Original Research Article

Mapping Soil-Crop Nutrient Dynamics in Continuous Cotton Cultivation Areas of Sangareddy District, Telangana

ABSTRACT

A soil-crop nutrient survey was conducted in Sangareddy district, Telanganaduring *Rabi*, 2023 to study the fertility status of cotton growing soils at 0-15 cm and 15-30 cm depth. Georeferenced soil and leaf samples were collectedfrom 112 sites covering 23 *mandals*during flowering stage. Soil physical and physico-chemical properties and cotton leaf nutrient content were analysed. In the study area, bulk density, sand, silt and clay content ranged from 1.36-1.66 Mg m^{-3}, 41.84-78.02 %, 6.74-29.60 % and 10.76-42.76 %, respectively. The soils were strongly acidic to slightly alkaline in reaction (4.25-7.98; 4.44-7.97), non-saline (0.026-0.254 dS m^{-1}; 0.020-0.241 dS m^{-1}) and low tohigh in organic carbon (2.03 to 11.52 g kg^{-1}; 1.13 to 8.24 g kg^{-1}) at 0-15 cm and 15-30 cm depths, respectively.

Soil nutrient status: Available nitrogen, phosphorus, potassium and exchangeable magnesium contents ranged from 101 to 448 kg ha^{-1}, 7 to 41 kg ha^{-1}, and 154 to 763 kg ha^{-1} at 0-15 cm depth, respectively while 91 to 319 kg ha^{-1}, 4 to 39 kg ha^{-1}, and 142 to 730 kg ha^{-1} at 15-30 cm depth, respectively.

Crop nutrient status: Total nitrogen, phosphorus, potassium and magnesium contents in the collected cotton leaves ranged from 0.53 to 3.64 %, 0.12 to 0.68 %, 0.80 to 1.84 % and 0.27 to 0.92 %, respectively.

Soil fertility mapping: Soil fertility maps were prepared considering the low/deficient, medium and high/sufficient range of soil macronutrients (N, P, K and Mg) at the depth of 0-15 cm under QGIS 3.36.1. Soil fertility maps showed that soils of the study area were mostly low in available nitrogen, medium in available phosphorus, high in available potassium and sufficient in exchangeable magnesium.

Regular soil testing is crucial to monitor the variations in nutrient levels and formulation of appropriate management strategies to address it.

Keywords: Soil fertility status;nutrients; physico-chemical properties; maps, cotton, GIS.

1. INTRODUCTION

"Cotton (*Gossypiumhirsutum*L.)is an important cash and fibre crop across the world and in India as well. Cotton is popularly known as 'White Gold' as it has a key role in economic, political and social status of the world by earning foreign exchange. India is the second largest producer of cotton with 53.85 lakh tones equivalent to 316 lakh bales of 170 kg. Cotton being deep rooted crop, it removes large quantities of nutrients from the soil profile. There is a significant decline in area under cotton in 2023-24 in southern states of India up to 20.22% and production is also expected to decline by 22.76%"[1]."In Telangana region, cotton is grown in an area of 19.73 lakh hectares with a production of 57.45 lakh bales (170 kg each) and productivity of 495 kg ha^{-1} in which area of cotton in Sangareddy district is 1.48 lakh hectares with a production of 5.56 lakh bales (170 kg each) and productivity of 816.47 kg ha^{-1}"[2]. Due to continuous cotton cultivation, soil properties may get affected thereby modifying nutrient contents and their availability to the crops.Since, cotton is a long duration crop, soil under cotton cultivation is exhausted very soon as the nutrient uptake is very high due to the simultaneous production of vegetative and reproductive structures during the active growth phase in this crop. High-yielding cotton crops impose a high demand for mineral nutrients from the soil over a short period of time, and foliar nutrient deficiency symptoms can arise during crop maturity due to rapid translocation of nutrients from the foliage into the developing bolls. Knowledge of the physico-chemical properties, available nutrients status of the soils helps in demarcating the areas where nutrient application is needed for profitable crop production. In this aspect, assessment of leaf nutrient status is advantageous because plant integrates nutrient supply over a period and can thereby, indicate the extent of nutrient deficiency in the crop and soil nutrient supplying capacity required to manage the crop for increasing the yield.GIS-based soil fertility mapping is instrumental in soil fertility due to its ability to integrate spatial data with soil information.Thus, delineating the cotton growing soils for their fertility helps in understanding the soil related constraints and their intensity which is essential to develop site specific management strategies.Detailed and systematic investigation on the properties of soils, specifically in cotton growing soils of Sangareddy district of Telangana is meagre. Hence, the present investigation was undertaken to study the soil-crop nutrient status of cotton growing areasof Sangareddy district in Telangana.

