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RESEARCH PAPER

Nutritional constraints for nut drop of arecanut in Western Ghats soils of Uttara Kannada of Karnataka in India

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Abstract : In recent years, nut drop in arecanut crop is becoming a common problem in Western Ghats soils of Uttar Kannada district. To find out the reasons for nut drop in arecanut, a research was conducted during 2010-11 and 2011-12 in the area involving survey of nut drop affected fields, collection of soil samples from the affected fields and their analysis. The soils were analysed for pH, EC, organic carbon, available NPK, DTPA-Zn and available boron. The soils of the area match with the laterite characters. The initial data (before onset of monsoon) indicated that the soils were acidic in lower depths while neutral in surface soils, low in EC, low in available P, DTPA-Zn and available boron. The available K was low to medium. However, the soils were found medium to high in organic carbon and available N. The soil samples were also collected after receipt of rainfall and analyzed. The results indicated that the soil pH was slightly lowered but EC and available K were lowered more as compared to intial values. Similarly the organic carbon and available N were increased but DTPA-Zn and available B were remained low and not affected much as compared to initial status. Depth-wise soil analysis indicated that surface soil were having more acidic pH, low salts, higher organic C, higher available NPK than sub-soils. Further, these were lowered after receipt of rain, particularly EC and potash. The available Zn and B remained deficient. The available K, DTPA-Zn and available B were found to be deficient in these soils and need to be corrected immediately after heavy rains. The nutrients and other soil properties status if not improved may become constraints for nut drop in arecanut. To improve the soil pH, it is necessary to apply lime / dolomite, to improve EC level and available potash status of soil there is a need to apply extra dose of potash to soil than the recommended dose. To increase available P in acidic soils, there is a need to apply rock phosphate. Since the available N is medium to high, the recommended N may be continued. The recommended dose of Zn and B have to be applied before onset of monsoon and if nut drop prevails these have to be applied immediately after receipt of rains.

Key Words : Nutrient constraints, Arecanut, Heavy rainfall, Acid soils, Laterite

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INTRODUCTION

Arecanut (*Areca catechu* L.) is cultivated in India in an area of 3.13 lakh hectares with a production of 3.79 lakh tonnes. It is grown primarily in Karnataka,

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Kerala, Assam, Maharashtra and West Bengal. Karnataka is the leading state for arecanut with 1,68,000 hectare area and an annual production of 2.24 lakh tones (Anonymous, 2010). The major arecanut growing countries in the world are India, China, Bangladesh, Indonesia and Myanmar. India leads the world in production followed by China and Bangladesh. It is grown within a temperature range of 14°-36°C and temperature below 10°C and beyond 40°C adversely affects the crop. It requires wet soil moisture and sufficient rainfall throughout the year (1,500-5,000 mm). The depth of soil should not be less than 1 m. The soil should be well drained and water table should be at least below 4 feet. It can come up well in acidic to neutral pH soils. Conditions not fulfilling the above may cause many problems in arecanut. Nut drop is one of the problems encountered by farmers in Uttar Kannada district of Karnataka. Nut-drop is more a physiological and nutritional disorder than a pathological and insect problem of universal occurrence (Anonymous, 2014).

Tender nut drop and matured nuts drop can be due to various reasons (Anonymous, 1996) one of them being caused by a pentatomid bug, *Halyomorpha marmorea.* Premature drop of the nuts and pin-prick Iike black puncture marks on the shed nuts are the identifying symptoms. Scale insect (*Aanidiella arientalis* and *Ischnaapsis langinastris*) are seen feeding on nuts, rachillae and leaves. The damage is done by sucking the sap from the plant tissues. As a result of continuous sucking, the tissues become yellow in colour and severe feeding leads to withering and shedding of buttons/ fruits. Damage is very heavy during drought conditions. Koleroga or Mahali (*Phytophthara meadii*) heavy shedding of nuts during rainy season is the major symptom. Water soaked lesions are formed near the perianth end and as a result the nuts become dark green and finally shed. Considering the little influence of insect and pathogens for nut drop after the survey, it was decided to analyse soils of the area. To find out the nutritional reasons for nut drop in arecanut, an assessment of soil nutrient status was conducted in the area.

