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NUTRIENT MANAGEMENT FOR COCONUT DISEASES AND DISORDERS*

S. ROBERT CECIL, H. HAMEED KHAN and C. C. BIDDAPPA
Central Plantation Crops Research Institute, Kasaragod 671 124, *Kerala, India*

ABSTRACT

Soil and nutritional factors are known to exert considerable influence on the development, spread as well as the intensity of plant diseases, particularly when the associated pathogen is weak. The coconut palm, though appears to be sturdy, is susceptible to a variety of diseases. Most of the important diseases of the palm are generally found to occur on all soil types. However, the disease appear in a more acute form under unfavourable soil/nutritional environments. Some diseases like bud rot and leaf rot are known to be caused by pathogens; some like the tapering stem or 'pencil point' condition are believed to be due to unsuitable soil conditions while others like the stem bleeding are known to be associated with the infestation by pathogens predisposed by unfavourable soil and nutritional factors. Certain disorders like the 'crown choke' are caused purely by nutrient deficiency. The nutritional problems and their management for some of the diseases and disorders of the palm are reviewed and discussed.

INTRODUCTION

The soil and nutritional factors are believed to exert considerable influence on the development, spread as well as the intensity of plant diseases, particularly when the pathogen associated with the disease is weak. The coconut palm is grown under extreme conditions of soil ranging from littoral sand to heavy clays. It is often difficult to specify the influence of a specific soil or nutritional factor associated with the different diseases of the palm, mainly because of its perennial and hardy nature, the high heterogeniety among the field populations and also the highly heterogeneous soil characteristics, particularly the sub-soil which influence the growth and nutrition of the palm to an unpredictable extent. The influence of the extensive root system is yet another factor which is beyond the control of the investigator to explore the root functions in the sub-soil layers and also in places far beyond the basal region.

Most of the important diseases of the palm are generally found to occur on all soil types under which it has been grown (Menon and Nair, 1951; Martyn, 1948; Price, 1959). However, the diseases appear in a more acute form in areas with unfavourable soil environments such as poor aeration, waterlogging, soil drought, high water table/shallow soil depth, poor drainage, etc., leading to nutrient deficiency/imbalances (Martyn, 1948; Menon 1961). Menon (1961) has suggested that many of the coconut diseases cannot be primarily caused by unfavourable soil conditions or nutritional imbalances/deficiencies, but such factors provide an environment conducive to infection by biological agents. Menon and Pandalai (1960) have reported that certain diseases like bud rot and leaf rot are known to be purely parasitic, some like the bronze leaf wilt and the tapering stem or 'pencil point' conditions, are believed to be due to unfavourable soil conditions while others like the stem bleeding and the fungal

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root rot are known to be associated with parasitic attacks predisposed by unfavourable soil and nutritional factors. Besides the above, certain disorders like the crown choke (crown rot disease) and the problem of 'rubbery copra' are caused purely by specific nutrient deficiencies. The nutrient management of some of the disease and disorders in the coconut palm is reviewed in the present paper.

Tapering stem disease

The tapering stem disease or pencil point disease is generally considered to be due to deficiency of nutrients/water and unfavourable soil conditions, and the malady has been referred to as "starvation of palm" (Briton Jones, 1940; Menon and Pandalai, 1960). Ohler (1984) states that stem tapering is not a disease in itself, but is the result of various unfavourable growing conditions. The malady is more prevalent on waterlogged and other infertile areas and also in areas with very hard substratum of laterite, coral or other formations which are unsuitable for coconut culture. Intensive manuring and management may provide reasonable growth and productivity in the early period which eventually exhaust the limited soil of its nutrient reserves. Multiple deficiencies including secondary and micronutrients are often associated with the malady (Menon and Pandalai, 1960; Bhaskaran, Rethinam and Nambiar, 1989). In Kerala, the disease is commonly found in swampy or shallow soil situations which are basically unsuitable for coconut cultivation. In such areas planting is usually done on mounds and the land is periodically raised with transported sand or soil which is an expensive practice in most of the areas. As long as the land reclamation process is continued along with generous manuring, the palms grow normal and yield satisfactorily. Subsequent neglect leads to tapering stem problems in such areas. Park and Fernando (1941) and Menon and Pandalai (1960) have suggested some of these factors leading to tapering stem disease. The palms do recover when deficiencies are corrected through intensive manuring and improved soil conditions. Bhaskaran et al. (1989) studying the pencil point disease in coastal sandy and laterite soils of Thanjavur (India) observed that the affected palms responded better to application of micronutrient combination of Cu, Zn, Fe, and Mn as sulphate salts and B as borax than to NPK alone. Savy (1961) reports that in severe cases, the palms do not bear to their full capacity even after recovery. However, proper soil and nutritional management is needed for sustaining the palms to normal bearing.

