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Fertilizer Experiments and Coconut Yields

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The history of fertilizer experiments on coconut in Sri Lanka dates back to the period 1912-1914 when simple single plot tests were carried out at Peradeniya and Maha-Illuppalama. These were followed later by a few more trials by the Department of Agriculture, and by the experiments of the late Gate Mudaliyar A. E. Rajapakse on his lands at Negombo and Ja-Ela.

The modern techniques of scientific field experimentation were not available to these early investigators and hence their results were not amenable to critical examination. Further, the sites selected for experiments were either unsuitable or not representative of soil and climatic conditions of the major coconut growing districts of Sri Lanka. Therefore the findings from such experiments were not of general applicability and consequently of little value.

With the establishment of the Coconut Research Scheme in 1929, and the laying down of the first scientifically designed field experiment by Salgado[1] in 1935, the trend was set for a comprehensive and critical examination of the fertilizer requirements of coconut.

In this field experiment, the effects of three major nutrients nitrogen, phosphorus and potassium were tested at 3 levels of supply under the soil and climatic conditions prevalent at Bandirippuwa Estate, Lunuwila.

We could describe this experiment as a 3 × 3 × 3 factorial, implying that it is designed to test 27 possible combinations of three factors, namely, nitrogen, phosphorus and potassium. On the basis of scientific considerations, the minimum experimental unit or plot which may receive each treatment should not be less than 18 palms; and each such plot has to be separated from its neighbours by at least a single row of demarcating palms called the—"guard row". The purpose of these guard rows is to prevent a treatment applied to one plot effecting the neighbouring plot. Now, if the treatments are to be replicated, as it is normally done, an extent of about 33 acres would be required from a plantation holding 60-70 palms per acre. It is rarely possible to get a uniform extent of soil over such a wide acreage. Fortunately, complexities arising from this problem can now be adequately overcome by certain refinements in the experimental design and layout.

We also know that the coconut palm suffers from the handicap that yield responses to fertilizer application become manifest only about two years after manuring so that fertilizer experiments on coconut have necessarily to be continued for several years before any reliable information could be collected. These are undoubtedly some of the special problems which confront research workers on this crop.

1. Annual Report of the Soil Chemist for the Period July, 1933 to Dec., 1937. The Coconut Research Scheme (Ceylon), Bulletin No. 3, p. 20-23.

In Sri Lanka coconut is grown under a variety of soil and climatic conditions. It is obviously futile therefore, to expect a single field experiment to provide the answers to all problems pertaining to fertilizer requirements. During the past 35 years we have carried out 20 fertilizer experiments. Some of these were planned essentially to assess the requirements under a given set of conditions.

The information we have obtained from investigations at Bandirippuwa, supported by data from experiments carried out in various coconut growing districts of Sri Lanka, have generally shown that most if not all the classes of coconut soils are deficient in nitrogen, phosphorus and potassium. Magnesium which was originally thought to be deficient only in the heavily leached lateritic soils of the South and South Western regions of Sri Lanka, has now been shown to be, of widespread occurrence. It is of special interest to note that potassium whose function in the physiology of plants is not fully understood, has been established as a nutrient of prime importance to the adult coconut palm. Potassium not only increases production of nuts, but also improves copra out-turns. In other words, potassium increases both the yield of nuts and the weight of the husked nut.

An observation of special interest is the complementary role of nitrogen in the utilisation of potassium in the adult coconut palm. In general terms this would mean that the utilisation of potassium is strongly influenced by the amount of nitrogen that is available to the plant.

We have no evidence to suggest that the coconut palm could discriminate in its preference to either organic or inorganic forms of nitrogen. Neither has it yet been established that a particular form of inorganic nitrogen could be more efficiently utilized than others. Information of this nature no doubt could be utilized to effect economies on manure mixtures.

In the nutrition of the coconut palm, it has been shown that nitrogen and phosphorus increase the production of female flowers and nuts, but had no effect on copra outturn. In young palms, phosphorus has also been shown to hasten the process of initial flowering.

With this information in hand it has been possible to assess the annual requirements of the coconut palm, and strike a balance in the composition of a fertilizer mixture. This mixture we believe, could provide the coconut palm with its requirements of nitrogen, phosphorus and potassium under depleted soil conditions. It contains 1.00 lb. of basic nitrogen, 0.55 lb. of phosphoric acid and 1.8 lb. of potash. These amounts are available in 10. lb. of the coconut fertilizer mixture commonly referred to as C.R.I. "C". The fertilizer mixtures referred to as C.R.I. "A" and C.R.I. "B", are for rich soils and moderately rich soils respectively. In the composition of these mixtures, appropriate adjustments have been made by proportionately reducing the quantities of nitrogen and potassium.

