

CERTAIN CLOSELY ASSOCIATED MORPHOLOGICAL SYMPTOMS
OF ROOT (WILT) DISEASE OF COCONUT (COCOS NUCIFERA)

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ABSTRACT

The morphological symptoms of root (wilt) diseased coconut palms are manifested by softening and whitening of leaflets of the spindle with necrotic spots followed by rotting. Interveinal yellowing in the leaves of the middle whorl was an additional symptom. These symptoms are important in the early diagnosis of the disease in field-grown palms.

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Three major destructive diseases of coconut are cadang-cadang, lethal yellowing, and root (wilt) disease. The root (wilt) differs from other diseases in that it is of unknown etiology and non-lethal in nature. Also, the growth and yield of root (wilt) diseased palms decline slowly and the palms eventually become unproductive. If the seedling is attacked by this disease, growth of the plant ceases and it does not bear fruit. More than 250 thousand hectares of coconut gardens are affected by this disease in India (1). Flaccidity of leaves of the middle and outer whorls, and yellowing and necrosis of outer leaves, have been described as diagnostic symptoms of root (wilt) disease (13). Healthy mature seedling palms growing under shaded -- a nutrient imbalanced state -- and dry or saturated conditions also exhibit similar symptoms and could be diagnosed as diseased (Fig. 1). The biochemical (7) and serological (14) tests developed to detect this disease have been the only techniques to differentiate such palms into diseased and healthy categories; however, these are laboratory tests. A method to differentiate between healthy and diseased palms under field conditions was needed. Hence this study was undertaken.

MATERIALS AND METHODS

Field Experiment: One hundred mature palms and 100 seedlings of coconut each in early, middle, and advanced stages of disease were selected. The same number of seedling and apparently healthy mature palms (that is, healthy palms growing in a diseased zone), as well as healthy mature and seedling palms growing in a healthy zone were also marked. The study was conducted on West Coast Tall variety of coconut palms growing in coastal sandy, sandy loam, red sand loam, and laterite soils. Palms growing in saturated and nutrient imbalanced soils, and under shade conditions, were also selected. Detailed observations were recorded on the pattern of yellowing, necrosis, flaccidity, spindle condition, and general growth of leaves, during both dry and rainy seasons. The palms were classified into different categories on the basis of diagnostic symptoms described earlier (13).

The different morphological characters of palms recorded during dry and rainy seasons and in different soil types were not significantly different, hence, the common features have been mentioned in Table 1. These symptoms have also been compared with diagnostic symptoms reported earlier (13).

Laboratory Experiment: Root tips and the spindle (unopened leaf-central shoot-heart leaf) were sampled from all mature and seedling palms in the dry and rainy seasons, and were subjected to rapid biochemical tests (7) to detect root (wilt) disease.

RESULTS AND DISCUSSION

Observation made during this study showed that yellowing, necrosis, and flaccidity were present in both healthy and diseased palms, but flaccidity was greater in diseased palms. Some morphological characters, which were closely associated with root (wilt) diseased palms but not recorded previously are as follows:

1) The first crown symptom observed in root (wilt) affected palms and seedlings was deterioration of the spindle, as indicated by whitening and softening of the leaflets. Soft leaflets of the spindle were whitish-brown to a pale green. Round to rod-shaped necrotic spots were prevalent along the margins. Very soft-white leaflets were found in the spindle of the diseased palms. Whitish leaflets were usually rotten at their tip margin. This rotting is very different from that of bud-rot. In bud-rot, rotting usually starts from the spindle base and affects the meristematic tissue, which causes a withering of the heart shoot and subsequent death of the palm (4). Also, the organism causing bud-rot (*Phytophthora palmivora* Butl.) has not been reported to be involved in the root (wilt) disease (1, 2). Decay of the spindle, with an accompanying foul smell and partially folded leaves, constitutes the last stage of lethal yellowing (9), which is unlike the symptoms of root (wilt) disease.

The frequency of rotting and necrosis was the same during rainy and summer seasons, but the severity was visually greater in the rainy season. No distinct variation was recorded with soil types. Based on these symptoms, the spindle characters of healthy, apparently healthy, and different categories of diseased palms could be grouped in Table 1.

2) Close observations of the yellowing pattern of leaves in the middle and outer whorls of diseased palms indicated that the leaflets had interveinal yellowing (chlorosis) followed by marginal necrosis. Such typical chlorosis was easily recognized in the middle leaves, where the yellowing had just begun. Seasons and soil types had no effect on the frequency, but had some effect on the intensity, of interveinal yellowing. After heavy rains for 1 week and a few very hot days, interveinal yellowing become more intense in palms growing in sandy and sea beach soils. This may be due either to leaching of nutrients by rainfall, or to scorching. Chlorosis starts from the tip of leaflets and advances toward the base. Scattered interveinal yellowing in leaflets was also sometimes seen. In leaves of outer whorls, where yellowing was in an advanced stage, interveinal yellowing was not clearly visible. Therefore, the interveinal yellowing of middle leaves only was taken into consideration in the present study.

Interveinal yellowing of middle leaves differs from yellowing of outer leaves followed by browning of the tip of leaflets in "red ring" disease (8,11). It also differs from symptoms described for "cadang-cadang" disease (3,10), namely tiny yellow translucent spots on the veins of pinnae of young leaves, which results in yellow mottling accompanied by water-soaked spots on the under surface of the leaves. The yellow discoloration of the distal part of oldest leaves, as observed in "lethal yellowing" disease (9), also differs from the yellowing of root (wilt) disease. The interveinal yellowing of middle leaves is similar to symptoms of magnesium and manganese deficiency (6,12); however, the application of magnesium sulfate and manganese sulfate has brought about only partial recovery (5). Healthy palms growing close to diseased trees do not show such disorders, which indicates that interveinal yellowing of middle leaves is one of the most closely associated symptoms of root (wilt) disease.



FIGURE 1. A -- A root (wilt) diseased coconut palm. B -- A healthy coconut palm, growing under adverse soil conditions, appears like a diseased palm.

Table 1. Spindle characteristics of healthy and root (wilt) diseased palms.

Characters	Healthy and		Diseased		
	apparently healthy	Soft	Early	Middle	Advanced
Hardness	Stiff			Very soft	Very soft
Color	Leaflets green at the margin; remaining portion of leaflets cream-yellowish-brown or yellowish-green	Leaflets whitish-pale brown; margins of leaflets green		Whitish leaflets with brownish tinge, pale green at the margins	White leaflets almost devoid of chlorophyll
Necrosis-rotting	Nil	Necrosis only seen		Necrotic spots develop into rotting	Rotting prevalent

Mature leaves of diseased palms usually have round holes toward the margin of leaflets, which are caused by *Mylocerus curvicornis* F. A heavy attack by this insect on healthy looking palms, particularly seedlings, indicated a latent stage of the disease; this was also confirmed by the rapid biochemical test (7).

Healthy mature or seedling palms that were grouped under diseased categories on the basis of diagnostic symptoms described earlier (13) did not show any closely associated symptoms reported here and were further confirmed as healthy by rapid biochemical test. The combined diagnostic symptoms of flaccidity, yellowing, and necrosis (13) were recorded on 50% and 20% of early-diseased mature and seedling palms, respectively; the closely associated symptoms described here were recorded in all cases. Based on these observations, it is suggested that the closely associated symptoms will help, both to identify diseased palms in the field, and to diagnose early stage of the disease in both seedling and mature palms.

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