MATERIAL AND METHODS

A research was conducted during 2010-11 and 2011-12 involving survey of nut drop affected fields (in Sirsi and Siddapura talukas of Uttar Kannada districts), collection of soil samples from the affected fields and their analysis.

Soil samples in these two talukas were taken up where arecanut is the major crop and nut drop is severe (>100 g per plant in at least 10% of the area). The soil samples from two depths (0-30 cm and 30-60 cm depth) were collected from 12 sites in Sirsi taluka and 21 sites in Siddapura taluka before onset of monsoon (May-June) and after receipt of rain (October-November). The soils were analysed for pH, EC, organic carbon, available NPK, DTPA-Zn and available boron using standard procedures. The following standard procedures were adopted for analysis of the nutrients in the laboratory. The pH by potentiometer, EC by conductivity bridge, organic carbon by Walkley and Black's (1934) wet oxidation method, nitrogen estimation by Kjehl Tech. method, phosphorus by spectrophotometer, available potassium by flame photometer as described by (Jackson, 1973). The exchangeable calcium and magnesium by versenate titration method and available zinc and boron by DTPA method and Azomethane-H method, respectively were also carried out.

The rainfall data for the two talukas were collected from the source departments of the talukas. The soil analysis of data was correlated for finding the relation among them.

RESULTS AND DISCUSSION

The data presented in Table 1, indicated that the rainfall in the area ranged from 2500 to 3400 mm in Sirsi taluka (normal 2500 mm) and 3100 to 4200 mm in Siddapura taluka (normal 3100 mm) during 2009 to 2011. It is concentrated from June to October months of the year. According to the rainfall classification, the area can be classified under heavy rainfall area. The Siddapura taluka receives more rainfall than Sirsi taluka.

Soil properties of Sirsi during 2010-11 before the onset of monsoon :

To find the constraint for nut drop, it is discussed here from the point of deficiency of a nutrient. The soil properties of Sirsi area before onset of monsoon (Table 2) indicated that the soils are acidic in lower depths (average 6.00) which ranged from 5.80 to 6.09, while near neutral in surface soils (average 6.44) which ranged from 6.03 to 6.60. The electrical conductivity was non-saline (average 0.38 dS/m in surface soils and 0.35 dS/m in subsurface soils) in both the depths. The plant available P and K was also low in both the soil depths (<20 and <144 kg/ha). The DTPA-Zn and available boron

Table 1: Rainfall data of Sirsi and Siddapra talukas of Uttar Kannada district (mm)

Months	Sirsi				Siddapura			
	Normal	2009	2010	2011	Normal	2009	2010	2011
Jan.	0.90	0	38.50	0.00	0.3	0	16.2	0
Feb.	1.30	22.3	0.00	0.00	0.8	0	0	0
Mar.	5.00	0	0.00	12.50	2.6	36.0	0	0
Apr.	31.20	20.3	39.50	72.00	23.0	21.6	71.0	65.2
May	68.20	38.5	43.00	67.50	88.6	50.8	47.0	42.0
Jun.	512.70	257.7	443.50	1118.00	630.9	232.4	466.8	976.2
Jul.	1019.30	1582.7	822.23	753.00	1263.8	2061.6	1205.3	1163.6
Aug.	520.80	520.8	448.50	577.00	704.6	338.2	535.6	620.2
Sept.	184.60	184.6	382.50	552.20	208.4	322.6	455.2	536.2
Oct.	137.60	137.6	79.50	182.75	135.5	238.2	234.4	177.5
Nov.	45.10	45.1	278.00	80.00	45.9	934.0	107.4	88.6
Dec.	8.50	8.5	0.00	0.00	0	0	0	0
Total	2535.20	2818.1	2575.23	3414.95	3104.4	4235.4	3138.9	3669.5

Table 2: Soil analysis data of Sirsi taluka of Uttar Kannada district (before onset of monsoon 2010-11)

