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# SYMPTOMATOLOGY

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The root (wilt) disease is of complex nature and the external and internal symptoms expressed by the affected palms are discussed separately in the following pages.

Varghese (1934) followed by Menon and Nair (1951) and Menon and Pandalai (1958) considered wilting and drooping of the leaves, flaccidity, ribbing, paling/yellowing and necrosis of leaflets as typical foliar symptoms of the disease (see cover picture). With the progress of the disease, there is a reduction in the number of leaves and successive leaves become smaller, shorter and narrower resulting in the stunting of the crown (Varghese, 1934; Menon and Pandalai, 1958). A better understanding of the symptomatology of the disease was arrived at on the basis of the quantitative evaluation of the foliar symptoms of 7000 palms of varying age by Radha and Lal (1972). They recorded flaccidity, the characteristic bending or ribbing of leaflets, as the earliest consistent visual symptom (Fig. 3). This will be expressed by the leaves of the central and outer whorls. Holmes (1965) pointed out that such affected leaflets were curved along the entire length and formed a structure resembling the ribs of mammals. Rajagopal *et al.* (1986) attributed this to the impaired stomatal regulation resulting in excessive water loss.

Foliar yellowing and marginal necrosis of the older leaves were observed

in association with the disease (Menon and Nair, 1952; Menon and Pandalai, 1958). According to Varghese (1934), these symptoms occurred in varying intensities in the outer whorl. Varghese (1934) followed by Menon and Nair (1951) and Nagaraj *et al.* (1954) recorded paling of the younger leaves in advanced stages of the disease. Dwivedi *et al.* (1979) claimed that the initial symptoms of root (wilt) disease were the manifestations of softening and whitening of the leaflets of the spindle.

Expression of foliar symptoms varies both in frequency and association with each other, depending on the soil type and ecological conditions (Radha and Lal, 1972). In general, 67 to 97 per cent of the palms have flaccidity; 38 to 67 per cent develop yellowing and 28 to 48 per cent show marginal necrosis. Intensity of foliar symptoms also varies according to the age of the palms. In palms below the age of ten years, 96.8 per cent have flaccidity while yellowing and marginal necrosis are virtually absent. Flaccidity is regarded as the most frequent and common of the three foliar symptoms associated with the disease irrespective of the age of the palm or the soil type.

Based on the relative contribution of the above three visual symptoms, George and Radha (1973) developed a scoring system for quantifying the disease severity. The formula for arriving at disease index (I) is  $I = \sum \frac{F+Y+N}{L} \times 10$ , where F = flaccidity with



Fig. 3 Characteristic symptoms of the disease - Flaccidity, foliar yellowing and marginal necrosis against the backdrop of healthy trees

