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Fertility status and relationship between zinc, boron with other properties of soils between five to ten year aged are canut plantations

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Abstract
A survey was conducted in the areca growing tracts of Davangere districts to assess the fertility status of soils in areca plantations of five to ten year age group. The soils were neutral to alkaline in reaction, EC was normal for plant function and production and medium to higher content of organic carbon, and cation exchange capacity coincided with organic carbon. Available nutrient status of nitrogen, potassium, Sulphur were ranged from low to high, phosphorus was ranged from low to high. Exchangeable calcium and magnesium were recorded higher than the critical limits. Except boron all other micronutrients were sufficient. All these nutrients were decreased with increase in depth but boron was decreased with increase in depth. With respect to correlation studies Zn and B was positively correlated with clay, pH, EC, OC, CEC, Ca, Fe, Mn and sand, clay, OC, N, Mg, and Cu respectively.

Keywords: aged plantations, arecanut, deficiency, macronutrients, micronutrients

Introduction
Arecanut palm (*Areca catechu* Linn.) is one of the commercial plantation crop grown in humid tropics of India. It is a native of Philippines and other East India Islands. It is grown in India, Srilanka, Bangladesh, Malaysia, Indonesia, China, Myanmar, Thailand, Nepal, Kenya and Philippines. In Karnataka, arecanut growing area is divided into two tracts, viz. the Malnad and Maidan tracts. The Malnad tract experiences heavy rainfall of about 4,000mm annually. This tract consists of coastal plains of Dakshina Kannada, Udupi, shimoga and hilly terrains of Chikkamagalur district. The Maidan tract experiences less rainfall about 1,000 mm annually also requires irrigation especially during summer for better yield. This tract consists of Chitradurga, Davangere, and some parts of Shimoga.
The arecanut is the main crop and principle source of income for the farmers in these areas. Bearing starts in areca plant between the age of five to ten year. Hence this research was conducted with objective to study about the nutrient or fertility status of areca plantations in the initial stage of yield bearing.

Material and Methods
The representative, twelve soil samples were collected from each depth of 0-20 and 20 – 40 cm depth from Channagiri, Honnali and Davangere taluks of Davangere district.
The soil samples were air dried under shade, powdered by using wooden pestle and mortar, passed through 2 mm sieve and stored in a polyethylene bags. For organic carbon determination, 2mm sieved samples were further subjected for grinding and passed through 0.2 mm sieve.
The samples were analyzed for texture, pH, EC, CEC, organic carbon, (Jackson., 1958) [9] available macronutrient N, (Subbiah and Asija., 1956) [22] P, K, Ca, Mg, S (Jackson., 1973) [10] and micronutrients like Fe, Mn, Zn, Cu (Lindsay and Norvell., 1978) [12] and B (Berger and Troug., 1939) [4] contents using standard procedure.

Results and Discussion
The percentage of sand, silt and clay were presented in Table. 1 According to that the samples belongs to sandy clay loam to sandy clay loam in texture, Similar results were given by Prashantha (2012) [19] and Jayaprakash *et al.,* (2012) [11] highest sand, clay content was observed in Honnali and davangere talluks, respectively. Sand was dominant fraction in

surface soils as well as sub-surface soils, which might be due to granite parent material from which the soil was derived. Similar results were observed by Prashantha (2012) [19] (Anon, 1986) [2]. The results are in conformity with the findings of Sathyanarayana and Biswas (1970) [22] who reported that soils developed from granite type of parent material had coarse texture. The surface enrichment of sand fraction was also due to the removal of finer particles by clay eluviations and erosion. The clay showed an increasing trend with the depth which may be attributed to continuous tillage operations which make the finer particles to move to the subsurface layer leaving coarser particles on surface as it was confirmed by Logananthan and Krishnamurthy (1976) [14] and Basavaraju *et al*, (2008) [3].

The electrochemical properties like pH, electrical conductivity, organic carbon and cation exchange capacity were presented in Table 2. According to that data all analyzed soils samples were neutral to alkaline in reaction or nature, Electrical conductivity measures salt content in soils and EC was normal for plant function and production in all the soils. Organic matter was low to medium, highest was recorded in Honnali talluk. Organic matter in soils is one of the major nutrient reservoir (especially nitrogen and sulphur) for plants. Low OC content might be due to coarse soil nature, cultivation practices and reduced application of organic matter to soil (Dudal, 1965) [7] (Veeranagappa 2013). [25] Medium status could be ascribed to regular addition of organics, in the forms of FYM and compost. Similar observations were reported by Chidanandappa (2003) [5] indicating that organic manures addition enhanced the organic carbon content in soils. Higher cation exchange capacity was recorded in surface soil than in sub-surface soils of all arecanut plantations this may be due to higher organic carbon content noticed in present study and also supported by other workers like Vadiraj and Rudrappa, (1990) [24]

