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Soil fertility status of Pannur North-3 microwatershed of Manvi Taluk, Raichur District, Karnataka

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Abstract
Soils of Pannur North-3 Microwatershed of Manvi Taluk, Raichur District, Karnataka, were studied for available nutrient status and mapped by GIS technique. One hundred and twenty two surface soil samples and thirty two samples from soil profiles were collected and assessed for the available major nutrient status. The results revealed that, the most of the area (621ha ha) in the watershed was low in available nitrogen, available P_2O_5 was low to medium in entire study area, available K_2O was medium in 216 ha (33.71 % of samples) area and high in 405 ha (63.16 % of samples) and available S content was low in entire study area.

Keywords: Microwatershed, Soil fertility, mapping, GIS.

Introduction
Increasing population and overexploitation of productive lands creates serious problem of lowering the fertility status of soil and it leads to deterioration of soil. The deficiency of nutrients directly affects on the growth of crops and crop response become poor. Hence it is necessary to assess the fertility status of soil with the consideration of available nutrients in soils and to recommend the specific nutrients for the proper management of soil. Information on soil fertility status in crop field is very important and useful for fertilizer requirement and also to the specific management of the crop and soil. In the recent past, concept of watershed based overall development has emerged as one of the potential approach in rainfed areas, which can lead to higher productivity and sustainability in agriculture. Land available per capita in India has been declining significantly from 0.48 ha in 1951 to 0.20 ha in 1981 and to 0.15 ha in 2000 (Singh, 1999) [18] and is likely to become 0.10 ha by 2025 (Kanwar, 1999) [4]. To meet the demand for food grains to feed more than one billion people, vigorous exploitation of natural resources such as land and water will be done which poses serious threat to the sustainability of environment.

Hence, assessing the fertility status and mapping of soils is needed to identify extent of nutrient deficient area for site specific recommendations. With this objective, a study was undertaken in Pannur north-3 microwatershed in Manvi taluk of Raichur district.

Material and methods
Study area
Pannur North-3 microwatershed is located Manvi taluk, of Raichur district, Karnataka lies between 16° 12′ N latitude and 77° 22′ E longitudes and having total area of 640.78 ha. The microwatershed is surrounded by Pannuur, Chikalparvi, hosur and mustur village. The location map of the study area is depicted in Fig. 1.

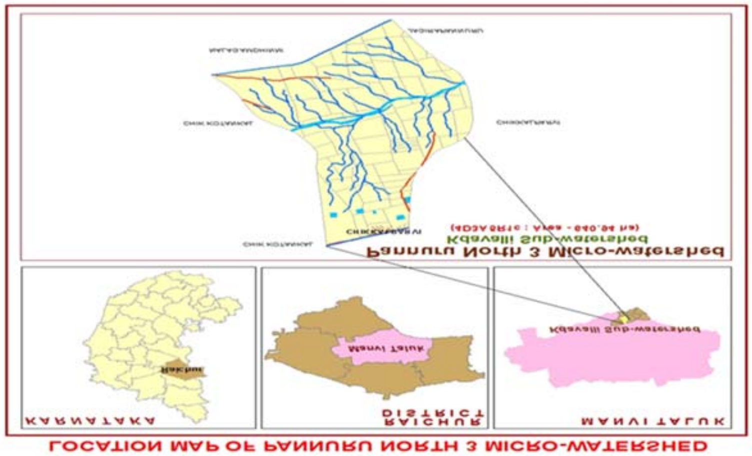

Fig 1: Location of the Pannur North-3 MWS

Semi arid climate prevails on Pannur north-3 microwatershed and it belongs to North Eastern Dry zone of Karnataka state. The average annual rainfall is 707.16 mm. Mean maximum and minimum temperatures are 33.82 °C and 21.16 °C, respectively. The highest rainfall was received during the month of September (164.90 mm). The length of growing period, which indicates the availability of water for plant growth, is about 150 to 180 days in a year. It starts from the middle July and continues up to the end of December. The area qualifies for *hyperthermic* temperature regime.

Soil sampling

Preliminary traverse of the entire village was carried out with the help of cadastral map, satellite imageries and toposheet. During the traverse, based on geology, drainage pattern, surface features, slope characteristics and land use, landforms and physiographic units were identified and initial legend was prepared by studying soils in few selected places.

