

## 22. Studies on the anatomical changes in the tissues of the coconut palms affected by wilt (root) disease

### I. A note on the changes in the mesophyll

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#### INTRODUCTION

CONSIDERING the vast strides made in the field of viruses and virus diseases, the attention devoted to the anatomical changes in the affected host plants has been little, perhaps, due to its less fascinating nature. References to the internal abnormalities that accompany the external manifestations of the disease in plants are not lacking though, especially in the general mosaic and leaf curl group of viruses (Clinch, 1932; Cook, 1930; Esaw, 1948; Schneider, 1945 etc.). The more critical of these (Esaw, 1944 and 1948) reveal that apart from the similarity of external symptoms, allied viruses or groups of viruses bring about more or less the same type of changes in their different hosts. Thus viruses of the leaf curl type produce phloem necrosis and mostly proliferation of the same tissue whereas those of the mosaic group mainly affect the mesophyll. Apart from a complete loss of chlorophyll and the disintegration of the plastids, hyperplasy of the mesophyll tissue is also met with in beet mosaic. Cells are smaller in size, rounder with little interspaces in the yellow areas especially if the symptoms set in the early developmental stages of the leaf (Esaw, 1944).

Although the aetiology of the Wilt (Root) disease is not, as yet, established, possibilities of its being of a viral origin have been pointed out (Menon and Nair, 1951, Nagaraj and Menon, 1956). The primary external symptoms presented by the affected trees are varied and range from flaccidity and abnormal bending of leaves and petioles indicative of typical wilting to chlorosis and marginal necrosis of the middle and outer whorl of leaves - these symptoms occurring individually and in combination with varied intensity. Nevertheless, the one constant feature of the disease is the systemic nature of it. Anatomic

