Environment & Ecology 27 (1A) : 407—412, 2009
 ISSN 0970-0420

Nutritional Status of Healthy and Yellow Leaf Disease Affected Gardens of Arecanut in Sringeri Taluk of Karnataka State

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Abstract

The fertility status of selected healthy, moderately yellow leaf disease (YLD) affected and severely YLD affected gardens of arecanut in Sringeri taluk of Karnataka state and nutrient composition of corresponding palm leaves were examined. It was found that all the soils were generally acidic in nature, low in soluble salts content and adequate in organic carbon irrespective of prevalence or absence of the disease. The available major, secondary and micronutrients were adequate except magnesium in all the gardens. However, available nitrogen and magnesium accumulation were greater in soils of healthy gardens and tend to diminish with the intensity of incidence of YLD. While, the reverse trend was observed for phosphorus, potassium, sulfur, manganese and copper content. The nutrient composition of palm leaves of healthy, moderately and severely YLD affected gardens showed a gradual decline with the onset of YLD. The healthy palm leaves were quite high in copper content while the leaves of diseased palms were deficient in nitrogen, magnesium and manganese contents.

Key words : Arecanut, Yellow leaf disease, Fertility, Nutrient composition.

Yellow leaf disease (YLD) is the most serious malady affecting the arecanut palm. The earliest information on YLD is found in Varghese (1). The disease is commonly known as Kattuveezcha or Chovakedu in Malayalam (2) and Chandiroga or Arasinaroga in Kannada (3). The disease was first reported in 1914 from Muvattupuzha, Meenachal and Chalakudi areas of Central Kerala succeeding a heavy flood and recorded the characteristic symptoms of the disease as yellowing of the leaves and shedding of both mature and immature nuts (2). However, the first visible symptom is yellowing, starting from the tips of leaflets in two to three leaves of the outer most whorls. The chlorosis could be distinguished from the physiological yellowing by abrupt demarcation between the green and yellow regions in the diseased leaf. Tips of the chlorotic leaves eventually dry up. In advanced stage, leaves are reduced in size, become stiff and pointed, closely bunched and abnormally puckered. The root system of the palm is also affected. The lateral roots are not produced as profusely as in healthy palms. Tips and absorbing regions of young roots turn dark and gradually rot. The endosperm of the diseased nuts becomes brownish/blackish and soft, which render them unsuitable for consumption. The internodal length of the affected stem reduces due to reduction in normal growth. As the disease advances, the girth of the crown gradually tapers. Ultimately the crown falls off leaving a bare trunk. The yield of the affected palms is reduced to the extent of 50% over a period of three years. This is mainly due to the reduction in the inflorescence production and number of nuts (4). The etiology of YLD of arecanut was a matter of dispute for a long time. The experimental evidences ruled out the involvement of fungi, bacteria, virus and nematodes in the cause of YLD. Among different factors associated with YLD of arecanut, soil health and balanced nutrition are profoundly important as they are assumed to influence the disease incidence either directly or indirectly. Hence, information on soil physico-chemical properties and nutrients composition of palm leaves are of greater importance for better assessment as to whether nutrient deficiencies or toxicities are associ-

ated with it. In this context, this study was taken up to assess the nutritional status of selected healthy and yellow leaf disease affected gardens of arecanut in Sringeri taluk of Karnataka and the nutrients composition of corresponding palm leaves.

Methods

Selection of Arecanut Gardens

Considerable area under arecanut garden exists in Sringeri taluk of Chikmagalur district. Scanning of the affected arecanut gardens was taken up. The locations for the study were fixed on the basis of intensity of incidence of YLD in the area. Meticulous care was taken in differentiating the healthy, moderately and severely YLD affected gardens based on the visible symptoms of disease along with the advice of scientists and local arecanut growers. Twelve areca gardens were selected apportioning four each into healthy, moderately YLD affected and severely YLD affected gardens.

