The Pharma Innovation Journal 2022; 11(12): 4234-4239

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 4234-4239

www.thepharmajournal.com
Received: 19-10-2022
Accepted: 25-11-2022

Jayaprakash SM
Department of Soil Science and Agricultural Chemistry, ZAHRS, Brahmavar, KSNUAHS, Shivamogga, Karnataka, India

Faijalahmadmulla
Department of Soil Science and Agricultural Chemistry, KSNUAHS, Shivamogga, Karnataka, India

Thippeshappa GN
Professor and Head, Department of Soil Science and Agricultural Chemistry, KSNUAHS, Shivamogga, Karnataka, India

Naveen NE
Scientist, Department of Agronomy, KVK, Brahmavar, Udupi, Karnataka, India

Chaitanya HS
Scientist, Department of Horticulture, KVK, Brahmavar, Udupi, Karnataka, India

Pruthvi Raj HM
Department of Soil Science and Agricultural Chemistry, ZAHRS, Brahmavar, KSNUAHS, Shivamogga, Karnataka, India

Lakshman
Associate Director of Research, ZAHRS, Brahmavar, KSNUAHS, Shivamogga, Karnataka, India

Corresponding Author:
Jayaprakash SM
Department of Soil Science and Agricultural Chemistry, ZAHRS, Brahmavar, KSNUAHS, Shivamogga, Karnataka, India

Characterization of soils of micronutrients under arecanut based cropping systems in the coastal region of Udupi District

Jayaprakash SM, Faijalahmadmulla, Thippeshappa GN, Naveen NE, Chaitanya HS, Pruthvi Raj HM and Lakshman

Abstract
The fertility status of soils under arecanut based cropping systems in Coastal region of Udupi district was studied by GPS based soil survey which was carried out in the farmer's field in three taluks of Udupi district *viz*., Udupi, Kundapura and Karkala taluks during the period of 2019 to 2021 in order to know the "Status of micro nutrients under arecanut based cropping systems in the coastal region of Udupi district" by using Arc GIS 10.4 software. Surface soil samples were collected from soils under arecanut based cropping systems in Udupi district and were analysed for physical and micro nutrients. Study revealed that soils are sandy clay loam in texture and soil pH was extremely acidic to strongly acidic range with soil pH ranged from 4.03 to 6.60, organic carbon status is medium to high with normal electrical conductivity. Analytical results showed that DTPA extractable micronutrients like zinc, iron, manganese and copper ranged from 0.02 to 1.04, 10.56 to 29.04, 4.48 to 14.52 and 0.16 to 6.42 mg kg^{-1}. The DTPA extractable micronutrients iron, manganese and copper are found sufficient whereas zinc found deficient in soils under arecanut based cropping systems of Udupi district.

Keywords: Arecanut, micronutrients, coastal region, GPS and Arc GIS

Introduction
The Arecanut palm (*Areca catechu* Linn.) is one of the most profitable commercial plantation crop grown in the humid tropics of India. The area under arecanut cultivation in Udupi district has increased, the total area of arecanut cultivation in Udupi was about 21,365 hectares. In India, the crop is grown in an area of 2.68 lakh hectares with a production of 3.34 lakh tones (Nampoothiri, 2000) [5]. India ranks first in area (47%), production (47%) and 4th in productivity. As such crop like arecanut is perennial in nature and their productivity is affected by many reasons, out of which soil nutrient imbalance is one of the important productivity constraints. The incidence of micronutrient deficiencies in soils increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, decreased proportions of farm manure compared to chemical fertilizers, increased purity of chemical fertilizers and use of marginal lands for crop production. Micronutrients are important for maintaining soil health and also increasing productivity of crops Ratan *et al*. (2009) [8]. The soil must supply micronutrients for desired growth of plants. Increased removal of micronutrients as a consequence of adoption of high yielding varieties (HYV's) and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil. The improper nutrient management has led to emergence of multi-nutrient deficiencies in the Indian soils (Sharma 2008) [11]. Keeping in view the close relationship between soil properties and available zinc and iron, the present study was undertaken to analysis the micronutrient status under arecanut based cropping systems in coastal region of Udupi district.

