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REPORT ON LEAF SCORCH DECLINE OF COCONUTS

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The purpose of my visit as Consultant Plant Physiologist was to "Advise on future lines of work on the leaf scorch problem of coconuts from the physiological angle".

Previous work

The history of the disorder has been reviewed (Ekanayake 1968). All the scientific departments of the Coconut Research Institute have been concerned with the problem at some time, as well as visiting specialists.

Whether the condition has been present for a long time will perhaps never be known, but it seems to be more obvious now. Some think increased use of fertilizers may be responsible for this but Davis (1962) states that symptoms were first recognised after a period of heavy rain. All who have worked with diseases and disorders of coconut palms are agreed on the difficulties of diagnosis and there are many maladies of coconuts in various parts of the world so far unresolved in spite of many investigations. It is not even certain whether pathogens are concerned in some of the most devastating "diseases". Hence the facts must be clear before dismissing any possible cause. At present the sporadic nature of the disorder, with little evidence of spread from a focus of infection, suggests a pathogen is not concerned. Robertson (1965) confidently asserted that the disorder was not caused by nematodes. A virus does not appear to be implicated either but this aspect has not been thoroughly investigated and merits more attention. The disorder appears nearly always to be associated with a decaying root system and two genera of fungi, *Fusarium* and *Cylindrocarpon* are more abundant on dead roots and neighbouring soil than on living roots. Inoculation of living roots with preparations of the two fungi has not resulted in appearance of characteristic symptoms.

Although the total number of affected palms is small and at present does not affect copra production significantly it is very important to discover the cause of the disorder without delay. As long as it persists, without the cause being known, it is a potential threat to the Coconut Industry of Ceylon.

Visual Symptoms

Browning of the distal leaflets of older leaves spreads lengthwise from the tip, often preceded by yellowing, but the transition from living to dead tissue appears to be relatively sudden, which is consistent with a toxic substance being transported to the leaflet tips. The fungus *Botryodiplodia theobromae* appears to be invariably present on the dead parts (but never on the living). Evidently the dead region of the leaflet contains nutrients which support this fungus. This is probably because of the relatively rapid death of the leaf so that nutrients are not transported back into the living plant. In normal senescence most of the nutrients are withdrawn. The occurrence of *B. theobromae* is so consistent on dead

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parts of leaflets of affected palms that it is regarded as a diagnostic feature of the disorder. When scorch is more severe, there are fewer living leaves and eventually the crown is small, the trunk tapers and the palm dies. All accounts suggest the decline is slow; the period is usually given as 6 years but I was shown a tree in the Gonapinuwela area still living 11 years after the disorder was first noticed. Mr. C. T. Van Geyzel, showed me a palm on Garston Estate that from his own observations had been affected for at least 30 years and was still only in a moderate state of decline. There is thus little information about the time required for the disorder to kill the palm but it is certainly a slow process and if a pathogen is concerned it is relatively ineffective. There are conflicting reports whether palms can recover from the disorder, probably because there are relatively few detailed observations. It seems likely, however that recovery can occur. A striking feature of the disorder is that there appears to be little, if any, spread of the symptoms from palm to palm and surveys by the Crop Protection Officer show that affected palms are grouped together only where soil conditions are bad. This is evidence against a pathogen being primarily concerned.

Distribution

Surveys made by officers of the Coconut Research Institute indicate the disorder is widespread but much more common in the Gonapinuwela region in the South West. It can probably be found on many estates and small holdings, even the best-managed on good coconut growing land. The manager of a fertile coconut estate thought that most (perhaps 80%) of affected palms occurred where coconut husks were heaped to await transport. There is also some evidence that affected palms are more common near habitations but surveys have been inconclusive.

As already mentioned the disorder is most prevalent in the Gonapinuwela region and most studies have been done there. For instance a survey in 1962 showed that 77% of the region had affected palms—and on average 1 palm in $1\frac{1}{2}$ acres was dying. The mortality rate was greater on soils with bad physical properties and the Soil Survey Unit of the CRI made a detailed study of the area. The disorder was mainly confined to 2 soil types : (1) a lateritic soil with a hard pan near the surface which impeded drainage and root growth and (2) soils with a high fluctuating water table (see Perera 1970). No affected palms occurred on well-drained soils without a hard pan or where the water table did not fluctuate.

Attempts to cure the disorder

There is no evidence that it is caused by a deficiency of major or minor elements. Experiments by the Soil Chemist showed that fertilizers applied to the soil or foliage had no beneficial effect. However, results from experiments by the Soil Chemist testing the effects of lime will be referred to later.

Inoculations of fungi into healthy roots did not reproduce the symptoms and applying fungicides to the soil had no effect.