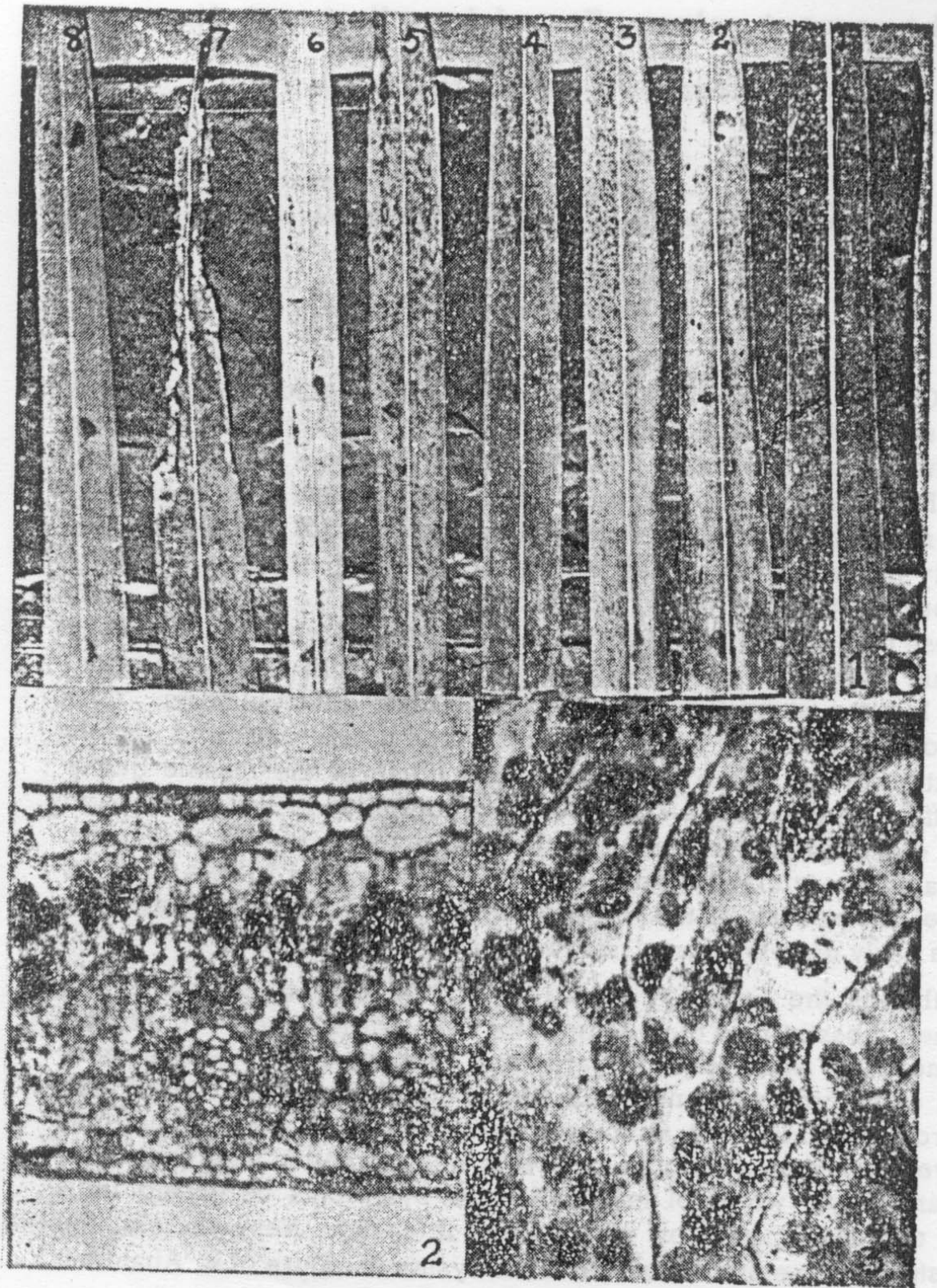


PLATE I

- Fig. 1. Different foliar symptoms associated with the 'wilt' disease. 1. healthy; 2. general yellowing; 3 & 4. mosaic type of chlorosis; 5. flaccidity with yellowing; 6. bronzing; 7. marginal necrosis; 8. physiological yellowing. Approx.  $\times 1$ .
- Fig. 2. T. S. of a healthy leaf showing the compactly arranged palisade with little spongy tissue. Approx.  $\times 150$ .
- Fig. 3. The palisade cells of healthy leaf showing the shape and arrangement of chloroplasts. Approx.  $\times 1000$ .

studies on the various tissues, especially the conducting strands and the mesophyll in relation to these diverse symptoms is bound to yield interesting results which may perhaps be useful in understanding its aetiology as well. The following is the result of preliminary studies carried out on the changes in mesophyll of affected palms.

#### MATERIALS AND METHODS

Samples of leaves showing the different symptoms were collected, fresh sections of them taken in the freezing microtome at 10  $\mu$  thickness and mounted in tap water for immediate observation of the mesophyll tissue. Sections stained in carbol fuchsin were also examined.

The different symptoms (Plate I, Fig. 1) were grouped as given below for convenience of studies.

A. Healthy.

B. Chlorosis - 1) mosaic type of chlorosis i. e. chlorosis localised as patches and spots.  
2) general chlorosis.  
3) bronzing, i. e. an orange yellow colouration of leaves.

C. Flaccidity - 1) flaccidity of leaflets with chlorosis.  
2) " " " without chlorosis.

D. Physiological

Yellowing - a general yellowing of all leaves.

#### RESULTS

The mesophyll of a healthy sample reveals (Plate I. Fig. 2) a more or less compactly arranged, elongated palisade cells extending from the upper hypoderm to the lower epidermis with very little spongy tissue and air spaces in between. The chloroplasts evenly distributed along the periphery of the cells, are uniformly spherical to oval in shape with compact yellowish green chlorophyll (Plate I. Fig. 3).

In the leaves exhibiting the different symptoms of the disease no variation is met with in the mesophyll as far as the arrangement and size of cells are concerned. However, the chloroplasts seem to be highly sensitive and present greatest variation in distribution, size and the chlorophyll contents. In all cases where chlorosis is evident, the chloroplasts are more or less disintegrated, the chlorophyll disappearing partly or *in toto*.

#### *Chlorosis*

The mosaic type of chlorosis is first evident as minute specks of yellow areas in the mature leaves of the middle whorl and anatomically



