

✓ THE TAPERING DISEASE OF COCONUTS—II

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WE have to confirm the observations made by previous writers, that what would appear to be the same disease is being described under different names in various parts of the world. Since the publication of the introductory paper on this subject by F. C. Cooke in the previous number of this *Quarterly*, an article entitled "The Wilt (Root Disease) Disease of Coconuts" by K. P. V. Menon and U. K. Nair has appeared in the *Indian Coconut Journal*, Vol. III., No. 1, October-December, 1949.

The symptoms of the Wilt Disease in Travancore, as described by these writers, corresponds almost exactly with those of the so-called quick-tapering disease of Ceylon. They state that the disease was first recorded in that country about 75 years ago, that it spreads outwards "from more than one independent focus of infection and has since been spreading steadily" and that today the annual loss due to this coconut disease in Travancore is said to exceed Rs. 10,000,000.

The tendency has hitherto been to continue to regard this particular type of coconut wilt as being due to some infectious plant disease, even though, after very many years of patient investigation, no evidence whatever has been forthcoming to support this theory.

On the contrary, these two investigators now describe five different experiments, all unsuccessful, to infect healthy tissue and induce the disease artificially, both in young seedlings and in mature palms. Then there is the fact that repeated examinations of the roots, leaves and butt-ends of tapering palms in Ceylon have in no single instance revealed other than secondary infections by organisms which are only to be found on tissue, after it is already dead or decaying. Furthermore, the systematic recording and plotting of the progress of the disease on an affected plantation here in Ceylon has definitely shown that the disease does not spread outwards in zones from centres of infection, as is commonly supposed, and that the disease is therefore not a contagious one. It is submitted, therefore, that the wilting of coconut palms associated with quick-tapering can now be considered as being definitely not due to some obscure plant disease, such as an ultra-microscopic virus.

The Wilt Disease in Travancore, as maintained by the present workers, is said to have no relation to the age of the coconut palm, since the disease has been noticed on trees of all ages, the best and most vigorous palms, usually being the first to develop disease symptoms. Similarly differences in the nature of the soil are said to have no effect on the incidence of the disease, since it has been found to infect palms growing in all kinds of soil. These observations are in entire conformity with what has been recorded by us about the Tapering Disease of Coconuts in Ceylon. The symptoms as they affect the root system of the diseased palms too appear to be similar.

At the conclusion of the article by Menon and Nair, the general statement is made that pathological symptoms exhibited by many plants have been attributed to the deficiency or lack of one or more of the major or minor elements in the soil, and consequent

defective metabolism. The writers record that the soils from diseased areas were generally found to be deficient in the major elements of nutrition and that there was a marked deficiency of potash. This is true also in Ceylon, nevertheless there are areas where individual palms, bearing as many as 100 nuts or more per palm, on soils which has been regularly manured with N.P.K. fertilisers will suddenly commence to develop the symptoms of tapering, leading to premature death, and that additional application of N.P.K. fertilisers will not cure the "disease" when it occurs under these conditions.

The investigations now being carried out by the Coconut Research Scheme are accordingly based on the assumption that tapering is not a communicable disease, but is due either to lack of plant food or due to the unsatisfactory conversion of nutritive matter into living plant tissue, i.e. faulty metabolism.

Tapering may be gradual and may develop over many years, or it may be sudden, of only four or five years' duration, prior to the death of the palm. It is necessary to make this distinction because although the basic cause may be the same, viz. malnutrition, it is quick-tapering which is generally described as tapering disease.

Slow Tapering

It is considered that slow or gradual tapering, which is very common indeed in Ceylon is due to three main causes:—

- (1) prolonged neglect of palms growing under unfavourable conditions;
- (2) failure to open-up and drain low-lying soils;
- (3) soil-hardening or compacting.

Neglect.—These unfavourable conditions may be cabooky soils from which most of the fertile top soil has been removed by sheet erosion or a shallow top soil with an impenetrable subsoil, such as ironstone, coral, conglomerate, brick clay, or rock. On such soils, the palms generally show early promise, but after 10 years, they begin to decline in yield on account of malnutrition caused by the restricted root system and the cumulative lack of plant food. In consequence there is a very natural inclination to retrench on estate expenditure. As the soil in time becomes progressively more exhausted and with increasing neglect remains impoverished, the girth of the palm diminishes, crops decline, and the conversion ratio of nuts to copra increases. A state of total neglect may ultimately be reached when the property becomes completely unproductive, and the palms suffer premature senility and death on an extensive scale.

