

# PHYSICO-CHEMICAL STUDIES IN THE COASTAL AND HILLY SOILS UNDER ARECANUT PALM OF THE BOMBAY DECCAN

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## Introduction

Areca nut (*Areca Catechu Linn*), a typically moistureloving palm is extensively grown in Ceylon, Phillipines and India. In India it is grown along the coast of Indian Peninsula and Assam and Bengal States.

The area under the crop and the production of arecanut in principal growing states in India is as under.

(Garg 1963)

State	Area (Ha)	Production (Metric tonnes)
1. Kerala	59,052	46,692
2. Mysore	30,540	27,418
3. Assam	20,929	14,324
4. West-Bengal	2,198	2,460
5. Maharashtra	2,053	2,836
6. Madras	1,727	1,351
7. Andhra Pradesh	172	92
8. Orissa	92	
Total	1,16,833	95,173

The soils on which areca-palm is grown in the Bombay Konkan are generally coastal alluvium formed from the deposition

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of river silt on the lime and shell deposits. They are situated on the level coastal area having about 2% slope and at altitude less than 10 m. The rainfall in this area ranges from 2000 to 3500 mm. The palm is also grown on the lateritic hilly soils situated in the sub-montane region on terraced land or on gentle slopes (about 40%) lying at distance of two to 25 km. from the seacoast, and at altitudes ranging from 15 to 330 m. The rainfall in this area ranges from 3125 to 4375 mm.

Areca nut is an article of everyday use in India and at present the indigenous demand far exceeds the production and therefore currently attempts are being made in many of the arecanut growing States to expand the area under cultivation. However at present very little information is available on the nature and properties of the soil on which the crop is cultivated and therefore investigations on these aspects were undertaken. The results obtained from these are given in the following pages.

## Experimental

As stated earlier the arecanut soils in Maharashtra are broadly grouped into two categories (1) Coastal alluvium soils and (2) laterite soils from hill areas. Four profiles from each group were selected for

the investigations. The profiles from Murud, Diveagar, Shriwardhan and Guhagar fall under coastal alluvium soils, while those from Nagloli, Asud, Kumbhave and Palshet fall under laterite hilly soils.

### Description of profiles

Soils from coastal region  
Profile 1

Location:— Levelled land in village Murud, Dist. Kolaba.

Rainfall:— 3000 mm.

Depth in inches

#### Description

0—22

Dark brown (7.5 YR 3/2 dry & moist) sandy loam type with loose granular structure, profuse root distribution few nodules of lime, effervescence with HCL.

22—42

Dark yellowish brown (10 YR 4/4 dry) to dark brown (7.5 YR 4/2 moist) sand soil with loose granular structure. Large pebbles of lime, vigorous effervescence with HCL.

42—60

Brown (10 YR 5/3 dry) to dark reddish brown (5 YR 3/2 moist) sandy, compact, blocky structure. Effervescence with HCL.

#### Profile 2.

Location:— Levelled land in village Diveagar, Dist. Kolaba.

Rainfall:— About 3250 mm.

Depth in inches

#### Description

0—20

Reddish brown (5 YR 4/3 dry) to dark reddish brown (5 YR 3/4 moist) sandy loam texture, loose crumb structure, lime nodules, effervescence with HCL.

27—48

Light Grey (2.5 Y 7/2 dry) to light brownish grey (2.5 Y 6/2 moist) large size lime (soft) pebbles, vigorous effervescence with HCL.

#### Profile 3

Location:— Levelled garden in Shriwardhan Dist. Kolaba.

Rainfall:— About 3500 mm.

Depth in inches

#### Description

0—25

Dark brown (10 YR 3/3 dry) to very dark red (2.5 YR 2/2 moist) sandy loam texture, granular structure, profuse root distribution, no effervescence with HCL.

25—45

Grey brown (10 YR 5/2 dry) to dark reddish brown (5 YR 3/4 moist) sandy texture, compact granular structure no effervescence with HCL.

45—60

Dark brown (10 YR 4/3 dry) to dark reddish brown (5 YR 3/2 moist) sandy, slight effervescence with HCL.

#### Profile 4

Location:— Levelled garden in village Guhagar Dist. Ratnagiri.

Rainfall:— About 2000 mm.

Depth in inches.

#### Description

0—10

Dark reddish brown (5 YR 3/3 dry & moist) sandy clayey loam texture, loose granular structure with presence of high humus imparting dark colour, profuse root distribution, slight effervescence with HCL.