The field boundaries and survey numbers given on the cadastral sheet were located on ground by following permanent features like roads, cart tracks, canals, streams, tanks, *etc*. and wherever changes noticed were incorporated on the cadastral map (Fig.2). After this, intensive traversing of each physiographic units like uplands, lowland, midland and river banks were carried out. Based on the variability observed on the surface, transects were selected across the slope, covering all the landform units. The surface soil samples were collected at every 300m grid with dept of 30x30cm.

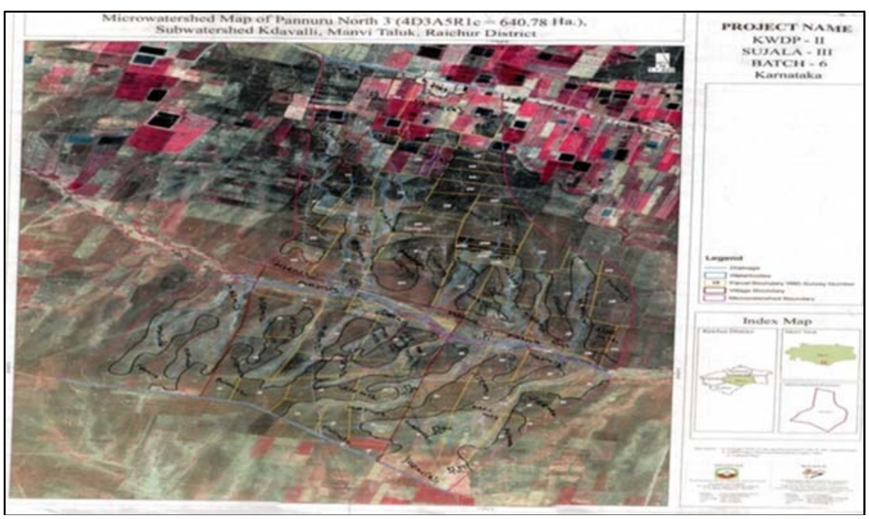

Fig 2: Cadastral map of Pannur North-3 MWS

In the selected transect, profiles were located at closely spaced intervals to take care of any change in the land features like break in slope, erosion, gravel, stones *etc*. In the selected sites, profiles (vertical cut showing the soil layers from the surface to the rock) were opened upto 160 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all profile sites on a standard proforma as per the guidelines given in USDA (Soil Survey Staff, 1999) [19].

Based on the recorded observations, the soils were grouped into different soil series, soil depth, amount and nature of gravel, depth of occurrence of gravel layer and nature of substratum present below soil and horizon sequence were the major identifying characteristics of the soil series established in the area and soil texture, slope, erosion and gravelliness were used to identify phases of the soil series. Based on these soil–site characteristics Pannur North-3 micro watershed area was divided into different homogeneous units known as mapping/management units. Mapping units under study were YADmC (A) 1, PNUmC2, HSRmB2 and MASmC2 &

MASmC3 under Yadavalli, Pannur, Hosur and Maskihalla series, respectively (Fig. 3). Among five mapping units obtained three different landforms *viz.*, upland, midland and stream revealed the slope varying from very gentle sloping (1-3%) to gentle sloping (3-5%).