Experiments which have been carried on over a long period of years by the Soil Chemist, Dr. M. L. M. Salgado, have shown conclusively that such soils can generally be reconstituted economically and profitably by a combination of the application of N.P.K. fertilisers with cattle manuring, the systematic burial of husk, and the provision of contour drains to stop erosion and removal of top soil. If this is done a crop of 2,500 nuts per acre can generally be obtained. (See C.R.S. leaflet No. 12).

Water-logging.—Here the state of malnutrition of the coconut palms is due to a combination of poor soil aeration, inadequate movement of soil moisture, the restriction of root-development by the high water table and root-damage by rotting. The result is that although most low-lying soils are initially rich in plant nutrients, the plant is gradually starved. In

such conditions, the correction of the disease is a problem of drainage and of improvement in soil texture by the burial of husk and the regular incorporation of grass and green manures.

On no account must a system of drains, once established, ever be refilled with husks, coir dust or plant trash as the object of these drains is to remove excess water and so lower the water-table. See C.R.S. leaflet No. 5.

Soil hardening. A packed-up condition of the soil can also produce symptoms of tapering and for much the same basic reasons as those given above. This can occur in a heavy clay soil during a drought; where a soil is compacted owing to trampling and pressure; or where the soil has been cemented in to a solid mass by termites.

Everyone of the palms in the market-place at Dankotuwa is today in some stage of tapering and several have already died, although originally they were all as healthy as those in the gardens immediately adjoining. The loose sandy surface of the floor of the market

is rich in cattle manure, urine and decaying vegetable matter, but immediately below this the ground is hard, compact and impervious, due to constant trampling and pressure. There is no soil aeration and no movement of rain-water downwards to the roots; instead successive accumulations of storm-water carry away the loose rich top sand by sheet erosion. A similarly packed-up condition of the soil with similar effects on the palms occurs if harvested nuts are stacked in the same spot for several years.

The palms in the brick-fields at Toppuwa road junction also are tapering because of the impermeable clay in which they are growing and because of the extensive root damage which must occur during a long drought when the brick clay becomes rock-hard and shrinks and cracks.

Tapering and Termites.—The destructive possibilities of white ants and the avidity with which they attack woody tissue are only too well-known. It is not so generally appreciated that soils can be profoundly modified from their original condition and that a



The root system of a coconut palm.

".....The earth sets like concrete and holds the major roots in a vice-like grip....."

"living" soil can be converted into an inert, hard, impervious, aggregate by wide-spread termite activity.

On very neglected properties, it is a common sight to find weak and tapering palms in association with ant-hills. Under such conditions, the termites can operate for years undisturbed and the presence of tree-stumps, dead logs and leaf butt-ends stimulate their activity. They can so multiply their colonies that the ant-hills may ultimately be counted in hundreds, but the condition of the land is even worse than it appears as the majority of the termitaries are below ground-level and invisible, and the soil is just one hard, cemented, compact mass, riddled with galleries.

This is the same soil condition so unfavourable for coconuts which has just previously been described ; the position is, however, aggravated because the termites tend to build their hard conical nests in the root systems of individual palms. The earth sets like concrete and holds the major roots in a vice-like grip ; the hair-like subsidiary roots are gradually killed and the palm commences to taper through progressive starvation. Ultimately this slow-tapering will result in the death of the plant.

Quick-Tapering

The simple explanation of slow-tapering, as being due to slow starvation, cannot be used to explain the quick-tapering of high-yielding palms which may occur on coconut estates with an annual yield of as much as 6,000 nuts per acre per annum and where a diseased and dying palm and a healthy, high-yielding palm are usually to be found standing side-by-side.

Even so, it is possible that quick-tapering may still be a manifestation of malnutrition, but, in this case, the starvation of the plant may be due to the unsatisfactory conversion of the available plant foods into living plant tissue. The following causes for this are suggested :—

- (1) The prolonged use of improperly-balanced or incompatible fertiliser mixtures.
- (2) Lack of certain essential, minor or trace elements in the soil, or their non-availability.

