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FERTILITY STATUS OF COTTON (*Gossypium hirsutum*) GROWING SOILS IN THIMMAJIPET MANDAL, MAHABUBNAGAR DISTRICT, TELANGANA

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ABSTRACT

Georeferenced surface soil samples (0-15 cm) collected from cotton growing fields of Thimmajipet mandal in Mahabubnagar district were analysed for pH, EC, organic carbon (OC), macronutrients (N, P, K, and S) and micronutrients (Fe, Zn, Cu and Mn). The soils were slightly to moderately alkaline, non-saline, low to medium in organic carbon, low in available N and medium to high in available P and K. High correlation between organic carbon and available nitrogen indicated that semi-arid climate induced oxidation coupled with limited litter addition led to poor accumulation of organic carbon in soils, in turn caused N deficiency, predominantly under rainfed conditions. Moreover, zinc and boron were deficient in 73 and 52 per cent of the soils, respectively, due to high pH in the soils. Integrated nutrient management with foliar application of deficient micronutrients could be viable option for enhancing cotton productivity.

KEYWORDS: Cotton growing soils, organic carbon, soil alkalinity, soil fertility.

INTRODUCTION

Cotton is the major commercial fibre crop of India. In Deccan plateau, it occupies major cultivated area and grown predominantly under rainfed conditions. This region comprises of mostly red and black associated soils and they are poor in fertility (Wani *et al*., 2009). Cotton productivity is severely limited due to poor soil fertility in general and in the cultivated fields of small and marginal farmers, in particular, due to poor resource availability. Thimmajipet mandal in Mahabubnagar district is mostly rainfed with an average annual rainfall of 500 mm and cotton occupies 60 per cent of the cultivated area mainly in the *Kharif* season. The yield level of cotton is low varying from 220 to 310 kg ha^{-1}. Though, productivity of cotton is influenced by both edaphic and non-edahpic factors, soil nutrient status and rate of fertilizer application plays a major role in deciding the yield of cotton. Information on soil fertility status of the cotton growing soils is limited in this mandal.

Hence, it is imperative to study the soil fertility status of cotton growing fields, which not only paves the way for increasing crop productivity but also sustains the cotton yields in Thimmajipet mandal.

MATERIALS AND METHODS

The study area is Thimmajipet mandal, Mahabubnagar district, located 100 km from Hyderabad. It lies between 16º 35' to 16º 44' N latitudes and 78º 07' to 78º 18' E longitudes and covers an area of 21,560 ha out of which 14,020 ha is cultivated (Vasu *et al*., 2015). A total of 214 surface soil samples (0-15 cm) were collected from cotton growing fields from the 19 villages of the mandal (Fig. 1). Soil pH, EC and organic carbon (OC) were estimated using standard procedures. Available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956) and available P was extracted with 0.5 N $NaHCO_3$ extractant (Olsen *et al*., 1954) and extracted P was determined by ascorbic acid method (Watanabe and Olsen, 1965). Available sulphur was extracted by 0.15% $CaCl_2$ and estimated by turbidimetry (Chesnin and Yien, 1950). The DTPA extractable micronutrients such as Fe, Cu, Mn and Zn were estimated as per the procedure outlined by Lindsay and Norvell (1978). Available boron was estimated by hot water extraction method (Berger and Truog, 1939).

Based on the analytical results soil samples were categorised into low, medium and high as per the ratings proposed by Muhr *et al*. (1965) with respect to organic carbon and available N, P, and K. The available micronutrients were classified as sufficient or deficient based on critical limits of Lindsay and Norvell (1978). Nutrient indices were computed for available N, P and K (Parker *et al*., 1951). Simple correlations between various soil fertility parameters were carried out as per the procedure given by Gomez and Gomez (1984).

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Table 1. Descriptive statistics of soil fertility parameters of cotton growing soils of Thimmajipet mandal

Properties	Min	Max	Mean	Std Dev	CV
pH	6.5	9.3	7.8	0.7	8.7
EC (dS m^{-1})	0.08	1.81	0.33	0.2	80.1
OC (%)	0.1	1.6	0.9	0.3	39.5
N (kg ha^{-1})	32.5	397.7	202.6	49.4	44.1
P (kg ha^{-1})	4.3	87.6	36.6	20.5	56.0
K (kg ha^{-1})	37.0	466.8	241.4	101.3	62.7
S (mg kg^{-1})	0.4	43.4	17.0	14.5	85.2
Fe (mg kg^{-1})	2.2	56.0	17.0	12.9	76.3
Mn (mg kg^{-1})	2.8	36.2	18.1	12.2	67.3
Zn (mg kg^{-1})	0.1	3.6	0.6	0.7	110.3
Cu (mg kg^{-1})	0.1	3.0	1.2	0.8	66.9
B (mg kg^{-1})	0.1	4.2	0.6	0.5	80.0

RESULTS AND DISCUSSION

The descriptive statistics of soil fertility parameters and the variability of fertility parameters (Table 1) were interpreted using coefficient of variation (Wilding, 1985). All the parameters except pH were (Table 1) high in variability (CV > 35%). The large variability of soil nutrients could be attributed to parent material, topographic position of soils and difference in fertilizer management. Most of the cotton growing soils occur in relatively higher topographical position, therefore, soil erosion caused by slope during high intensity rainfall could have eroded the top soil along with nutrients. The high standard deviation for available N, P and K suggests that the nutrient management of the cotton growing soils was not uniform.

