ON THE NATURE OF WILT IN THE ROOT (WILT) DISEASE OF COCONUT PALM

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Wilting of the foliage is the most predominant symptom of the root (wilt) disease, as well as most of the other diseases of coconut palm which have been known as "diseases of undetermined causes" (Menon and Nair, 1951; Menon, 1963). In India, the root (wilt) disease prevalent in certain coastal districts of Kerala State has been the subject of investigations for over two decades in the past. The disease has been found to be infectious in nature. A virus or virus like pathogen has been associated as the primary cause of the disease while fungal organisms as well as other unknown factors have been described as secondary factors in the production of the disease (Menon, 1963; Menon and Shanta, 1962; Nagaraj and Menon, 1956; Radha and Menon, 1954; Shanta *et al.*, 1960; and Holmes *et al.*, 1965).

The disease occurs in patches in all types of soils, especially in an intensive form along the banks of rivers and backwater canals. While wilting of foliage preceded by flaccidity and ribbing of leaflets is the characteristic symptom of the disease, other symptoms associated with the disease are premature yellowing of older leaves, premature shedding of nuts, necrosis of leaves and drying up of spadices. It is worthwhile to note that exact field symptoms of the disease were not reproduced in inoculated potted seedlings maintained under controlled conditions (Shanta *et al.*, 1964).

The problem of wilt pathogenesis in plants has been the subject of intensive and extensive studies in the past. Most of these studies have been confined to fungal or bacterial wilts, while only few reports are there concerning wilt diseases caused by plant viruses. However, a point of considerable importance to which Sadasivan (1961) has drawn attention is the striking similarity between the disease syndrome of wilt diseases caused by fungi, bacteria or viruses.

Dwarfing and stunting, leaf yellowing and necrosis with wilting foliage and a reduced root system have been described as characteristic features of wilt pathogenesis in plants. It is also known that in all such cases studied the progress of the disease has been found to be either slow or sudden, the severity of expression of symptoms being variable according to age, nutrition and temperature. Besides, a growing imbalance in water economy, deranged permeability of host cells, "indiscriminate absorption" as evidenced by accumulation of electrolytes in leaves, reduction in leaf area and a low C/N ratio of leaf tissue are other features of wilt pathogenesis in which toxemia has been implicated (Sadasivan, 1961). It is significant to note that all these features are characteristic of the root (wilt) disease of coconut palm.

In the root (wilt) diseased palms a higher percentage of root decay has been

reported (Nagaraj and Menon, 1955). However, 50% root decay has been found to be common in comparable healthy and diseased palms in the early stages of disease (Menon, 1963). Besides, a high percentage of root decay is common in very old coconut palms. Thus, it would seem that visible root damage is not a pre-requisite for production of wilt and that uptake of water by the roots may not have been affected although root system is crippled (Ramadasan, 1966). However, recent studies of the author reveal that uptake of water by diseased palms is considerably reduced. The rate of uptake of water by palms was studied following the method described by Fenwick and Maharaj (1963). The study was conducted in ten pairs of palms, each pair consisting of one healthy and one diseased palm of identical age and growing nearby. The data (Fig. 1) show that in diseased palms the rate of uptake of water is considerably reduced as compared to that in the corresponding healthy. The rate of loss of water from the leaf surface of healthy and diseased palms has been studied (Lily and Ramadasan, unpublished). The results indicate that the rate of loss of water from the leaf surface is about 25% more in the diseased palms than that in the healthy.

Further, conductivity studies, using thin sections of freshly cut growing root tips of healthy and diseased palms, were conducted in 50 palms. One hour after equal weights of tissues were suspended in known quantities of distilled water, conductivity measurements were recorded every hour for five hours. The results (Fig. 2) suggest that the permeability of root cells of diseased palms is deranged. Accumulation of electrolytes in the diseased leaf tissue has already been reported (Menon, 1963). The root sap of diseased palms collected following the method described by Davis (unpublished), has been observed to contain 65-72% more solid content than in the root sap of healthy palms. These results suggest that in diseased palms conditions exist for a growing imbalance in water economy and that the deranged permeability of root cells would have resulted in "indescriminate absorption" (Kramer, 1951) leading to accumulation of minerals in the leaves. However whether these are effects or causes of the disease are yet to be understood.

The mechanism of wilt in viral wilt diseases is very little understood. In the susceptible variety of Tobasco pepper, Tobacco etch virus inoculation induced marked permeability derangements 24-36 hrs before these plants started wilting, while in the resistant variety in which no wilt is produced by the virus inoculation, no such permeability changes were observed following virus inoculation (Gabriel and Pirone, 1964). Thus, the possibility of a virus causing disfunction to the mechanism of absorption can be envisaged. But whether such a situation alone would cause wilt in a perennial crop like coconut palm is a matter for further consideration. While, in fungal wilts, in several cases, it has been proved beyond doubt that it is a resultant toxemia that leads to ultimate wilting, a subject of considerable significance for detailed studies is that whether a virus can induce similar derangements leading to wilt. It may be pointed out here that in Pierce's disease of grape vines, in which wilt is an important symptom, the causal virus has been shown to induce formation of