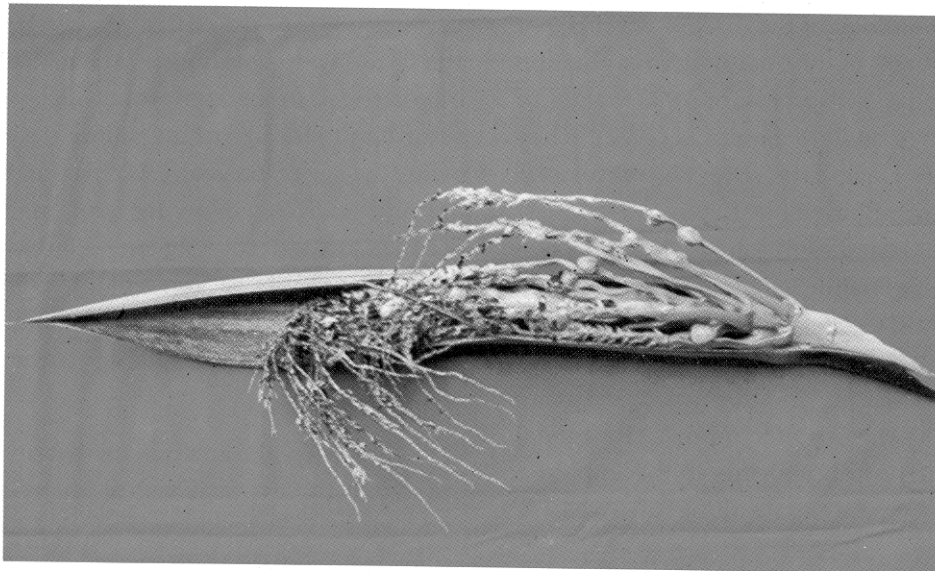


Fig. 4 Inflorescence necrosis

0-5 score, Y = yellowing with 0-3 score, N = necrosis with 0-2 score and L = total number of leaves. They categorised the disease into early, middle and advanced stages. This method has been further simplified and made easier by rating the three major symptoms present in the leaves in any of the five spirals (Nambiar and Pillai, 1985). Although assignment of grade points to the symptom expressions is based on visual observations, this system helps in quantifying the disease severity in simple numerical expression.

The vitality of the reproductive system is also adversely affected (Menon and Nair, 1951). Inflorescence necrosis (Fig. 4) and lack of ability to produce female flowers (Varghese, 1934) and pollen sterility (Varkey and Davis, 1960) render the palm unproductive. Nambiar and Prasannakumari (1964) observed meiotic irregularities in diseased palms. The spathes of the affected palm become small, weak and do not open normally (Maramorosch, 1964). The extent of decline in yield as a consequence of these is estimated to be 43 to 80 per cent depending on the stage of development (Radha *et al.*, 1972) and 43 per cent in disease early and 74 per cent in disease advanced palms compared to the disease free palms (Anon., 1985). The fact that the disease is not a fatal one and causes gradual yield decline as the disease progresses has prompted Dr. M S Swaminathan to call it 'Coconut decline' (Swaminathan, 1983).

Shedding of immature nuts and poor quality of nuts/copra is often attributed to be yet another character of the disease (Menon

and Pandalai, 1958). The husk becomes thinner, less firm and shell does not properly harden or turn black as compared to healthy nuts (Varghese, 1934). Kernel exhibits uneven thickness, does not dry normally and remains flexible (Varghese, 1934; Maramorosch, 1964).

Rotting of roots is considered to be one of the symptoms of the disease by many workers (Butler, 1908; Menon and Nair 1949; Menon and Pandalai, 1958; Michael, 1964; Radha *et al.* 1971). Percentage of root decay varied from 12 to 94.4 depending on the intensity of disease (Michael, 1964; Radha *et al.*, 1971). Butler (1908) observed that half of the main roots were affected by rot in some disease advanced palms. The proportion of the smaller roots rotten was much higher. According to Menon and Nair (1949) rotting of roots and rootlets starts from the tip backwards. Michael (1964) recorded reduction in the number of roots produced as compared to healthy. Maramorosch (1964) noticed root rotting only in a few cases and not in all palms. Significant difference in the extent and frequency of root decay could not however, be traced by many other workers (Nagaraj and Menon, 1955; Radha and Lal, 1967; Lal, 1969). Joseph and Jayasankar (1981) did not consider root rot as a characteristic symptom of the disease as they could not observe more than 10.6 per cent root decay in diseased palms. It is significant in this context that Mathen *et al.* (1990) also did not observe root rot in the transmission experiment conducted under controlled conditions in field cages.

Anatomical studies of the leaflets revealed degenerated chlorophyll

(Shanta *et al.* 1959). Joseph and Shanta (1964) observed reduction in wall thickness of sclerenchymatous tissues, enhanced division of upper epidermal cells, increased stomata per unit area, proliferated phloem and narrow xylem.

Except tapering of the stem in a few diseased palms, no valid information on the stem anatomy is available (Menon and Pandalai, 1958).

Varghese (1934) reported cortical browning in diseased roots; but Maramorosch (1964) did not observe any

discoloration in the cortex. Anatomy of the roots of diseased palms revealed degenerated phloem, disorganised tracheal elements and tylosis in metaxylem (Indira and Ramadasan, 1968; Govindankutty and Vellaichamy, 1983). Internal browning in the root vascular elements was observed by Indira and Ramadasan (1968). However, with the use of the antioxidant while severing the roots from diseased palms, Dwivedi *et al.* (1978) could not observe discoloration.

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