Diagnosis of the cause of leaf scorch decline from present knowledge

Although present evidence is against a pathogen being concerned, aggregation of affected palms secure on certain soil types with bad physical properties. This suggests that root growth is adversely affected and in soils with a hard pan near the surface, roots do not penetrate very deeply. The discovery that some fungi, particularly *Fusarium Spp.* are more abundant around the roots of affected palms also suggests a connection with the disorder. Kranz (1967) pointed out that many *Fusarium spp.* can only infect plants when their vigour has been lowered by adverse factors. It is known that some species of *Fusarium*, parasitic on plants, produce toxins which in turn produce characteristic symptoms on the

foliage. So these fungi present on parts of the root system or in close proximity to living roots might produce toxins which when translocated to the leaves would give the characteristic scorch symptoms. If the disorder were merely due to impeded water uptake by the roots, the leaf symptoms are likely to be different and drying of the fronds would be the result. It need not be assumed that the *Fusarium spp.* are parasitic on the roots in order for toxins to be translocated to the leaves. Some coconut disorders in other parts of the world are associated with toxins translocated to the foliage.

Palms less than 20 years old and some varieties like king coconut are said not to be affected by leaf scorch decline. This may be because the root systems are smaller and less likely to encounter adverse conditions, but this requires investigating.

A striking example of how soil conditions can induce the disorder occurs on a site at the Negombo Ceramic Factory, where discarded pottery, kaolin and other waste has been dumped between coconut palms growing in low-lying land. All the palms show typical symptoms but nearby in a similar situation, where there is no dumping, and on the railway side of the fence, palms are healthy. In fact the distribution of the disorder at this site appears now to be exactly the same as described by Kranz in 1967.

The question is what are the adverse soil conditions that affect root growth. Many coconut soils in Ceylon are very acid. Some measurements made by Mr. K. S. O. Perera of the Soil Survey Unit shows that some low Deniya poorly drained soils have pH as low as 3.85 whereas the pH of the High Deniya, well-drained soils, is 4.73 (see also Appendix Table I). Unfortunately extensive data on the pH of coconut soils in Ceylon is not available. Possibly acidity has increased somewhat during the last decade by use of more fertilizers containing ammonium sulphate (see Appendix Table II); the effect would be particularly severe on lateritic soils, on which many coconuts are grown, because of their low base-exchange capacity. It must be emphasised, however, that increased use of fertilizers has greatly increased yield in the last few years. Thus it is possible that localised parts of the soil have become too acid to support root growth, or conditions have developed which support the growth of *Fusarium spp.* There may be other reasons why local conditions cannot support root growth or encourage fungi and they need investigation. The coconut apparently tolerates a wide range of soil pH but most authors give pH 5.0 as the lower limit. Some coconut soils in Ceylon exceed this acidity. The results of the Soil Chemist's liming experiment on Walahapitiya Estate show how yields are improved when the soil is made less acid. The experiment, started in 1961, shows that applying lime as required, to maintain the soil pH between 6 and 7 has raised yields over the last 4 years by 10% (Appendix Table 3). A survey of the liming experiment done at my request by the Crop Protection Officer and the Soil Chemist showed palms yellowed less when limed (176 compared with 229 on unlimed plots). Another experiment at Kirimetiya where mixtures of fertilizers were applied in the presence and absence of lime showed that yields of copra declined more slowly both from healthy and affected palms when lime was included in the mixture. (see Appendix Table 4). These experiments suggest that palms yield better on less acid soils where adverse factors are less likely to occur. Soil pH is also important in regard to the action of soil nitrifying bacteria. A reference by the Soil Chemist (Nalliah 1958) indicates that on some soils much nitrogen occurs as the ammonium ion suggesting conversion to nitrate is slow. This aspect needs further study.

The present evidence suggests that leaf scorch decline is caused by adverse soil conditions leading to poor root growth and local death of the root system. This is associated with increase in *Fusarium spp.* Toxins from these fungi may be responsible for the leaf symptoms associated with leaf scorch decline. It is essential to do experiments to test this hypothesis.

Suggestions for Future Work

(*a*) *Experiments to improve soil conditions*

Some experiments should be directed to improving soil conditions in selected areas; these will include liming experiments, especially on those soils where leaf scorch is common. Other experiments should be directed to improving the physical condition of the soil so that root growth is improved. These experiments would resemble some demonstrations already set up by the Crop Protection Officer, but would require replicated treatments based on an experimental design approved by the Biometrician.

On some of the best-managed estates there is a consistent policy of burying husks in pits around the palms; although this is a relatively expensive operation it is evidently considered economic. No one has investigated the benefits from husk burying but no doubt it improves the physical properties of the soil and encourages root development. Experiments designed to study the benefits and effects of husk burying would be well worthwhile. Such experiments could be combined with other experiments to promote better root growth such as filling pits with river sand or coconut coir dust† mixed with sand (say in ratio of 2 : 1 by volume). These treatments should be compared with similar treatments where fertilizer is also added to the contents of the pit. The treatments should be repeated annually. It would also be desirable to increase the number of observation pits, such as the Crop Protection Officer now has, to get more information about root growth. It is essential that these experiments, designed to improve soil conditions, include detailed observations on the severity of leaf scorch symptoms and to record any improvements that may occur. Without accurate and detailed observations the efforts put into the rest of the experiments will largely be wasted.

