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Soil fertility status of soybean growing soils of Adilabad district, Telangana

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Abstract

Soybean is an important oilseed crop predominantly grown in Adilabad district. Investigating the fertility status of soybean growing soils is required to under pin future land use planning. A survey was carried out in major soybean growing soils of Adilabad district of Telangana state. One hundred and ten representative surface soil samples (0-15 cm) were collected and analysed for their salient characteristics *viz.*, pH, EC, OC, available N, P₂O₅, K₂O, S and micronutrients (Zn, Fe, Cu and Mn). Soil fertility maps were prepared for macro and micro nutrients. Results revealed that, soil pH ranged from 6.10 to 8.51. The soils were non-saline to slightly saline (0.14 to 1.26 dSm⁻¹). The organic carbon ranged from 0.18 to 0.80 per cent. With regard to available nutrients, the values varied from 105 to 241 kg/ha for nitrogen, 9.7 to 98 kg/ha for phosphorus, 198 to 395 kg/ha for potassium and 6.12 to 25.32 mg/kg for sulphur. Among the micronutrients 61.81 and 22.72 percent soils were deficient in available zinc and iron, respectively. Further, the soils were not deficient in Cu and Mn.

Keywords: Soil, fertility, soybean, predominantly, Telangana

Introduction

Soybean (*Glycine max* (L.)) is the second largest oilseed crop in India after groundnut. It is the cheapest and richest source of high-quality protein. It is a legume crop belonging to family Leguminosae and sub-family Papillionaceae. Soybean is also called as "Gold of soil" as it builds up the soil fertility by fixing atmospheric nitrogen through nodules. Symbiotically soybean fixes nitrogen and leaves about 25 percent to succeeding crop (Nutan Lal *et al.*, 2019) ^[5]. In India soybean is grown in 11.33 million hectares with a production of 13.79 million tonnes and productivity of 1217 kg ha⁻¹ (Directorate of Economics and Statistics, 2020) ^[2]. The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana and Gujarat. In Telangana the crop is grown in an area of 0.15 million hectares with 0.23 million tonnes of production and productivity of 1584 kg ha⁻¹. The cultivation of soybean crop is increasing at a faster rate and is extensively grown in Adilabad, Nizamabad, Medak and Karimnagar districts in Telangana state (Sathyanarayana *et al.*, 2021)^[10].

Soil fertility is a major constraint to its productivity. Low organic matter content coupled with low and imbalanced application of nutrients limits its full potential yield and is the main yield barrier (Bellakki *et al.*, 1999)^[1]. Nutrient level is decreasing continuously in Indian soils due to extensive agriculture while meeting the food demand of escalating population growth. Inventory of the physico-chemical properties, available macro and micronutrients status of the soils helps in demarcating the areas where the application of particular nutrient is needed for profitable crop production (Singh, 2010)^[11]. Also, it is already well known that the properties of a soil are the basic attributes that influence directly on the soil response to any specified use (Sood *et al.*, 2009)^[12]. Though sporadic information is available on characterization and classification of soils in Adilabad district, detailed and systematic investigation on the properties of soils, specifically in soybean growing soils is meagre. Hence, the present study was taken up in the major soybean growing soils of Adilabad district with an objective to understand and update the knowledge on the potentials and limitations of these soils in enhancing the productivity of soybean. This paper deals with nutrient status (physical, physico-chemical and chemical properties) of soybean growing soils of Adilabad district.

Materials and Methods

Study Area and Sample Collection

The soil survey was carried out representing the major soybean growing soils of the Adilabad district (Fig. 1). A total of one hundred and ten soil samples (0-15 cm depth) were collected.

The soil samples were collected using GPS (Global Positioning System) and the longitude and latitude points of a particular location were recorded. The soil fertility maps were prepared with the help of Arc GIS v 10.2 software using GPS points. The soil samples were packed and labelled properly in polythene bags and brought to the laboratory for further analysis.

