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Assessment of physico-chemical properties of soils under arecanut gardens of bhadra command area of Davanagere district

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Abstract
Arecanut is the major commercial crop of Karnataka having root in fifteen districts. Most of the traditional areca growing soils are acidic in nature while non- traditional areca growing soils are alkaline in nature. Arecanut productivity is affected by many reasons, out of which soil nutrient imbalance is one of the important productivity constraints. A detailed soil survey was undertaken with the aim of evaluating physico-chemical properties of arecanut gardens in Channagiri, Honnali, Harihara and Davanagere taluks of Southern transition zone of Karnataka. A total of fifty samples were collected from surface (0-15 cm) and sub-surface soils (15-30 cm) and analyzed for pH, electrical conductivity, organic carbon, exchangeable calcium and magnesium and cation exchange capacity by using standard analytical methods. Study revealed that soils are sandy loam to clay in texture, acidic (slight to moderate) in soil reaction and non-saline in nature, medium to high in organic carbon content and low in cation exchange capacity.

Keywords: Arecanut, cation exchange capacity, organic carbon, soil reaction, textural class

Introduction
The arecanut palm is the source of common chewing nut, popularly known as betel nut or Supari. India is the largest producer of arecanut and at the same time largest consumer also. In India, it is extensively used by large sections of people and is very much linked with religious practices. Arecanut (*Areca catechu* L.) belongs to family "Arecaceae" is one of the most profitable commercial plantation crops grown in humid tropics of India. Major states cultivating this crop are Karnataka (40%), Kerala (25%), Assam (20%), Tamil Nadu, Meghalaya and West Bengal [1]. It is grown in Karnataka in 4.66 lakh hectare area with an annual production of 7.3 lakh tonnes [2]. Karnataka state has two distinct tracts *viz.*, the traditional and non- traditional region. Most of the traditional areca growing soils are acidic in nature while non- traditional areca growing soils are alkaline in nature. The non-traditional tract, essentially consist of Chitradurga, Davanagere, Chickmagalur and parts of Shivamogga districts. These districts are characterized by medium to heavy rainfall (150-400 cm), variation in altitude, temperature fluctuations etc. These factors play a dominant role in determining the soil fertility and productivity. As such, crop like arecanut is perennial in nature and its productivity is affected by many reasons, out of which soil nutrient imbalance is one of the important productivity constraints [3]. The area under arecanut cultivation in Davanagere district has increased. In the present study, an effort is made to determine the physico-chemical properties of the selected Davanagere taluks that would focus on adopting appropriate cultural and nutritional management practices to keep the plants healthy and productive.

Materials and Methods
Characterization of surface soil (0-15 cm) and sub-surface soil (15-30 cm) was studied by taking fifty representative samples of arecanut gardens in each taluk of Channagiri, Honnali, Harihara, and Davanagere. Major land use pattern of these areas consists of intercropping of arecanut with banana, coconut and black pepper. The topsoil of these areas vary in colour which include brown, light and dark reddish brown, yellowish red, yellowish brown and black. The soils are gentle to moderately slope (3-10 %) in nature with moderately well drained condition having acidic pH ranging from 4.5-6.5.
Soil samples were air-dried under shade and then powdered and sieved through 2 mm sieve and stored in clean polyethylene containers. Processed soil samples were analyzed in the laboratory for various physico-chemical parameters *viz.*,

the soil pH was measured in 1:2.5 soil water suspension using pH meter and EC (dS m^{-1}) was measured in the supernatant solution of 1:2.5 soil water extract using conductivity bridge [4]. Organic carbon was estimated by Walkley and Black's wet oxidation method [4]. Exchangeable calcium and magnesium was determined by Versenate titration method [5] and CEC by Neutral N ammonium acetate saturation method [6]. Particle size distribution of soil samples were determined by International pipette method [7]. The laboratory analysis of soil samples was conducted at Agricultural and Horticultural Research Station, Kathalagere, Davanagere, Karnataka during 2016-17.

Results and Discussion

Physico-chemical properties

A. Physical properties

The data on particle size distribution is presented in Table 1 and 2. It was observed that sand was the dominant fraction in soils of Channagiri taluk, which varied from 33.56 to 72.91 and 32.56 to 72.18 per cent in surface and sub-surface soils, respectively. The silt content is higher in the soils of Honnali taluk ranged from 3.91 to 17.60 and 3.41 to 17.80 per cent in surface and sub-surface soils, respectively. Clay content was found higher in the soils of Channagiri taluk varied from 21.72 to 54.33 and 22.36 to 55.50 percent in surface and sub-surface soils, respectively. The arecanut growing soils are under semi-arid conditions, have varied soil texture from sandy clay loam, sandy clay, sandy loam and clay with sand as the dominant mineral fraction. These wide variations in soil texture may be due to differences in parent material, physiography, in-situ weathering and translocation of clay [8]. The increase in clay content with depth might be attributed to the intensive tillage operations, which make finer particles to move down leaving behind the coarser particles on the surface [9] (Table 1 and 2).