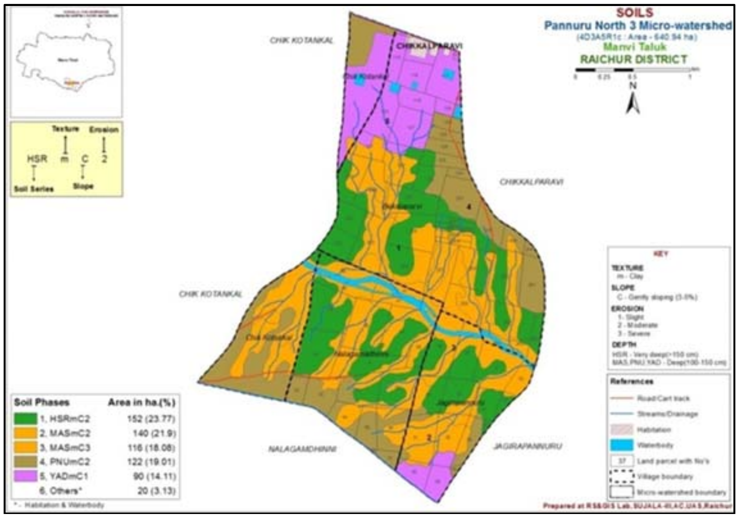

Fig 3: Soil mapping units of Pannur North-3 MWS

Results and discussion

Available Nitrogen

Soil available nitrogen status was low in all the five mapping units and ranged from 160.83 to 218.20 kg ha^{-1}. The lowest soil available nitrogen was noticed in MASmC3 mapping unit (Table 1). Similar finding was recorded by Shiva Prasad *et al*. (1998) [17] available nitrogen content was decreasing with the depth in most of the pedons this could be attributed to low organic carbon status of soil coupled with low nitrogen fertilization application leading to nitrogen deficiency. The results were in accordance with study conduct by Parasuram and Jayaraj (1982) of Coimbatore district, and also agreement with the findings of Mathews *et al.* (2009). Low organic matter content in these areas due to low rainfall and low vegetation cover facilitate faster degradation and removal of organic matter leading to nitrogen deficiency. Similar result quoted Basavaraju *et al.* (2005) [2] in Chandragiri mandal of Chittoor district, Andhra Pradesh, Thangasamy *et al.* (2005) [20] in Sivagiri microwatershed of Chittoor district in Andhra Pradesh and Shankaraiah *et al.* (2006) in black soils of Karimnagar district, Andhra Pradesh.

Available Phosphorus

The available P_2O_5 was low to medium in all the soil series which ranged from 16.78 to 30.47 kg ha^{-1}. The lowest available P_2O_5 (16.78 kg ha^{-1}) was observed in MASmC3 mapping unit due to lower CEC and clay content. Whereas highest available P_2O_5 (30.47 kg ha^{-1}) was noticed in HSRmB2 mapping unit due to higher CEC and clay content (Table 1). This is due to low and medium CEC and clay content. The value obtained in the present study was in agreement with those reported by Shiva Prasad (1998) [17] in Purna Command area of Maharashtra. The content of available P_2O_5 decreased with the depth this may be attributed to its higher removal than replenishment in sub soil and also high phosphorous fixation capacity. Sathish and Badrinath (1994) [14] in Western Ghats of Dakshina Kannada district, Karnataka, Dasog and Patil (2011) [3] in black, red and lateritic soils of Northern Karnataka obtained similar results as that is present study.

Available Potassium

The available potassium content of soils was medium to high which ranged from 330.48 to 385.58 kg ha^{-1} (Table 1). The higher content of K_2O which might be due to the predominance of potash rich micaceous and feldspar minerals in parent rocks, the results was in agreement with study conducted by Patil and Sonar (1993) [9] Dasog and Patil (2011) [3] and Pulakeshi *et al.* (2014) [11]. High content of available potassium in surface horizon than sub surface horizons may be due to more intense weathering, release of labile potassium from organic residues and application of low K fertilizers. Similar results were reported by Basavaraju *et al.* (2005) [2] in Chandragiri soils.

Available sulphur

The available sulphur ranged from 10.37 to 16.70 kg ha^{-1} indicating these soils are low in available sulphur. The lowest SWA of available sulphur (10.37 kg ha^{-1}) noticed in MASmC3 mapping unit (Table 1), due to continuous removal of sulphur by crop. These results are conformity with findings of Pulakeshi (2010) [10] in Mantagani village of Haveri district in Karnataka and Manojkumar (2011) [6] in Northern Zone of Karnataka .The low amounts of sulphur in surface samples are mainly because of high pH and low EC values and also might be due to lack of sulphur addition and continuous removal by intensive cropping systems (Madhan Mohan, 2008; Badrinath *et al.* (1986) [5, 1]. Similarly, Sharma and Gangwar (1997) [16] observed that negative correlation between available sulphur and pH and also between available sulphur and electrical conductivity.