2. MATERIALS AND METHODS

A survey was conducted during *Rabi* 2023 in continuous cotton growing soils of Sangareddy district (13.70 sq km)which is situated between 17.6294^0 N and 78.0917^0 E.Sangareddy district comes under semi-arid climate with an annual average rainfall of 843.2 mm. The highest mean monthly rainfall of 197.2 mm is recorded in July and lowest of 3.7 mm in December. The district experiences an average annual maximum and minimum temperature of 33.3^0 C and 20.5^0 C with annual relative humidity varying from about 61% to 93% in the morning to 21% to 64% in the afternoon [3].Total of 224 soil samples (112 at 0-15 cm depth and 112 at 15-30 cm depth) and 112 leaf samples were collected from continuous cotton growing areas covering 23 *mandals*of Sangareddydistrict during the flowering stage of cotton crop. GPS points were recorded for each sampling site (Fig. 1.).Soil samples were collected from two depths, as cotton is a highly nutrient exhaustive crop due to its deep-rooted nature.Soil and crop nutrient status was determined along with the physical and physico-chemical properties of the soils. Bulk density and soil texture analysis were carried out for surface soils only while both surface and sub-surface soils were analysed for soil pH, EC, OC, available N, P and K and exchangeable Mg. Soil fertility mapping for N, P, K and Mg at 0-15 cm depth was carried out under QGIS 3.36.1. The leaf samples were analysed for N, P, K and Mg. The analyses were carried out following standard procedures furnished in Table 1.The statistical analysis was carried out using Microsoft excel.

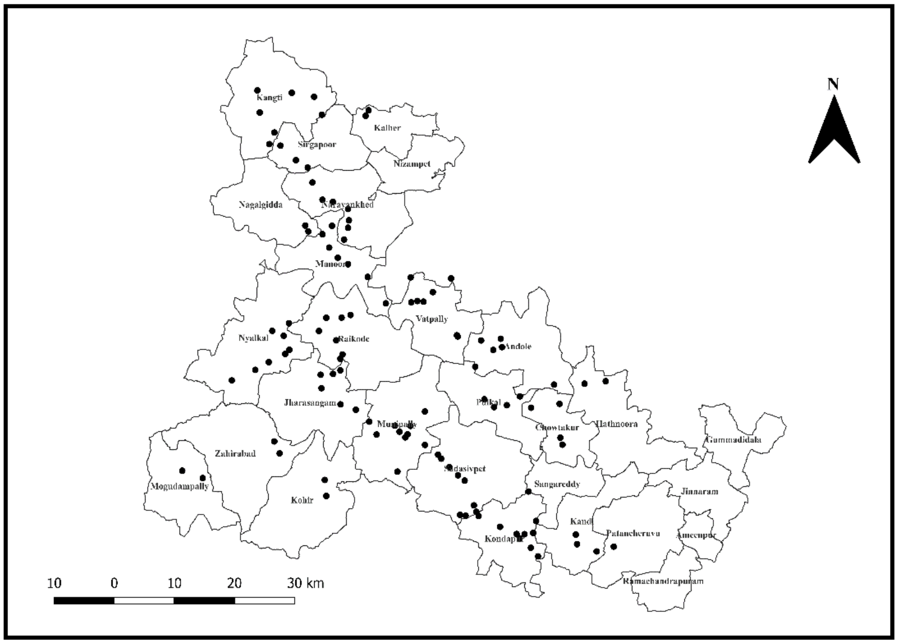

Fig. 1. Location of the sampling sites of Sangareddy district.

Table 1. Details of the analytical methods followed for soil and plant analysis.

S. No.	Parameter	Method or reference
A	**Physical Properties**	
1.	Soil Texture	Hydrometer method (Bouyoucos, 1962)
2.	Bulk Density (Mg m^{-3})	Core sampler method (Black and Hartge, 1986)
B	**Physico-chemical Properties**	
3.	Soil pH (1:2.5 soil water suspension)	Digital pH meter (Jackson,1973)
4.	Soil EC (dS m^{-1}) (1:2.5 soil water suspension)	Conductivity meter (Jackson,1973)
5.	Organic Carbon (g kg^{-1})	Wet Oxidation Method (Walkley and Black, 1934)
C	**Chemical Properties**	
6.	Available N in soil (kg ha^{-1})	Alkaline permanganate method (Subbaiah and Asija, 1956)
7.	Available P in soil (kg ha^{-1})	Olsen's method (Olsen *et al*., 1956)/ Bray's method (Bray and Kurtz, 1945) of extraction followed by spectrophotometric method
8.	Available K in soil (kg ha^{-1})	Extraction with neutral normal ammonium acetate followed by flame photometer method (Jackson, 1973)
9.	Exchangeable Mg in soil (meq.100 g^{-1} soil)	Extraction with neutral normal ammonium acetate followed by MP-AES method (Jackson, 1973)
D	**Crop Nutrient Content**	
10.	Plant N content (%)	Piper, 1966
11.	Plant P content (%)	Piper, 1966

12.	Plant K content (%)	Piper, 1966
13.	Plant Mg content (%)	Piper, 1966

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Cotton Growing Soils

In the continuous cotton growing soils of Sangareddy district, bulk density ranged from 1.36 to 1.66 Mg m^{-3} with a mean of 1.49 Mg m^{-3} (Table 2).Chauhan and Bhunia [12] reported that bulk density of American cotton growing soils was 1.53 Mg m^{-3}.Chaudhari*et al.*[13]and Warhade*et al.*[14] reported similar results. “The higher percentage of sand content in the cotton growing soils of the district along with low organic carbon content might be attributed to higher bulk density of the soils”[13].

