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Crop Production Constraints Related to Secondary and Micro Nutrients in the Soils of Jajpur District, Odisha

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Abstract: Surface and sub-surface status of secondary and micronutrients help in knowing their status and preparing judicious agricultural plan. GPS based 300 surface soil samples from 10 blocks and horizon-wise soil samples from 3 pedons occurring in three physiographic units of Jajpur district were collected and analyzed. The colour of soils of pedon varied from brownish yellow to red. The clay content ranged from 21.8% to 38.8% and increased with depth. The soil pH, exchangeable and DTPA- Ca, Mg, Fe, Mn and Zn were increased with depth while OC, S, Cu and B decrease with depth. The surface soil of (92.33% soil samples) had acidic pH, non-saline (0.02-0.89 dS m^{-1}) and 28.66% soils low in SOC. The exchangeable Ca and Mg were sufficient barring 6 % soils being deficient in Mg. The available S varied from 1.13 to 114.98 mg kg^{-1} with 40% soil samples showed its deficiency. The available DTPA-Fe, Mn, and Cu were above the critical limit ranging from 11.68 to 396.8, 4.96 to 271.74, 0.39 to7.54 mg kg^{-1} respectively. Deficiency of Zn and B were found in 26.6% and 73.3% soil samples respectively. The multi-nutrients deficiency were observed in order of S+Zn, S+B, B+Zn, B+Zn+S in 10.3, 32, 26, 8% soil samples respectively. Plant tissue analysis showed that PSD with respect to S, B, Zn, Mn and Cu were 25.7%, 51.4%, 17.14%, 5.7% and 5.75 respectively. Apart from acidity, S, B and Zn were soil constraints in achieving the higher production. Toxic level of Fe was present in high land zone. Application of S and B for vegetable, pulse and oilseed crops whereas Zn for rice may be recommended along with lime to increase production and productivity of agricultural crops of Jajpur district.

Key words: *Jajpur, micro-secondary nutrients, soil profile, remote sensing*

Introduction

Increasing demand for food to support the growing population necessitates a systematic study of the soil resources for effective land use plan. Crop production in soils of Odisha is much below compared to other states due to geographic position. Jajpur is an agriculturally important district of Odisha with total geographical area of 2887.69^2 km while comprises of two agro-climatic zones namely North Eastern Coastal Plain and Mid Central Table Land. The production and productivity of various crops of Jajpur district is comparatively lower than state average due to many soil related constraints. In order to achieve a sustainable agricultural production, productivity need to be enhanced and for which information on soil fertility status is required. In view of this an attempt has been taken to identify the soil related crop production constraints of Jajpur district in order to pinpoint the limitations imposed by nutrients availability.

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Materials and Methods

The representative soil samples (one sample/4km^2 areas) were collected from each community block of district (20°.30' to 21°.10' N; 85°.40' to 86°.44 E). Thus there were thirty surface samples from each block with a total of 300 soil samples. To know the vertical (sub-surface) distribution of nutrients, profile soil samples were collected from upland, medium land and low land situations. The major crops grown in the area are rice, ground nut, black gram, green gram and vegetable the surface and sub-surface soils samples were processed and analysed for pH, organic carbon (OC) and particle-size distribution following standard procedures (Jackson *et al.* 1973). Available sulphur was determined by $CaCl_2$ extractable Turbidimetric method (Chesnin and Yien 1951). Exchangeable Ca and Mg content of soils were determined by EDTA titration method. The available micronutrient cations were extracted with 0.005 *M* DTPA solution and determined with Atomic Absorption Spectrophotometer as described by Lindsay and Norvell (1978). Available boron was determined by hot water extractable method of Berger and Truog (1939) by using Azomethin – H indicator (John *et al.* 1975).

Results and Discussion

The data related to pH, EC and organic carbon has been presented in table 1.