Laboratory Analysis

All the soil samples were air dried, grounded and passed

through 2 mm sieve for chemical analysis. The soils were analysed for salient characteristics viz., pH, EC, OC, mechanical analysis & available nutrients (N, P₂O₅, K₂O, S, Zn, Fe, Cu and Mn) following standard procedures. After analysis for available nutrient status, the soils were categorised as low, medium and high for N, P₂O₅ and K₂O. The available sulphur and micronutrients (Zn, Fe, Cu and Mn) were rated as deficient and sufficient based on the critical levels as given by Tandon (2005)^[15].

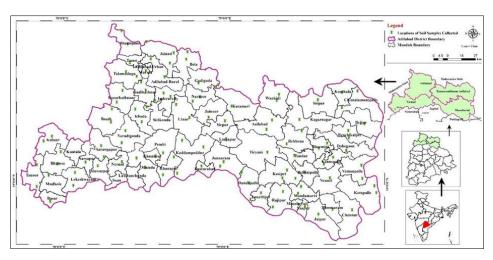


Fig 1: Location of soil samples collected in Adilabad district

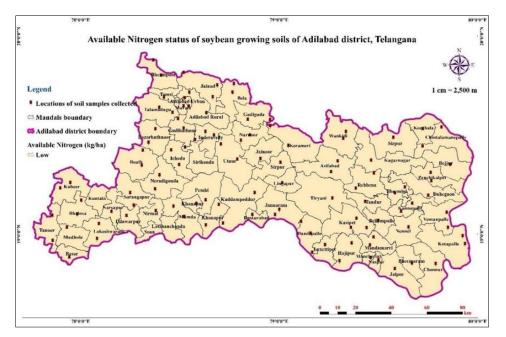


Fig 2: Available Nitrogen status of soybean growing soils of Adilabad district

Results and Discussion

Physical and Physico-chemical Characteristics

The soil texture varied from clay to sandy loam. Out of 110 samples analysed, 43.63 percent soils were clayey, 7.28% were clay loam, 25.45% were sandy clay loam, 21.82% were sandy clay and 1.82% soils were sandy loam in texture.

Soil reaction (pH) of the surface soils ranged from 6.10 to 8.51 indicating that, these soils are slightly acidic to alkaline in reaction. The observations on the soil pH revealed that, 2.72 percent of soils were slightly acidic (<6.5), 66.36% of samples were neutral (6.5-7.5) and 30.92% of samples were alkaline (>7.5) in nature.

Electrical conductivity (EC) of surface soils ranged from 0.14

to 1.26 dSm⁻¹ indicating that, these soils were non-saline to slightly saline in nature. The observations on EC revealed that, 97.28% of samples were non-saline, 2.72% of samples were slightly saline in nature.

With regard to the status of organic carbon (%) it did not very much in surface soils. The values found to vary from 0.18 to 0.80%. The observations on organic carbon revealed that, 80.90% of soils were low (<0.5%), 13.65% of soils were medium (0.5-0.75%) and 5.45% of soils were high in organic carbon. The reason for low organic carbon content in most of the soils may be attributed to the prevalence of semi-arid condition, where the degradation of organic matter occurs at a faster rate coupled with little or no addition of organic

manures and low vegetation cover on the fields, there by leaving less chances of accumulation of organic carbon in the soils. Intensive cropping is also one of the reasons for low organic carbon content in soils. The similar results were also reported by Nalina *et al.* (2016) ^[4].

Available Nutrients

The available nitrogen content of the soils ranged from 105 to 241 kg/ha (Table 1 and depicted in Fig. 3). Out of the 100 samples analysed, all the soils found to have low (<280 kg/ha)

available nitrogen. From the survey data, previous history of the crops grown was taken which indicated that, cotton is one of the major commercial crops grown in Adilabad. The low available N could be attributed to soil management, varied application of FYM and fertilizers to previous crops. Another possible reason may also be due to low organic matter content in these areas and high temperature which facilitate faster degradation and removal of organic matter leading to N deficiency (Karthikeyan *et al.*, 2014)^[3].