On an average, the soils of the study area contained 59.59 per cent sand, 14.30 per cent silt and 26.06 per cent clay at 0-15 cm depth. The sand content ranged from 41.84 to 78.02 per cent, silt content ranged from 6.74 to 29.60 per cent and clay content ranged from 10.76 to 42.79 per cent. The different textural classes reported were sandy clay loam, sandy clay, sandy loam and loamy sand (Table 3). Similar results were reported by Chaudhari*et al.*[13] in Coimbatore soils, Malik *et al.* [15] and Kone *et al.* [16] in cotton-based cropping systems. Textural classes of all the collected surface soil samples demonstrated their suitability to grow cotton. The wide variation in textural classes might be due to different soil forming processes, *in-situ* weathering and translocation of clay [17].

Thus, the surveyed soils contain higher sand content resulting in high bulk density.

Table 2. Range, mean, SD and CV of bulk density of the study area.

Total Samples	Range (Mg m^{-3})	Mean (Mg m^{-3})	SD (Mg m^{-3})	CV (%)
112	1.36-1.66	1.49	0.08	5.08

Table 3. Percentage distribution of textural classes in the study area.

Textural Class	Number of samples	Percentage
Sandy clay loam	52	46
Sandy clay	30	27
Sandy loam	16	14
Loamy sand	14	13

3.2 Physico-chemical Properties of Cotton Growing Soils

“The soils of continuous cotton growing areas of Sangareddy district were strongly acidic to slightly alkaline in reaction with pH ranging from 4.25 to 7.98 with a mean of 7.30 at 0-15 cm depth, whereas 4.44 to 7.97 with a mean of 7.40 at 15-30 cm depth (Table 4,5). This indicated that pH increased with increase in depth. This might be due to presence of calcium carbonate in the sub-surface layer” [18]. Similar findings ofWarhade*et al.* [14] in Wardha district of Maharashtra andVasu *et al.*[19] in Mahbubnagar district of Telangana were reported.“The reason for lower pH value might be depletion of basic cations by crop and runoff by accelerated erosion and neutral to slightly alkaline nature might be due to presence of high exchangeable bases attributed to low intensity leaching”[20].

Electrical conductivity of the soils of the district ranged from 0.026 to 0.254 dS m^{-1}with a mean of 0.111 dS m^{-1} at 0-15 cm depth and 0.020 to 0.241 dS m^{-1} with a mean of 0.101 dS m^{-1} at 15-30 cm depth (Table 4,5). The soilswere non-saline and in accordance with the results of Warhade*et al.* [14] and Reddy *et al.* [21].“The EC decreased with increase in depth which might be due to the mechanism of the heavy root system of cotton making the soil loose and porous so that added salts leach away resulting in low EC in the soils”[30]. “The results indicated that the soils were suitable for cotton cultivation and the non-salinity of the study area could be attributed to good drainage condition”[20,23,31].

Organic carbon content of the study area was low to high with more than 50 per cent of the soils in low range. The values ranged between 2.03 to 11.52 g kg^{-1} with a mean of 5.17 g kg^{-1}at 0-15 cm depth, while, 1.13 to 8.24 g kg^{-1} with a mean of 3.00 g kg^{-1} at 15-30 cm depth (Table 4,5). Sowjanya *et al.*[24] reported that organic carbon content of the soils varied from 1.50-12.60 g kg^{-1} with a mean value of 6.12 g kg^{-1}in North Karnataka.“Low organic carbon content might be due to faster degradation of organic matter under the semi-arid conditions of the district. The decrease in OC with soil depth might be attributed to the accumulation of plant residues on the soil surface and less movement to the sub-surface horizon due to the rapid rate of mineralization at a higher temperature and adequate soil moisture level”[14].

The soil reaction (pH) was found to increase with depth, while total soluble salts (EC) and organic carbon decreased with depth.