Table 1. Basic properties of surface soils of Jajpur

Name of the block	pH (1:2.5)	EC(dS m^{-1})		OC (%)	
	Range	Range	Mean	Range	Mean
Sukinda	4.09-6.83	0.015-0.874	0.138	0.16-1.87	0.82
Danagadi	4.40-7.40	0.035-0.306	0.102	0.35-1.57	0.76
Korei	4.43-7.23	0.035-0.399	0.129	0.19-1.63	0.62
Dasarathpur	4.82-6.92	0.015-0.38	0.121	0.09-1.63	0.73
Badachana	4.59-6.49	0.03-0.183	0.061	0.29-1.00	0.68
Dharmasala	4.38-6.62	0.022-0.74	0.139	0.21-1.12	0.59
Rasulpur	4.34-6.74	0.054-0.894	0.23	0.17-1.19	0.61
Binjharpur	4.86-5.91	0.02-0.133	0.062	0.39-0.99	0.73
Jajpur	4.64-6.97	0.04-0.493	0.14	0.09-1.00	0.48
Bari	4.44-7.40	0.023-0.894	0.08	0.15-1.63	0.63
Jajpur district	**4.09-7.40**	**0.02-0.89**	**0.12**	**0.09-1.87**	**0.66**

The pH of surface soils of Jajpur district ranged from 4.09 to 7.40. About together 92.33% of soil samples were acidic, 7.33% samples were neutral and 0.33% samples were alkaline. The EC varied from 0.02 to 0.89 dSm^{-1} with mean value of 0.12. The soils were mostly non saline with few exceptions.

The status of DTPA extractable Fe, Mn, Cu, Zn and hot water soluble boron of the soils of Jajpur district were presented in table 2 and 3. Data indicated DTPA-Fe, Mn, Cu of surface soil was sufficient in all blocks.

Table 2. Block-wise DTPA-Fe, Mn and Cu status of Jajpur district

Block	Fe (mg kg^{-1})		Mn (mg kg^{-1})		Cu (mg kg^{-1})	
	Range	Mean	Range	Mean	Range	Mean
Sukinda	11.68-396.8	68.87	25.12-271.4	92.16	0.39-4.06	1.94
Danagadi	25.0-207.8	104.13	16.92-196.12	74.41	1.18-6.72	3.89
Korei	23.76-282	141.87	4.96-206.16	50.05	1.91-4.37	2.40
Dasarathpur	23.44-294.54	101.28	55.16-152.68	99.80	1.37-7.54	4.30
Badachana	24.28-318.18	142.16	5.36-126.0	53.08	1.16-4.83	3.21
Dharmasala	53.24-238.8	123.25	7.0-94.52	52.47	1.07-3.9	1.82
Rasulpur	22.96-189.84	75.48	9.2-117.08	54.28	0.79-3.02	1.90
Binjharpur	73.36-232.86	135.60	29.65-149.58	78.22	1.67-5.53	4.14
Jajpur	36.12-178.28	87.89	10.74-134.82	61.88	0.89-4.95	3.04
Bari	53.80-318.18	129.30	23.44-206.16	71.73	0.42-7.54	2.08
Jajpur district	**11.68-396.8**	**110.98**	**4.96-271.4**	**68.81**	**0.39-7.54**	**2.87**

The DTPA-Zn of the soil varied from 0.13-4.08 mg kg^{-1} with mean value of 0.99 mg kg^{-1} with deficiency per cent of 26.66 %. The maximum DTPA-Zn was observed in Sukinda block and minimum in Badachana block though deficiency was present in all blocks.

The (HWS) boron in surface soil ranged between 0.02 to 1.77 mg kg^{-1} with a mean value of 0.40 mg kg^{-1}. Similar results were also reported in the districts of Nayagarh and Dhenkanal (Mishra *et al.* 2016). The soils of the district were found deficient in boron up to 73.33%. The extent of deficiency was maximum in Badachana block (86.66 %) and minimum in Dharmasala block (33.33 %). Six blocks were found deficient (>80%) in boron.