Material and Methods
Study area
Udupi district situated between the foothills of the Western Ghats in the East and the Arabian Sea in the West. The region lies between 13° 34' N latitude and 74° 75' E longitudes, covering an area of 3,582 sq. km. The district is roughly 88 kilometers long and 100 kilometers broad at its widest point. It includes three distinct natural regions: a coastal region with a 98-kilometer-long coastal belt, a midland plain topography, the Malnad region and the ghats.

Udupi district has varied climatic zones. The mean temperature ranges from 22 °C (72 °F) in winter to 37 °C (99 °F) in summer. The annual precipitation of Udupi district is 4,119 mm per annum. District is blessed with high rainfall from the south-west monsoon (June to September).

Soil samples collection

One fifty three surface soil samples were collected from three taluks of Udupi district (Udupi, Kundapura and Karkala). These surface soil samples were air dried, sieved and analyzed for particle size distribution (Representative 35 soil samples) and soil reaction (pH), electrical conductivity (EC), soil organic carbon (OC) and micronutrient status by adopting standard procedures.

Soil analysis

Particle size distribution was determined with international pipette method as described by (Piper, 1966) [7]. Soil pH was determined for 1:2.5 soil: water suspension by using digital pH meter fitted with combined electrodes (Jackson, 1973) [2]. Soil organic carbon was estimated by wet oxidation method (Walkley and Black, 1934) [13]. The DTPA extractable micronutrients estimated as described by (Lindsay and Norvell, 1978) [3].

Statistical analysis

The correlation analysis of data was computed in relation to available major nutrients content with different physicochemical properties of the soils as suggested by Sundararaj, N. *et al*., 1972.

Preparation of maps

Maps of soil survey of farmer's field were generated based on x, y coordinates recorded in the farmer's field using GPS. Maps showing the spatial distribution of low, medium and high area for individual major nutrients and digitalized by using Arc GIS 10.4 software.

Results and discussion

The results presented in Table 1 indicates that the particle size distribution of selected soils under different arecanut based cropping systems in coastal regions of Udupi district. It was noticed that in the 35 representative soils of Udupi district, the sand content varied from 50.87 to 79.13 per cent, silt was in the range of 6.77 to 18.35 per cent and clay content in these soils ranged from 12.5 to 33.11 per cent. As per textural diagram given by USDA, it was noticed that 74 per cent of the samples were recorded a sandy clay loam and the remaining 26 per cent belong to sandy loam texture. Hence, majority of soils had a sandy clay loam texture. This is due to the fact that these were derived from coarse grained parent materials and also by transportation and accumulation of finer particles from uplands towards low lands through runoff due to heavy rainfall. Sahu *et al*., (1983) [9] have also reported similar observations.

From the result Table 2, 3 and 4, it was noticed that all soil samples collected from Udupi district were recorded the pH in the range of 5.04 to 6.65, 4.09 to 6.12 and 4.03 to 6.48 with average values of 5.59, 5.01 and 4.81 in Udupi, Kundapura and Karkala taluk, respectively. The median of pH is 5.52, 5.10, 4.64 with standard deviation of 0.41, 0.54 and 0.53 indicating the acid nature. Among the taluks of Udupi district soil acidity was more prominent in Karkala taluk followed by Kundapura and Udupi taluks. The acidic nature of these soils may be attributed to the high intensity of weathering coupled with intensive leaching of bases due to heavy rainfall. Similar results also reported by (Sathyanarayana and Biswas, 1970) [10]. Electrical conductivity of soils ranged from 0.079 to 0.606, 0.065 to 0.841 and 0.08 to 0.39 dSm^{-1} with average values of 0.367, 0.259 and 0.190 dSm^{-1} in Udupi, Kundapura and Karkala taluk, respectively. The median of EC is 0.36, 0.22, 0.18 with standard deviation of 0.14, 0.16 and 0.08 enlightening that soils were normal with respect to EC might be due to continues leaching of soluble salts with water through rain water from surface soil (Padhan *et al*., 2016) [6]. Organic carbon content was found to be in the range of 3.0 to 24.0, 3.2 to 17.3 and 3.3 to 17.3 g kg^{-1} with average values of 10.27, 9.7 and 9.1 g kg^{-1} in Kundapura, Karkala and Udupi taluks, respectively. The median of Organic carbon is 8.5, 8.95, 9.45 with standard deviation of 3.46, 4.14 and 3.53, it was observed that low to high in OC status. These variations in organic carbon status were related to agricultural activities, namely crop management, particularly the use of FYM, fertilizers, green manure and plant residues Bhat and Mohapatra (1981) [1] observed similar findings.