3.3 Chemical Properties of Cotton Growing Soils

“The soils of Sangareddy district were low to medium in available nitrogen content varying from 101 to 448 kg ha^{-1} with a mean of 198 kg ha^{-1} at 0-15 cm depth, while 91 to 319 kg ha^{-1} with a mean of 157 kgha^{-1} at 15-30 cm depth (Table 4,5). Similar findings were reported” byVasu *et al.* [19], Reddy *et al.* [21] and Sowjanya *et al.*[24]. “Cotton, being a deep rooted, heavy feeder crop might lead to nitrogen deficiency in the soils”[26]. “Low available N status in almost all the soils might be ascribed to low organic carbon content of these soils due to high temperature prevailing in the study area along with low inorganic inputs and rapid loss of applied N by various mechanisms like volatilization, nitrification, denitrification, chemical and microbial fixation leaching and runoff”[27,33,35]. “Also, decrease in nitrogen content with depth might be due to the low organic carbon in the sub-surface compared to surface soils”[22].

The soils were low to high in available phosphorus content ranging from 7 to 41 kg ha^{-1} with a mean of 20 kg ha^{-1} at 0-15 cm depth, while, 4 to 39 kg ha^{-1} with a mean of 15.44 kg ha^{-1} at 15-30 cm depth (Table 4,5).Vasu *et al.* [19] andReddy *et al.* [21] in Telangana reported low nitrogen levels and low to high phosphorus levels in the soils.“Similar results were also reported bySowjanya”*et al.*[24],Ranjith *et al.* [28] and Ghode*et al.*[29].“Decreasing trend of available P was observed with depth. The lower phosphorus content could be due to the fixation of released phosphorus by clay minerals and oxides of iron and aluminium and presence of excess free calcium carbonate, while higher P content might be due to phosphorus confinement to the rhizosphere, due to its immobile nature in soilsand indiscriminate use of DAP and other complex fertilizers leading to phosphate buildup”[20,24,25].

The soils of the surveyed area revealed wide range of available potassium varying from 154 to 763 kg ha^{-1} with a mean of 468 kg ha^{-1} at 0-15 cm depth and 142 to 730 kg ha^{-1} with a mean of 441kg ha^{-1} at 15-30 cm depth (Table 4,5).Similar results were reported byIngole [18] in Maharashtra, Vasu *et al.* [19] and Reddy *et al.* [21] in Telangana. The medium to higher content of available potassium in the soils of the study area could be attributed to the predominance of K-rich micaceous and feldspar minerals in parent material [21]. The available K content was higher in the surface horizons and decreased with depth. This could be attributed to intense weathering, release of labile-K from organic residues, application of K fertilizers and upward translocation of K from lower depths along with capillary rise of ground water [20,29].

The exchangeable magnesium content was recorded in the range of 0.61 to 18.30 meq 100 g^{-1} with a mean of 6.16 meq 100 g^{-1} at 0-15 cm depth, while 0.52 to 17.67 meq 100 g^{-1} with a mean of 5.47 meq 100 g^{-1}at 15-30 cm depth.The results were similar to the findings of Kone *et al*. [16], Sadanshiv*et al.* [17], Reddy *et al.* [21] and Sowjanya *et al.*[24]. Lower magnesium content was recorded in soils of lower pH, whereas in neutral to slightly alkaline soils, magnesium content was in sufficient range. The calcareous nature and dominance of smectitic clay minerals in soils might contribute to sufficiency of magnesium content because of higher availability of magnesium content in soils under such conditions [24].

The nutrient content decreased with increase in depth which might be due to accumulation of comparatively more amount of organic matter in surface soil layers than sub-surface layers.

Table 4. Mandal means of the soil physico-chemical and chemicalproperties of the study area at 0-15 cm depth.

S.No.	Mandal	pH	EC	OC	N	P	K	Mg
1	Hathanoora	7.57	0.113	5.97	145	32	437	5.52
2	Kandi	7.47	0.138	6.86	184	41	236	4.89
3	Patancheru	7.50	0.060	3.96	159	18	636	3.81
4	Sangareddy	6.68	0.097	4.70	201	39	265	9.44
5	Kondapur	7.22	0.079	5.05	251	13	369	5.34
6	Sadasivpet	7.16	0.124	6.08	207	24	606	5.16
7	Munipally	7.51	0.133	3.56	204	25	378	6.33
8	Kalher	6.86	0.096	3.52	182	7	165	5.42
9	Manoor	7.68	0.145	4.17	147	16	446	11.27
10	Nagalgidda	7.55	0.239	5.44	209	29	463	8.84
11	Narayankhed	7.40	0.122	4.87	211	22	326	6.40
12	Sirgapoor	7.28	0.099	6.50	152	25	233	9.71
13	Kangti	7.53	0.097	5.27	201	23	555	8.15
14	Jharasangam	7.17	0.120	5.20	192	12	660	3.55
15	Raikode	7.66	0.125	4.56	214	18	645	5.72
16	Kohir	7.45	0.103	6.57	194	11	380	11.23
17	Zaheerabad	6.96	0.083	6.91	176	10	386	4.39
18	Mogudampally	6.98	0.072	4.94	157	16	424	3.83
19	Nyalkal	6.85	0.100	6.17	192	17	683	5.03
20	Chowtkur	7.25	0.073	4.39	162	26	479	8.63
21	Pulkal	6.78	0.095	4.88	202	15	527	4.61
22	Andole	7.33	0.096	4.82	208	23	396	3.65
23	Vatpally	7.35	0.088	6.05	200	27	356	4.85
District Mean		7.30	0.111	5.17	198	20	468	6.16
Range		4.25-7.98	0.026-0.254	2.03-11.52	101-448	7-41	154-763	0.61-18.30
SD		0.63	0.04	2.11	70	9	155	3.27
CV (%)		8.59	36.69	40.83	36	43	33	53.17