Table 3. DTPA-Zn and HWS B of Jajpur district

Block	Zn (mg kg^{-1})			B (mg kg^{-1})		
	Range	Mean	PSD %	Range	Mean	PSD%
Sukinda	0.22-4.08	1.23	16.6	0.03-0.92.	0.47	56.6
Danagadi	0.25-2.43	1.32	23.3	0.12-1.71	0.40	73.3
Korei	0.29-2.93	1.03	36.6	0.08-0.95	0.33	83.3
Dasarathpur	0.27-1.97	0.91	36.6	0.17-0.66	0.38	70.0
Badachana	0.12-1.60	0.81	33.3	0.10-0.58	0.34	86.6
Dharmasala	0.17-2.49	1.15	20.0	0.22-1.19	0.97	33.3
Rasulpur	0.13-2.21	0.86	26.6	0.07-0.61	0.26	80.0
Binjharpur	0.20-2.25	1.04	13.3	0.02-0.63	0.27	83.3
Jajpur	0.46-1.26	0.82	30.0	0.04-0.73	0.28	83.3
Bari	0.22-3.25	0.72	43.3	0.03-1.77	0.29	80.0
Jajpur district	**0.13-4.08**	**0.99**	**26.66**	**0.02-1.77**	**0.40**	**73.33**

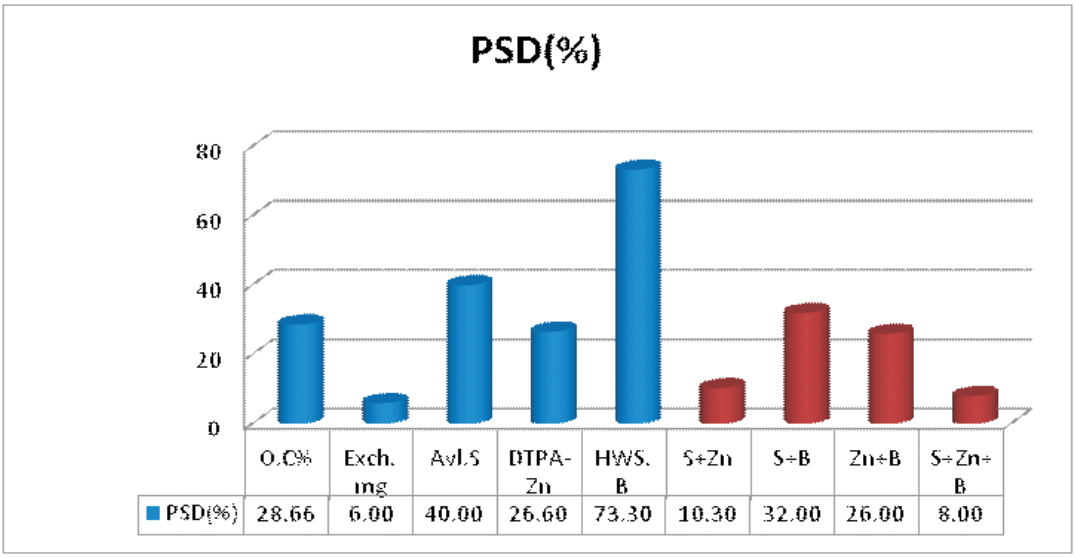


Fig. 1. Single and multi nutrient deficiency of Jajpur district

Multi-nutrient deficiency for the soils of Jajapur is presented in figure 1. Both sulphur and zinc were deficient upto 10.33% of soils. Similarly S+B, Zn+B and S+Zn+B were found deficient to the extent of 32%, 26% and 8%, respectively. The maximum deficiency of S+B was observed followed by Zn+B, S+Zn and S+Zn+B.

Sub-surface micronutrient status

Sub-surface and sub-soils from upland, medium land and low land at Sukinda, Badchana and Dasrathpur, respectively were presented in table 4.