10—18	Reddish brown (5 YR 4/3 dry & moist) sandy clayey loam texture, loose granular structure, pebble of partially disintegrated murrum, good effervescence with HCL.	9—16	Dark brown (5 YR 3/4 dry) to dark reddish brown (5 YR 2/2 moist) clayey loam type, loose granular structure with profuse root growth and moderate effervescence, with HCL.
Below 18	Partially disintegrated murrum layer. soils from Hilly region.	16—33	Reddish brown (5 YR 4/4 dry) to dark reddish brown (5 YR 3/2 moist) sandy clayey loam, loose granular structure with profuse root growth and slight effervescence with HCL.
	Profile 5		Profile 7
Location:-	A levelled garden in village Nagloli Dist, Kolaba.	Below	Partially disintegrated yellowish murrum layer.
Rainfall:-	About 3375mm		
Depth in inches	Description	Location:-	A terraced garden on steep hill slope in village Kumbhave Dist, Ratnagiri.
0—10	Dark brown (7.5 YR 5/6 dry) to yellowish red (5 YR 5/6 moist) clayey type granular structure with more organic matter and more root distribution, slight effervescence with HCL.	Depth in inches	Description
		0—14	Reddish brown (5 YR 4/3 dry) to dusky red (2.5 YR 3/2 moist) clayey texture and loose granular structure, very profuse root distribution, no effervescence with HCL.
10—15	Reddish brown (5 YR 4/4 dry) to dark reddish brown (5 YR 3/4 moist) clayey texture, loose granular structure, high organic matter, slight effervescence with HCL.	24—42	Reddish brown (5 YR 4/4 dry) to dark reddish brown (2.5 YR 3/4 moist) clayey loam, Loose granular, less root distribution slight effervescence with HCL.
Below 15	Hard murrum and bed rock.		
	Profile 6	42—60	Reddish brown (5 YR 4/4 dry) to dark reddish brown (2.5 YR 3/4 moist) clayey type with loose granular structure, no root growth and slight effervescence with HCL.
Location:-	Terraced garden on hill slope in Village Asud Dist, Ratnagiri.		
Rainfall:-	3125 mm.		
Depth in inches	Description		
0—9	Reddish brown (5YR 4/3 dry) to dark reddish brown (5 YR 3/3 moist) clayey loam texture loose granular structure high humus, and moderate effervescence, with HCL,		

### Analysis

For all determinations the standard methods given in A. O. A. C. (1955) and Piper's Soil and Plant Analysis (1950) were followed. The available  $P_2 O_5$  and  $K_2 O$

were determined by Troug's method (1930) and Morgan's method, the latter being estimated by means of a flame photometer. The exchangeable  $C_a$  and  $M_g$  were determined by Puri's method (1958) by treating the soil with triple salt solution. Exchangeable  $N_a$  and K were determined by using Lange's flame photometer. The acid soluble  $M_n$ ,  $C_u$ ,  $Z_n$  and  $M_o$  were determined as per procedure described by sandell (1950)

### Experimental results

The results of analysis of the soil under study are given in Table I and 2. The results are discussed below.

#### Soils from coastal region

##### Chemical Properties:-

From Table I it can be seen that the organic carbon and total nitrogen contents in the soils of the coastal region are moderately high in the surface layers but go on decreasing with depth. The Soil from Shriwardhan is however, comparatively poor in its organic carbon and total nitrogen contents. The C/N ratio is varying in all the profiles, but the effect is marked in the case of Murud and Shriwardhan soils. The acid insoluble matter is highest in the surface layer in all the Profiles, and decreases with the depth, which may be due to the corresponding increases in the calcium carbonate (vide table 2).

The sesqui oxides, iron oxide and alumina contents in the profiles of Murud, Shriwardhan and Guhagar remain more or less constant in all the layers of the soils. This may be due to the continuous wet nature of vegetation and biological activities in the soils. In the case of soil from Diveagar, these contents decrease with the depth probably due to the high amount of calcium carbonate present in these soils.

The phosphorus and potash contents are rather high, but at the same time their availability appears to be low, the availability decreasing with the depth. The abundance of phosphate may be attributed to the coastal location of the soils and consequent influx of organic marine residues, also and to probaxble application of fish meal and such other refuse generally available in the coastal region. The  $C_aO$ ,  $M_gO$ , and  $N_a2O$  contents are fairly high. The soils are more or less neutral, the PH varying from 6.5 to 7.4.

##### Micronutrients:—

Acid soluble Mn, Cu, and Mo are present in fairly large amount and their quantities decrease with the depth, except in case of soil profile from Murud where the Cn contents are variable. The Zn contents in soils from Murud and Diveagar are lower as compared to those from Shriwardhan and Guhagar where they are high and decrease with the depth of soil in these two profiles.

##### Exchangeable bases:— (Table 2)

The exchangeable calcium is higher in soils from Murud, Diveagar and Guhagar, while it is comparatively low in the soil from Shriwardhan where the level of exchangeable magnesium is high. In all the profiles, the exchangeable calcium increases with the depth. The exchangeable magnesium and potassium are also present in fairly good amount except in case of soil from Diveagar. The high amount of exchangeable calcium, magnesium and potassium in these soils may probably be due to the influence on these soils of sea water which contains these elements in fair amounts.

##### Physical Properties:— (Table 2)

These soils are characterised by their sandy alluvium nature. The silt and clay

fractions decrease with depth. The lime content is generally high and increases with depth of soil. In the Shrivardhan soils the lime content is totally absent upto 45 inches.

