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Symptomatological and histopathological observations on oil palms from Brazil and Ecuador affected by fatal yellowing*

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Abstract

Fatal yellowing in oil palms from Brazil and Ecuador is characterized by a chlorosis of the young unfolded leaves and a decay of spear leaves. Contrary to healthy-looking palms, diseased palms do not have roots with soft and white tips.

In search for a possible causal agent of fatal yellowing, tissues of leaves, the apical region of stems and root tips of healthy-looking and diseased palms were examined by light microscopy. Fungi and bacteria were frequently, but not always found in necrotic lesions in the leaves. These organisms, however, have never been found outside the lesions or in the vascular tissues of affected palms, nor in the tissues of healthy-looking palms. Tyloses frequently occluded the xylem vessels of affected leaves. In a diseased palm from Ecuador hypertrophic cells were found in the epidermal layer of the pinnae of a spear leaf with water-soaked lesions. In the apical region of the stems and roots of diseased palms, only a few meristematic cells could be detected.

Additional keywords: Elaeis guineensis, pudrición del cogollo, amarelecimento fatal, speerrot

During recent years, considerable numbers of oil palms (*Elaeis guineensis* Jacq.) in Latin America have been lost due to fatal yellowing (also known as pudrición del cogollo in the Spanish speaking countries, amarelecimento fatal in Brazil and speerrot in Surinam). Denpasa (Brazil) lost 70 000 palms and Victoria (Surinam) lost several hundred hectares of oil palms during 1987 and 1988. Also in other plantations explosively increasing losses have been reported. La Arenosa (Colombia) and Icacal (Panama) succumbed to fatal yellowing in the seventies, and the disease presently threatens an oil palm industry covering about 250 000 hectares with an annual oil production to the value of over US$ 300 million a year.

The epidemical character of fatal yellowing strongly suggests that it is an infectious disease (Turner, 1981; Van Slobbe, 1987). The cause, however, has not yet been established. Several fungi and bacteria have been isolated from different parts of diseased palms, but their pathogenicity could not be proven (Turner, 1981; Renard and Quillec, 1984; Van de Lande, 1986). In the present study, observation of symptom development and

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histopathological studies on different parts of diseased palms were performed to provide new information on this disease and on the identity of the possible pathogen involved.

Parts of spear leaves, of the rachis and pinnae of young unfolded leaves, and of the stem collected just beneath the apical meristem, inflorescence primordia and segments of root tips of diseased and healthy-looking (control) palms from the plantations Canaima in Ecuador (two palms in initial stages of the disease) and Denpasa in Brazil (three palms in more advanced stages and two control palms) were fixed in 2.5% glutaraldehyde, embedded in polyethylene glycol methacrylate (Technovit 7100, Kulzer & Co GmbH, W-Germany), sectioned at 2-4 μm, stained with toluidine-blue and examined with the light microscope. Of each tissue piece embedded, at least 10 to 20 cross and longitudinal sections were examined for the presence of micro-organisms and anatomical deviations.

The initial symptom of fatal yellowing is a partial or complete chlorosis of the youngest unfolded leaves. The chlorosis subsequently proceeds downwards to about leaf number 10, leaf number one being the youngest fully unfolded leaf. Simultaneously, one or more spear leaves may become affected by a wet rot. In Pará, Brazil, the spear leaves predominantly are healthy looking in the early stages of the disease. In the Amazon region of Brazil and in Ecuador, mostly the spear leaves are already affected at the time the chlorosis of the youngest unfolded leaves becomes visible. The decay of the spear leaves starts with brown necrotic patches on the white, still folded pinnae. The tips of these leaflets often dry out. Next, the rachis is affected and the rot proceeds downwards to the apical meristem which sooner or later becomes affected as well. When the rot of the meristem proceeds slowly, temporary new leaves are formed. However, these leaves are much shorter than those formed on healthy-looking palms. No abnormalities have been observed on unopened inflorescences and fruit bunches. Contrary to healthy-looking palms, diseased palms no longer have young roots. Unlike the normal whitish to light brown colour, the tips of old roots of diseased palms are dark brown. However, the other parts of these roots do not seem to be affected. This is for the first time that abnormalities on the roots have been described. So far, it has been reported that the roots are normal (Turner, 1981; Van de Lande, 1986; Van Slobbe, 1987).

The anatomy of leaves, roots and stems of the healthy-looking palms corresponded with the descriptions by Tomlinson (1961), Ruer (1967) and Parthasarathy and Klotz (1976).

Bacteria and fungi were seen in many, but not all, necrotic lesions on leaves of diseased palms. However, neither in the tissues bordering the lesions, nor in the vascular bundles in the affected area, any micro-organism could be detected. Even outside the lesions at sites where the cytoplasm of the mesophyll cells had disintegrated, no micro-organisms were seen at all. In a diseased palm from Ecuador, numerous bacteria were found in water-soaked lesions on the pinnae of a spear leaf. The bacteria were present in the intercellular spaces between mesophyll cells, a few of which were disintegrated (Fig. 1). Hypertrophic cells were sometimes found in the epidermal layer in the lesions as well (Fig. 1). These two phenomena were not observed in the other diseased palms studied.

