Agropedology 2013, 23 (2), 113-117

Micronutrient mapping in soils of Wardha district, Maharashtra

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The deficiencies of micronutrients have of late become major constraints to productivity, stability and sustainability of soils. The emerging widespread deficiency of micronutrients in the cracking clay soils of semi-arid regions of central India is causing decline in crop productivity and threatening nutritional security.

Assessment and delineation of micronutrients plays pivotal role in determining sustainable productivity of an agro-ecosystem. The present study was undertaken in Wardha district of Maharashtra to assess the status of micronutrients in soils and their relationship and to identify and delineate areas of micronutrient deficiencies using Global Positioning System (GPS) based georeferenced soil fertility mapping in order to utilize the current knowledge of soil nutrient status in Site Specific Nutrient Management.

Wardha district in Vidarbha region of Maharashtra lies between 20°28' N and 21°21' N latitude and 78°4' E and 79°15' E longitudes with total geographical area of 6, 32,110 ha. Three distinct physiographic units within the district *viz.,* the uplands of the North and North West Talegaon, Karanja plateau on its top, the narrow Arvi plains to the west of the first unit and the Wardha-Hinganghat plains, have been identified. The climate of Wardha district is characterized by hot summer and general dryness throughout the year except during the south –east monsoon, when the humidity exceeds 60 per cent. The district receives 1062.8 mm annual rainfall.

Georeferenced surface soil samples from 0-20 cm depth at 5 km interval using GPS were collected from eight tehsils of Wardha district. Available zinc, iron, copper and manganese were extracted with 0.005 *M* diethylene triamine penta acetic acid (DTPA) and the concentration of nutrients was determined on Atomic Absorption Spectrophotometer (Lindsay and Norvell 1978). Available molybdenum was determined by Grigg's reagent method given by Grigg (1953) and boron by method outlined by Berger and Truog (1939). The nutrient indices were computed as suggested by Parker *et al.* (1951).

The pH of soils ranged from 6.5 to 8.6, EC from 0.11 to 0.56 dSm^{-1}, $CaCO_3$ from 2.87 to 15.62 per cent and organic carbon from 1.2 to 6.5 g kg^{-1} (Table 1).

Table 1. Chemical properties of soils in Wardha district

Name of tehsil	pH (1:2.5)		EC (dS m^{-1})		$CaCO_3$ (%)		Organic carbon (g kg^{-1})	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Ashti	7.2-8.5	7.94	0.12-0.36	0.22	4.12-10.5	6.25	3.4-5.7	4.5
Karanja	6.5-8.3	7.77	0.13-0.30	0.22	3.0-8.75	5.61	2.7-5.1	3.4
Arvi	7.3-8.6	8.09	0.11-0.26	0.17	2.87-13.75	6.29	1.2-5.1	3.7
Devli	7.2-8.4	8.12	0.11-0.54	0.21	3.87-10.62	6.74	1.5-4.8	2.6
Wardha	7.1-8.3	8.03	0.15-0.51	0.24	7.62-15.62	13.75	3.3-6.3	4.7
Selu	7.3-8.1	7.88	0.23-0.56	0.34	3.12-11.75	8.61	2.8-6.5	4.9
Samudrapur	7.6-8.5	8.19	0.12-0.47	0.20	3.37-9.12	6.66	2.3-5.8	3.5
Hinganghat	7.5-8.4	8.10	0.12-0.21	0.19	5.37-14.75	10.12	2.4-6.3	4.7
District	**6.5-8.6**	**8.02**	**0.11-0.56**	**0.22**	**2.87-15.62**	**8.00**	**1.2-6.5**	**4.0**

The DTPA-Zn in soils of Wardha district ranged from 0.12 to 2.17 mg kg^{-1} (Table 2). Out of 190 samples, 57.6 per cent were deficient while 40.5 per cent samples were in medium category indicating widespread deficiency of zinc (Fig. 1). The highest deficiency of zinc was observed in Wardha followed by Hinganghat and Devli tehsils. The availability of micronutrient cations is generally low in alkaline soils and the crops grown on these soils suffer from their hunger (Malewar 2005). Patil and Kharche (2006) reported widespread deficiency of zinc in intensively cultivated districts of Western Maharashtra having pre-dominantly alkaline, calcareous, black clay soils.