The Macronutrients content in these samples were presented in Table 3. According to that available N, P_2O_5 and K_20 content were recorded Low to high and all these nutrients were decreased with increase in depth. This might be due to management practices which included the amount of organic manures added every year and due to application at higher doses. Low status might be related to low clay content and low organic carbon content and due to higher uptake in initial stage of yield bearing, whereas higher P_2O_5 status was ascribed to use of organics, addition of fertilizers and cultivation practices (veeranagappa 2013). [25] Higher potassium content was mainly due to presence of potassium bearing minerals, and addition of fertilizers. Similar observations were made by Roy and Landey (1962). [21]

Exchangeable calcium and magnesium status in soils were found to be in sufficiency range for plant availability available sulphur was high in all soils all these nutrients were decreased with increase in depth. Lower amount of secondary nutrients in these plantations is might be due to higher uptake in the stage of initial yield bearing. Higher amount of secondary nutrients in these plantations may be attributed to application of gypsum, $CuSO_4$ and S containing fertilizers. Similar observations were reported by Dharakanath (1995), [6] Nambiar, (1994) [16] and Powlson and Johnston, (1994). [18]

The Micronutrients content in these samples were depleted in Table 4. According to that The DTPA extractable micronutrients (Zn, Mn, Fe and Cu) were above the critical limits in both surface and sub-surface soil, these all micronutrients were decreased with depth. The availability of micronutrients in soils increased with CEC of soils due to more availability of exchange sites of soil colloids with increase in organic matter which enhanced the soil structure and aeration protects the oxidation and precipitation and increases the solubility.

Among the available micronutrients content Boron was recorded lower in soils it might be attributed to boron sorption to Fe & Al oxides surfaces of soil mineral (Goldberg and Glaubig, 1986). [8] Available boron content increased with depth, low content of boron was due to leaching from surface to subsoil due to intense rainfall and leaching of available boron making surface deficient in boron. The results are inconformity with the findings of Anita *et al.*, (2011). [1]

Correlation coefficient (r) between available boron and zinc with soil properties

Available Zn had positive and negative significant correlation with sand (r =0.880) and silt (r = 0.865), respectively. Available Boron had positive and significant correlation with sand (r =0.787), and clay (r =0.979) but silt (r = - 0.719) was negatively and significantly correlated.

Available Zn had positive and significant correlation with EC (r =0.834), OC (r =0.474) and CEC (r =0.789). Similar results were showed Meenakshi *et al*. (2005) [15] Verma (2005) [26] and Jyothi *et al.* (2009). [12] Areca growing areas in Koppa, Sringeri and Kundapur taluk soil samples. This may be due to organic carbon status of these soils have positive correlation between available Zn and organic carbon content. This suggest that organic acid produce during decomposition of organic matter react with Zn and form soluble organo-zinc complexes, which prevent the Zn from fixation by soil constituents.

Available Boron had positive and significant correlation with only OC (r =0.946) (Raza *et al*., 2002 and Saleem *et al*., 2010) [20] and CEC (r = 725) But with other properties like, pH (r =0.943) (Patil and Shingte., 1982), [17] EC (r =0.407) it was negatively and significantly correlated.

Available Zn had negative and significant correlation with only N (r = - 0.480), K_2O (r = - 0.865) S (r= - 0.849) and positive and significant correlation with Ca (0.823**) Fe (1.000) and Mn (0.993). Available Boron had positive and significant correlation with N (r = 0.787), P2O5 (r = 0.969) Ca (r = 0.696) and Cu (r = 1.000) but with K2O (r = - 0.636) it was negatively and significantly correlated.

Table 1: Particle size distribution in areca growing soils

Sl. No	Talluks	Depth		Sand	Silt	Clay	TG
1.	Channagiri	0 - 20	Range	60.2-68.42	6.4-15.06	16.21-28.47	SL – SCL
			Mean	64.07	10.21	23.97	
		20 - 40	Range	61.04-69.03	6.82-16.64	22.81-29.46	SL – SCL
			Mean	65.09	11.13	26.38	
2.	Honnali	0 - 20	Range	65.69-80.1	3.37-7.68	16.23-28.41	SL – SCL
			Mean	69.41	5.77	23.34	
		20 - 40	Range	64.54-78.19	2.92-9.14	16.23-29.25	SL – SCL
			Mean	67.25	6.03	26.16	

3.	Davangere	0 - 20	Range	61.21-68.26	8.84-16.25	20.1-25.22	SCL
			Mean	64.96	12.63	22.32	
		20 - 40	Range	58.90-67.80	6.80-16.07	20.39-28.28	SCL
			Mean	62.79	12.68	24.22	

Table 2: Electrochemical properties of areca growing soils

Sl. No	Talluks	Depth		pH	EC	OC	CEC
1.	Channagiri	0 - 20	Range	6.32-8.46	0.04-0.18	0.51-1.11	10.1-20.69
			Mean	7.79	0.10	0.80	15.98
		20 - 40	Range	6.25-9.39	0.04-0.14	0.36-0.84	12.74-19.23
			Mean	7.59	0.07	0.59	15.91
2.	Honnali	0 - 20	Range	7.67-8.5	0.04-0.17	0.6-1.8	10.15-19.97
			Mean	8.05	0.11	0.88	13.14
		20 - 40	Range	7.13-8.30	0.08-0.39	0.36-0.84	10.04-19.45
			Mean	7.73	0.18	0.63	15.03
3.	Davangere	0 - 20	Range	8.01-8.54	0.1-0.25	0.36-0.99	11.11-18.84
			Mean	8.30	0.15	0.70	15.12
		20 - 40	Range	7.90-8.50	0.09-0.17	0.12-0.93	10.92-20.66
			Mean	8.21	0.13	0.47	15.35