Sr. No.	Soil pH (1:2.5)	EC dS/m	Org.C %	Av.N kg/ha	Av.P_2O_5 kg/ha	Av.K_2O g/ha	DTPA Zn ppm	Av.B ppm
Depth : 0-30 cm								
1.	6.39	0.433	0.64	244.5	17.2	80.1	0.60	0.23
2.	6.03	0.329	0.45	268.2	13.8	83.2	0.50	0.20
3.	6.31	0.32	0.42	272.6	14.1	62.5	0.46	0.21
4.	6.62	0.398	0.54	238.4	21.3	62.5	0.54	0.22
5.	6.50	0.392	0.45	260.8	14.7	91.3	0.50	0.19
6.	6.60	0.387	0.54	256.0	13.8	62.5	0.67	0.22
7.	6.49	0.412	0.54	272.0	14.1	91.3	0.60	0.25
8.	6.23	0.402	0.45	256.0	14.6	88.9	0.50	0.23
9.	6.56	0.396	0.54	273.6	20.9	83.2	0.63	0.20
10.	6.53	0.376	0.52	273.6	15.7	62.5	0.61	0.21
11.	6.51	0.372	0.62	256.7	20.9	91.3	0.60	0.23
12.	6.55	0.356	0.77	307.2	14.7	98.7	0.50	0.20
Mean	6.44	0.38	0.54	264.97	16.32	79.83	0.56	0.22
S.D. $\pm$	0.13	0.02	0.06	11.91	2.31	10.67	0.05	0.01
C.V. %	1.94	6.15	11.68	4.49	14.17	13.36	9.77	6.06
Depth : 30-60 cm								
1.	5.80	0.356	0.83	289.6	13.3	84.03	0.46	0.21
2.	6.09	0.334	0.48	294.5	11.0	76.55	0.40	0.18
3.	5.98	0.368	0.45	257.5	11.2	57.52	0.36	0.19
4.	6.07	0.354	0.59	281.7	16.6	81.77	0.42	0.20
5.	5.98	0.356	0.83	276.5	11.9	76.55	0.40	0.17
6.	6.07	0.343	0.59	293.8	10.8	57.52	0.52	0.20
7.	6.07	0.334	0.59	276.5	10.6	84.03	0.45	0.23
8.	5.97	0.366	0.48	295.5	11.2	81.77	0.39	0.21
9.	6.03	0.352	0.45	295.5	16.7	81.77	0.50	0.18
10.	6.01	0.334	0.59	277.3	12.4	76.55	0.48	0.19
11.	5.99	0.322	0.48	331.8	16.1	84.03	0.46	0.21
12.	5.98	0.334	0.83	286.2	11.8	90.83	0.40	0.18
Mean	6.00	0.35	0.60	288.03	12.80	77.74	0.44	0.20
S.D. $\pm$	0.05	0.01	0.11	11.15	1.77	6.77	0.04	0.01
C.V. %	0.82	3.36	17.78	3.87	13.82	8.71	8.81	6.68

were also in deficient range (<0.6 and <1.0 ppm, respectively). However, the soils were found with low to medium in organic carbon and medium in available nitrogen in soil.

Being the soils laterites, they have acidic pH, it is quite obvious. Low EC may be attributed to high rainfall. This was due to leaching of soluble salts by high rainfall. Low P and K in these soils may be because of the fact that the native P and K reserves may be low in these laterites. Though the soils are acidic, the micronutrient Zn was found deficient which may because of leaching losses. It is quite obvious that plant available boron in acid soils would be in deficient range.

After receipt of rains :

The properties data (after receipt of rains) (Table 3) indicated that the soils have become more acidic than initial level. However in lower depths it raised (average 5.70) from the previous level which ranged from 5.51 to 5.79, while in surface soils the average pH was 6.12 with range of 5.73 to 6.29. The impact of leaching down of basic cations due to heavy rainfall (150-400 cm) and

Table 3 : Soil analysis data of Sirsi taluk of Uttar Kannada district (after receipt of rains, 2010-11)