Table 2. DTPA- extractable micronutrients in soil

Name of tehsil	Zn (mg kg^{-1})		Fe (mg kg^{-1})		Cu (mg kg^{-1})		Mn (mg kg^{-1})	
	Range	PSD*	Range	PSD*	Range	PSD*	Range	PSD*
Ashti	0.21-1.48	54.16	1.92-31.56	16.67	0.22-4.67	0	2.18-32.52	0
Karanja	0.25-1.45	52.17	1.44-31.67	39.13	0.49-5.01	0	2.59-77.43	0
Arvi	0.24-1.99	54.16	2.57-36.71	8.33	1.14-3.62	0	0.75-35.76	8.33
Devli	0.15-1.93	62.50	1.01 - 6.84	45.84	0.97-2.74	0	4.96-51.36	0
Wardha	0.12-1.59	79.17	1.25-19.91	29.17	0.62-5.63	0	1.85-51.16	4.17
Selu	0.16-1.48	33.33	1.57-13.47	66.67	1.0-7.22	0	3.56-92.40	0
Samudrapur	0.15-1.82	54.16	1.79-34.90	29.17	0.43-5.35	0	2.97-80.08	0
Hinganghat	0.22-2.17	65.38	6.08-33.68	0	0.17-3.61	3.85	8.40-31.0	0
District	**0.12-2.17**	**57.65**	**1.01-36.71**	**28.43**	**0.17-7.22**	**0.53**	**0.75-92.40**	**1.58**