Distribution of available N, P_2O_5 and K_2O in surface soil

In surface soil available N ranged from 146.6 to 281.0 ha^{-1}, with an average value of 203.6 kg ha^{-1} and standard deviation of 28.9. The available N was low in most of the study area (621ha) shown in (Fig.4). Available P_2O_5 in surface soil ranged from 20.59 to 42.96 kg ha^{-1}, with an average value of 30.87 kg ha^{-1} and standard deviation of 5.19. The available P_2O_5 was low to medium in entire study area (Fig. 5). The available K_2O ranged from 241.8 to 474.0 kg ha^{-1}, with an average value of 346.4 kg $ha^{-1}$and standard deviation of 46.9.

Available K_2O was medium in 216 ha (33.71 % of samples) area and high in 405 ha (63.16 % of samples) shown in (Fig.6) and available S content was low in entire study area (Fig.7).

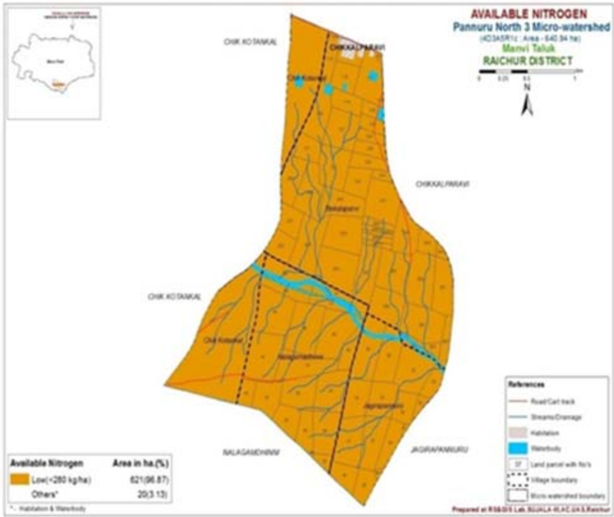

Fig 4: Available N of Pannur North-3 MWS

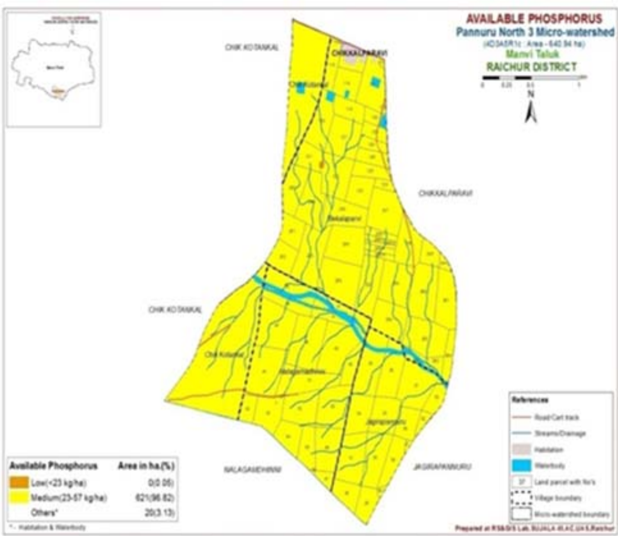

Fig 5: Available P of North-3 MWS

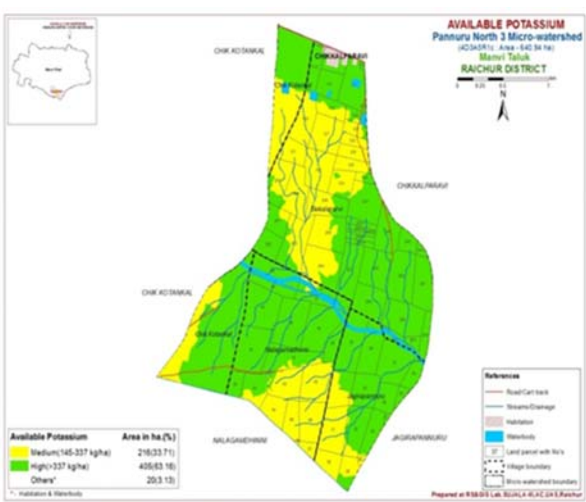

Fig 6: Available K of Pannur North-3MWS

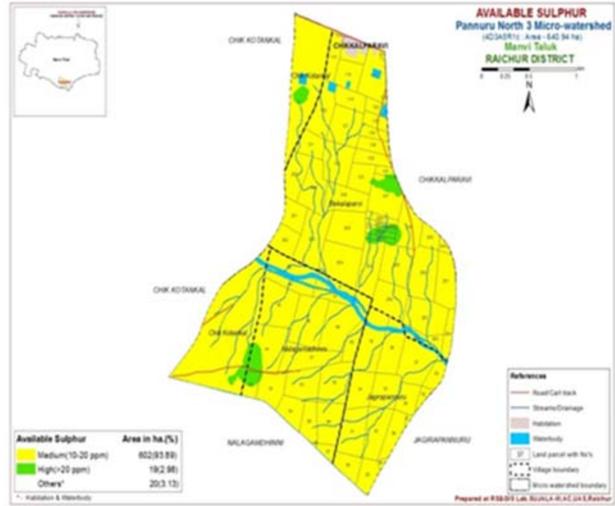

Fig 7: Available S of Pannur North-3 MWS

Vertical distribution of DTPA –extractable micronutrients in different mapping units of Pannur North -3 MWS

DTPA extractable Cu

The extractable copper content was sufficient in all the soil units which ranged from 0.94 to 1.59 mg kg^{-1} (Fig.8). The sufficient copper content in the study area might be due to the parent material (Rajkumar, 1994) [12]. However