Sr.No.	Soil pH (1:2.5)	EC dS/m	Org.C %	Av.N kg/ha	Av.P_2O_5 kg/ha	Av.K_2O kg/ha	DTPA Zn ppm	Av.B ppm
Depth : 0-30 cm								
1.	6.07	0.40	0.66	259.17	16.2	75.3	0.6	0.22
2.	5.73	0.30	0.46	284.29	13.0	78.2	0.5	0.19
3.	5.99	0.29	0.43	288.96	13.3	58.8	0.4	0.20
4.	6.29	0.37	0.56	252.70	20.0	58.8	0.5	0.21
5.	6.18	0.36	0.46	276.45	13.8	85.8	0.5	0.18
6.	6.27	0.36	0.56	271.36	13.0	58.8	0.6	0.21
7.	6.17	0.38	0.56	288.32	13.3	85.8	0.6	0.24
8.	5.92	0.37	0.46	271.36	13.7	83.6	0.5	0.22
9.	6.23	0.36	0.56	290.02	19.6	78.2	0.6	0.19
10.	6.20	0.35	0.54	290.02	14.8	58.8	0.6	0.20
11.	6.18	0.34	0.64	272.10	19.6	85.8	0.6	0.22
12.	6.22	0.33	0.80	325.63	13.8	92.8	0.5	0.19
Mean	6.12	0.35	0.56	280.87	15.34	75.06	0.54	0.21
S.D. ±	0.12	0.02	0.07	12.62	2.16	10.01	0.05	0.01
C.V. %	1.94	6.32	12.07	4.49	14.07	13.33	9.94	6.35
Depth : 30-60 cm								
1.	5.51	0.33	0.86	307.0	12.50	78.99	0.43	0.20
2.	5.79	0.31	0.50	312.2	10.34	71.96	0.38	0.17
3.	5.68	0.34	0.47	273.0	10.53	54.07	0.34	0.18
4.	5.77	0.33	0.61	298.6	15.60	76.86	0.39	0.19
5.	5.68	0.33	0.86	293.1	11.19	71.96	0.38	0.16
6.	5.77	0.32	0.61	311.4	10.15	54.07	0.49	0.19
7.	5.77	0.31	0.61	293.1	9.96	78.99	0.42	0.22
8.	5.67	0.34	0.50	313.2	10.53	76.86	0.37	0.20
9.	5.73	0.32	0.47	313.2	15.70	76.86	0.47	0.17
10.	5.71	0.31	0.61	293.9	11.66	71.96	0.45	0.18
11.	5.69	0.30	0.50	351.7	15.13	78.99	0.43	0.20
12.	5.68	0.31	0.86	303.4	11.09	85.38	0.38	0.17
Mean	5.70	0.32	0.62	305.32	12.03	73.08	0.41	0.19
S.D. ±	0.05	0.01	0.11	11.82	1.66	6.37	0.03	0.01
C.V. %	0.85	3.16	17.69	3.87	13.81	8.71	8.43	7.04

high organic matter content were the reasons behind the pH values observed to be vary from strong to slight acidic in nature (Ananthanarayana and Perur, 1973). Further, it is noted that between 0-30 and 30-60 cm, samples recorded slightly more acidity in top layer may be due to decomposition of organic matter as it also supports the more mean values of organic carbon in those layers. Also, the salt proportions were very low in the soils studied (0.01 - 0.13 dS m^{-1}) across locations. This is due to leaching of soluble salts due to well distributed rainfall (Jayaprakash *et al.*, 2012).

The electrical conductivity remained non-saline (average 0.35 dS/m in surface soils and 0.32 dS/m in subsurface soils) in both the depths. Low electrical conductivity of soils indicate that the conditions prevailed was not favourable for accumulation of salts (Roy and Landey, 1962). The plant available P and K were also remained low in both the soil depths (<20 and <144 kg/ha). Ananthanarayana *et al.* (1986) have observed in their studies that the soils of Malnad area are low in exchangeable cations, including potassium. The DTPA-Zn and available boron were also remained in deficient range (<0.6 and <1.0 ppm, respectively). However, the soils were found with medium organic carbon and low

Table 4 : Soil analysis data of Siddapura taluk of Uttar Kannada district (before onset of monsoon, 2010-11)