Results represented in Table 2, 3 and 4 indicated that zinc content varied from 0.10 to 0.94, 0.04 to 0.96 and 0.02 to 1.04 mg kg^{-1} with an average value of 0.41, 0.48 and 0.50 mg kg^{-1} and median and standard deviation values of 0.4, 0.49, 0.52 mg $kg^{-1}$and 0.20, 0.26, 0.27 in Udupi, Kundapura and Karkala taluks, respectively. Whereas iron content ranged from 10.82 to 23.78, 10.56 to 28.86 and 11.42 to 29.04 mg kg^{-1} with an average value 16.15, 21.27 and 22.53 mg kg^{-1} and median and standard deviation values of 16.24, 21.43, 24.65 mg kg^{-1} and 3.01, 4.91, 4.63 in Udupi, Kundapura and Karkala taluks, respectively. Similarly manganese content ranged from 4.48 to 11.89, 5.38 to 14.43 and 5.71 to 14.52 mg kg^{-1} with an average value 7.82, 10.54 and 11.29 mg kg^{-1} and median and standard deviation values of mg kg^{-1} 7.89, 10.51, 12.32 and 1.72, 2.46, 2.27 in Udupi, Kundapura and Karkala taluks, respectively. The copper content ranged from 0.21 to 5.13, 0.18 to 6.42, 0.16 to 6.02 mg kg^{-1} with an average value 1.81, 2.38 and 2.07 mg kg^{-1} and median and standard deviation values of 1.68, 1.98, 1.72 mg kg^{-1} and 1.44, 1.61, 1.09 in Udupi, Kundapura and Karkala taluks, respectively.

Among the micronutrients, only zinc deficiency was observed, which was varied from 64 to 82 per cent in different taluks with mean 67 per cent deficiency in the Udupi district soils. Other micronutrients such as iron, manganese and copper were found in the sufficiency range in all taluks of the Udupi district (Table 5, Fig 1, 2, 3, 4 & 5).

Deficiency of zinc content in the soils is attributed to the crop uptake and high rainfall in the study area resulted in heavy leaching losses of zinc. The results are in similarly with the findings of Mini (2003) [4] and it was observed that all soils recorded available iron above the critical limit (4.0 mg kg^{-1} soil). Similar results were noticed in all the taluks of Udupi district. This was attributed to the soils were derived from granite and gneiss parents rocks with hot humid climatic condition resulted in development of lateric type soils which are rich in iron and aluminium hydro oxides. Sufficiency level of available copper in arecanut soils might be attributed to Bordeaux mixture spraying to control fruit rot (koleroga) disease may be added copper to soil, resulted above the critical limit (0.2 mg kg^{-1} soil) and also sufficiency of copper might be due to acidic nature of soil, with decrease in soil pH

and adsorption of copper to the permanent charges will decrease, which makes higher availability of copper. Moreover, Cu being ingredient in fungicide and their frequent application either to soil or crops might have increased their level in the soils. Sufficiency of manganese might be attributed to chelation by organic compounds released during decomposition of organic matter. These results are in accordance with the findings of Verma *et al*. (2005) [12].

Table 1: Particle size distribution soils under arecanut based cropping systems in Udupi district

Sl. No.	Parameter	Units	Maximum	Minimum	Average/mean	Median	S.D.
1.	Sand	%	79.13	50.87	64.93	65.10	8.37
2.	Silt		18.35	6.77	10.91	10.18	3.36
3.	Clay		33.11	12.50	23.87	26.08	6.21

Table 2: Descriptive statistics of analytical results of soils under arecanut based cropping systems in Udupi taluk