pH, EC and organic carbon

The soil pH varied from 6.5 to 9.3 and 24 per cent of the soil samples were neutral (6.5-7.5) and 62 per cent were slightly to moderately alkaline (7.5-9.0). The variation in pH could be attributed to nature and chemical composition of parent material. The alkaline pH of most soil samples might be due to accumulation of sodium from ground water which is high in sodium concentration (Vasu *et al*., 2015). Electrical conductivity of all the samples were below 2 dS m^{-1} indicating non-saline nature. Organic carbon varied from 0.1 to 1.6 per cent with a mean of 0.9 per cent. However, the data in table 2 indicate that 16 per cent of the soils were low and 62 per cent were medium in organic carbon suggesting poor fertility status of the soils. The low organic carbon content could be attributed to poor crop cover, oxidation due to semi-arid climate. Since the mandal is predominantly rainfed dependent, single crop of cotton in a year is common practice due to poor resource and limited water availability. Further, poor litter addition could also be the major reason for poor organic carbon content of soils.

Available N, P, K and S

Available N varied from 32.5 to 397.7 kg ha^{-1} with 81 per cent samples showing deficiency. Available P was high in 72.4 per cent and medium in 19.6 per cent soils. Available K varied from 37 to 466.8 kg ha^{-1} and 25.2 per cent soils were low (< 140 kg ha^{-1}) in available K. The Parker nutrient index of N (1.2), P (2.6) and K (1.9) indicated that soils were acutely deficient in N, medium in K and high in P. Nitrogen management should be given due care for improving cotton yield. High P content might be due to addition of single super phosphate. The available S was (Table 3) deficient in 41 per cent of the soils.

Available Fe, Zn, Cu, Mn and B

Micronutrients zinc and boron were deficient in 73 and 52 per cent (Table 3) of soils, respectively. It indicates

Table 2. Status of organic carbon and available macronutrients

Parameters	S (mg kg^{-1})	Number of samples	Fe (mg kg^{-1})	Number of samples	Mn (mg kg^{-1})	Number of samples	Zn (mg kg^{-1})	Number of samples	Cu (mg kg^{-1})	Number of samples	B (mg kg^{-1})	Number of samples
Deficient	<10	87 (40.7)	<4.5	18 (8.4)	<1.2	0 (0)	<0.6	156 (72.9)	<0.2	5 (2.3)	<0.5	111 (51.9)
Sufficient	>10	127 (59.3)	>4.5	196 (91.6)	>1.2	214 (100)	>0.6	58 (27.1)	>0.2	209 (97.7)	>0.5	103 (48.1)

Figures in parenthesis indicate percentage of soil samples

Table 3. Status of available micronutrients

Parameters	OC (%)	Number of samples	N (kg ha^{-1})	Number of samples	P (kg ha^{-1})	Number of samples	K (kg ha^{-1})	Number of samples
Low	<0.5	36 (16.8)	<280	174 (81.3)	>11	17 (7.9)	<140	54 (25.2)
Medium	0.5-0.75	43 (20.1)	280-560	40 (18.7)	11-22	42 (19.6)	140-330	119 (55.6)
High	>0.75	135 (63.1)	>560	0 (0)	>22	155 (72.4)	>330	41 (19.2)

Figures in parenthesis indicate percentage of soil samples

Fig. 1. Sampling locations in the cotton growing fields of Thimmajipet mandal

that multi nutrient deficiency could be one of the major factor affecting cotton productivity in Thimmajipet. Similarly Sahrawat *et al*. (2007) also reported deficiency of S, Zn and B in the farmers fields of Mahabubnagar district.

Correlations

The Pearson correlation matrix of soil fertility parameters indicated significant negative correlation between pH and micronutrients such as Z and Mn (Table 4). The deficiency of Zn was due to high pH in these soils. However, organic carbon was highly and positively correlated with available N indicating poor organic carbon content was major reason for the deficiency of N.

CONCLUSION

The cotton growing soils were slightly to moderately alkaline, non-saline, low to medium in organic carbon, low in available N and medium to high in available P and K. Parker nutrient index indicated that N management should be given due importance for better cotton productivity. The poor quality groundwater was responsible for accumulation sodium in soil, hence application of gypsum along with organic manures is highly essential to control alkalinity in these soils. Application of urea (acid forming fertilizer) along with organic manures not only enrich the N content of soils but also reduce the soil pH. Hence, integrated nutrient management is recommended to improve cotton productivity in the study area.

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Table 4. Pearson correlation coefficient of soil fertility parameters

Parameters	pH	EC	OC	N	P	K	S	Fe	Mn	Zn	Cu	B
pH	1											
EC	0.397**	1										
OC	0.243**	0.212**	1									
N	0.235**	0.264**	0.932**	1								
pH	0.001	0.027	0.178**	0.204**	1							
K	0.016	0.087	0.112	0.096	0.146*	1						
S	-0.031	0.111	0.092	0.065	-0.045	0.060	1					
Fe	-0.085	0.023	-0.061	-0.013	0.110	0.034	0.125*	1				
Mn	-0.115*	-0.021	-0.049	-0.035	0.045	0.019	0.138*	0.209**	1			
Zn	-0.131*	-0.021	0.011	0.059	-0.016	-0.003	-0.035	0.068	-0.006	1		
Cu	-0.059	0.030	0.015	0.014	0.041	0.092	0.074	0.407**	-0.023	0.019	1	
B	0.077	-0.029	0.023	0.006	-0.069	0.033	-0.021	-0.024	0.082	0.009	0.045	1

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level

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