Sr. No.	Soil pH (1:2.5)	EC dS/m	Org.C %	Av.N kg/ha	Av.P_2O_5 kg/ha	Av.K_2O kg/ha	DTPA Zn ppm	Av.B ppm
Depth : 0-30 cm								
1.	5.52	0.193	0.85	305.6	16.0	86.5	0.345	0.24
2.	5.48	0.129	0.92	335.2	18.7	68.5	0.402	0.20
3.	5.80	0.120	0.92	340.8	13.6	66.0	0.306	0.20
4.	5.80	0.178	0.80	298.0	18.6	80.5	0.386	0.22
5.	5.56	0.192	0.56	326.0	14.6	82.0	0.300	0.20
6.	5.80	0.167	0.52	320.0	12.0	85.0	0.443	0.22
7.	5.76	0.172	0.68	340.0	12.6	86.0	0.432	0.24
8.	5.45	0.182	0.56	320.0	18.9	82.0	0.334	0.22
9.	5.74	0.176	0.68	342.0	12.8	94.0	0.400	0.22
10.	5.84	0.156	0.70	342.0	14.0	84.0	0.442	0.22
11.	5.86	0.152	0.88	320.9	18.9	83.5	0.345	0.22
12.	5.83	0.156	0.93	384.0	12.9	82.0	0.432	0.20
Mean	5.70	0.16	0.75	331.21	15.30	81.67	0.38	0.22
S.D. ±	0.12	0.02	0.12	14.88	2.25	4.62	0.04	0.01
C.V. %	2.17	10.21	16.41	4.49	14.68	5.65	11.03	4.73
Depth : 30-60 cm								
1.	5.320	0.175	0.868	317	15.71	69.8	0.339	0.20
2.	5.240	0.111	0.938	348	18.35	59.7	0.395	0.18
3.	5.520	0.101	0.939	356	13.35	58.1	0.300	0.18
4.	5.480	0.163	0.815	320	18.33	66.2	0.380	0.18
5.	5.440	0.187	0.565	350	14.53	66.3	0.299	0.16
6.	5.600	0.159	0.528	346	11.91	70.8	0.440	0.18
7.	5.480	0.147	0.705	351	12.28	71.2	0.421	0.20
8.	5.130	0.155	0.587	332	18.40	67.1	0.325	0.19
9.	5.580	0.164	0.692	355	12.64	77.5	0.395	0.18
10.	5.600	0.139	0.717	356	13.76	70.9	0.434	0.19
11.	5.540	0.131	0.901	336	18.50	70.8	0.338	0.19
12.	5.550	0.143	0.943	406	12.74	69.2	0.427	0.17
Mean	5.46	0.15	0.77	347.75	15.04	68.13	0.37	0.18
S.D. ±	0.11	0.02	0.12	13.50	2.17	3.58	0.04	0.01
C.V. %	1.96	12.01	16.16	3.88	14.40	5.25	11.14	4.48

to medium in plant available N. Low to medium organic C may be attributed to the elevation of the place 'Sirsi', which is at the highest elevation compared to the adjoining talukas.The heavy rainfall must have taken away the organic carbon added through the forest. Shukla *et al.* (1965) also observed wide variations of nitrogen in their studies.

Soil properties of Siddapura during 2010-11:

Before the onset of monsoon :

The results of initial soil properties data (before onset of monsoon) (Table 4) indicated that the soils are more acidic than Sirsi soils. Again in lower depths it was more acidic (average 5.70) which ranged from 5.13 to 5.60, while acidic in surface soils (average 5.70) which ranged from 5.48 to 5.86. The electrical conductivity was non saline and low (average 0.16 dS/m in surface soils and 0.15 dS/m in subsurface soils) in both the depths. The plant available P and K was also low in both the soil depths (<20 and <144 kg/ha). The DTPA-Zn and available boron were also in deficient range (<0.6 and <1.0 ppm, respectively). However, the soils were found with medium to high in organic carbon and plant available N.

Table 5 : Soil analysis data of Siddapura taluk of Uttar Kannada district (after receipt of rains, 2010-11)