PLATE II

*Fig. 1. Showing the arrangement and shape of chloroplasts in the palisade cells of leaves exhibiting different types of symptoms (a) the mosaic type of chlorosis, (b) general yellowing, (c) bronzing, (d) flaccidity (e) flaccidity with yellowing, (f) physiological yellowing. Approx.  $\times 2000$ .*

this is evident by the partial disintegration of chloroplasts and disappearance of chlorophyll in a few palisade cells (Plate II. Fig. 1-a) which later on spreads to a limited number of adjoining cells, wherein the chloroplasts are found as small, translucent, irregularly shaped bodies. The majority of the chloroplasts in the surrounding green areas are of a granular consistency while the original shape and mode of arrangement is retained. Where general chlorosis is manifested, different types of cells are met with, the chloroplasts showing varying degrees of disintegration, still, maintaining their peripheral arrangement in the majority of cases (Plate II. Fig. 1-b). In many, the plastids appear granular while in rare cases the membrane is broken liberating the contents into the surrounding cytoplasm. The chlorophyll is either retained in the cytoplasm or has completely disappeared, the plastids then becoming yellowish. Complete disintegration of plastids and disappearance of chlorophyll is evident (Plate II. Fig. 1-c) in the mesophyll where 'bronzing' of leaves is found. The disintegrated, transparent, minute particles of the plastid become chromogenic in later stages assuming an orange red colour.

#### *Flaccidity with and without yellowing*

In the leaves showing flaccidity, the marginal distribution of plastids are maintained in a number of cells although in some it has been disturbed and the plastids have disintegrated to a certain extent (Plate II. Fig. 1-d). The chlorophyll, however, is retained within these plastids. When chlorosis starts, marked changes set in, the chloroplasts get disintegrated into minute irregularly shaped bodies, are fragile and the majority of them swell up in contact with water (Plate II. Fig. 1-e) so that the cells present an effervescent appearance.

#### *Physiological yellowing*

The general yellowing of leaves met with in the case of some palms in the diseased tract, although not actually a symptom of the disease, cannot be said to be entirely unrelated to it. The plastids in this case get degenerated into irregular, minute, granular particles which are often retained within the plastid membrane (Plate II. Fig. 1-f). The peripheral arrangement of these plastids is naturally adversely affected and most of the chlorophyll is lost, though this disintegration and derangement are not as acute as in the case of 'bronzing'. A swelling of the plastids on contact with tap water is also met with in some cases.

#### DISCUSSION

The foregoing work shows the effect of foliar symptoms of the Wilt (Root) disease on mesophyll and especially on the chlorophyll.

The effect of chlorosis is characteristic in that it affects the distribution, size, shape, properties and contents of the chloroplasts - disintegration and degeneration being met with in the majority of cases. This effect of chlorosis on the chlorophyll is a common feature observed in other mosaic diseases as well (Esaw, 1944).

The actual role of the virus and its mode of action in bringing out these changes in the plastids have been much discussed. Cook (1930) and Sheffield (1933) put forward the view that viruses generally inhibit the formation of plastids and do not destroy chlorophyll or plastids. This is true in the case of typical mosaic diseases where the symptoms are more clear on leaves which are developing at the time of infection, the mature leaves being apparently unaffected. But some viruses are capable of affecting mature leaves causing chlorosis (Smith, 1935). Apparently, the ability to affect the plastids in the formative as well as in the mature stages is the property of individual virus, for Esaw (1944) reported that in the case of beet mosaic virus both an inhibition of plastid formation as well as plastid disintegration were met with. Indeed, similar degeneration is known to occur in plastids exposed to many different injurious agents (Esaw, 1944). The behaviour of plastids in the case of 'physiological yellowing' is reminiscent of this. Obviously chloroplasts are highly sensitive to any physiological disturbances inside the cells, which might be the direct or indirect outcome of any viruses or other chemical toxins.

The lack of any structural derangement in the cells of the mesophyll affected by these different symptoms is because, in no case does the chlorosis start in the developing stage of the leaf. The patches of yellow spots that coalesce later start as minute specks from the third or fourth mature leaf onwards and in some cases are found only in the outer whorl of leaves - hence, the reaction of general disintegration of plastids and chlorophyll. Detailed work on this aspect is necessary before any theory can be advanced regarding the aetiology of the disease. But it is clear that one of the early yet, major effect of infection is a physiological disturbance, probably the accumulation of some toxic chemical in the tissues resulting in complete or partial disfunction of the chloroplasts.

#### SUMMARY

In the coconut palm, affected by the Wilt (Root) disease, different types of chlorosis of leaves, often accompanied with flaccidity are met with. No change is noticed in the size, shape and arrangement of cells of the mesophyll which is attributed to the comparatively late appearance of chlorosis in mature leaves. However, the chloroplasts are

found to be highly affected, the desintegration and degeneration of which result in the partial or complete disappearance of the chlorophyll.

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