highest (1.59 mg kg^{-1}) SWA found in HSRmB2 mapping unit due to higher biological activity and the chelating of organic compounds, released during the decomposition of organic matter left after harvesting of crop. However in YADmC (A) 1, PNUmC2 and HSRmB2 mapping units, the SWA of DTPA extractable Fe was lower than those of MASmC2 and MASmC3 (Table 1). The available Fe content decreased significantly with the increase in the depth. Low Fe content at lower depths may be due to precipitation of Fe by $CaCO_3$ and decrease its availability. Similar results were also observed by Mahantesh *et al.* (2016) in Dundur village under Malaprabha command area in Karnataka; Ravikumar *et al.* (2009) [13] in Malaprabha right bank command of Karnataka and Rajkumar (1994) [12] in paddy soils of Tungabhadra project area, Karnataka.

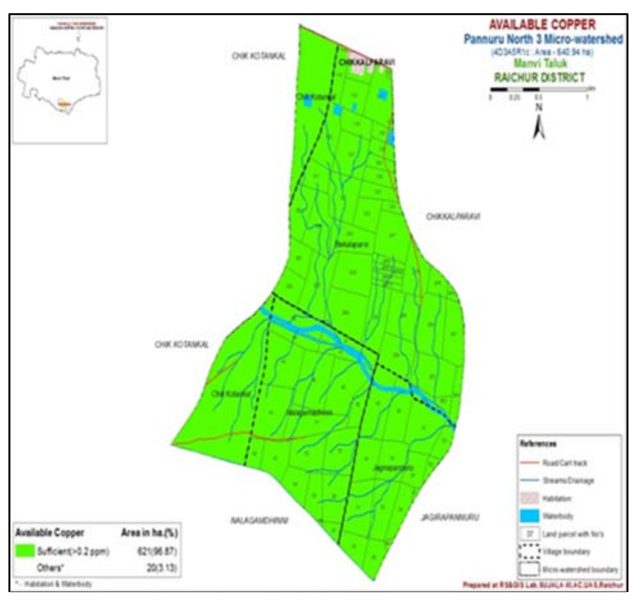

Fig 8: DTPA extractable Cu soil Pannur North-3 MWS

DTPA extractable Fe

The DTPA extractable Fe was deficient to sufficient range in all the mapping units which varied from 3.33 to 4.30 mg kg^{-1} (Fig.9). The available Fe content decreased significantly with the increase in the depth. Low Fe content at lower depths may be due to precipitation of Fe by $CaCO_3$ and decrease its availability. Similar results were also observed by Mahantesh *et al.* (2016) in Dundur village under Malaprabha command area in Karnataka; Ravikumar *et al.* (2009) [13] in Malaprabha right bank command of Karnataka (Table 1).