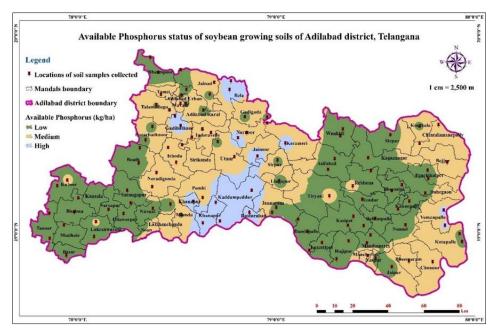


Fig 3: Available Phosphorus status of soybean growing soils of Adilabad district

The available phosphorus content of the soils exhibited extreme variation between 9.7 to 98 kg ha⁻¹ (Table 1 and depicted in Fig. 4). The soils found to have low to very high available phosphorus. Among the soils analysed, 64.54, 21.85 and 13.61 per cent of soils registered low (<22 kg ha⁻¹), medium (22-54 kg ha⁻¹) and high available phosphorus (>54 kg ha⁻¹), respectively. Continuous application of DAP to crops

without soil testing might have resulted in phosphorus build up and led medium to high available phosphorus status in these soils (Sathish *et al.*, 2018)^[9]. Another reason for higher P in surface soils possibly might be due to P confinement to the rhizosphere due to its immobile nature in soils (Rajeshwar and Mani, 2014)^[8].

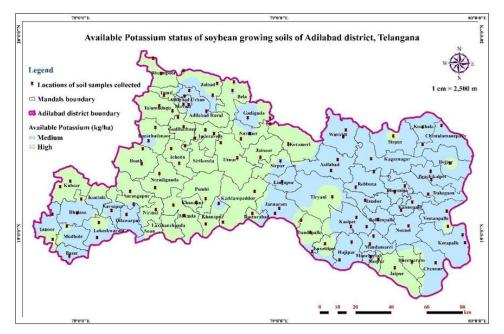


Fig 4: Available Potassium status of soybean growing soils of Adilabad district

The available potassium content of the soils varied from 198 to 395 kg ha⁻¹ (Table 1 and depicted in Fig. 5). About 53.63% and 46.37% of soils recorded medium (123-296 kg ha⁻¹) to high (>296 kg ha⁻¹) available potassium, respectively. These soils were able to maintain a sufficient or even high level of exchangeable K and provide a good supply of K to plants f or many years. The medium to higher content of available K₂O in soybean growing soils of Adilabad district may be due to

the predominance of K-rich micaceous and feldspar minerals in parent material. Similar results were observed by Srikant *et al.* (2008) ^[13]. Further, high available K status in surface soils could be attributed to 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. Similar results were reported by Pal and Mukhopadyay (1992) ^[6].

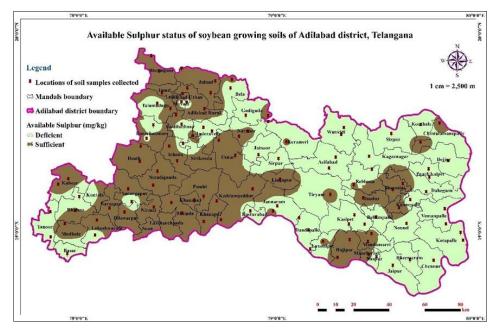


Fig 5: Available Sulphur status of soybean growing soils of Adilabad district

The available sulphur content of the soils ranged from 6.12 to 25.32 mg kg⁻¹ (Table 1 and depicted in Fig. 6). Considering 10 ppm as critical limit for available sulphur, 19 and 81 per cent of soils registered deficient (<10 mg kg⁻¹) and sufficient (>10 mg kg⁻¹) available sulphur status, respectively. Intensive cropping without application of sulphur fertilizers may lead to

depletion of sulphur in these soils. The low available S is partly due to gypsiferous nature of S which is non-available in black soils, continuous removal of S by crops and use of high analysis complex fertilizers (Venkatesh and Satynarayana, 1999)^[16].