**EC: electrical conductivity (dS m^{-1}), OC: organic carbon (g kg^{-1}), N, P, K: available nitrogen, phosphorus, potassium (kg ha^{-1}), Mg: exchangeable magnesium (meq $100g^{-1}$)*

Table 5. Mandal means of the soil physico-chemical and chemicalproperties of the study area at 15-30 cm depth.

S.No.	Mandal	pH	EC	OC	N	P	K	Mg
1	Hathanoora	7.65	0.106	3.07	115	24	412	5.04
2	Kandi	7.58	0.108	3.62	143	36	216	4.42
3	Patancheru	7.68	0.058	1.25	122	16	578	3.59
4	Sangareddy	6.77	0.095	2.78	164	29	237	8.26
5	Kondapur	7.34	0.069	3.24	190	10	342	4.89
6	Sadasivpet	7.28	0.114	4.28	164	15	563	4.41
7	Munipally	7.62	0.123	2.18	160	19	356	5.43
8	Kalher	6.92	0.077	2.34	160	5	150	4.67
9	Manoor	7.81	0.136	2.69	120	13	434	10.50
10	Nagalgidda	7.65	0.225	3.19	179	21	399	8.02
11	Narayankhed	7.52	0.107	2.91	172	18	309	5.65
12	Sirgapoor	7.13	0.087	3.48	130	20	218	7.52
13	Kangti	7.65	0.089	3.46	166	18	539	7.48
14	Jharasangam	7.26	0.111	2.68	148	8	605	3.07
15	Raikode	7.74	0.115	2.54	167	13	622	5.22
16	Kohir	7.54	0.090	3.07	139	9	362	10.66
17	Zaheerabad	6.98	0.056	3.55	131	6	367	4.28
18	Mogudampally	7.09	0.061	2.22	115	11	402	3.16
19	Nyalkal	6.94	0.089	3.41	161	12	643	4.78
20	Chowtkur	7.35	0.071	2.31	128	22	459	7.48
21	Pulkal	6.87	0.085	2.91	161	10	509	4.34
22	Andole	7.50	0.086	2.98	174	19	372	3.00
23	Vatpally	7.48	0.084	3.02	148	20	336	3.61
District Mean		7.40	0.101	5.17	157	15	441	5.47
Range		4.44-7.97	0.020-0.241	2.03-11.52	91-319	4-39	142-730	0.52-17.67
SD		0.63	0.04	1.46	50	7	149	3.05
CV (%)		8.53	39.00	48.62	32	47	34	55.85

**EC: electrical conductivity (dS m^{-1}), OC: organic carbon (g kg^{-1}), N, P, K: available nitrogen, phosphorus, potassium (kg ha^{-1}), Mg: exchangeable magnesium (meq $100g^{-1}$)*

3.4 Nutrient Content of Cotton Leaves

The nitrogen content of the collected cotton leaf samples ranged from 0.53 to 3.64 per cent with a mean of 1.49 per cent.The phosphorus content varied from 0.12 to 0.68 per cent with a mean of 0.35 per cent.The potassium concentration of the cotton leaves of the study area ranged from 0.80 to 1.84 per cent with a mean of 1.20 per cent.The total magnesium in the cotton leaves varied from 0.27 to 0.92 per cent with a mean of 0.54 per cent. Similar results were obtained by Rochester [30],Singh *et al*.[31] and Pranantoe*t al*. [24].

The concentration of a nutrient in plantsincreases when the supply of that nutrient in the soil is higher[33]. The nitrogen, phosphorus and potassium content were maintained in the plants due to their higher availability during the growing stage of the cotton crop. Any deficiency in plant nutrient content was due to lower level of nutrient available in the soil for plant uptake. Magnesium content was maintained in the leaves due to its presence in sufficient levels in the soils.

Table 6. Mandal means of nutrient content of cotton leaves.