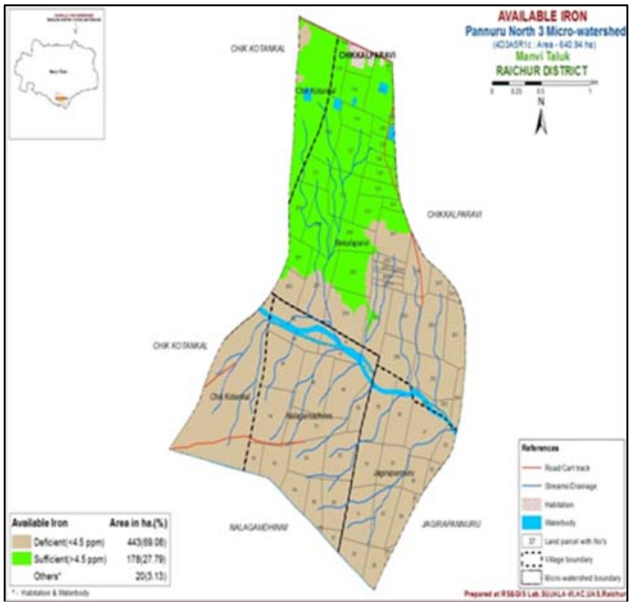

Fig 9: DTPA extractable Fe of Pannur North-3 MWS

DTPA extractable Mn

DTPA extractable Mn was sufficient in all the five mapping units which ranged from 5.82 to 6.41 mg kg^{-1} (Fig.10). The lowest SWA of DTPA extractable Mn (5.82 mg kg^{-1}) noticed in HSRmB2 mapping unit (Table 1), was due to relatively high pH of black soils coupled with semi-arid conditions decreases the availability of Mn by converting into unavailable forms (Mn^{2+} converted to Mn^{4+}). Similar result reported by (Rajkumar, 1994) [12].

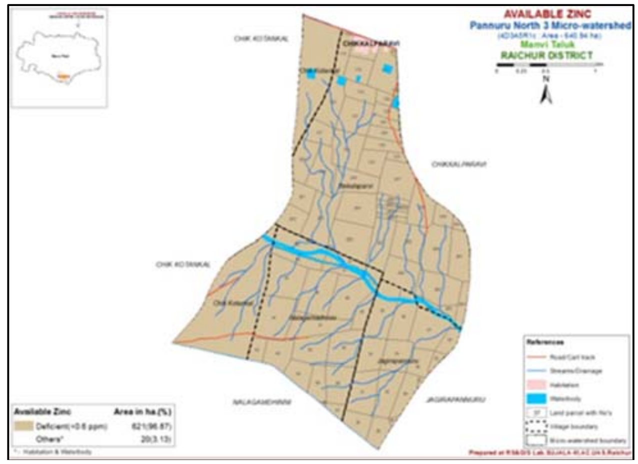

Fig 10: DTPA extractable Mn of Pannur North-3 MWS

DTPA extractable Zn

The DTPA extractable Zn was deficient in all the mapping units which ranged from 0.18 to 0.36 mg kg^{-1} (Fig.11). The larger extent of zinc deficiency was due to calcareousness, high pH and low organic matter which might have resulted in the formation of insoluble compounds of zinc or insoluble calcium zincate (Table 1). The soils are alkaline and dominated by $CaCO_3$. Zinc might have precipitated as hydroxides and carbonate as a result their solubility and mobility might have decreased and reduced the availability similar findings was obtained by Vijayshekar *et al.* (2000) [21] Thangasamy *et al.* (2005) [20] and Ravikumar *et al.* (2009) [13].