Collection of Soil and Leaf Samples

A total of four surface soil samples (0—15 cm) were collected from each garden at a distance of one foot away from the palm as per standard procedures out lined by Jackson (5). Corresponding four representative palm leaf tissue samples (center portion of third leaf from the top) were collected from each garden, dried, powdered and analyzed for nutrients composition.

Preparation of Soil and Leaf Samples for Analysis

The soil samples were dried in shade, powdered with wooden mallet, passed through 2 mm sieve and stored in clean polythene bags for analysis. For the determination of organic carbon, 2 mm sieved soil was further powdered in an agate mortar and pestle and passed through 0.2 mm sieve and stored in paper covers for analysis. The palm leaves were washed with water. In each leaflet, central 10 cm of the leaf blade was taken out, air dried and then oven dried at 60 C. The dried samples were ground to a fine powder using mixer grinder and stored for analysis.

Soil Analysis

Soil pH was estimated in the 1 : 2.5 (soil : water) suspension using glass electrode pH-meter, while the electrical conductivity (EC) of the supernatant was measured by using conductivity meter after keeping the samples overnight for settling of the soil particles. Organic carbon was determined by following the Walkley and Black's wet-oxidation method as described by Jackson (5). Available nitrogen was determined by alkaline potassium permanganate method (6). Available phosphorus was extracted with Bray's No. 1 extractant and determined by spectrophotometric method (5). Available potassium was determined Flame photometrically using neutral normal ammonium acetate extractant (5). Exchangeable calcium and magnesium were determined (7) and available sulfur by turbidometry (8). The DTPA Extractable iron, manganese, zinc and copper were determined using atomic absorption spectrophotometer (9).

Plant Analysis

One gram of powdered sample was predigested with 5 ml of concentrated nitric acid and was kept over night. It was digested on a hot plate with diacid mixture (HNO_3 : $HCIO_4$ in 10 : 4 ratio) until a snow white residue was formed. It was cooled and made to a known volume with distilled water. This extract was used for analysis of macro (except nitrogen), secondary and micronutrients (10). For determination of nitrogen, plant sample (0.5 g) was digested with concentrated sulfuric acid in presence of digestion mixture by boiling till a bluish green residue was formed. The nitrogen in the digested sample was determined by micro Kjeldahl distillation method (10).

Results and Discussion

Fertility status of surface soil samples (0—15 cm depth) collected from one foot away from palms of healthy, moderately and severely YLD affected gardens of arecanut presented in Table 1 reveal that soils of all the gardens were acidic in reaction, quite low in soluble salts content and quite high in organic carbon content.

Major Nutrients

The available nitrogen, phosphorus and potassium contents of healthy, moderately and severely

Table 1. Physico-chemical properties of surface soil samples from healthy and YLD affected arecanut gardens (mean of four gardens of four samples each). Figures in parentheses indicate the level of nutrient compared to healthy garden (diseased/ healthy × 100).

Description of garden	pH (1:2.5)	EC (dS/m)	OC (%)	Avail N	Avail P_2O_5 (kg/ha)	Avail K_2O	Exch Ca [cmol (p^+)/kg]	Exch Mg [cmol (p^+)/kg]
Healthy	6.06	0.20	2.18	760.5 (100)	453.4 (100)	478.9 (100)	5.75 (100)	1.86 (100)
Moderately YLD affected	6.34	0.14	2.32	678.2 (89.2)	514.3 (113.4)	515.1 (107.6)	6.85 (119.1)	1.39 (74.7)
Severely YLD affected	6.01	0.14	1.91	612.0 (80.5)	539.4 (119.0)	672.2 (140.4)	5.18 (90.1)	1.22 (65.6)

Table 1. Continued.