Sr.No.	Soil pH (1:2.5)	ECdS/m	Org.C %	Av.N kg/ha	Av.P_2O_5 kg/ha	Av.K_2O kg/ha	DTPA Zn ppm	Av.B ppm
Depth : 0-30 cm								
1.	5.24	0.18	0.88	323.9	15.04	81.31	0.32	0.23
2.	5.21	0.12	0.96	355.3	17.58	64.39	0.38	0.19
3.	5.51	0.11	0.96	361.2	12.78	62.04	0.29	0.19
4.	5.51	0.16	0.83	315.9	17.48	75.67	0.36	0.21
5.	5.28	0.18	0.58	345.6	13.72	77.08	0.28	0.19
6.	5.51	0.15	0.54	339.2	11.28	79.90	0.42	0.21
7.	5.47	0.16	0.71	360.4	11.84	80.84	0.41	0.23
8.	5.18	0.17	0.58	339.2	17.77	77.08	0.31	0.21
9.	5.45	0.16	0.71	362.5	12.03	88.36	0.38	0.21
10.	5.55	0.14	0.73	362.5	13.16	78.96	0.42	0.21
11.	5.57	0.14	0.92	340.2	17.77	78.49	0.32	0.21
12.	5.54	0.14	0.97	407.0	12.13	77.08	0.41	0.19
Mean	5.42	0.15	0.78	351.08	14.38	76.77	0.36	0.21
S.D. $\pm$	0.12	0.02	0.13	15.76	2.11	4.34	0.04	0.01
C.V. %	2.17	10.71	16.45	4.49	14.69	5.65	11.66	4.96
Depth : 30-60 cm								
1.	5.05	0.16	0.90	336.0	14.77	65.61	0.32	0.19
2.	4.98	0.10	0.98	368.9	17.25	56.12	0.37	0.17
3.	5.24	0.09	0.98	377.4	12.55	54.61	0.28	0.17
4.	5.21	0.15	0.85	339.2	17.23	62.23	0.36	0.17
5.	5.17	0.17	0.59	371.0	13.66	62.32	0.28	0.15
6.	5.32	0.15	0.55	366.8	11.20	66.55	0.41	0.17
7.	5.21	0.14	0.73	372.1	11.54	66.93	0.40	0.19
8.	4.87	0.14	0.61	351.9	17.30	63.07	0.31	0.18
9.	5.30	0.15	0.72	376.3	11.88	72.85	0.37	0.17
10.	5.32	0.13	0.75	377.4	12.93	66.65	0.41	0.18
11.	5.26	0.12	0.94	356.2	17.39	66.55	0.32	0.18
12.	5.27	0.13	0.98	430.4	11.98	65.05	0.40	0.16
Mean	5.18	0.14	0.80	368.63	14.14	64.05	0.35	0.17
S.D. $\pm$	0.10	0.02	0.13	14.32	2.04	3.37	0.04	0.01
C.V. %	1.97	12.36	16.19	3.88	14.41	5.25	11.02	4.73

The Siddapura soils are laterites, hence, they have acidic pH, it is quite obvious. The soils are acidic due to high rainfall (>3500 mm) and leaching of bases. Low EC may be due to the high rainfall in the region during past several years . Low P and K in these soils also may be because of the fact that the native P and K reserves may be low in these laterites. Though the soils are acidic, the micronutrient Zn was found deficient which may because of leaching losses. It is quite obvious that plant available boron in acid soils would be in deficient range. It is also obvious that the area has dense forest which contributes sufficient organic matter to soil and must have built-up organic carbon and plant available nitrogen in these soils.

The available K, DTPA-Zn and available B need to be corrected immediately by giving extra dose of respective fertilizers after heavy rains. To improve the soil pH, it is necessary to apply lime / dolomite, to improve EC level and available potash status of soil there is a need to apply extra dose of potash. To increase available