Fig 11: DTPA extractable Zn soil of Pannur North-3 MWS

Table 1: Vertical distribution of available nutrients in different mapping units of Pannur North -3 MWS

Sl. no.	Soil series (Mapping unit)	Depth (cm)	Available Nutrients (kg ha^{-1})				DTPA extractable Nutrients			
			N	P_2O_5	K_2O	S	Cu	Fe	Mn	Zn
			(kg ha^{-1})				(mg kg^{-1})			
1	Yadavalli [YADmC(A)1]	0-11	241.2	36.82	449.88	19.66	1.53	5.78	7.25	0.34
		11 - 40	220.6	33.75	406.68	18.51	1.34	4.73	6.48	0.25
		40-63	173.1	30.69	339.76	16.91	1.28	4.13	6.26	0.21
		63-81	165.4	21.48	307.32	15.19	1.12	3.60	5.43	0.18
		81-95	130.3	16.88	303.84	10.25	1.06	3.28	5.14	0.16
		95-125	127.9	13.81	295.80	9.38	1.02	3.07	3.25	0.11
Solum weighted average		0-125	176.42	25.57	350.55	14.98	1.23	4.10	5.64	0.21
2	Pannur (PNUmC2)	0-12	240.3	35.29	464.9	19.88	1.53	4.51	7.38	0.34
		12 - 28	225.6	30.69	433.8	18.87	1.42	4.40	6.24	0.34
		43-97	176.8	29.15	406.6	16.99	1.36	4.32	6.11	0.25
		55-82	152.8	23.01	277.2	15.85	1.31	4.07	6.08	0.26
		82-120	130.4	16.87	268.4	13.32	1.23	3.91	5.65	0.20
		120-140	117.4	13.80	265.8	9.22	0.94	3.10	5.37	0.23
Solum weighted average		0-145	173.88	24.80	352.8	15.69	1.30	4.05	6.14	0.27

3	Hosur (HSRmB2)	0-11	276.4	44.49	433.44	19.98	2.04	4.74	7.85	0.34
		11-40	258.3	38.36	426.72	18.67	1.65	4.35	7.11	0.21
		40-60	240.6	35.29	411.12	17.84	1.59	3.76	5.43	0.12
		60-83	238.3	29.15	393.72	16.58	1.48	3.72	5.11	0.18
		83-95	199.7	27.62	376.08	16.79	1.53	2.58	4.96	0.18
		95-120	176.2	24.55	362.16	14.68	1.43	2.11	5.63	0.14
		120-160	137.9	13.81	295.8	12.38	0.98	2.07	4.65	0.11
Solum weighted average		0-160	218.20	30.47	385.58	16.70	1.59	3.33	5.82	0.18
4	Maskihalla (MASmC2)	0-12	230.8	28.93	390.88	18.36	1.35	5.12	7.11	0.13
		2-24	229.3	26.15	367.52	15.21	1.31	4.22	6.75	0.19
		24-42	174.2	24.88	352.32	11.19	1.18	4.83	6.36	0.15
		42-75	126.5	21.31	321.72	9.56	1.03	4.31	6.21	0.24
		75-105	111.8	15.93	267.04	8.11	0.92	3.60	5.36	0.23
		105-140	106.4	10.74	249.56	7.63	0.78	3.50	5.12	0.26
Solum weighted average		0-140	163.2	21.32	324.84	11.68	1.09	4.25	6.15	0.20
5	Maskihalla (MASmC3)	0-18	239.6	30.69	371.56	15.18	1.21	5.18	7.32	0.48
		18-30	210.5	24.55	363.36	14.23	1.12	4.80	7.23	0.41
		30-45	188.2	19.95	350.2	13.15	1.04	4.52	6.45	0.39
		45-58	153.4	12.27	337.96	10.21	0.85	4.24	6.24	0.37
		58-75	120.4	10.74	312.52	8.32	0.91	4.36	6.12	0.33
		77-95	110.3	9.21	290.52	6.20	0.75	3.20	5.59	0.25
		95-135	103.4	10.05	287.25	5.31	0.71	3.18	5.95	0.29
Solum weighted average		0-135	160.83	16.78	330.48	10.37	0.94	4.30	6.41	0.36

Conclusion

The available N, P_2O_5, K_2O and S content in all the five mapping units were low, low to medium, medium to high and low category, respectively. All these said nutrients decreased with depth. DTPA extractable Cu and Mn in all the five mapping units was sufficient. Whereas DTPA-extractable Fe was deficient to sufficient range in all the mapping units and DTPA-extractable Zn was deficient. Application of organic manures, nitrogen and potassic fertilizers on site specific recommended dosage within the required areas with periodic skipping of phosphorus fertilizers can improve the soil quality and nutrient status thereby increased crop productivity.

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