Description of garden	Avail S (ppm)	DTPA extractable micronutrients (ppm) Fe	Mn	Zn	Cu	Ca/Mg ratio	Mn/Fe ratio
Healthy	22.25 (100)	41.21 (100)	25.04 (100)	1.35 (100)	9.91 (100)	3.09 (100)	0.61 (100)
Moderately YLD affected	24.04 (108.0)	52.04 (126.3)	32.26 (128.8)	2.08 (154.1)	18.79 (189.6)	4.93 (156.6)	0.62 (101.6)
Severely YLD affected	28.58 (128.5)	82.10 (199.2)	129.27 (516.3)	5.15 (381.5)	28.81 (290.7)	4.24 (137.2)	1.57 (257.4)

YLD affected soils were quite adequate in all the gardens irrespective of prevalence or absence of the disease and the values ranged from 612.0—760.5, 453.4—539.4 and 478.9—672.2 kg/ha, respectively. None of the soil samples tested showed deficiency in nitrogen, phosphorus and potassium. This is mainly because the cultivation practices especially manure and fertilizers application are mainly confined to the rhizosphere and supplementing the depleted major nutrients by the external application of fertilizers. The major nutrient content of soils does not differ significantly between healthy and diseased arecanut gardens (11).

However, the available nitrogen content was higher in soils of healthy gardens and was found to decrease with intensity of incidence of YLD. But the available phosphorus and potassium contents were higher in soils of severely YLD affected gardens and were found to decrease with the healthiness of palms. The reason that could be attributed to relatively less available P and K contents of healthy garden is probably due to better utilization of native and applied fertilizers than diseased palms but more availability of nitrogen in healthy garden may be due to fertilizer application. The nitrogen was deficient but phosphorus and potassium were present in normal quantities in the affected gardens at the time when symptoms begin to appear (12).

Secondary Nutrients

The exchangeable calcium and magnesium content of soils was found to be marginal to adequate. The calcium content of soils ranged from 5.18 to 6.85 cmol (p^+)/kg whereas the magnesium content was quite low in the soils and was found to decrease with the incidence of yellowing of leaves and the values ranged from 1.22 to 1.88 cmol (p^+)/kg. But the Ca/Mg ratio in healthy gardens was low (3.09) compared to diseased gardens (4.24—4.93). The relatively less magnesium content of diseased gardens may be due to utilization of native magnesium over the years. Also, majority of farmers are not in the habit of adding magnesium in any of the forms. The soils from diseased gardens were low in magnesium. Likewise, the diseased gardens had high Ca/Mg ratio presumed to be due to low magnesium concentration (13). The available sulfur content was quite high (22.25—28.58 ppm)

Table 2. Major, secondary and micronutrients content of leaf tissues of healthy and YLD affected arecanut palms (mean of 16 palms of four gardens each). Figures in parentheses indicate the per cent increase or decrease over healthy palm.

Description of garden	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	Ca/Mg ratio	Mn/Fe ratio
				(%)				(ppm)				
Healthy	2.61	0.26	0.99	0.88	0.47	0.53	498.63	124.25	18.31	217.94	1.87	0.25
Moderately YLD affected	2.27 (–13.0)	0.25 (–3.9)	0.97 (–2.0)	0.86 (–2.3)	0.35 (–25.5)	0.50 (–5.7)	459.56 (–7.8)	89.38 (–28.1)	16.44 (–10.2)	72.50 (–66.7)	2.46 (+31.6)	0.19 (–24.0)
Severely YLD affected	2.22 (–14.9)	0.21 (–19.2)	0.95 (–4.0)	0.75 (–14.8)	0.30 (–36.2)	0.56 (+5.7)	574.81 (+15.3)	98.31 (–20.9)	16.26 (–11.3)	59.50 (–72.7)	2.50 (+33.7)	0.17 (–32.0)

in all the gardens. However, it was high in severely YLD affected gardens than others.