PSD* – Per cent sample deficient

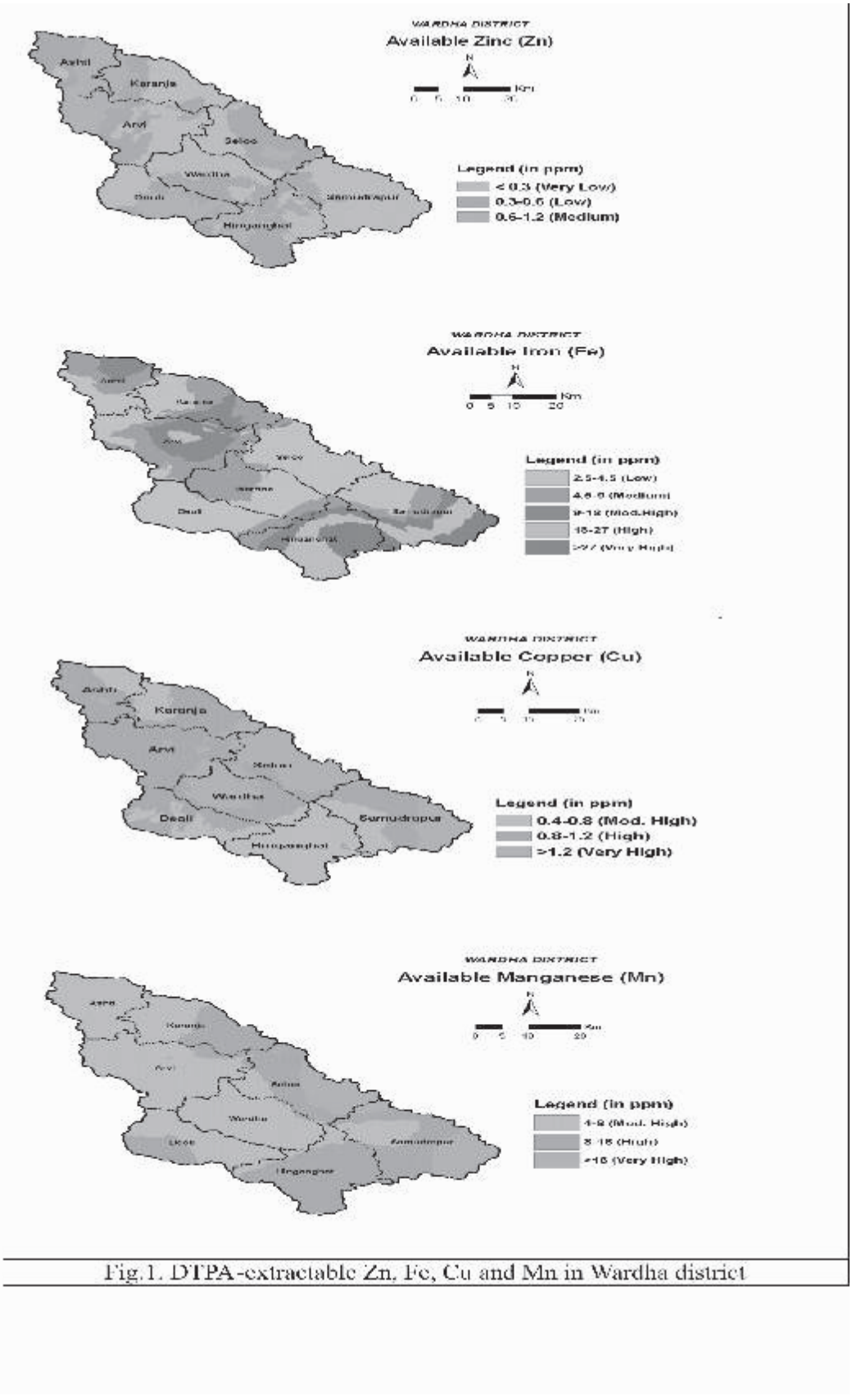

Fig.1. DTPA-extractable Zn, Fe, Cu and Mn in Wardha district

The DTPA-Fe content showed wide variation (1.01 - 36.71 mg kg^{-1}) in the soils of Wardha district. The per cent deficiency of available iron was 28.4 (Table 2). Patil *et al.* (2004) reported 40 and 34.7 per cent soils deficient in zinc and iron in Vidarbha. The deficiency of iron in pre-dominantly clay black soils of Wardha can also be attributed to their alkaline nature (Patil and Kharche 2006).

The DTPA-Cu (0.17 – 7.22 mg kg^{-1}) indicated that Cu deficiency is not a problem (Table 2). Patil and Sonar (1994) also reported similar findings. The DTPA-Mn (0.75 – 92.40) mg kg^{-1} showed 1.6 per cent deficiency (Table 2). Gajbhe *et al*. (1976) reported 13.3 to 65.20 mg kg^{-1} available Mn content in soils of Marathwada.

The available boron varied from 0.52 to 0.99 mg kg^{-1} (Table 3) and found deficient only in Hinganghat tehsil might be due to the presence of higher calcium carbonate in soils (Malewar 2005). In Wardha district 22 per cent soils samples were found deficient in boron. The percentage samples in medium category of zinc, iron and boron were 40.5, 59.4 and 68.0 respectively, which indicates that these sites may become deficient in near future (Table 4) and needs urgent attention. The data indicated widespread deficiency of zinc in Wardha (79.17%), Hinganghat (65.38%), Devli (62.50%) and Ashti, Arvi and Samudrapur (54.16%) tehsils followed by iron in Selu (66.67%), Devli (45.84%) and Karanja (39.13%) tehsils. The nutrient indices (Table 4) were low for zinc (1.45), medium for iron (1.83) and boron (1.88) and high for manganese (2.68) and copper (2.87).

Table 3. Available boron and molybdenum in soils of Wardha district

Name of tehsil	B (mg kg^{-1})		Mo (mg kg^{-1})	
	Range	Mean	Range	Mean
Ashti	0.44 - 0.59	0.53	0.13 - 0.97	0.55
Karanja	0.65 - 1.19	0.94	0.17 - 0.28	0.22
Arvi	0.52 - 0.98	0.76	0.24 - 0.25	0.24
Devli	0.62 - 2.36	1.14	0.15 - 0.20	0.17
Wardha	0.62 - 0.75	0.67	0.18 - 0.23	0.20
Selu	0.48 - 0.79	0.62	0.13 - 0.38	0.25
Samudrapur	0.40 - 0.66	0.57	0.15 - 0.17	0.16
Hinganghat	0.42 - 0.60	0.48	0.20 - 0.21	0.20
District	**0.52 - 0.99**	**0.71**	**0.13 - 0.97**	**0.24**

Table 4. Status of micronutrients and nutrient indices in Wardha district

Nutrients	Per cent samples			Nutrient Indices*
	Low	Medium	High	
Zn	57.6	40.5	2.1	1.45 (Low)
Fe	28.4	59.4	12.1	1.83 (Medium)
Cu	0.5	11.6	87.9	2.87 (High)
Mn	1.6	28.4	70.0	2.68 (High)
B	22.0	68.0	10.0	1.88 (Medium)
Mo	00	94.0	6.0	2.06 Medium)

*<1.66 (Low), 1.66 – 2.33 (Medium) and > 2.33 (High)

DTPA extractable zinc (Table 5) showed negative and significant correlation with soil pH (r = -0.20**) and calcium carbonate (r = -0.24*). Available zinc was positively and significantly correlated with organic carbon (r = 0.36*). The positive and significant correlation of iron with organic carbon (r = 0.23*) indicated that availability of iron increases with an increase in organic carbon in soil. The iron content was negatively and significantly correlated with pH (r = -15*) and $CaCO_3$ (r = -0.35**). This indicates that higher the calcium carbonate in soil lower the availability of iron and zinc in the soil. Available copper and manganese showed negative relation with pH of the soil.

The deficiency of available zinc (57.6%), iron (28.4%) and boron (22%) was found increasing in the soils of Wardha district, which needs immediate attention to ensure balanced nutrition of crops and to sustain the agricultural productivity. The current status of micronutrients in soils of Wardha district will be useful to suggest the efficient ways and methods for enhancing the crop productivity by proper use of organic manures and inorganic fertilizers in the areas of micronutrients deficiency.

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Received : October 2012; Accepted : July 2013