree annually for several years, though no artificial fertilizers.

Still a third orchard on the rich alluvial soils of the eastern Cape Province which received no fertilizers or manure in the past, showed no response to the identical fertilizer treatments one way or the other.

Analysis of Citrus leaves The above results may seem rather confusing at first sight, yet when analyses of leaves from these orchards were made, the whole position became clear.

In the case of the first orchard, which showed the greatest response the amount of nitrogen in the leaves was originally very low. Where ammonium sulphate was given, the nitrogen content of the leaves was raised and at the same time increases in yield invariably followed. In no case was the nitrogen content of the leaves raised to what could be called an abnormally high figure, and in all cases the more nitrogen given as ammonium sulphate, the more the yields were raised.

In the case of the second orchard (in the western Transvaal) the leaves were already very high in nitrogen when the experiment was started due to the effect of the nitrogen previously given in the kraal manure. Here the applications of ammonium sulphate raised this content even higher still and the more of this fertilizer given, the more the yields *decreased*. From this it was judged that nitrogen was not lacking in this orchard, and that by giving more than was actually required, the tree was so to speak, nitrogen poisoned, and yields fell off in consequence

In the third orchard (in the eastern Cape Province) the leaves were about normal in nitrogen content at the start, and even after several years of fertilizing only slight increases could be brought about by giving ammonium sulphate. In this orchard no provable differences in yield were found between any of the different treatments. This again fits into the picture, and suggests that the way in which a tree is likely to respond to nitrogen fertilzers can be predicted if we know whether its leaves are low, normal or high in nitrogen to start off with. If the content is low, the crop will probably be increased; if normal—probably not, though harmful effects will not necessarily follow; if already high, no good can be done, nitrogen fertilizers will be wasted, and an actual falling-off yield is quite possible.

The amounts of the other most important plantfoods, namely phosphorus, calcium, potassium, magnesium and sulphur present in Valencia leaves have been investigated in a similar manner, and both the normal content of leaves and the levels at which deficiencies are likely to occur for each of these has been determined.

A practical example An interesting case of the practical application of leaf analysis may be mentioned here in connection with the eastern Transvaal orchard already referred to. Here soil analyses showed that the soil was very acid, and low in both calcium (or lime) and magnesium. The normal recommendation here would be to give lime, or perhaps dolomite, which contains both lime and magnesium. An analysis of the citrus leaves, however, showed that they were very high in lime and very low in magnesium. Applications of magnesite (which contains magnesium, but no lime) were therefore given to two out of the four trees in each experimental plot. After two years it now appears that this treatment is having beneficial results, since in eleven out of sixteen cases the magnesite treated trees are now outyielding the trees which did not receive it. Had lime alone been given the uptake of calcium, already high, would have been raised still higher and the shortage of magnesium would probably have been aggravated, with probable harm to the tree.

Method of taking samples Many hundreds of analyses of leaves made by the writer during different times of the year, and of samples taken in various ways have shown quite clearly that the amounts of each of the different plantfoods vary greatly from leaf to leaf in any particular tree, chiefly according to the age of the leaf on the tree. This makes it quite clear that for leaf analyses to be of any value a definite method of taking samples must be followed, and leaves must only be picked from a certain stage of growth and at a certain time of the year. This sampling method is simple and may be summarised as follows:—

Leaves are taken from the stalk of the fruit, directly up against the fruit during the period June to July. Since the date of the Spring flush when the fruits and leaves were first formed, can easily be found out, the exact age of these leaves can also be found—namely, ten to eleven months old. All samples, picked in any part of the country, will be of approximately the same age, and are thus comparable. No great skill is needed in selecting a good sample of leaves, which can easily be picked by any interested grower.

An invitation to growers The work outlined above has now reached a stage where it seems desirable to test out conclusions more extensively. To this end, the Division of Horticulture wishes to get into touch with interested growers in all parts of the country with a view to diagnosing the fertilizer needs of their orchards by leaf analysis methods, and following up the responses caused by the fertilizers applied.

The fertilizer position in the Union at the moment is such that every effort must be made by all growers to apply only those fertilizers actually essential for maintaining or raising production.

In very many cases fertilizer mixtures are quite unnecessary for citrus trees, and growers could economize by changing over to single fertilizer alone. In other cases it is quite possible that the amounts of fertilizer given are excessive, and could be cut down quite safely without causing a drop in yields. Growers would not only help themselves by such economies, but would leave more fertilizers to those farmers who might otherwise be forced to do without them.

Any growers interested in this subject, and wishing the Department to report on the probable fertilizer requirements of their orchards as indicated from leaf analyses are cordially invited to communicate with the Chief, Division of Horticulture, P. O. Box 994, Pretoria. No charge will be made for this service, and the grower will be under no obligation to carry out suggestions which may be made. *Farming in S. Africa, Vol. 18, No. 206, May 1943.*

Intensified Potato Culture in the U. S. S. R.

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At the outbreak of war the Russian Agricultural Research Stations devoted themselves to the problem of maximum production of food and raw materials in the U. S. S. R. The potato, yielding as it does the highest amount of human food per acre of any crop in common cultivation, naturally figured prominently in the plan. The necessary large increase in potato acreage raised several serious problems in regard to the supply of seed tubers, and the way in which these difficulties are being met is an interesting example of the work of Russian scientists during the war.

Tips as Seed The first problem was to reduce the tonnage of potatoes taken for seed to an absolute minimum. Something much more drastic than the usual cutting of large potatoes into two sets was required. The solution came from Professor Lysenko and his colleagues at the Lenin Agricultural Science Academy who developed a method of saving for seed the tips of potatoes that were to be used for domestic or industrial purposes. The procedure was to cut off quite a small portion of the rose end of the tuber with the buds attached and collect and store the tips in such a way that their vitality was preserved until planting time. The remainder of the tuber was used as food. The weight of the tip being only about ½ oz., the quantity of food material used for seed could therefore be reduced to about one-quarter of the normal when this procedure was adopted. By organization, demonstrations and the issue of working instructions, some 380,000 acres were planted with tips in 1942, representing a saving of thousands of tons of seed.

Comparisons of the produce of tips with that for whole seed under field conditions showed that the yield from the tips was much the same as that produced by ordinary seed potatoes. The idea has been carried still further by Professor Yakushkin of the Timizyazev Agricultural Academy, Moscow. He proposes a method of "tuberless" sowing of potatoes. The eyes are cut in spring and planted in boxes or forcing houses, and in May the young plants are put out in the open. At least three-quarters of the original tuber is saved for food by this method and it is claimed that the plants grown from eyes are 15—20 days earlier than those from ordinary seed tubers (in 1942 at any rate), and that they yielded quite as well.

Two crops in one season Other physiological studies on potato seed have been directed towards controlling the period of dormancy of tubers. In certain parts of the U. S. S. R. it would be quite practicable to secure two crops of potatoes in a single season if seed dug in early summer could be planted the same