S.No.	Mandal	N (%)	P (%)	K (%)	Mg (%)
1	Hathanoora	1.51	0.39	1.75	0.63
2	Kandi	0.79	0.31	0.92	0.48
3	Patancheru	1.34	0.26	1.09	0.57
4	Sangareddy	1.28	0.33	1.48	0.48
5	Kondapur	2.22	0.29	1.16	0.58

6	Sadasivpet	1.26	0.41	1.34	0.61
7	Munipally	1.45	0.28	1.24	0.49
8	Kalher	0.99	0.50	0.97	0.44
9	Manoor	1.89	0.41	1.38	0.50
10	Nagalgidda	1.41	0.56	1.25	0.52
11	Narayankhed	1.32	0.35	1.12	0.45
12	Sirgapoor	2.30	0.43	1.14	0.47
13	Kangti	2.01	0.44	1.05	0.54
14	Jharasangam	1.40	0.32	1.33	0.47
15	Raikode	0.89	0.50	1.42	0.53
16	Kohir	1.54	0.35	1.03	0.49
17	Zaheerabad	1.48	0.28	1.08	0.53
18	Mogudampally	1.36	0.36	1.18	0.59
19	Nyalkal	1.62	0.35	1.07	0.81
20	Chowtkur	0.97	0.26	1.10	0.43
21	Pulkal	1.12	0.25	1.21	0.52
22	Andole	0.89	0.20	1.15	0.59
23	Vatpally	1.74	0.24	1.06	0.57
District Mean		1.49	0.34	1.20	0.54
Range		0.53-3.64	0.07-0.68	0.80-1.84	0.27-0.92
SD		0.58	0.13	0.25	0.14
CV (%)		38.59	38.64	20.90	26.18

3.5 Categorization of Soils into Low/Deficient, Medium and High/Sufficient Categories

The percentage of soil samples falling in low/deficient, medium and high/sufficient categories at 0-15 cm depth and 15-30 cm depth are presented in Table 7. The soil samples were classified into low, medium and high or deficient and sufficient categories as per the ratings forwarded by Muhr *et al.* [34] for organic carbon and available N, P and K and Tandon [35] for exchangeable Mg.Out of 112 surface soil samples, 51 per cent were low, 37 per cent were medium and 13 per cent were high in organic carbon, while in case of sub-surface soil samples, 92 per cent were in low, 6 per cent were in medium and 2 per cent were in high range of organic carbon. Available nitrogen was low in 90 per cent samples while medium in 10 per cent samples at 0-15 cm depth, while 96 per cent samples were in low and 4 per cent samples were in medium range at 15-30 cm depth. For available phosphorus, 18 per cent were in low, 56 per cent were in medium and 26 per cent were in high range at 0-15 cm depth, while 32 per cent were in low, 57 per cent were in medium and 12 per cent were in high rangeat 15-30 cm depth. In case of available potassium, 12 per cent were in medium and 88 per cent were in high categoriesat 0-15 cm depth, while 13 per cent were in medium and 87 per cent were in high categoriesat 15-30 cm depth. Exchangeable magnesium was deficient in 10 per cent soil samples and sufficient in 90 per cent soil samples at both the depths.

Soil fertility maps showed that available nitrogen was low, available phosphorus was low to high, available potassium was medium to high and exchangeable magnesium was sufficient in the soils of the study area (Fig. 2,3,4,5).

Table 7. Classification of soils into low/deficient, medium and high/sufficient categories based on ratings.

Parameters	Soil Depth (cm)	Ratings (%)		
		Low/ Deficient	Medium	High/ Sufficient
Organic Carbon	0-15 cm	51	37	13

	15-30 cm	92	6	2
	0-15 cm	90	10	-
Available N	15-30 cm	96	4	-
	0-15 cm	18	56	26
Available P	15-30 cm	32	57	12
	0-15 cm	-	12	88
Available K	15-30 cm	-	13	87
	0-15 cm	10	-	90
Exchangeable Mg	15-30 cm	10	-	90