B. Chemical properties

The data pertaining to chemical properties of arecanut growing soils of Davanagere district are presented in Table 3 and 4.

The results indicated that the pH values of surface soils were slightly lower than the sub-surface soils. The pH of soils of Channagiri taluk ranged from 5.27 to 8.04 in surface and 5.88 to 8.04 in sub-surface depth. In Honnali taluk, it varied from 5.02 to 7.95 and 5.58 to 7.95 in surface and sub-surface soils, respectively. The surface soils of Harihara taluk recorded pH range from 5.41 to 7.82 whereas; in sub-surface soils, it varied from 5.68 to 7.82. The pH of soils of Davanagere taluk ranged from 5.06 to 7.91 and 5.33 to 7.95 in surface and sub-surface, respectively. The soil pH increased with increase in depth, which might be due to leaching of bases on account of well drained conditions leaving behind iron and aluminium oxides on the surface soil [10].

The electrical conductivity in Channagiri taluk varied from 0.10 to 0.84 and 0.18 to 0.99 dS m^{-1} in surface and sub-surface soils, respectively. In Honnali taluk, the electrical conductivity in surface and sub-surface soils was varied from 0.10 to 0.87 and 0.21 to 0.99 dS m^{-1}. In Harihara and Davanagere taluks, it was ranged from 0.10 to 0.93 and 0.19 to 0.98 dS m^{-1} and 0.24 to 0.72 and 0.28 to 0.80 dS m^{-1}, in surface and sub-surface soils respectively. Electrical conductivity is higher in sub-surface layer than in surface layer due to leaching of salts from the soil surface to lower depths due to irrigation and their accumulation in lower depths [11].

The organic carbon content of Channagiri taluk ranged from 7.0 to 14.10 g kg^{-1} and 5.50 to 12.80 in surface and sub-surface soils, respectively. The soil organic carbon content in Honnali taluk was ranged from and 4.10 to 15.80 and 2.90 to 14.33 g kg^{-1} in surface and sub-surface soils, respectively. The soil organic carbon content in Harihara taluk varied from 4.38 to 12.87 and 3.87 to 10.98 g kg^{-1} in surface and sub-surface soils, respectively. The lower values of soil organic carbon recorded in Davanagere taluk (2.56 to 11.38 and 2.13 to 10.56 g kg^{-1}) in surface and sub-surface soils, respectively. The organic carbon content of surface soil was greater than sub-surface soil. This was attributed to the addition of farmyard manure and plant residues to surface horizons, which resulted in higher organic carbon content in surface horizons than that of lower horizons [8].

The cation exchange capacity of the soils of Channagiri taluk ranged from 20.48 to 37.90 and 24.20 to 29.61 cmol (p^+) kg^{-1} in surface and sub-surface depths, respectively. The exchangeable Ca varied from 1.20 to 6.30 cmol (p^+) kg^{-1} in both surface and sub-surface soils. The exchangeable Mg ranged from 0.80 to 2.12 and 0.80 to 2.30 cmol (p^+) kg^{-1} in surface and sub-surface soils, respectively (Table 3 and 4).

The cation exchange capacity of surface and sub-surface soils was found in the range of 13.44 to 27.88 and 14.11 to 28.88 cmol (p^+) kg^{-1} in Honnali taluk. The surface and sub-surface soils of Honnali taluk showed varied amounts of exchangeable Ca status. However, exchangeable calcium content ranged from 1.23 to 4.99 and 1.68 to 5.80 cmol (p^+) kg^{-1} in surface and sub-surface soils, respectively. Similarly, the exchangeable Mg status recorded in the range of 1.00 to 3.10 and 1.05 to 3.98 cmol (p^+) kg^{-1} in surface and sub-surface soils, respectively.

In arecanut growing soils of Harihara taluk, CEC of the soil varied from 14.30 to 26.50 cmol (p^+) kg^{-1} in surface and from 18.10 to 29.98 cmol (p^+) kg^{-1} in sub-surface soil. In most of the soils CEC was found to be more in sub-surface than in surface soils. The exchangeable Ca in surface soil ranged from 1.12 to 16.12 cmol (p^+) kg^{-1} and in sub-surface it ranged from 2.31 to 19.40 cmol (p^+) kg^{-1}. The exchangeable Mg in surface soil ranged from 0.80 to 14.39 cmol (p^+) kg^{-1} and in sub-surface it ranged from 1.91 to 17.83 cmol (p^+) kg^{-1}.