Table 6 : The correlation between soil properties and nutrients

	Available N	Available P_2O_5	Available K_2O	DTPA Zn	Available B
Sirsi					
Sirsi (0-30 cm): Before onset of monsoon					
Soil pH	0.01	0.45	-0.15	0.54	0.06
EC	-0.49	0.30	0.15	0.53	0.50
Organic C	0.35	0.27	0.37	0.28	0.12
Sirsi (0-30 cm): After receipt of rain					
Soil pH	0.01	0.44	-0.15	0.43	0.06
EC	-0.48	0.28	0.11	0.62	0.50
Organic C	0.36	0.27	0.36	0.39	0.12
Sirsi (30-60 cm): Before onset of monsoon					
Soil pH	-0.02	-0.05	-0.22	0.10	-0.10
EC	-0.52	-0.07	-0.33	-0.40	-0.12
Organic C	-0.20	-0.17	0.33	-0.04	-0.17
Sirsi (30-60 cm): After receipt of rain					
Soil pH	-0.02	-0.05	-0.22	0.11	-0.09
EC	-0.52	-0.12	-0.36	-0.43	-0.06
Organic C	-0.20	-0.17	0.33	-0.04	-0.18
Siddapura					
Siddapura (0-30 cm): Before onset of monsoon					
Soil pH	0.31	-0.43	0.15	0.42	0.01
EC	-0.42	-0.01	0.75	-0.09	0.53
Organic C	0.27	0.26	-0.50	-0.07	-0.25
Siddapura (0-30 cm) : After receipt of rain					
Soil pH	0.31	-0.42	0.14	0.43	0.01
EC	-0.44	0.03	0.71	-0.19	0.53
Organic C	0.28	0.25	-0.50	-0.06	-0.25
Siddapura (30-60 cm): Before onset of monsoon					
Soil pH	0.41	-0.64	0.42	0.42	-0.20
EC	-0.28	-0.11	0.57	-0.04	-0.12
Organic C	0.19	0.27	-0.41	-0.08	0.11
Siddapura (30-60 cm) : After receipt of rain					
Soil pH	0.41	-0.64	0.41	0.41	-0.20
EC	-0.28	-0.15	0.61	0.04	-0.08
Organic C	0.19	0.27	-0.42	-0.09	0.10

P, there is a need to apply rock phosphate. The recommended dose of N may be continued. The recommended dose of Zn and B have to be applied before onset of monsoon.

After receipt of rains :

The properties data (after receipt of rains) indicated that the soils have become more acidic than the initial level (Table 5). However, in lower depths it raised from the previous level which ranged from 5.05 to 5.32 (average 5.18), while in surface soils the average pH was 5.42 which ranged from 5.18 to 5.57. Chandran *et. al.* (2005) also reported the impact of leaching of cations due to heavy rainfall and high organic matter content were the reasons behind the pH values observed to be vary from strong to slight acidic in nature (Gajanan *et al.*, 1978). The electrical conductivity was non saline and low (average 0.16 dS/m in surface soils and 0.14 dS/m in subsurface soils) in both the depths. It may be due to the high rainfall in the region during past several years. Further, it is noted that between 0-30 and 30-60 cm, samples recorded slightly more acidity in top layer may be due to decomposition of organic matter as it also supports the more mean values of organic carbon in those layers. Also, the salt proportions were very low in the soils studied across locations. This is due to leaching of soluble salts due to well distributed rainfall (Jayaprakash *et al.,* 2012).

The plant available P and K was also low in both the soil depths (<20 and <144 kg/ha). It may be because of the fact that the native P and K reserves may be low in these laterites. Moreover, the iron content under acidic nature of soils might complex with soluble phosphorus and become unavailable to plants. At the same time, addition of lime to correct the acidic pH would also leach out the exchangeable K leading to its deficiency. The DTPA-Zn and available boron were also in deficient range (<0.6 and <1.0 ppm, respectively). Though the soils are acidic, the micronutrient Zn was found deficient which may be because of leaching losses (Jyothi *et al.*, 2009). The DTPA- Zn content in 0–30 and 30– 60 cm depth did not vary much. The DTPA-Zn showed positive significance with OC and exchangeable cation in almost all the locations studied. Organic carbon content in 0–30 cm depth had higher value compared to 30–60 cm depth. It is quite obvious that plant available boron in acid soils would be in deficient range. The soils were found with medium to high in organic carbon and plant available N. It is also obvious that the area has dense forest which contributes sufficient organic matter to soil and must have increased organic carbon and plant available nitrogen in these soils. Among the talukas studied the soils of Sirsi had lower organic carbon content in 30–60 cm depth compared to 0–30 cm depth while, Siddapura soils recorded wider range and higher values.

The available K, DTPA-Zn and available B were found to be deficient in these soils and need to be corrected immediately by giving extra dose of respective fertilizers after heavy rains. The nutrients and other soil properties status if not improved may become serious constraints for nut drop in arecanut in the area. To improve the soil pH, it is necessary to apply lime / dolomite, to improve EC level and available potash status of soil, there is a need to apply extra dose of potash to soil than the recommended dosage. To increase available P in acidic soils, there is a need to apply rock phosphate. Since the available N is medium to high, the recommended dose of N may be continued. The recommended dose of Zn and B have to be applied before onset of monsoon and if nut drop prevails after receipt of rains these have to be applied immediately after receipt of rains once again.