The maximum water holding capacity and moisture equivalent in the first 20 to 25 inch layers of all the four profiles remain more or less constant and fall abruptly below this layer confirming the alluvial deposition of the soil over the marine deposits in the substratum. The loss on ignition is more or less constant but the total soluble salts are negligible and are evenly distributed in the soil profiles.

### Soils from Hill region

#### Chemical properties:-

The soils from Nagloli, Asud, Kumbhave and Palshet are rich in their contents of organic carbon and total nitrogen. These two constituents however decrease with the depth except in case of soil from Nagloli. The C/N ratio though variable is within the optimum range. The acid-insoluble matter sesquioxides, iron oxide and alumina are more or less in the same order in all the layers of the profiles. The hill soils are however poor in their contents of total phosphoric acid and  $K_2O$  and in the availability of these nutrients. They are also poor in their  $CaO$ ,  $MgO$  and  $Na_2O$  contents. Further they are distinctly acidic the pH ranging from 5.7 to 6.1.

#### Micronutrients:

The level of micronutrients in these soils is very high and they are unevenly distributed in the profile.

#### Exchangeable bases:

The soils are poor in their base exchange capacity the levels of exchangeable Ca, Mg and K being comparatively lower than those of the coastal soils.

#### Physical Properties:

These soils are clayey in texture the silt plus clay fractions being very high i. e. between 45 to 75 percent. The water holding capacity and the moisture equivalent are also high due to the clayey nature of the soils, the calcium carbonate contents are very poor while the loss on ignition is fairly high and ranges from 10 to 12 percent in the surface soils. The total soluble salts are low and are evenly distributed.

### Discussion

From the general features such as location and from results of analysis it is evident that the soils from the coastal region comprising of profiles from Murud, Diveagar, Shrivardhan and Guhagar are distinctly different in their physical and chemical properties from those of the hilly region comprising of profiles from Nagloli, Asud Kumbhave and Palshet.

A very high amount of phosphoric acid, Potash and Calcium Carbonate, low contents of organic carbon total nitrogen and the silt plus clay fractions (about 20 % or less) and high base exchange capacity are the characteristic features which distinguish these soils from those of the hilly area.

The hilly soils on the other hand are very poor in their phosphoric acid, potash and calcium Carbonate, contents. They are poorly base saturated, very rich in organic carbon and total nitrogen contents and are clayey in texture the percentage of silt plus clay varying between 45-75. The loss on ignition in these soils is higher than that from the coastal soils.

The high amount of sesquioxides in the soils under study and the presence of calcium carbonate in the deeper sub-soils compares them with the red basaltic soils studied by Bryan et. al. (1949) in Eastern

Australia. All the eight profiles show a low contents of soluble salts which agrees well with the observations made by Sen Gupta et. al (1946) who reported that soils of Sirsi have low contents of total soluble salts distributed evenly in the profiles. According to Schuylenborgh (1957) latosolic soils derived under humid tropical conditions show a decrease in C/N ratio with the depth. No such observation could be made under hilly soils, on the contrary there was either an increase with the depth or it remained constant. The low supply of phosphoric acid in the hilly soils agrees well with the observations made by Kandiah (1949) in the Ceylon soils. The coastal soils showed an inverse correlation between the levels of exchangeable calcium and available phosphoric acid. These observations are in contrast to the observations made by Dhar et. al (1955) who established a positive correlaiton between exchangeable calcium and available phosphoric acid.

The levels of micro-nutrients are high in both the soil-groups, but between the two groups the values are higher in the hilly soils. However, unlike the hilly soils the coastal soils show some relationship between the micronutrient contents, organic carbon and total nitrogen. The higher amount of acid soluble copper present in all these soils agrees well with the observations made by Harmer (1943) who noted that the CuO contents of 23 Michigan soils varied from 90 to 1150 pp. m. The figures for acidsoluble Mo contents of the soils under study are in close agreement with those from Hawaiian soils reported by Fujimoto at-al (1951)

## Summary

Eight soil profiles from coastal and hilly localities where the arecanut palm is grown extensively in the Bombay Konkan, were studied for their general morphological and profile characters, physicochemical properties and micro-nutrient status. The study of the soil profiles revealed the following facts.

- 1) The coastal soils are sandy in nature as against the clayey nature of the hilly soils.
- 2) They are calcareous whereas the hilly soils are acidic in reaction.
- 3) Coastal soils are rich in phosphate and potash contents but poor in nitrogen contents, whereas the hilly soils are richer in nitrogen but poor in phosphate and potash.
- 4) The coastal soils are highly base saturated as against the low exchangeable bases in the hilly soils.
- 5) Both the coastal and hilly soils are rich in their micronutrient contents but the hilly soils are still richer.

## Aknowledgement

The authers wish to express their sincere thanks to the Indian Central Arecanut Committee, for permitting the publiaction of these data which had been collected in connection with the grant-in-aid scheme on "Band" disease financed by the Committee. Their thanks are also due to Prof. D. K. Ballal, Agricultural Chemist, Department of Agriculture, Maharashtra State, Poona, for his valuable suggestions during the progress of the work, and Shri G. K. Zende, Soil Chemist, Padegoan, for his kind help in presentation of the data.

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