In Davanagere taluk, CEC of the soil varied from 12.26 to 30.29 cmol (p^+) kg^{-1} in surface and from 13.59 to 31.66 cmol (p^+) kg^{-1} in sub-surface soil. In most of the soils CEC was found to be more in sub-surface than in surface soils. The exchangeable Ca in surface soil ranged from 6.50 to 18.63 cmol (p^+) kg^{-1} and in sub-surface it ranged from 9.00 to 14.10 cmol (p^+) kg^{-1}. The exchangeable Mg in surface soil ranged from 3.27 to 8.98 cmol (p^+) kg^{-1} and in sub-surface, it ranged from 5.10 to 11.48 cmol (p^+) kg^{-1}. Exchangeable calcium was the dominant cation over magnesium in all the soils of arecanut growing areas of Davanagere district [12]. The CEC was found more in surface soils than in sub-surface soils. It may be attributed to the pH dependent charge contributed from higher organic matter in surface soil [13]. The CEC of soil with a tendency to decrease with depth but it was found closely associated with clay and clay plus organic carbon in grape growing soils in Nasik district of Maharashtra[14] (Table 3 and 4).

Table 1: Particle size analysis in surface (0-15 cm depth) soils of arecanut gardens of Davanagere district

S. No.	Taluks	Particle size distribution			Textural class
		Sand (%)	Silt (%)	Clay (%)	
1	Channagiri	33.56 -72.91	4.88-13.60	21.72-54.33	SCL - C
2	Honnali	33.40-72.38	3.91-17.60	14.80-44.62	SL - C
3	Harihara	37.20-72.16	2.73-17.40	14.80-50.40	SL - C
4	Davanagere	59.68-72.50	8.35-14.48	15.82-29.73	SL - SCL

Table 2: Particle size analysis in sub-surface (15-30 cm depth) soils of arecanut gardens of Davanagere district

S. No.	Taluks	Particle size distribution			Textural class
		Sand (%)	Silt (%)	Clay (%)	
1	Channagiri	32.56-72.18	2.33-12.60	22.36-55.55	SCL - C
2	Honnali	31.40-71.36	3.41-17.10	16.00-45.62	SL - C
3	Harihara	35.20-73.06	2.23-16.90	15.80-53.60	SL - C
4	Davanagere	62.12-71.23	4.26-14.13	21.27-32.31	SL -SCL

Table 3: Chemical properties in surface (0-15 cm depth) soils of arecanut gardens of Davanagere district

S. No.	Taluks	pH (1:2.5)	EC (1:2.5) (dS m^{-1})	OC (g kg^{-1})	CEC [cmol (p^+) kg^{-1}]	Exchangeable bases	
						Ca	Mg
						[cmol (p^+) kg^{-1}]	
1	Channagiri	5.27-8.04	0.10-0.84	7.00-14.10	20.48-37.90	1.20-6.30	0.80-2.12
2	Honnali	5.02-7.95	0.10-0.87	4.10-15.8	13.44-27.88	1.23-4.99	1.00-3.10
3	Harihara	5.41-7.82	0.10-0.93	4.38-12.87	14.30-26.50	1.12-16.12	0.80-14.39
4	Davanagere	5.06-7.91	0.24-0.72	2.56-11.38	12.26-30.29	6.50-18.63	3.27-8.98

Table 4: Chemical properties in sub-surface (15-30 cm depth) soils of arecanut gardens of Davanagere district

S. No.	Taluks	pH (1:2.5)	EC (1:2.5) (dS m^{-1})	OC (g kg^{-1})	CEC [cmol (p^+) kg^{-1}]	Exchangeable bases	
						Ca	Mg
						[cmol (p^+) kg^{-1}]	
1	Channagiri	5.88-8.04	0.18-0.99	5.50-12.80	24.20-29.61	1.20-6.30	0.80-2.30
2	Honnali	5.58-7.95	0.21-0.99	2.9-14.33	14.11-28.88	1.68-5.80	1.05-3.98
3	Harihara	5.68-7.82	0.19-0.98	3.87-10.98	18.10-29.98	2.31-19.40	1.91-17.83
4	Davanagere	5.33-7.95	0.28-0.80	2.13-10.56	13.59-31.66	9.00-14.10	5.10-11.48

Conclusion

Fifty soil samples were collected from surface (0-15 cm) and sub-surface (15-30 cm) depths of arecanut gardens in each taluk of Channagiri, Honnali, Harihara, and Davanagere from the Bhadra command area to study the physico-chemical characteristics. In the present study, the majority of soils belong to SL - C textural class. The soils were observed acidic to alkaline in reaction, non-saline and low to high in organic matter content. CEC and exchangeable bases (Ca and Mg) are higher in sub-surface soils compared to surface soils.

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