Micronutrients

The DTPA extractable iron, manganese, zinc and copper content of soils of healthy, moderately and severely YLD affected gardens were found to be sufficient and the values ranged from 41.21—82.10, 25.04—129.27, 1.35—5.15 and 9.91—28.81 ppm, respectively. The contents of Fe, Mn, Zn and Cu were above the level of sufficiency in both Karnataka and Kerala states (11). However, higher concentrations of Fe, Mn, Zn and Cu were recorded in severely affected gardens and were found to decrease in healthy gardens. The yellow leaf disease was due to toxicity of either manganese or iron (14). The supply of higher levels of iron and manganese created toxicity in arecanut seedlings. Leaves of seedlings supplied with higher levels of manganese showed interveinal chlorosis and necrosis at tips (15). The soils of severely YLD affected gardens had high Mn/Fe ratio, which may be due to their higher concentrations in soils and a serious disturbance in iron and manganese accumulation and it was found to diminish with healthiness of the gardens. The soils in disease affected areas in Kerala and Karnataka were found to be high in exchangeable Fe, Mn, Zn and Cu contents (16).

Nutrient Composition of Arecanut Palm Leaf

The nutrient composition of healthy, moderately and severely YLD affected arecanut palms presented in Table 2 reveal a gradual decline with the onset of a yellow leaf disease.

Healthy Palms. The N, P, K, Ca, Mg and S contents of healthy palm leaves recorded were 2.61, 0.26, 0.99, 0.88, 0.47 and 0.53%, respectively and the status of Fe, Mn, Zn and Cu were 498.63, 124.25, 18.31 and 217.94 ppm, respectively. The nutrient composition of healthy palm leaves was found to be adequate with respect to major, secondary and micronutrients. It was observed that copper concentration of leaf tissues was quite high in healthy palms.

Moderately YLD Affected Palms

The condition of moderately affected palms showed variations on the composition of nutrients compared to healthy ones. It was observed that in addition to manganese deficiency, they were also slightly deficient in nitrogen and magnesium. It was noticed that the major, secondary and micronutrients were on a declining trend compared to healthy palms.

Severely YLD Affected Palms

The severely affected palms were found to be low in nitrogen, magnesium and manganese. It was observed that all the major, secondary (except S) and micronutrients (except Fe and Mn) were on a decreasing trend compared to moderately affected palms.

Further, Ca/Mg ratio increased with the intensity of YLD, which may be due to decrease in magnesium content whereas Mn/Fe ratio was reduced with the intensity of incidence of YLD which may be due to lower concentration of manganese in diseased palms. The results of the present study are in conformity with those of Mathai (17). Potassium and calcium were found to be involved in the membrane perme-

ability of all the plants and deficiency of both increases the permeability and enhances the metabolic leakage from plant tissues. Thus the affected cells will leak out metabolites. Washing away of the accumulated metabolites by water during rainy season is quite possible. The effect of such washing on the appearance of symptoms of YLD during rainy season is possible.

The symptoms of manganese deficiency could be induced in a plant system, when iron concentration in the medium is increased along with a constant manganese supply. Higher value of iron showed that more of this element has been translocated to the shoots in the affected palms. Excess iron is known to reduce the capacity to check the mobility of manganese in a plant system and this could also be a reason for the lower manganese content in the affected arecanut palms (18). the diseased arecanut leaves were tolerant to higher doses of manganese whereas even lower concentration of iron was found to be toxic. This is perhaps the reason for the manifestation of the disease symptoms, which could be that of manganese deficiency. The conditions existing in the soil system of the affected arecanut gardens must have resulted in the widening of Fe/Mn ratio. Though this disorder appears to be related to manganese deficiency, comparatively high iron content in the affected palms indicates the existence of Fe-Mn antagonism (14).

Excess levels of copper in the soil or nutrient medium are known to interfere with the uptake of zinc by plants (19). The copper spray on citrus plants increased the intensity of zinc deficiency symptoms in leaves (20). A serious disturbance in the Mn/Fe and Ca/Mg ratios may be responsible for the appearance of symptoms. The leaves of diseased palms had a lower Mn/Fe ratio compared to healthy palms (17).

Conclusion

From the results on nutrient status of arecanut gardens where YLD was prevalent, it may be inferred that the soils are not deficit in any nutrients. The nutrient composition of arecanut palm leaf tissues showed a gradual decline in their nutrient status with the onset of YLD. The healthy palm leaves were quite high in copper while YLD affected leaves were deficit in nitrogen, magnesium and manganese content.

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