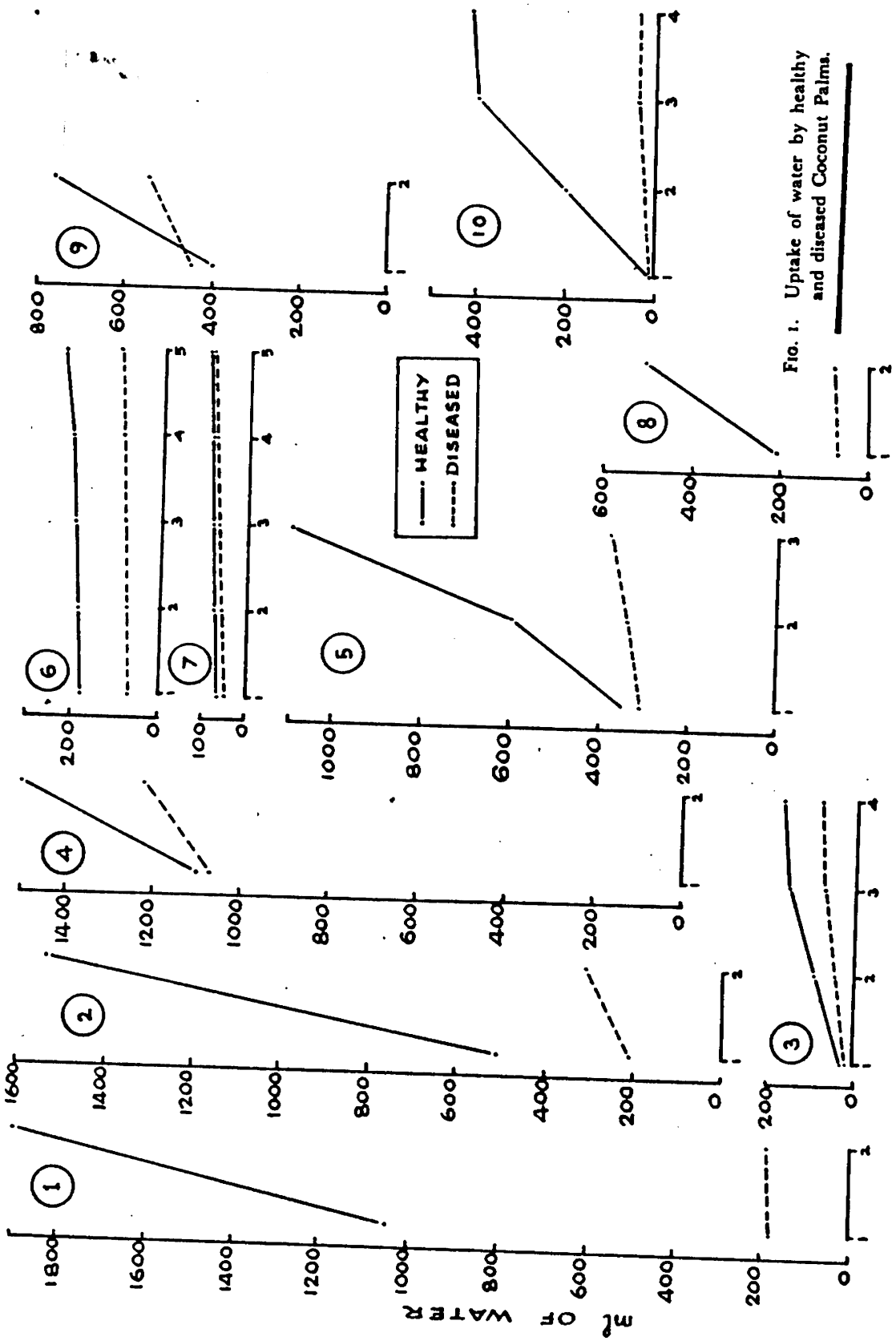
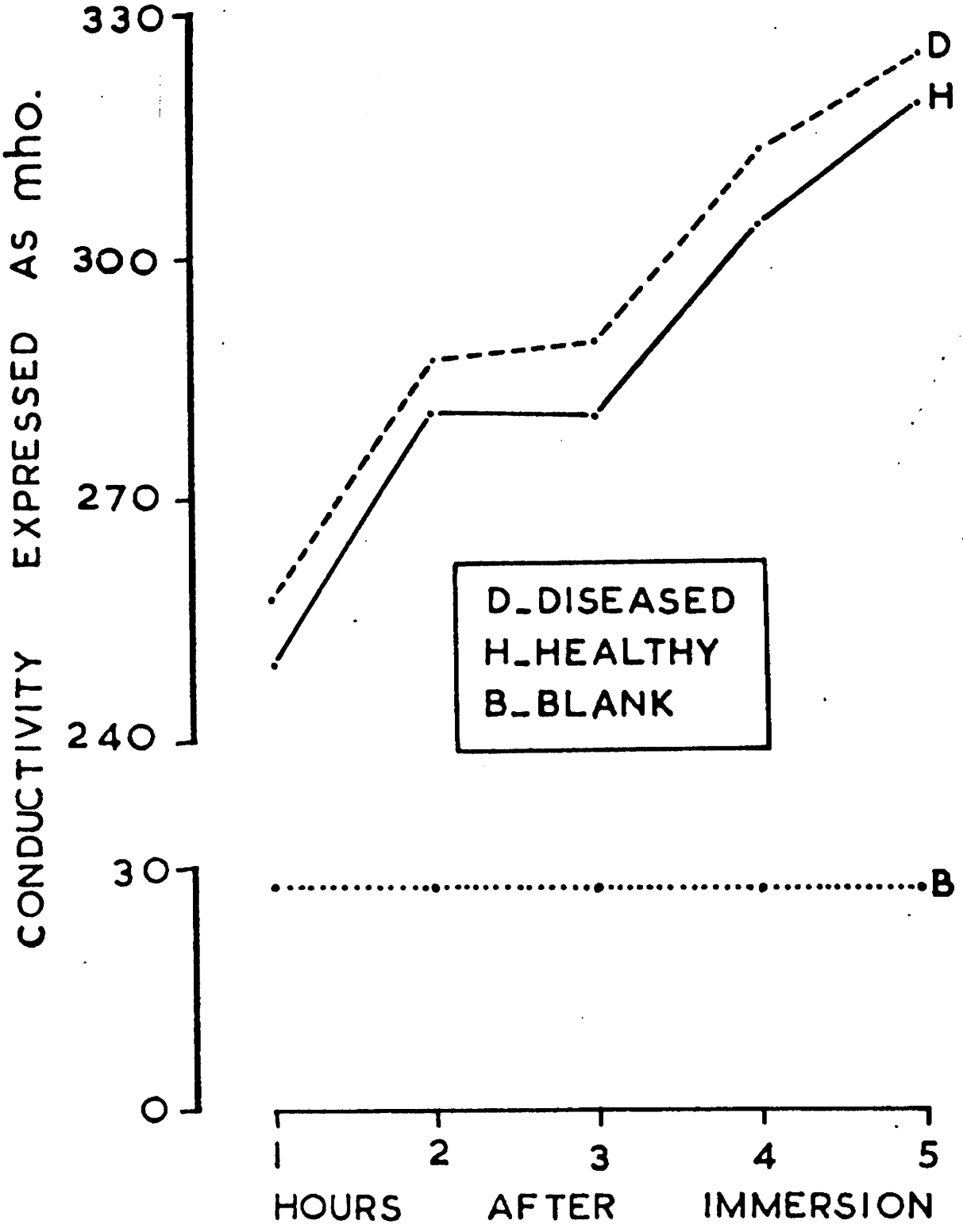