Conclusion :

The results indicated that the soil pH due to heavy rainfall (2500 to 3500 mm) was slightly lowered but there was more reduction in EC and available K after receipt of rainfall as compared to initial values. Similarly the organic carbon and available N have increased but DTPA-Zn and available B remained low and not affected much as compared to initial status. Depth-wise soil analysis indicated that surface soil were having more acidic pH, low salts, higher organic C, higher available NPK than sub-soils. Further, these were lowered after receipt of rain, particularly EC and potash. The available Zn and B have remained deficient. The available K, DTPA-Zn and available B were found to be deficient in these soils and need to be corrected immediately by giving extra dose of respective fertilizers after heavy rains. The nutrients and other soil properties status if not improved may become serious constraints for nut drop in arecanut in the area. To improve the soil pH, it is necessary to apply lime / dolomite, to improve EC level and available potash status of soil there is a need to apply extra dose of potash to soil than the recommended dosage. To increase available P in acidic soils, there is a need to apply rock phosphate. Since the available N is medium to high, the recommended dose of N may be continued. The recommended dose of Zn and B have to be applied before onset of monsoon and if nut drop prevails after receipt of rains these have to be applied immediately after receipt of rains once again.

REFERENCES

Ananthanarayana, R. and Perur, N. G. (1973). Characterization of some acid soils of Mysore state. *Mysore J. Agric. Sci.*, **7** : 349 – 353.

Ananthanarayana, R., Reddy M.N., Mithyantha, M.S. and Perur N.G. (1986). Status of available secondary nutrients in acid soils of Karnataka. *J. Indian Soc. Soil Sci.*, **34** (5) : 614-616.

Anonymous (1996). *NBSS & LUP Annual Rep*., ICAR, Nagpur, pp.12.

Bhat, N.T. and Mohapatra, A. R. (1981). Scientific management for arecanut soils of coastal Karnataka. *J. Indian Soc. Soil Sci*., **42** : 436 – 438.

Chandran P., Ray, S.K., Bhattacharyya, T., Srivastava, P., Krishnan, P. and Pal, D.K. (2005). Lateritic soils of Kerala, India: Their mineralogy, genesis and taxonomy. *Australian J. Soil Res.*, **43** (7): 839-852.

Gajanan, G.N., Upadyaya, G.S. and Deshpande, P.B. (1978). Factors affecting the lime requirement of coastal acid soil of Karnataka. *J. Indian Soc. Soil Sci*., **26** : 301.

Jackson, M.L. (1973). *Soil chemical analysis*, Prentice Hall of India (Pvt.) Ltd., NEW DELHI, INDIA.

Jayaprakash, R., Shetty, Y. Vishwanath , Punitha, B.C. and Shilpashree, V.M. (2012). Status of macronutrient in traditional arecanut growing soils. *Indian J. Fundamen. & Appl. Life Sci.*, **2** (1) : 59 -62.

Jyothi,T.V., Shetty, Y.Vishwanatha and Kumar, M. Dinesh (2009). Characterization and DTPA- Zn status in traditional arecanut garden soils of south Karnataka. *Karnataka J. Agric. Sci.*, **22**(5) : 1013-1015.

Roy, B.B. and Landey, R.I. (1962). Studies on red and lateritic soils of Mond watershed area of Raigarh district. *Indian J.Agric. Sci.*, **32**(6): 294-302.

Shukla, S.S., Ray, Chudhuri S.P. and Anjeneyalu, B.S.R. (1965). Studies on some foot hill soils of Himalaya. *J. Indian Soc. Soil Sci.*, **13** (6) : 115-122.

Walkley, A.J. and Black, C.A. (1934). Estimation of soil organic carbon by the chromic and titration method. *Soil Sci.*, **37**(5): 37-38.

WEBLIOGRAPHY:

Anonymous (2010). Directorate of arecanut and soils development. website: *decuet.nic.in/spices/events/totalevents.asp*.

Anonymous (2014). Agriculture planning and information bank: Package of Practice for Arecanut, *http://megapib.nic.in/pparecanut.htm*