Crown choke disease

The occurrence of crown choke disease of coconut was reported in 1964 at the CPCRI, Research Centre, Kahikuchi (Assam) by Chakrabarthy et al (1970), and later studies conducted by Brunin and Coomans (1973) in Ivory Coast, Cecil and Pillai (1978) and Baranwal, Manikandan and Ray (1989) in India have confirmed the possible association of boron deficiency in the development of the disorder. The "little leaf" disease of coconut described by Ashby (1917) and the "frondchoke" disease reported by Dwyer (1937) seem to be similar to the "crown rot" disease reported by Chakrabarthy et al (1970). Fremond (1965) reported a form of bud rot of coconut in the New Hebrides which might be due to boron deficiency. Similar symptoms of leaf malformation were also found in Madagascar, in the Solomon Islands and also in the New Hebrides where there was also an associated bud rot (V.M. Shorrocks 1981 - Personal communication). A recent survey conducted in Assam (Anonymous 1990) showed that about 10.8 per cent of the palms were

affected by the disease and the total annual loss in yield due to the malady was estimated at 6.38 million nuts.

Dufour and Quencez (1979) observed boron deficiency symptoms on one-year old coconut seedlings in solution culture. Only the first sign of deficiency was noticed which was the development of small chlorotic spots symmetrically oriented in relation to the main vein of young leaves. The symptoms of the disease in 3–10 year old palms have been described by Cecil and Pillai (1978) and Baranwal et al. (1989) and 18-20 month old palms in Ivory Coast by Brunin and Coomans (1973) which are more or less identical. The conspicuous symptoms of the disease are the fusion of terminal pinnae of young fronds, emergence of shorter fronds that crowd around the apex, development of deformed and crinkled pinnae, development of 'hook' at the frond tip and also at other parts of the frond, development of fronds with very short unfolded pinnae either on one or both the sides of the rachis with zig-zag foldings, necrosis on rachis and frond tips and the development of black necrotic stumpy frond without any pinnae in the advanced stage, and finally the growth of the bud is arrested and the palm dies. The unaffected outer whorls of leaves remain normal throughout and even for quite some time after the death of the growing point. Laminal expansion is very much restricted and the affected pinnae become thicker than normal and brittle. The crowding of young abnormal fronds around the bud gives a choked appearance to the palm and hence named as "frond choke". In some cases the young affected fronds show "Witche's broom" appearance. In other cases the petiole of the new frond becomes very thick and forms a tubular structure enclosing the entire space of the apex.

Brunin and Coomans (1973) could prevent the occurrence of the symptoms on young palms in Ivory Coast by the application of borax penta hydrate (14.8% B) at 15 g/palm at planting and again once after six months. For the affected palms, IRHO has recommended the above dose of borax in April and October for 1-3 year old palms, and 30–80 g borax penta hydrate as a single dose for 4-year old palms depending on the symptoms. Chakrabarthy et al. (1970) applied borax decahydrate (11.3% B) at 20 g per palm on nine occasions. Cecil and Pillai (1978) reported that application of borax decahydrate at 250 and 500 g/palm as a single dose followed by irrigation to 5–year old palms was effective in curing the disease, and the recovery was faster in palms treated with 500 g borax. The newly emerged leaves after treatment were normal in appearance. Baranwal et al. (1989) recommended soil application of borax at the rate of 50g each at an interval of 3–4 months which they found necessary for the redemption of the disorder.

Cecil and Pillai (1978) reported boron content of 5.7 ppm in frond 9 in affected palms and 9.2 ppm B in comparable healthy palms (frond 9). Margate, Magat and Abad (1979) suggested that the critical level of boron in hybrid coconut seedlings (frond 3) was likely to fall within the range of 13–14 ppm. They recommended the application of 1–1.5 g of borax per seedling in the nursery to prevent the occurrence of boron deficiency symptoms. Rosenquist (1980) reported a mean foliar content of 10.5 ppm B and suggested that 9.5 ppm B in frond 14 was critical.