Table 3: Macronutrients of areca growing soils

Sl. No	Talluks	Depth		N	P	K	Ca	Mg	S
1.	Channagiri	0 - 20	Range	368-514	36.28-50.36	280-525.57	3.5-5.32	2.12-3.8	28.06-65.47
			Mean	461.60	42.22	424.80	4.56	2.82	45.97
		20 - 40	Range	358-468	27.34-54.21	174.56-456	3.01-4.95	1.90-3.20	28.41-59.44
			Mean	407.08	35.57	335.90	4.09	2.46	42.10
2.	Honnali	0 - 20	Range	385-523	24.76-69.71	255.36-554	2.8-6.49	1.89-4.21	15.34-35.86
			Mean	450.50	44.67	308.42	4.40	2.88	27.34
		20 - 40	Range	326-478	22.86-49.53	128.80-387.52	1.70-5.97	1.14-4.14	12.30-12.30
			Mean	407.67	36.98	221.40	3.88	2.41	22.53
3.	Davangere	0 - 20	Range	405-547	28.36-46.94	302.4-584.64	3.7-6.3	2.38-3.8	28.54-35.38
			Mean	463.25	36.25	451.79	4.82	2.91	30.94
		20 - 40	Range	346-435	22.35-39.72	241.58-475	3.20-5.56	2.00-3.10	18.92-29.33
			Mean	388.83	29.80	362.20	6.91	2.46	24.76

Table 4: Micronutrients of areca growing soils

Sl. No	Talluks	Depth		Fe	Mn	Cu	Zn	B
1.	Channagiri	0 - 20	Range	7.42-11.84	4.95-8.96	2.09-4.74	0.63-2.05	0.12-0.40
			Mean	9.60	6.88	3.17	0.96	0.29
		20 - 40	Range	5.24-8.55	4.38-7.98	1.56-3.55	0.23-1.84	0.28-0.85
			Mean	7.32	6.15	2.29	0.69	0.60
2.	Honnali	0 - 20	Range	10.6-21.34	14.58-21.5	2.14-4.07	1.13-3.36	0.21-0.36
			Mean	15.05	19.35	3.02	1.61	0.30
		20 - 40	Range	9.32-18.22	12.15-19.85	1.51-3.39	0.71-1.35	0.42-0.66
			Mean	12.95	17.03	2.46	1.06	0.58
3.	Davangere	0 - 20	Range	4.68-21.34	4.26-23.12	1.06-3.49	0.34-3.05	0.15-0.36
			Mean	11.62	12.99	2.46	1.33	0.26
		20 - 40	Range	4.05-14.38	2.38-22.58	0.65-2.59	0.22-1.31	0.30-0.65
			Mean	9.01	10.60	1.77	0.69	0.48

Table 5: Correlation coefficient (r) between available boron and zinc with soil properties

	Sand	Silt	Clay	pH	EC	OC	CEC
Zn	0.880**	-0.804**	-0.040	0.175	0.834**	0.474*	0.798**
B	0.613**	-0.719**	0.979**	-0.943**	-0.407*	0.946**	0.725**

*Significant at 5% ** Significant at 1%

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	N	P_2O_5	K_2O	Ca	Mg	S	Fe	Mn	Cu
Zn	-0.480*	-0.400	-0.865**	0.823**	-0.364	-0.849**	1.000**	0.993**	0.186
B	0.787**	0.969**	-0.636**	0.696**	0.860**	0.383	0.176	0.044	1.000**

*Significant at 5% ** Significant at 1%

Conclusion

In five to ten year old areca plantations, the soils were belongs to sandy loam to sandy clay loam in texture, neutral to alkaline in reaction with medium to high organic carbon percentage. Macronutrients like N, P_2O_5 and K_2O were ranged between low to high due to application at higher dosages to grow both main and due to higher uptake in initial yield bearing stage. Higher amount of secondary nutrients in these plantations may be attributed to application of gypsum, $CuSO_4$ and S containing fertilizers. Micronutrients like Zn, Cu, Fe and Mn were in sufficient in range and all these nutrients were decreased with increase in depth. The availability of micronutrients in soils increased with CEC of soils due to more availability of exchange sites of soil colloids with increase in organic matter which enhanced the soil structure and aeration protects the oxidation and precipitation and increases the solubility. Among all the nutrients boron was deficient in these soils and it was increased with increase depth it might be due to leaching from surface to subsoil due to intense rainfall and leaching. With respect to correlation studies Zn and B was positively correlated with clay, pH, EC, OC, CEC, Ca, Fe, Mn and sand, clay, OC, N, Mg, and Cu respectively.

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