Our investigations have shown that yield increases ranging from about 30 percent in richer soils of the Chilaw district, to about 200 percent in poor lateritic soils of the South-Western zone, could be obtained for the annual application of 3½ to 5 lb. per palm of fertilizers containing nitrogen, phosphorus and potassium. In general, a minimum increase of about 1500 nuts per acre per annum, could be obtained from neglected lands within 3 to 5 years, by the annual application of such fertilizers.

Yellowing of fronds due to a deficiency of potassium in a fertilizer experiment at Bandirippuwa Estate, Lunuwila.

The fertilizer recommendations made for young palms are based mainly on the results of two fertilizer experiments. The first was a new plantation on a secondary jungle clearing, and the other was a new plantation on a virgin jungle clearing. In these experiments, six years after planting, 50 percent of the plants in the virgin jungle clearing had flowered, as against only 6 percent in the secondary jungle clearing. The application of the complete fertilizer mixture, increased the rate of flowering to 82 percent in the virgin jungle clearing, and to 42 percent in the secondary jungle clearing.

These results while demonstrating the need to fertilize young palms, show that even on relatively rich soils, the rate of flowering could be increased by fertilizers. A further inference that could be drawn is that for plantations on secondary jungle clearings, and more particularly for second plantations, the amount of fertilizer required is greater than for plantations on virgin jungle clearings.

Planting seedlings on a 20-acre block at Bandirippuwa Estate, Lunuwila for a fertilizer experiment on magnesium.

It has also been observed that young palms require a higher proportion of nitrogen and phosphorus, and less of potassium than adult palms to facilitate better growth, and to hasten initial flowering.

Thus taking into consideration these facts we have recommended a general fertilizer mixture for young palms, in which relatively higher proportions of nitrogen and phosphorus are available.

Turning now to magnesium, it is common knowledge that it enters into the structure of the green pigment in plants called chlorophyll. It is also known to play a vital role in the synthesis of carbohydrates. Hence its deficiency in coconut is reflected in the characteristic yellowing of fronds, and a decline in yields.

In the nutrition of coconut, we have also observed that when either magnesium is deficient, or when the plant is unable to utilize the available magnesium, movement of phosphorus within the plant is hindered. Under such circumstances, the crown of the palm experiences a defficiency of both magnesium and phosphorus without showing any visual symptoms. This could occur even when the plant is supplied with an available source of phosphorus.

In recent years therefore, we have taken the liberty to recommend the application of magnesium fertilizers as a routine measure to all plantations, in order to prevent what may be referred to as "hidden hunger".

In fact it has now been found that in some instances an increase in yield of about 1000 nuts per acre annually has resulted over and above what could be obtained from the nitrogen-phosphorus-potassium fertilizers, consequent on the additional application of magnesium fertilizers.

Among the six major mineral nutrients essential for the normal growth of plants, nitrogen, phosphorus, potassium and magnesium, have evidently attracted much greater interest than calcium and sulphur. This is chiefly because, nitrogen potassium and magnesium are easily lost from the soil by leaching, and also through removal by plants, while phosphorus in the soil is largely not available. Furthermore, we know that calcium and sulphur enter into the composition of some of the widely used fertilizers, which help them to retrieve their position in the soil.

Experiments with coconut seedlings carried out in sand cultures, have consistently shown that an absolute deficiency of calcium retards the growth of roots. Under field conditions, such symptoms of calcium deficiency have not been observed so far.

Therefore, at least for the present, there is no cause of concern, about the possibility of calcium reaching levels which would affect growth and yield of coconuts.

On the other hand, with the likelihood of urea fertilizer replacing sulphate of ammonia as a source of nitrogen for plants, one of the extensively used sources of sulphur for plants would be lost. Alert to this situation, we have already commenced field and laboratory studies to determine the requirements of sulphur for coconut. A deficiency of sulphur is known to affect seriously the quality of copra. Fortunately, so far we have not observed such symptoms in Sri Lanka.

However, leaf nutrient studies have shown, that in the Wet Zone, when sulphur fertilizers are not used, sulphur contents in the leaves are lowered. In view of this, as mentioned earlier, if urea replaces sulphate of ammonia in the standard fertilizer mixtures, we may be compelled sooner or later, to incorporate a suitable sulphur fertilizer in all standard mixtures.