(*b*) *Experiments to worsen soil conditions to see if the disorder can be induced*

One of the easiest ways to worsen soil condition is to increase its acidity. This may be done by applying elemental sulphur or solutions of aluminium sulphate. Some treatments should include large doses so that deterioration is rapid. Detailed observations should be made on palms as soil acidity increases. Experiments on water-logging are probably more difficult and costly to perform but should be considered later. A detailed investigation of the soil conditions at the Negombo Ceramic Factory where waste products in the soil apparently induce the disorder might also give a valuable clue to the relationship between soil conditions and leaf scorch decline.

(*c*) *Investigations on toxins produced by Fusarium spp. and other soil fungi*

The question of toxins produced by *Fusarium spp.* on dead or dying roots should be thoroughly investigated. This can be done in various ways, for instance by making cultures on both solid and liquid media and testing for the presence of toxins in the culture medium by applying to young seedlings of cereals, beans etc. Extracts of the cultures could also be tested on coconut seedlings growing in sterilised sand culture either via the roots or by introducing into the coconut shell during germination. It might also be possible to introduce preparations into the trunk of the coconut tree in the same way as insecticides.

Additional recommendations

There is urgent need for more work on the fungi invading roots of healthy and affected palms. The post for a research officer with special qualifications in Mycology has been vacant since 1968 and every effort should be made to recruit a suitable officer.

† An economic use of coir dust would be a great benefit to the industry; at the moment it is little used and is accumulating.

Investigations into the cause of Leaf Scorch Decline have been so far a co-operative effort between various departments of the Coconut Research Institute but a good deal of the work has been the concern of the Crop Protection Officer. He has devoted as much time as possible to the investigations but the demands on his time have inevitably resulted in lack of continuity in the research on the Leaf Scorch Decline problem. There is need for a full-time officer to be appointed whose sole duties would in the first instance be concerned with causes and effects of Leaf Scorch Decline.

This investigation could best be done by a qualified *Plant Physiologist* whose first task would be to set up some experiments as outlined above. An urgent task would be to make a thorough investigation of the root system of healthy and affected palms. At the moment progress is hampered by the fact that we know little about root growth of the healthy palm in different soil types and how leaf scorch decline affects it. The Crop Protection Officer has some preliminary data.

Although root studies would be one of the first concerns of the Plant Physiologist he could also begin investigations on other aspects of coconut palm physiology. As far as I know there is no qualified plant physiologist working on coconut in any of the coconut producing countries. It would be fitting if the Coconut Research Institute of Ceylon which has pioneered much research on coconuts, appointed a Plant Physiologist. He would need a supporting team of assistants to perform the work adequately.

I would like to see as many of these recommendations put into practice as soon as possible and if it can be arranged conveniently I would like to return to Ceylon in a year or so to see what progress has been made.

I am grateful to the Director of the Coconut Research Institute, Dr. W. R. N. Nathanael for providing facilities to carry out my task. I thank all members of the Institute who have helped me in various ways, especially Dr. U. B. M. Ekanayake and Mr. J. K. F. Kirthisinghe who accompanied me in the field. Mr. K. S. O. Perera kindly arranged for me to see soil profiles and coconut root systems in the South Western region. I thank Dr. O. S. Peries Director of Rubber Research Institute and Dr. U. Pethiyagoda of the Tea Research Institute for useful discussions.

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APPENDIX

TABLE I

Effect of liming on soil pH at Walahapitiya Estate

1961	.. ..		pH 4.2
1968	.. ..	0-9″	pH 6.8
		9-18″	pH 5.9

TABLE II

Fertiliser used on Coconut Lands

(Annual Totals—all NPK fertilizers)

Year	*Thousands of tons*
1957	31.3
1958	34.7
1959	44.0
1960	42.2
1961	38.8
1962	45.0
1963	48.7
1964	46.4
1965	50.1
1966	53.9
1967	51.2
1968	63.2

Figures kindly supplied by Dr. W. R. N. Nathanael.

TABLE III

Effect of liming on yield at Walahapitiya Estate

(Lbs. Copra per acre)

	1963	1964	1965	1966	1967	1968
No lime	1474	1590	1410	1127	851	1136
Lime	1490	1682	1528	1273	950	1256
Increase	16	92	118	146	99	120

TABLE IV

Mean decline in yield (1965-1968) of copra per palm

	+ Ca	*– Ca*
Affected palms	9.9	10.4
Healthy palms	3.2	5.3