FIG. 1. Uptake of water by healthy and diseased Coconut Palms.

FIG. 2. Conductivity of root tissue of healthy and diseased Coconut Palms



tyloses in wood and gum development in xylem (Esau, 1948). On the other hand plant viruses are known to induce several metabolic changes that are akin to to what has been observed in the cases of wilt pathogenesis in which toxemia is implicated; but wilt is rarely a symptom of virus infection (John, 1963).

Although very preliminary in nature, recent studies of the author indicate the probability of involvement of toxemia in this disease complex. When young tomato seedlings with suitable replications were maintained in 1/1, 1/5 and 1/25 concentrations of root sap of healthy and diseased palms, epinasty and complete bending of leaves was developed in all seedlings maintained in diseased root sap within 5 to 30 minutes, while no such foliar symptom was developed in seedlings maintained in healthy root sap or in distilled water, even after 30 hrs. These results could be reproduced in repeated experiments. For another field experiment, 6-month old coconut seedlings in a nursery were fed with two concentrations of diseased root sap viz., 1/1 and 1/10, through cut ends of roots, while another lot of seedlings of the same age were fed similarly with distilled water alone. A third set with no treatment served as control. All the 20 seedlings which absorbed 15 to 25 ml of the root sap developed necrosis of leaf tips within 40 days of the treatment while no such symptom was developed in those treated with distilled water alone or in the controls. Six months after the treatments all the seedlings developed slight necrosis of the leaf margins which could be seen in several other seedlings growing in the nursery also. However, the necrosis of the leaf tips of the seedlings treated with diseased root sap remain to be much more severe than in other seedlings. Repeated infectivity tests with the leaf extracts of the experimental seedlings using cowpea which is the indicator host of suspected pathogen of this disease failed to give positive results. Further intensive studies on the above lines are in progress.

The rhizosphere of coconut palm with special reference to development of wilt is yet to be investigated in detail. Since the role of rhizosphere in inducing changes in host metabolism is well known it may be worthwhile investigating this aspect of root (wilt) disease with all the thoroughness it deserves. On the otherhand in as much as it is known that the development and severity of expression of the symptoms of this disease are closely associated with flooding of soil, this aspect of the disease also deserves serious attention.

It may be pertinent to assume that the evidences indicated so far do not rule out the possibility of involvement of toxemia in the root (wilt) disease of coconut palm. It is also significant to note that no definite evidence against this possibility has been obtained in the investigations on this disease so far. Intensive and extensive studies in this direction, would be fruitful.

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