Sl. No.	Parameter	Units	Maximum	Minimum	Average/mean	Median	S. D.
1.	pH		6.65	5.04	5.59	5.52	0.41
2	EC	(dSm^{-1})	0.60	0.07	0.36	0.36	0.14
3.	OC	(g kg^{-1})	17.30	3.30	9.10	8.50	3.46
4.	Av. Fe	(mg kg-1)	23.78	10.82	16.15	16.24	3.01
5.	Av. Zn		0.68	0.10	0.41	0.40	0.20
6.	Av. Mn		11.89	4.48	7.82	7.89	1.72
7.	Av. Cu		3.04	0.21	1.81	1.68	1.44

Table 3: Descriptive statistics of analytical results of soils under arecanut based cropping systems in Kundapura taluk

Sl. No.	Parameter	Units	Maximum	Minimum	Average/mean	Median	S. D.
1.	pH		6.12	4.09	5.01	5.10	0.54
2	EC	(dSm^{-1})	0.84	0.06	0.25	0.22	0.16
3.	OC	(g kg^{-1})	24.0	3.0	10.27	8.95	4.14
4.	Av. Fe	(mg kg-1)	28.86	10.56	21.27	21.43	4.91
5.	Av. Zn		0.97	0.05	0.48	0.49	0.26
6.	Av. Mn		14.43	5.38	10.54	10.51	2.46
7.	Av. Cu		6.42	0.18	2.38	1.98	1.61

Table 4: Descriptive statistics of analytical results of soils under arecanut based cropping systems in Karkalla taluk.

Sl. No.	Parameter	Units	Maximum	Minimum	Average/mean	Median	S. D.
1.	pH		6.48	4.03	4.81	4.64	0.53
2	EC	(dSm^{-1})	0.39	0.08	0.19	0.18	0.08
3.	OC	(g kg^{-1})	17.3	3.2	9.7	9.45	3.53
4.	Av. Fe	(mg kg-1)	29.04	11.42	22.53	24.65	4.63
5.	Av. Zn		1.04	0.03	0.50	0.52	0.27
6.	Av. Mn		14.52	5.71	11.29	12.32	2.27
7.	Av. Cu		6.02	0.16	2.07	1.72	1.09

Table 5: Categorization of soil micronutrients (mg kg^{-1}) under arecanut based cropping systems in soils of Udupi district

	Taluk Categorization	Udupi (17)	Kundapura (60)	Karkala (76)	Udupi District (153)
Zn	Deficiency (< 0.6)	14 (82.3)	40 (66.6)	49 (64.4)	103 (67.3)
	Sufficiency (> 0.6)	3 (17.7)	20 (33.4)	27 (35.6)	50 (32.7)
Fe	Deficiency (< 4.0)	-	-	-	-
	Sufficiency (> 4.0)	17 (100)	60 (100)	76 (100)	153 (100)
Mn	Deficiency (< 2.0)	-	-	-	-
	Sufficiency (> 2.0)	17 (100)	60 (100)	76 (100)	153 (100)
Cu	Deficiency (< 0.2)	-	1 (1.6)	1 (1.3)	2 (1.3)
	Sufficiency (> 0.2)	17 (100)	59(98.4)	75 (98.7)	151 (98.7)

Table 6: Co relation b/w soil physic chemical properties with major nutrients of Udupi district

	pH	OC	Fe	Zn	Mn	Cu
pH	1.000					
OC	-0.812**	1.000				
Fe	-0.858**	0.958**	1.000			
Zn	-0.856**	0.913**	0.949**	1.000		
Mn	-0.695**	0.816**	0.848**	0.876**	1.000	
Cu	-0.855**	0.882**	0.933**	0.920**	0.695**	1.000

*Significant at 5% = (0.329)
** Significant at 1% = (0.424)