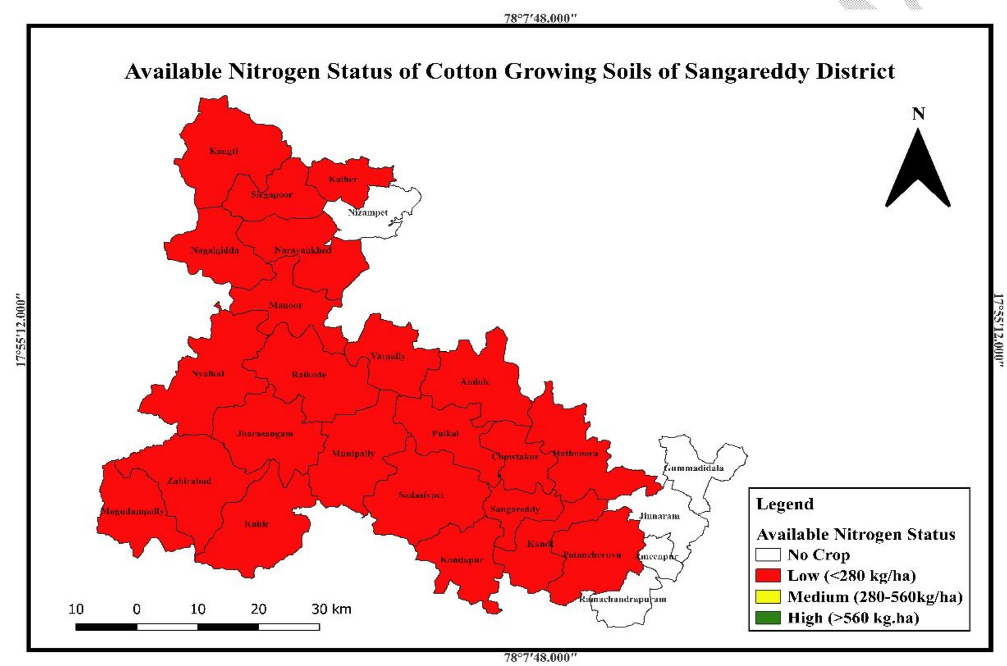

Fig. 2. Available Nitrogen Status in Cotton Growing Soils of Sangareddy District.

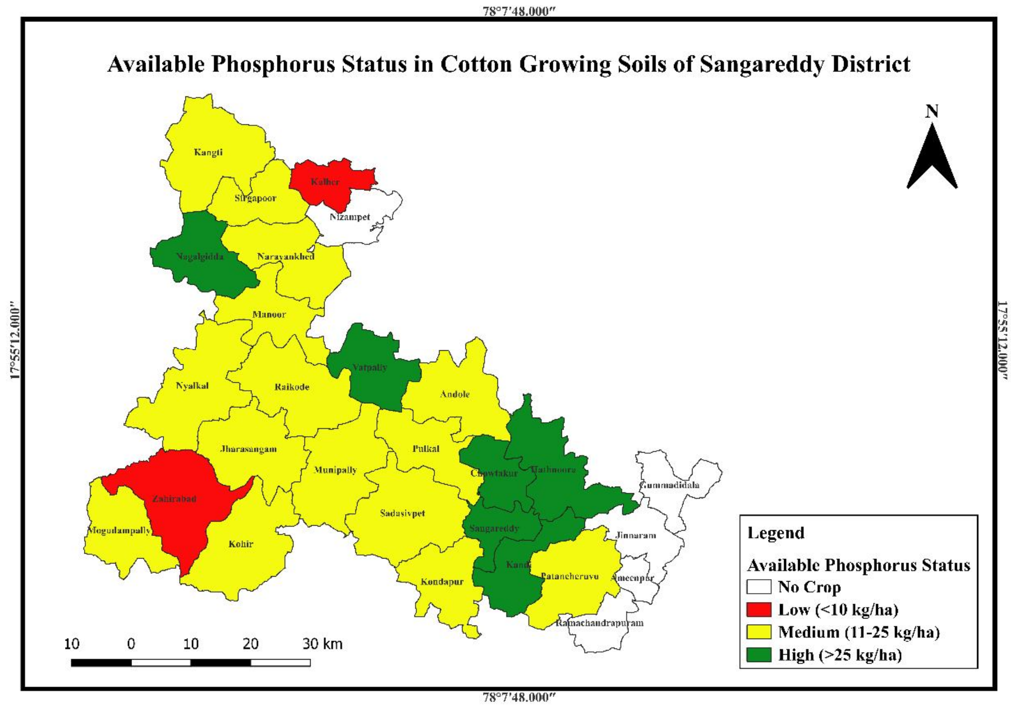

Fig. 3. Available Phosphorus Status in Cotton Growing Soils of Sangareddy District.