Table 4. Micronutrient content of soils

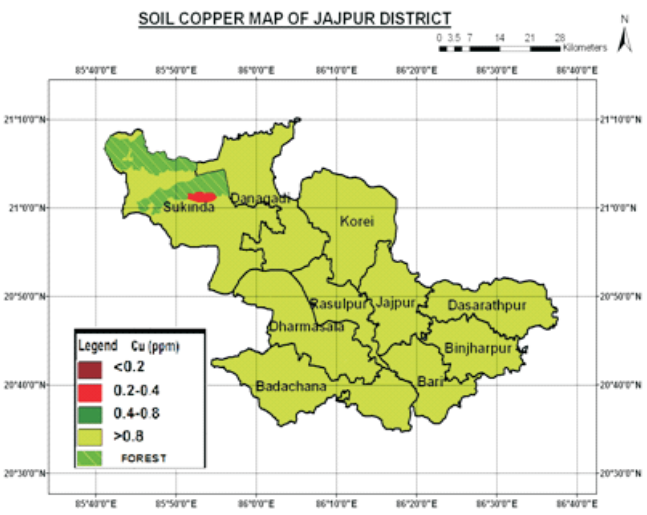
Pedon	Horizons	Depth (cm)	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})	B (mg kg^{-1})
Pedon 1	Ap	0-18	115.84	8.64	2.06	0.42	0.05
Midland	Bw_1	18-54	117.24	12.56	1.31	0.61	0.15
	Bw_2	54-76	121.32	22.84	0.62	0.72	0.07
	Bw3	76-110	124.2	22.68	0.68	0.89	0.05
Pedon 2	Ap	0-12	242.16	26.08	3.90	0.56	0.12
Upland	Bw_1	12-42	284.56	36.36	4.15	0.68	0.43
	Bw_2	42-82	312.08	36.76	4.17	0.75	0.25
Pedon 3	Ap	0-22	60.68	6.48	2.27	0.49	0.27
Lowland	Bw_1	22-56	68.68	7.4	1.99	0.64	1.01
	Bw_2	56-82	74.2	8.2	0.98	1.02	0.96
	Bw_2	82-120	85.5	9.3	0.86	1.15	0.43

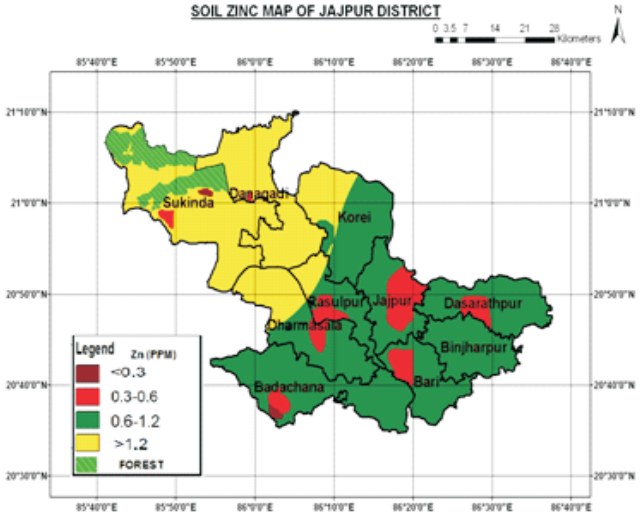
Irrespective of the position of pedons all the soils were rich in Fe owing to increase of Fe bearing parent material. The Fe content increased in underlying horizons than surface layer sub-surface. The content of Mn was sufficient in all pedons and its quantity increased with depth.