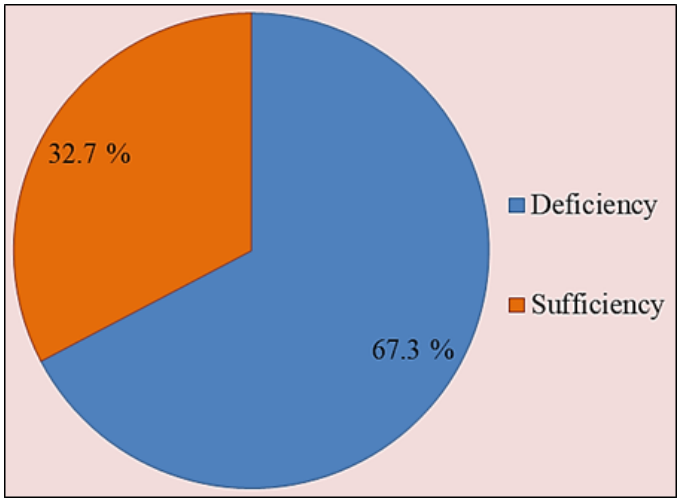


Fig 1: Percentage of available zinc status of soils under arecanut based cropping systems in Udupi district, Coastal Karnataka

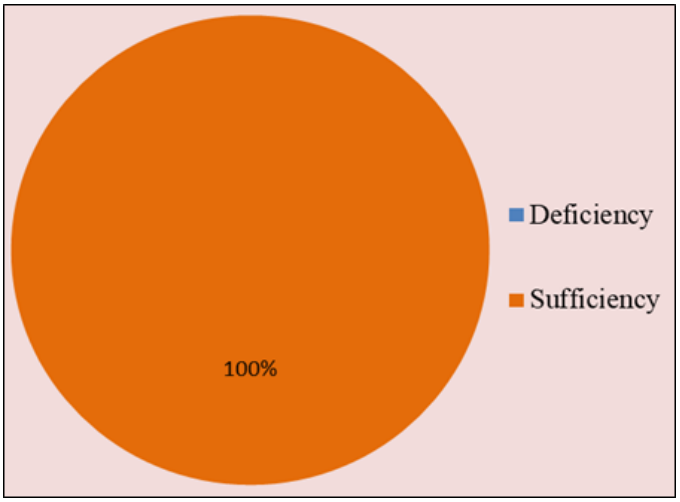


Fig 2: Percentage of available iron status of soils under arecanut based cropping systems in Udupi district, Coastal Karnataka

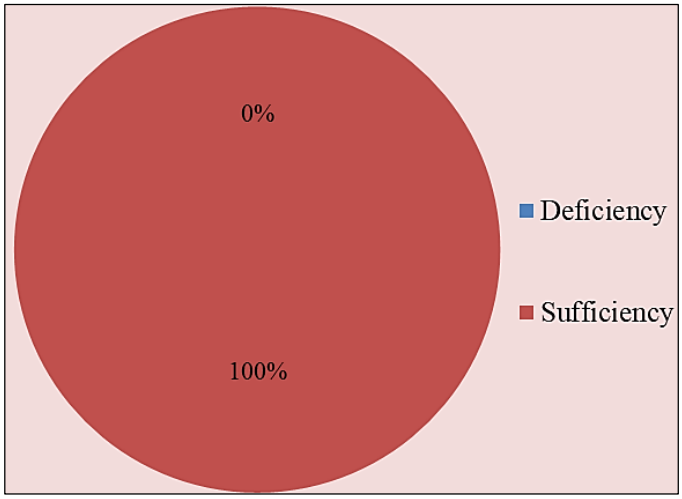


Fig 3: Percentage of available manganese status of soils under arecanut based cropping systems in Udupi district, Coastal Karnataka