In leaves with dry or wet necrotic lesions on the rachis or the pinnae, the xylem vessels were frequently occluded by tyloses or sometimes by gummy materials. Occasionally sieve tubes were also occluded with such gummy materials. Micro-organisms were not detected in the vascular bundles.

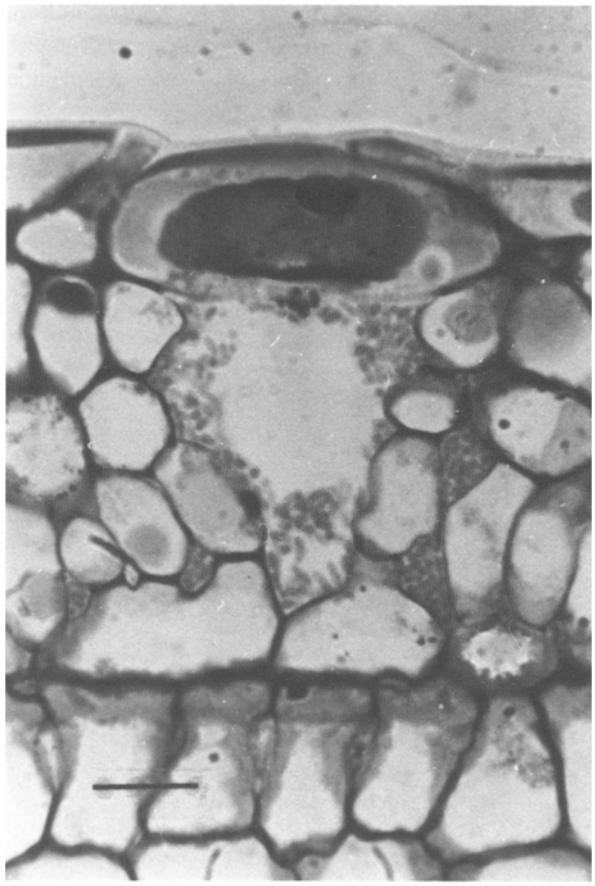

Fig. 1. bacterial pocket with disintegrating mesophyll cells and hypertrophic cell in epidermal layer of a leaflet of a spear leaf of an oil palm affected by fatal yellowing. Bar = 10 μm.

In the apical region of the stems and also in the root tips of diseased palms, less meristematic cells were detected than in comparable tissues of control palms. This suggests that fatal yellowing reduces meristematic activity throughout the plant. No other anatomical anomalies were observed in roots or stems, nor were any micro-organisms observed in these parts. The tissues of inflorescence primordia appeared to be normal.

So far, occlusion of xylem vessels has been reported for three palm diseases. In coconut palms (*Cocos nucifera*) affected by the MLO-associated root (wilt) disease tyloses were detected in the metaxylem (Solomon et al., 1983). Tyloses were also seen in xylem vessels in the midribs of pinnae of betel palms (*Areca cathechu*) affected by yellow leaf disease (Nair and Avravindakshan, 1970). MLOs were found in sieve elements of such diseased betel palms (Nayar and Seliskar, 1978). In oil palm seedlings inoculated with isolates of *Fusarium oxysporum* gums and tyloses were formed in xylem vessels (Ho et al., 1985). In such vascular wilt-diseased seedlings a plugging of sieve tubes was reported comparable to that observed in the present study. In the above-mentioned palm diseases

occlusion of vascular bundles coincides with the presence of some kind of micro-organism in the vascular tissues. In case of the five oil palms presently examined, no indications were found for the presence of a fungus or prokaryote organism in tissues of vascular bundles.

Since bacteria and fungi were not detected in all affected leaves, these micro-organisms may be secondary invaders and not the causative agents of fatal yellowing. Recently, RNA of viroid nature was detected in pinnae of fatal yellowing-affected oil palms from Brazil (Singh et al., 1988). A viroid etiology of fatal yellowing may explain the absence of a visible pathogen. As with cadang-cadang disease of coconut palms (Rasa, 1968), the reduced meristematic activity observed by us may have also been induced by such a viroid. Given the serious threat of fatal yellowing for the oil palm industry, the viroid etiology of the disease is in urgent need of confirmation.

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Samenvatting

Symptomatologische en histopathologische waarnemingen aan door speerrot aangetaste oliepalmen uit Brazilië en Ecuador

Speerrot van oliepalmen in Brazilië en Ecuador wordt gekenmerkt door vergeling van de jongere, geheel geopende bladeren en een rot van de speer. In tegenstelling tot palmen zonder ziekteverschijnselen, hebben aangetaste palmen geen wortels met zachte, witte worteltoppen.

Weefsel van bladeren, de apex van de stam en toppen van jonge wortels van gezond-uitziende en zieke palmen werden m.b.v. de lichtmicroscoop onderzocht op de aanwezigheid van een eventueel pathogeen. Schimmels en bacteriën werden vaak, doch niet altijd, waargenomen in necrotische lesies op de bladeren, maar nooit buiten lesies of in de vaatbundels van zieke palmen en de weefsels van gezond-uitziende palmen. Vaak verstopten thyllen de houtvaten van aangetaste bladeren. In een speerblad van een zieke palm uit Ecuador werden enige gehypertrofieerde cellen waargenomen in de epidermis van pinnae met waterige lesies. In de top van de stammen en wortels werden slechts enkele meristematische cellen waargenomen.

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