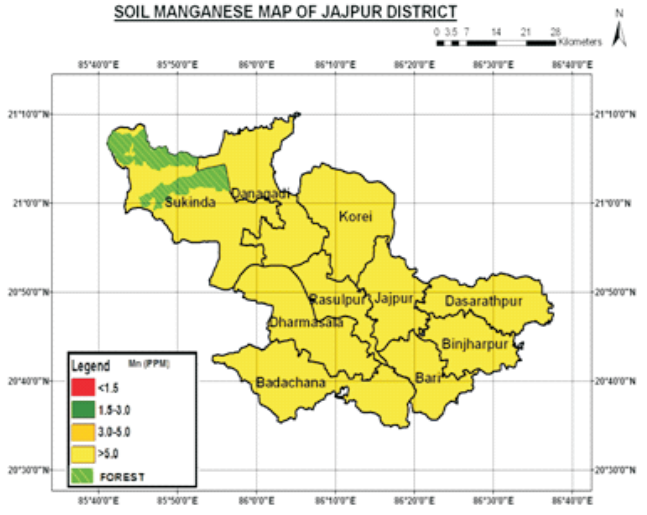
Sufficient quantity of Cu was found in all the pedons. The DTPA-Cu decreased from surface to sub-surface layers except in Sukinda profile. In most of the surface horizon soil, Zn was found to be deficient but it increased downwards. The available B content of soil increased up to sub-surface horizon then decreased. B is highly soluble and leached from light textured surface soil and gets deposited in second layer.

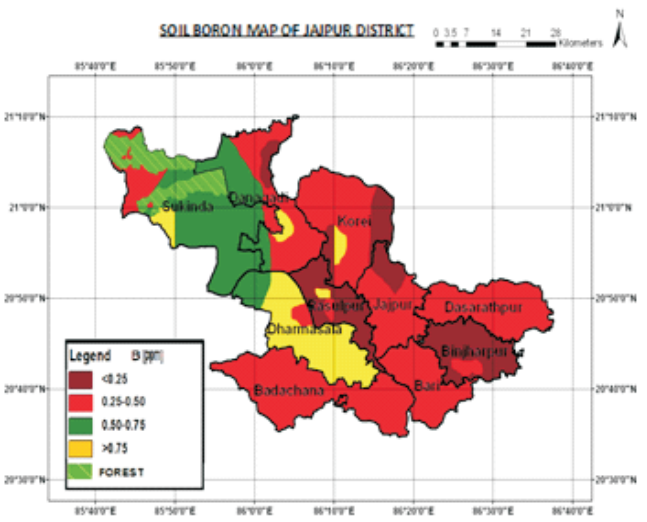
Conclusion

It may be concluded that highest deficiency of boron was observed in Jajpur followed by Sulphur. Deficiency of secondary and micro nutrients followed the order as B>S>Zn>Mn>Cu. Presence of multi-nutrient S+B+Zn deficiency in 8% of soils were observed. Copper and Mn deficiencies were observed at few locations. Since rice, pulse, oilseed vegetable are the dominant crops of Jajpur district so deficiency of micronutrients Zn and B will have a larger effect on proper grain filling and quality food grain production. Soil management practices with respect to the deficient nutrients needs to be addressed for crops and cropping systems of the district for higher production.









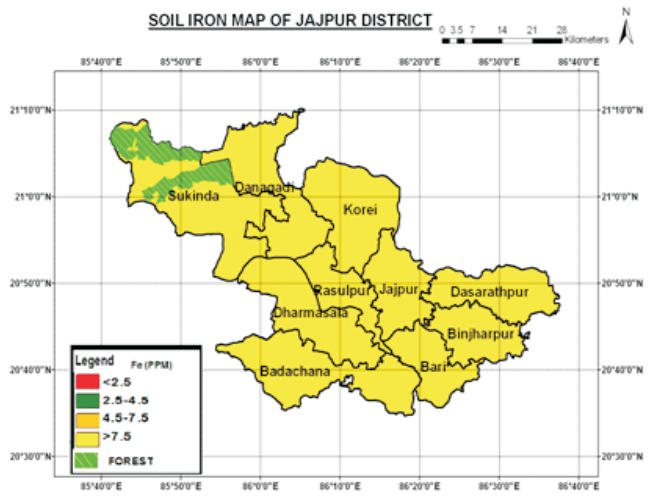


Fig. 4. Digitized fertility map of Jajpur soils

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