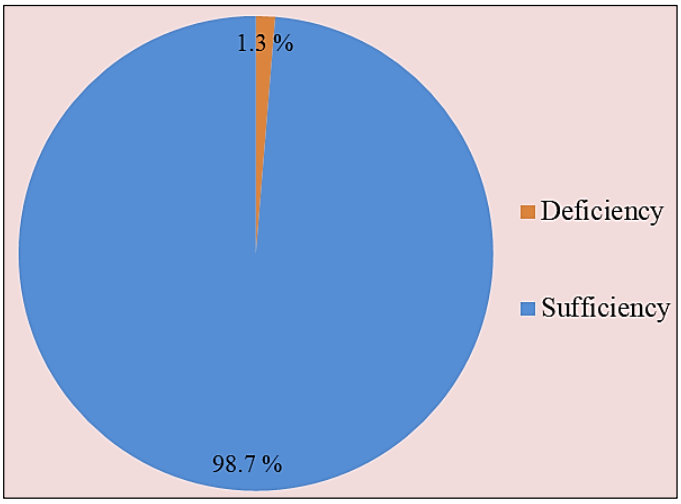
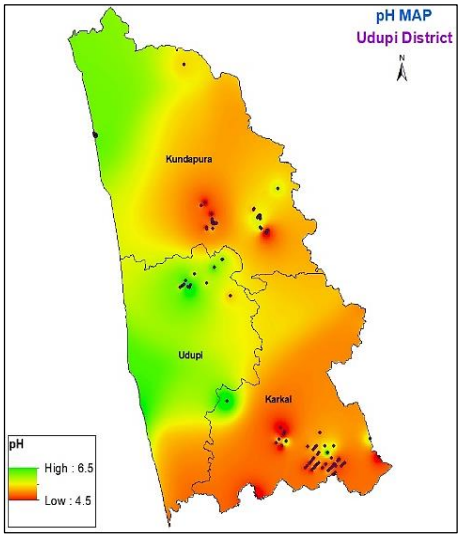
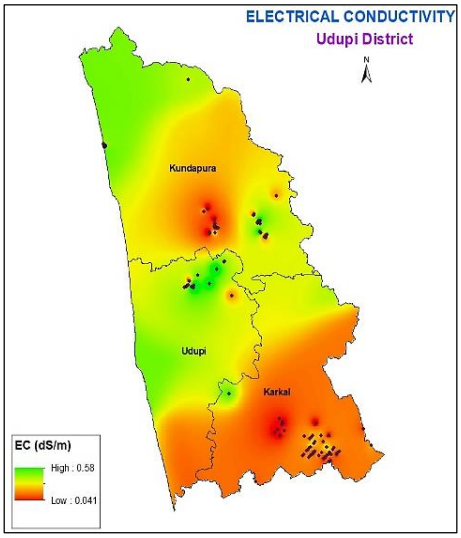
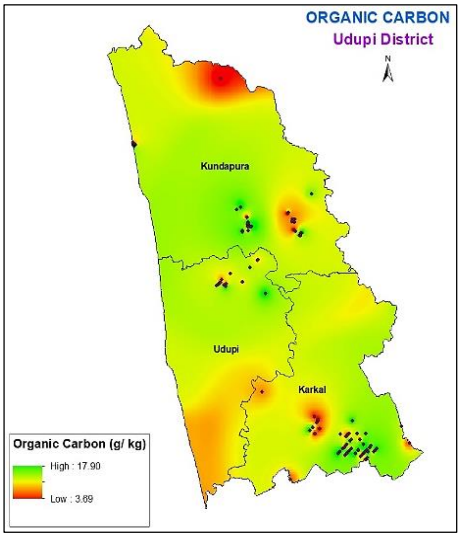


Fig 4: Percentage of available copper status of soils under arecanut based cropping systems in Udupi district, Coastal Karnataka