Fertiliser Mixtures.—It is the view of some coconut growers, that the long-continued use of artificial fertilisers exhausts a coconut palm, and that on the cessation of such manuring, the palms will suffer a severe set-back.

The continued use of N.P.K. fertilisers in a standard and fixed ratio, under all conditions, assumes three things :—

- (1) that each fertiliser element is taken up at the same rate ;
- (2) that there is no residual surplus of any fertiliser element, leading to a mounting accumulation of any one ;
- (3) that widely-different soils have the same amounts of available plant nutrients, already present in the soil.

The capacity of a soil to supply nutrients may change over a period of years. Soils that were originally highly productive may in time need additional nutrients to provide a balanced supply. Thus fertilizer practice on the same piece of land, cultivated with coconuts for 70 years or more, may need revision from time to time to meet changing conditions.

For practical manuring, it is important to know how far the effect of one plant nutrient depends on the presence or absence of another, and to what extent a cumulative excess of a major nutrient may affect plant growth adversely and so perhaps induce tapering. Unfortunately too few experiments have been carried out by soil experts to answer these difficult and involved questions with any precision.

The problem of coconut manuring has been systematically investigated at the Coconut Research Scheme by the Soil Chemist in modern field experiments over a long period of years. These experiments are specifically designed to disentangle the main effects of nitrogen, phosphorous and potash when they are applied to palms at different levels (i.e. none, single and double doses) and determine the effects of their mutual interaction on yields and on the condition of the palms.

At the same time, studies have been made of the changes occurring in the soil, due to the accumulations of individual plant nutrients over a long period of years. In this connection, an exhaustive study has been made of the phosphate reserves of the soil and the extent to which such reserves are available to the palm. Preliminary work has also been carried out to determine the degree of availability of potash in various types of coconut soils and to ascertain the fate of the potash, applied as manure.

This is all part and parcel of the problem of the correct economic dose for correctly-balanced manuring. It is not only a question of whether manure is being wasted but whether the surplus as it accumulates may have an increasingly deleterious effect, even as too much meat, rice or toddy may have an adverse effect on human metabolism.

In this connection, definite and convincing data has already been obtained regarding the deleterious and depressing effect of an excess of nitrogen, repeatedly applied over a period of years.

Such work is all long-range and never-ending, and the chemistry of the subject is complex and difficult to elucidate.

Minor and Trace Elements

From the soil, plants take up relatively large quantities of nitrogen, phosphorous, potassium, sulphur, calcium, magnesium and in some cases sodium. Elements are also required from the soil in trace amounts; these include boron, iron, manganese, zinc, copper, cobalt, and molybdenum. Such minor or trace elements, though only taken up in exceedingly small amounts, may be absolutely essential for healthy plant growth and a local deficiency of any one of them, after many years of mono-cultivation with coconuts, might well provide the explanation of quick-tapering disease on soils, otherwise well supplied with major plant foods.

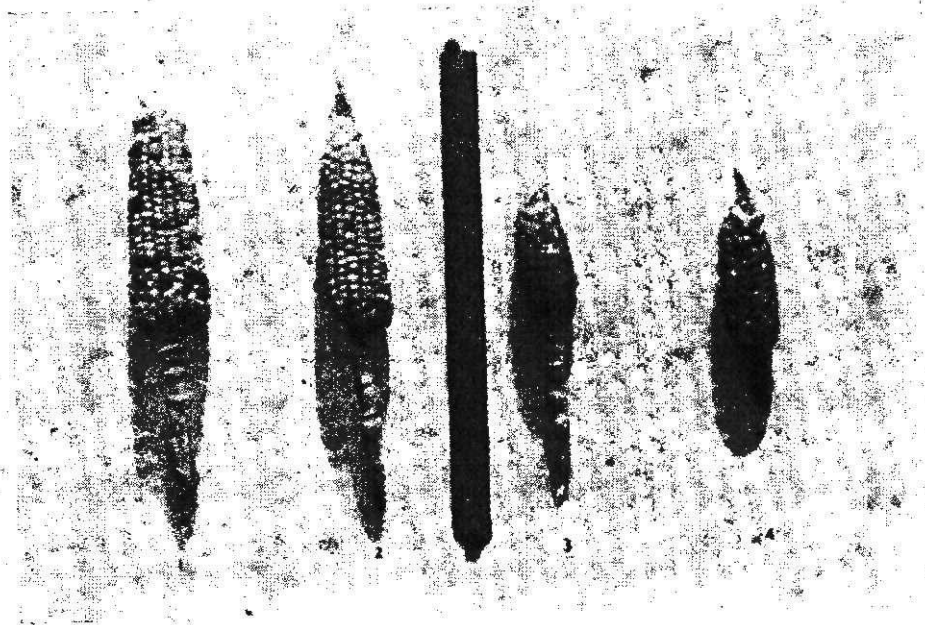
The case of the Hawaiian pineapple industry is an important example. The rich volcanic soils there were deficient in available iron, and the discovery that pineapples need a trace of iron, made it possible to grow pineapples on lands which were previously regarded as quite unsuitable. Zinc and copper have also now to be applied in trace amounts to exhausted lands which have been repeatedly planted with pineapples for over forty years.