Table 1: Available Nutrient	Status in Soybean	n Growing Soils of Adilabad District
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S.		Name of the		Available Macronutrients				Available Micronutrients			
S. No	District	Name of the Mandal	Name of the Village	Ν	P2O5	K ₂ O	S	Zn	Fe	Cu	Mn
INO		Mandai		(kg/ha)	(kg/ha)	(kg/ha)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
1	Adilabad	Adilabad	Wanwat	180	17.6	284	20.00	1.35	14.00	0.58	12.88
2	Adilabad	Adilabad Rural	Chanda	190	20.5	289	22.36	0.31	11.56	5.65	15.20
3	Adilabad	Adilabad Urban	Adilabad	210	18.7	222	11.85	2.11	18.50	2.32	2.56
4	Adilabad	Adilabad Urban	Adilabad	225	21.2	216	25.32	0.98	21.25	1.95	3.31
5	Adilabad	Asifabad	Asifabad	155	15.6	285	10.96	0.49	15.62	0.39	15.21
6	Adilabad	Asifabad	Chirrakunta	191	21.0	286	10.05	0.53	21.25	2.15	14.50
7	Adilabad	Basar	Basar	110	14.5	225	9.65	0.41	3.60	0.66	6.35
8	Adilabad	Bazarhathnoor	Bazarhatnoor	133	20.3	226	14.21	1.98	15.32	4.50	15.36
9	Adilabad	Bazarhathnoor	Morekhandi	198	17.5	333	13.00	0.52	9.23	0.88	35.65
10	Adilabad	Bejjur	Bejjur	188	48.0	310	13.50	0.65	14.12	1.28	19.00
11	Adilabad	Bela	Bela	178	91.3	290	7.10	0.44	10.25	3.33	30.12
12	Adilabad	Bela	Guda	225	95.6	355	16.10	3.12	23.35	1.10	26.30
13	Adilabad	Bellampalle	Bellampalle	156	18.3	198	11.45	0.90	2.61	2.36	24.26
14	Adilabad	Bhainsa	Chintalabori	210	11.0	299	8.00	0.30	2.98	1.00	15.36
15	Adilabad	Bheemaram	Bheemaram	110	51.0	336	8.12	1.12	3.56	1.25	5.64
16	Adilabad	Bheemini	Bhainsa	129	14.4	245	15.32	0.19	20.14	4.10	18.21
17	Adilabad	Bheemini	Bheemini	125	21.3	221	16.91	0.22	14.29	0.65	9.63
18	Adilabad	Bheemini	Thangallapalle	184	14.2	238	22.00	1.25	1.57	3.28	26.36
19	Adilabad	Bheempoor	Antargaon	206	15.6	296	19.56	0.35	3.49	0.98	21.12
20	Adilabad	Bheempoor	Dhanora	195	14.8	315	18.00	0.41	3.10	0.90	19.56
21	Adilabad	Boath	Boath Buzurg	129	19.3	315	20.50	2.58	15.30	4.12	6.36
22	Adilabad	Boath	Sonala	220	17.5	370	19.65	1.56	17.20	1.00	14.25

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	90	Adilabad	Penchikalpet	Yelkapalle	111	16.1	225	7.52	2.88	2.88	6.10	10.00