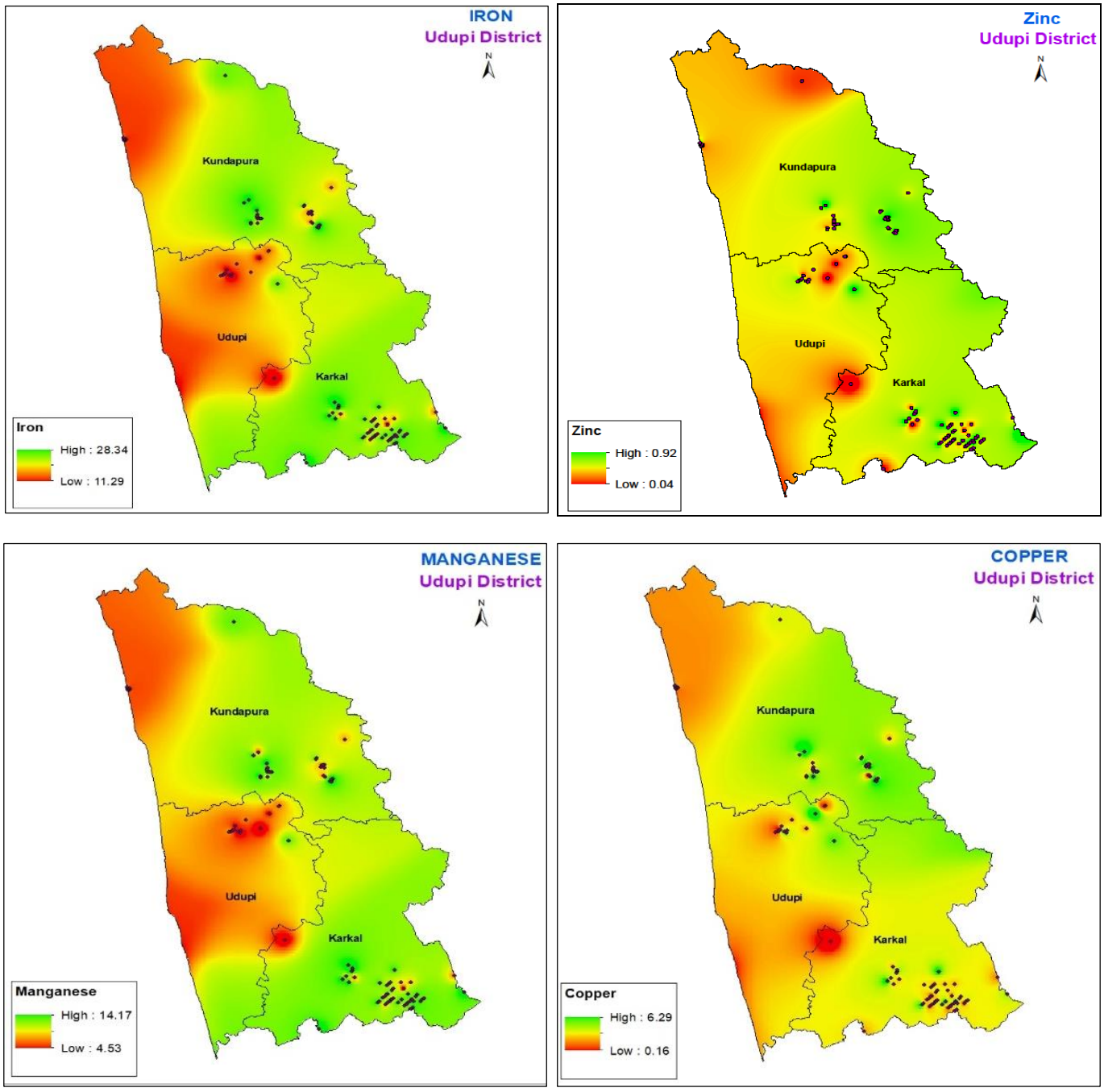


Fig 5: Mapping of soil major nutrients and secondary nutrients under arecanut based cropping systems is soils of Udupi district

Correlation coefficient (r)

Correlation coefficient (r) were observed between soil properties such as chemical properties; pH, OC and micronutrients of soils are presented in Table 6.

Results indicated that soil pH showed that it had negatively and highly significantly correlated with organic carbon (r = -0.812**), DTPA iron (r=-0.858**), zinc (r=-0.856**), manganese (r=-0.695**) and copper (r = -0.855**). Organic carbon showed positively and highly significantly correlated with DTPA iron (r=0.958**), zinc (r=0.913**), manganese (r=0.816**) and copper (r = 0.882**).

A positively and significantly correlation was observed between DTPA iron and zinc (r = 0.949**), copper (r = 0.933**), manganese (r = 0.848**). Similarly, positively and significantly correlation observed between DTPA zinc and copper (r = 0.920**), manganese (r = 0.876**). Similarly, positively and significantly correlation observed between DTPA manganese and copper (r = 0.695**).

Conclusion

Finally, it can be concluded that out of 153 soil samples collected from under recant based cropping systems in Udupi district, coastal Karnataka (Udupi, Kundapura, Karkala taluks), showed the soil texture predominantly found to be sandy clay loam to sandy loam. The soils found to be acidic in nature and the soil organic carbon was low to high. The available micronutrients such as iron, manganese and copper were found sufficient (Fig. 1, 2 and 3) but available zinc found deficient (Fig. 4) in soils under arecanut based cropping systems of Udupi district of coastal Karnataka.

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