Rubbery copra

The problem of "rubbery copra" in coconut was reported to be due to acute deficiency of sulphur (Southern, 1969). Extensive occurrence of S–deficiency was reported from Papua and New Guinea (Southern, 1969) and Madagascar (Ollagnier and Ochs, 1972).

Sumbak (1975, 1976) reported S-deficiency in Madang which according to him was associated with poor drainage conditions.

The main S–deficiency symptoms reported (Southern, 1969; Ollagnier and Ochs, 1972) are: orange yellow colour of both young and old leaves and weakening and arching of the rachis followed by necrosis of leaflets. Chlorosis and necrosis increase with the age of the leaves and in severe cases, second or even the first leaf may show yellowing. The number of live fronds becomes fewer. In the advanced stage, the crown losses most of the leaves and severe necrosis is found on the older leaves. The yield of nuts is reduced in number and the nuts are usually small with normal kernel thickness; but on drying, the kernel collapses into a soft, flexible and leathery copra, often brown in colour, which is usually referred to as "rubbery copra" possessing very poor physical and chemical characteristics. The rubbery copra is characterised by low oil content and high nitrogen, ash and sugar contents. The oil from rubbery copra has high iodine value and low saponification value compared to the oil from normal copra.

Sulphur deficiency can be corrected by the application of sulphur or sulphur-bearing fertilizers. Southern (1969) recommended the use of about 900 g sulphur or sulphur containing fertilizer (equivalent to 900 g sulphur per tree) once in two years in Papua and New Guinea. The response was spectacular within six months on the foliage, and the copra quality became normal in 18 months after sulphur application. Manciot, Ollagnier and Ochs (1980) emphasised the importance of N/S ratio in the palm as serious nutritional disturbances resulted from an imbalance between N and S. They further observed that there was deficiency when the foliar contents were below 0.13 per cent and they suggested a critical level of 0.15 to 0.20 per cent S in frond 14 while Magat (1979) from Philippines suggested a critical level of 0.15 per cent (frond 14). The total S contents (frond 14) reported by Pillai et al (1975) in India ranged from 0.113 to 0.152 per cent.

While discussing the sulphur nutrition of coconut, Cecil and Pillai (1976) reported that sulphur deficiency did not seem to be an immediate problem for coconut in the West Coast of Kerala(India) but continued application of sulphur-free fertilizers in the absence of bulky organic manures could eventually lead to sulphur deficiency problems. They recommended the inclusion of any one of the S–bearing fertilizers like single superphosphate, Ammophos, ammonium sulphate, magnesium sulphate or sulphate of potash in the fertilizer schedule for coconut. This was further demonstrated by Cecil (1981) who showed that regular addition of either magnesium sulphate (13% S) or Ammophos (15% S) could raise the foliar sulphur content of the palm to the desired level on a sulphur deficient sandy soil.

Stem bleeding disease

The stem bleeding disease has been reported from several coconut growing countries of the world. In Sri Lanka stem bleeding has been mostly attributed to physiological factors (Salgado, 1942), probably due to excessive development of sap following heavy rains after drought or following application of fertilizers to neglected gardens. Briton–Jones (1940) did not attribute the involvement of any environmental factor to the disease as it occurred on all types of soil, manured or unmanured, inland or coastal, upland or low-lying. Petch (1909) in Sri Lanka observed the disease to be occurring extensively in plantations which were not manured, manured only with cattle manure, and also in plots manured with chemical fertilizers. In India the disease occurs

under varying soil conditions in all the coconut growing States. Mathew and Ramanandan (1980) could not observe any significant difference in soil pH, electrical conductivity and major nutrient contents of soils between healthy and affected palms. Ramanandan and Antony (1976) reported that in a garden at Adat in Trichur district (Kerala) and another in Goa, stem bleeding could be cured by discontinuing the application of NPK fertilizers followed by the application of organic manures (in Adat) and fish manure (in Goa). Menon and Pandalai (1960) suggested that good soil husbandry could effectively check the incidence of the disease. If the stem bleeding is associated with water stagnation or lands with fluctuating water table, the first step should be to provide proper drainage to the garden. In low-lying areas, soil may be brought from outside for raising the land. In drought affected gardens regular agronomic practices such as ploughing, organic manuring, summer irrigation etc. would help to combat drought which would eventually check the incidence of the disease.