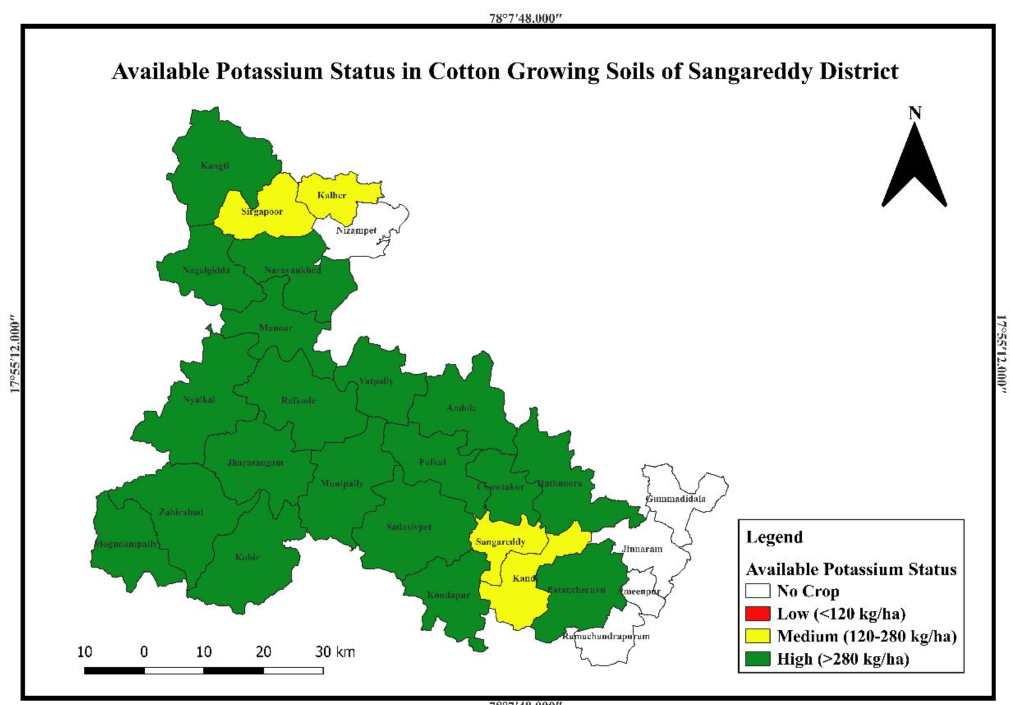

Fig. 4. Available Potassium Status in Cotton Growing Soils of Sangareddy District.

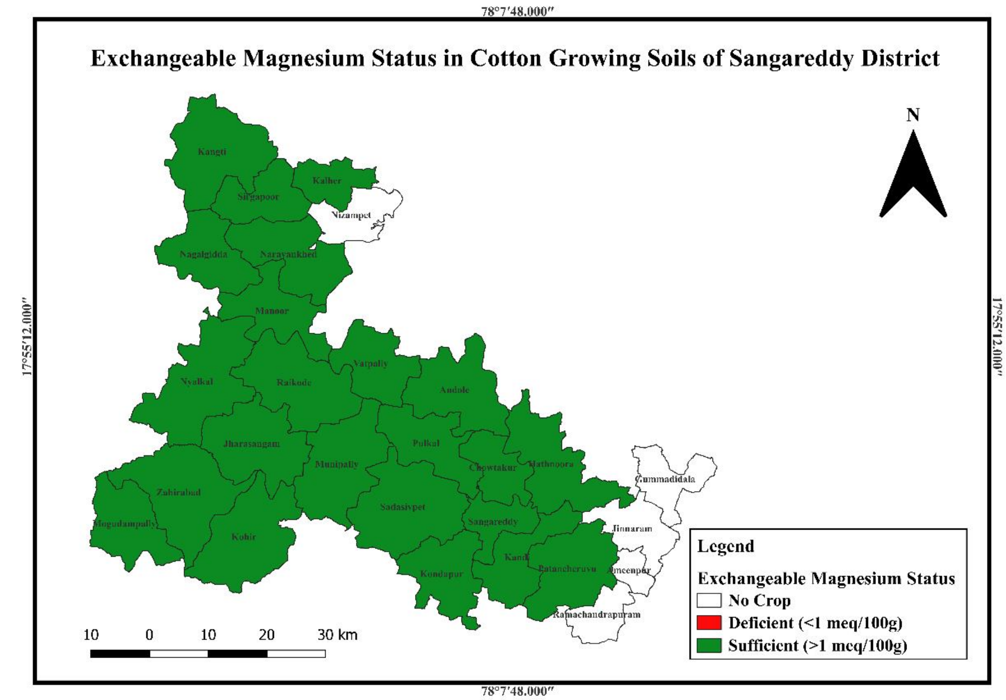

Fig. 5. Exchangeable Magnesium Status in Cotton Growing Soils of Sangareddy District.

4. CONCLUSION

The continuous cotton growing soils of Sangareddy district of Telangana were strongly acidic to slightly alkaline in reaction, non-saline, low to high in organic carbon. Cotton is cultivated in a wide range of soils ranging from sandy clay loam to loamy sand. Soil fertility maps showed that soils of the study area were mostly low in available nitrogen, medium in available phosphorus, high in available potassium and sufficient in exchangeable magnesium. High variability in leaf nutrient content indicates diverse soil fertility levels across the study area.Hence, there is a need of efficient nutrient management in soils of the study area to improve soil health and crop productivity. Application of nitrogenous fertilizers such as urea and slow-release fertilizers along with organic manures can be recommended for the low fertility areas. Regular soil testing is crucial to monitor the variations in nutrient levels and formulation of appropriate management strategies to address it.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

'Author a' performed the laboratory and statistical analysis,wrote the protocol and first draft of the manuscript. 'Author b' designed the studyand 'Author c' and 'Author d' managed the literature searches. All authors read and approved the final manuscript."

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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