91	Adilabad	Rebbena	Gollet	124	24.0	236	15.00	0.37	15.00	5.10	25.00
92	Adilabad	Rebbena	Tungeda	212	19.5	210	14.20	0.45	12.50	2.10	15.32
93	Adilabad	Sarangapur	Beeravelli	184	9.7	291	8.56	0.55	7.89	0.93	8.12
94	Adilabad	Sarangapur	Sarangapur	193	20.2	365	16.10	0.39	10.50	1.15	14.58
95	Adilabad	Sirkonda	Ponna	224	28.2	338	6.68	1.15	17.52	0.99	15.60
96	Adilabad	Sirpur (T)	Seetagondi	176	14.6	291	8.10	0.54	15.63	2.00	14.21
97	Adilabad	Sirpur (U)	Sirpur	231	15.3	305	9.10	0.92	18.10	1.14	18.21
98	Adilabad	Talamadugu	Devpur	210	18.7	295	18.50	0.38	10.52	1.88	11.25
99	Adilabad	Talamadugu	Talamadugu	235	20.3	389	9.10	0.41	11.25	4.55	12.85
100	Adilabad	Tamsi	Tamsi	190	28.0	396	18.00	0.46	2.99	6.10	10.00
101	Adilabad	Tandur	Kothapalle	131	17.6	270	16.35	0.48	15.26	4.25	17.12
102	Adilabad	Tanoor	Beltaroda	192	10.8	246	7.12	0.38	11.52	1.12	10.25
103	Adilabad	Tanoor	Kharbala	188	21.0	329	14.26	0.29	20.00	4.12	24.25
104	Adilabad	Tiryani	Tiryani	200	24.0	345	15.90	0.39	3.66	1.55	11.78
105	Adilabad	Utnur	Pulimadgu	225	15.1	355	20.36	0.96	14.60	0.78	16.23
106	Adilabad	Utnur	Utnoor	179	30.0	295	16.55	0.30	20.00	1.18	13.35
107	Adilabad	Vemanpalle	Mulkalpet	115	58.3	310	11.66	2.15	9.56	0.58	8.88
108	Adilabad	Vemanpalle	Vemanpalle	108	61.0	296	14.50	0.69	15.21	2.17	28.10
109	Adilabad	Wankidi	Bambara	169	18.1	292	9.65	0.55	11.68	0.55	11.00
110	Adilabad	Wankidi	Wankidi	224	20.4	290	8.96	0.36	11.00	3.55	6.98



Fig 6: Available Zinc status of soybean growing soils of Adilabad district

Available Micronutrients

The DTPA extractable micronutrients *viz.*, Zn, Fe, Cu and Mn were analysed in the soil samples. The observations on DTPA-extractable Zn (Table 1 and depicted in Fig. 7) stated that, 61.81 and 38.19 per cent of the soils registered deficiency (<0.60 mg/kg) and sufficiency (>0.60 mg/kg) in available zinc, respectively. Since, most of the soils are

neutral to alkaline, low in organic carbon, there is a possibility of deficiency of Zn and Fe in these soils. Similar results were observed by Patil *et al.* (2016) ^[7]. As zinc is an essential nutrient which plays an important role in oilseeds and legume crops for increasing yield, nodule development and nitrogen fixation, it is necessary to apply zinc to soils deficient in zinc.

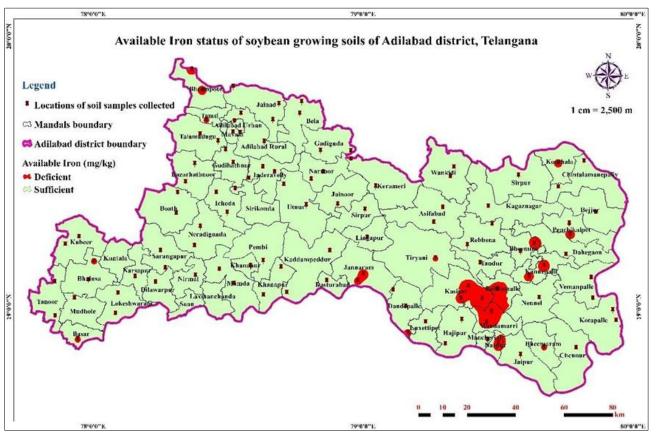


Fig 7: Available Iron status of soybean growing soils of Adilabad district

The available iron (mg/kg) varied from 1.28 to 39.32 mg/kg (Table 1 and depicted in Fig. 8). Out of the total samples (110) analysed, 22.72 per cent of samples were deficient (<4.0 mg/kg) and 77.28 percent of samples have available Fe more than 4.0 mg/kg.

Available copper and manganese deficiency is negligible (Table 1) in all the soils collected from soybean growing areas of Adilabad district. Similar results were also reported by Surendra Babu *et al.* (2019)^[14].