without a charge of crop. There has also been a substantial response to applications of traces of boron.

In the previous article, considerable promise was given to the theory that a localised deficiency of magnesium might be the cause of quick-tapering disease. Experiments have been started and after only four months, some improvement in the foliage of affected palms, now under treatment, is reported. It is early yet to decide whether the results of these preliminary experiments are sufficiently definite and conclusive to justify a full scale trial, using the system of replicated and randomised plots.

Meanwhile simple experiments to determine whether there may be some deficiencies of trace elements in our coconut soils have also been initiated. A piece of exhausted sandy, coconut land, on which mature coconuts were not doing well, was selected for these trials, and maize, a quick-growing indicator plant, was planted thereon.

There were, in all, eight observation plots under this crop and the seedlings were treated, once a fortnight with 1 per cent. solutions of the salts of boron, manganese, copper, sodium, cobalt and iron, in addition to a normal N.P.K. mixture. There were also two other plots, one with N.P.K. alone and one with no added chemicals.



TYPICAL CORN COBS FROM OBSERVATION PLOTS

1. N. P. K. Boron
2. N. P. K. Manganese
3. N. P. K. only
4. Control.

Such soil may be admittedly far from uniform in fertility, but the results were sufficiently striking to be worth quoting, more particularly since maize is not an easy crop to

grow without heavy manuring. The weight of seed obtained from these individual plots was as follows :

N.P.K. + boron	1,203 grms.	N.P.K. + Manganese	1,185 grms.
N.P.K. + copper	877 ..	N.P.K. + Sodium	560 ..
Control (nil)	342 ..	N.P.K. only	337 ..
N.P.K. + cobalt	334 ..	N.P.K. + Iron	174 ..

The boron and manganese plots produced the largest number of full-sized cobs and the smallest number of undeveloped seedless cobs. Differences were also apparent in vegetative growth; plants treated with boron, manganese and copper showed profuse growth and grew to the greatest height, and their leaves were longer, broader and juicier than the others.

These results, although not conclusive, justify a full-scale trial* using the system of randomised plots to correct for differences in individual plot fertility and this has since been started. In addition, it has now been decided to carry out empirical trials on individual tapering-palms with solutions of these trace elements, used singly and in various combinations, and if these show promising results, systematic trials on large areas of coconuts will be initiated.

It is necessary to point out that trace elements are only required in trace amounts and that the application of excessive amounts can do great damage to plants. They must, therefore, be used with caution. For those interested in carrying out experiments for themselves, a $\frac{1}{2}$ to 1 per cent. solution in water is used once a month, and the rate of application should lie between 5—20 lbs. of chemical per acre per annum, which must not be exceeded.

Conclusion

1. The conclusion has been reached that the tapering disease of coconuts is not due to an infectious organism or virus.
2. Slow-tapering, which is not true tapering disease, is due to plant malnutrition, caused by one of several possible causes.
3. Quick-tapering is probably due to the unsatisfactory conversion of available plant foods into living plant tissues.
4. The solution of this obscure problem is not to be found in some simple correction of current agricultural practice, otherwise the answer would have been found long ago.
5. There is the possibility that sodium and magnesium, elements present in sea-water, may be lacking as major plant foods.
6. There is another possibility, which is also being examined, that the trace element, boron, a deficiency of which affects the growth of new tissue, may provide the answer.

* These plots will be ready for inspection during the month of July.