Thanjavur wilt

The Thanjavur wilt disease of coconut is generally found prevalent in sandy or sandy loam soils in coastal areas where coconut is grown under rainfed conditions and also in neglected plantations. Lack of soil moisture during summer months, waterlogging in rainy seasons, presence of old infections in the garden and neglect of cultural practices were found to be conducive to the spread of the disease. Hard sub-soil observed in some parts of Thanjavur district impedes root penetration which in turn predisposes the palms to infection (Anonymous, 1976; Ramasami, Bhaskaran and Jaganathan, 1977; Bhaskaran, Rethinam and Nambiar, 1989). The result of a fertilizer trial conducted for a period of five years from 1977 to 1982 showed that NPK treatment at 350 g N, 250 g P_2O_5 and 450 g K_2O/palm/year had low disease index and high nut yield while higher levels of NPK aggravated the disease (Bhaskaran and Ramanathan, 1983). Sindha Mathar, Lewin and Sethuraman (1983) could not observe any micronutrient problem associated with the disease. Annual application of 50 kg farm yard manure or green leaves, 300 kg tank silt or 5 kg neem cake was found to be useful in containing the disease (Vijayan and Natarajan, 1975).

Root (wilt) disease

The coconut root (wilt) disease was considered as a disease of uncertain etiology until recently when Solomon, Govindankutty and Neinhaus (1983) observed constant association of mycoplasma-like organisms (MLOs) in sieve tubes of roots, tender stem, petiole and developing leaf bases of root (wilt) diseased palms as against their total absence in healthy palms from disease-free areas. The survey conducted by Pillai, Lal and Shanta (1973) indicated that the disease has been found to occur on all soil types of Kerala under varying ecological conditions ranging from foot hills of Western Ghats to the coastal plains. However, the spread of the disease has been faster on light textured sandy, sandy loam and alluvial soils, particularly in low-lying areas, and also on heavy textured clays compared to laterite soils. The incidence has also been higher in waterlogged low-lying areas adjacent to rivers and canals.

Soil sickness characterised by low pH, inadequate drainage, poor aeration, low microbial activity and nutrient imbalances together with mineral deficiencies, especially of K, Ca and Mg, were reported to have a decisive role on the incidence of the disease (Menon, Sankarasubramoney and Pandalai, 1950; Menon, Nair and Pandalai, 1952; Pandalai, Sankarasubramoney and Menon, 1958a, 1958b; Menon, 1961; Verghese, 1961; Lal,

1964; Cecil, 1969). Verghese (1966) indicated the association of imbalance of nutrients in soils, particularly K/Mg, K/Ca and N/K with disease incidence. Imbalances of cationic ratios like K/Na, K/Mg, K/ (Ca + Mg) and K (Ca+Mg+Na) and anionic ratios like P/S and N/S were reported to be associated with the diseased conditions of the palm (Pillai et al, 1975). Cecil (1975) observed that the palms in the disease affected areas were in a state of imbalanced nutrition with wider ratios of N/Mg, P/Mg, K/Mg and Ca/Mg indicating a lower content of Mg in proportion to other major nutrients. A critical evaluation of the earlier studies on the quality of nutrition in relation to the diseases suggests that the palms in the disease affected areas, whether apparently healthy or visibly diseased, are in a state of unbalanced nutrition, possibly the result of a relatively higher content of N, P and K on the one hand and a lower content of Ca, Mg and S on the other.