S. No	Available Nutrients	Values	Percent soils under different categories
	Nitrogen (kg/ha)		
1	Low	<280	100
1	Medium	280-560	-
	High	>560	-
	Phosphorus (P2O5 kg/ha)		
2	Low	<22	64.54
2	Medium	22-54	21.85
	High	>54	13.61
	Potassium (K ₂ O kg/ha)		
3	Low	< 123	-
3	Medium	123-296	53.63
	High	>296	46.37
	Sulphur (mg/kg)		
4	Deficient	<10	19
	Sufficient	>10	81
	Zinc (mg/kg)		
5	Deficient	<0.6	61.81
	Sufficient	>0.6	38.19
	Iron (mg/kg)		
6	Deficient	<4.0	22.72
	Sufficient	>4.0	77.28
	Copper (mg/kg)		
7	Deficient	< 0.2	-
	Sufficient	>0.2	100
	Manganese (mg/kg)		
8	Deficient	<2.0	-
	Sufficient	>2.0	100

Table 2: Ratings of soil available nutrients and percent soils falling under different categories

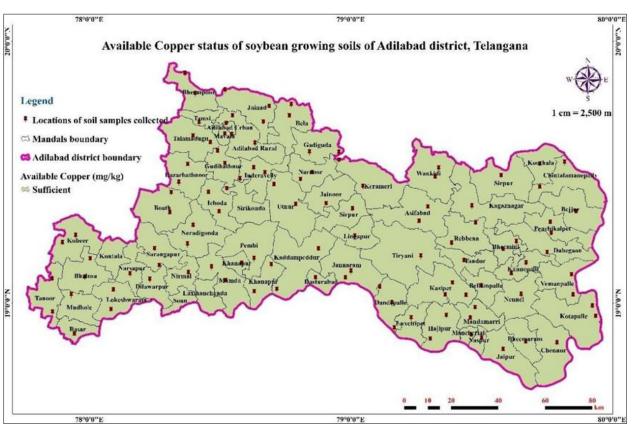


Fig 8: Available Copper status of soybean growing soils of Adilabad district

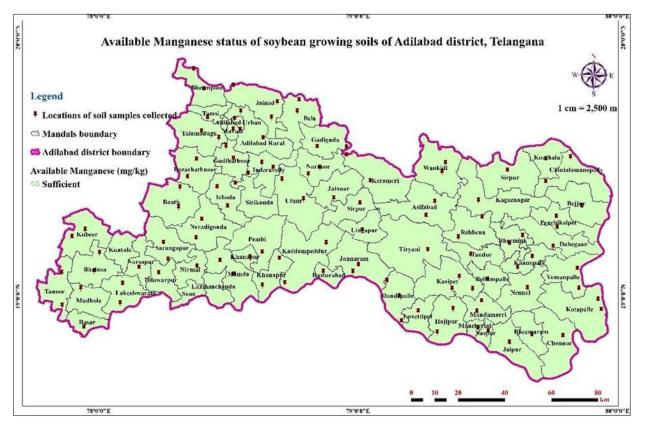


Fig 9: Available Manganese status of soybean growing soils of Adilabad district

Conclusion

- Based on the results obtained, it can be concluded that, application of organic manures needs to be encouraged in soybean growing soils of Adilabad district apart from crop residue incorporation as the soils has low organic carbon (<0.5%).
- As per the survey data, cotton is one of the predominant crops grown in Adilabad and is a heavy feeder of nitrogen, leading to nitrogen deficiency. Introducing legume crops like soybean in crop rotation with crops like cotton is effective as it adds nitrogen to soils.
- In medium to high P soils of Adilabad district, to make

the phosphorus available to crops, integrated use of organic manures along with P solubilizing bacteria can be recommended.

- As zinc and iron are deficient in 65 and 23 percent of soils, application of these micronutrients as ZnSO₄ and FeSO₄ is essential to minimize the yield losses.
- The soil fertility maps developed for Adilabad district helps in predicts the nutrient deficiencies or sufficiencies, based on which the crop based fertilizer recommendations can be given to sustain the crop productivity and also the excess use of fertilizers can be discouraged.

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