Foliar analysis generally indicated a higher concentration of N, P and K in the leaf tissues of diseased palms and the concentration of nutrients increased with the advancement of the disease (Sankarasubramoney, Pandalai and Menon, 1952; Pillai, 1959; Verghese, Sankaranarayanan and Menon, 1959; Pandalai, 1959; Pillai et al, 1975). Hameed Khan et al (1981) observed that the micronutrients *viz.*, Cu, Mn and Fe were higher in the crown of root (wilt) affected palms compared to healthy ones. Similar accumulation of nutrients in the leaves of cadang-cadang affected palms was reported by Yualves, Covaar and Ocfemia (1958). In the advanced stage of the disease there is considerable reduction in the total leaf biomass due to reduced rate of leaf production and increased rate of leaf fall, and the leaves developing at this stage would also be stunted and the nut yield is very much reduced. Later studies (Cecil, 1981) showed that there was no significant difference in the foliar nutrient levels of healthy and diseased palms when the palms were in the early stage, while the concentration of N, P and K were significantly higher in the middle and advanced stages of the disease. The soil exhausting nutrients by adult coconut palms reported by Pillai and Davis (1963) show that about 50 per cent of N and P and 78 per cent of K are removed through the harvest of bunches (with nuts). This indicates that when the yield of nuts in diseased palms are restricted, the excess nutrients are likely to get accumulated in the crown (foliage) of the diseased palms. So the accumulation of nutrients particularly in the advanced stage of the disease, is partly due to reduced rate of dry matter content of the foliage and partly due to the reduced rate of nut yield with increased rate of disease intensity.

The soil and nutritional aspects of the disease were recently reviewed by Cecil and Amma (1991) indicating no direct involvement of major and micro-nutrients in the disease. While discussing the nutritional disturbances in relation to root (wilt) disease, Pandalai (1959) suggested that absence or non-availability of nutrients was not the cause of tissue abnormalities, but was actually the inability of the palm to transact the normal processes at the appropriate site. Sahasranaman, Radha and Pandalai (1964) found that application of NPK fertilizers higher than the optimum dose generally aggravated the symptoms and reduced the yield of diseased palms while lower levels helped to maintain an economic yield. Cecil (1981) observed that increased levels of N, P and K had an adverse effect on the growth of young palms and on the yield of diseased palms. Davis and Pillai (1966) and Davis (1969) reported that the application of micronutrients and Mg did not prevent fresh incidence of disease. They observed that Mg had no significant influence on the yield of healthy palms, but

it had a favourable response on moderately affected palms while on severely affected palms the effect was highly significant. Similar differential responses of Mg on diseased palms were also reported by Varkey et al (1979), Cecil (1981) and Anonymous (1981). Lal (1968) reported that the foliar yellowing associated with the disease might be largely due to Mg deficiency, and the intensity of yellowing decreased markedly when the palms were sprayed with 2.0% solution of magnesium sulphate at quarterly intervals (Varkey et al, 1979; Anonymous, 1966). John and Jacob (1959) reported that in disease affected areas of West Coast, NPK application along with fungicidal and insecticidal treatments markedly increased the yield, possibly due to the improvement in the fertility levels of the neglected gardens. Nair and Radha (1959) and Lal (1964) reported reduction in foliar yellowing and increase in yield of diseased palms by applying NPK, lime and farmyard manure and spraying with Bordeaux mixture, micronutrients and magnesium sulphate. The results of a field fertility trial with 3 levels of NPK, and 2 levels each of Ca and Mg on diseased palms showed that the lowest level of NPK tried *viz.*, 350 g N, 300 g P_2O_5 and 600 g K_2O along with 500 g MgO/palm/year could be the economic dose for the management of the diseased palms (Anonymous, 1981). The above observations suggest that the addition of NPK fertilizers without having a balance with the availability of secondary nutrients, particularly Mg and S had an adverse effect on the diseased palms while the inclusion of secondary nutrients showed beneficial effects. This assumes importance in view of the fact that the diseased palms are in a state of unbalanced nutrition as mentioned earlier. Concluding his nutritional studies, Cecil (1981) recommended judicious application of magnesium sulphate in sandy soil right from the time of planting in the main field. The prebearing age was reduced by 9 months by the addition of Mg and the response was more pronounced on diseased palms than on healthy ones. When the increase in the yield of nuts in healthy palms was 37 per cent, the corresponding increase in root (wilt) affected palm was 60 per cent. Critical studies are needed to elaborate the beneficial role of Mg for the management of the disease as the interaction between disease incidence and Mg deficiency on the productivity of the palm is negative. However, a balanced and regulated supply of major (NPK) and secondary (Ca, Mg & S) nutrients is very much needed for the successful management of the disease. Further, the correction of unfavourable soil conditions like waterlogging, inadequate drainage and poor aeration shall help to reduce the rate of spread of the disease and also to check the faster deterioration of the palms in such situations.

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