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Delineation of Iron and Manganese Status in Soils of Central Research Station Akola

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ABSTRACT

A study of delineation of Iron (Fe) and Manganese (Mn) status in soils of Central Research station, Akola was conducted during the year 2006 and 2007. Detailed maps of micronutrient also prepared. Delineation of study area was completed with help of global positioning system and for predicting available cationic micronutrient status extraction with chelating agent such as di ethylene triamine penta acetic acid (DTPA) is used. The soils of Central Research Station were found 20 per cent deficient in iron and 7 per cent deficient in manganese. While the available micronutrient status of Central Research Station soils was found as iron 0.12 to 16.32 and manganese 0.32 to 16.78.

Introduction

Iron and manganese are categorized as Micronutrient, have also been called minor or trace elements, indicating that their concentrations in plant tissues are minor or in trace amounts relative to the macronutrients (Mortvedt, 2000).

Available iron in Indian soils greatly varies from traces to 386 ppm. The variation is mainly attributed to the soil types and their characteristics nature of chemical extractants used and agro ecological conditions (Singh and Sekhon, 1991, Sangwan and Singh 1993, Bhogal 1993, Rajkumar *et al.*, 1990).

The role of Fe in plant metabolism was recognized after the observation by Gris in 1844 that Fe was necessary for the maintenance of chlorophyll in plants. Iron is an essential component of many enzymes and carriers such as catalase, peroxidase, cytochrome and ferredoxin and performs an essential role in nuclic acid metabolism.

The essentiality of Mn in plant nutrition was established by McHargue in 1992. Manganese exists on Mn^{+2} in plant cell in various complexed states and can form metallo proteins. It is tightly bound in chloroplast.

Though, manganese average concentration in the plant cell is about 100 ppm it plays an important role in several biochemical processes in plants (Agrawal and Sharma 1979). It's most critical role in green plants is in light dependent water splitting reaction and oxygen evolution during photosynthesis. Manganese enhances assimilation of carbon dioxide and sugar in plants.

It also plays a role in the synthesis of secondary metabolites, is involved in shikimic acid pathway (Burnell, 1988) and enhances the resistance of plants to diseases. Manganese supply retards the rate of electron transport and IAA oxidase activity for root nodulation.

Keeping this in a view a systematic study, including assessment of nutrient status of different soils with delineation of areas of Iron and Manganese deficiency and/or sufficiency was started.

Materials and Methods

In view of the emerging micronutrient deficiencies in soils and plants, a systemic approach for assessment of micronutrient status of soils of eight blocks of central Research station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. was employed which comprising soil sampling, their analysis and delineation of Fe and Mn deficient areas.

Total 222 surface soil (0-30 cm) geo referenced samples from central Research station with latitude and longitude using global positioning system (GPS) were collected and soil variability were analyzed for DTPA extractable Fe and Mn.

The central research station is situated about 2 km east of Akola town. It is located at longitude 77^{0} 02^{l} 44^{ll} to 77^{0} 04^{l} 59^{ll} E, Latitude 20^{0} 42^{l} 15^{ll} to 20^{0} 43^{l} 18^{ll} N. The research station extends over an area of 1145 hectares.

Akola town is accessible both by road NH No. 6 and rail Nagpur Mumbai, central Railway. The farm area is bounded by Gudadhi and Akola- Borgaon Manju road in the north, Sivani village in the south, Babhulgaon in the east and Umri in the west.

Mechanical analysis was done by using Bouyoucos hydrometer method (Bouyoucos, 1928), Soil pH (1:2.5) and Ec were estimated By using pH meter and Electrical Conductivity meter respectively (Jackson, 1967) and Available Fe and Mn were determined by using DTPA (Diethylene triamine penta acetic acid) extract on AAS (Lindsay and Norvell,1978).

Maps for soil sampling sites were generated using map send worldwide, Thales Navigation system.

Results and Discussion

Soil of study area

It was observed (Table 1) that soil pH varied from 7.6 to 8.8 with an average of 8.1. According to classification of soil reaction suggested by Brady (1985) samples were found moderately alkaline to strongly alkaline. The minimum value of pH 7.6 was observed in Malkapur western and Babhulgaon Soils and maximum value of pH 8.8 was observed in soil of Malkapur and Western Block.

The electrical conductivity of the soils varied from 0.18 to 0.68 d S m^{-1}. On the basis of the limits suggested by Muhr *et al.*,(1963) for judging salt problem of soils, most of samples were found normal (EC < 1.0 dSm^{-1}). The soil texture varied from clay to clay loam and silty clay.

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Table 1. Important soil characteristics of CRS Akola

Sr. No.	Block	pH	EC (dSm^{-1})	Texture			
				Sand %	Silt %	Clay %	Textural Class
1	Mission school	7.8-8.6	0.18-0.36	20	13	67	Clay
2	Malkapur	7.6-8.8	0.28-0.36	21	23	56	Clay
3	Shivar	7.8-8.6	0.22-0.38	34	21	45	Clay loam
4	Western	7.6-8.8	0.24-0.44	35	25	40	Silty clay
5	Shivani	7.8-8.7	0.23-0.49	53	12	35	Clay loam
6	Gudadi	7.7-8.4	0.24-0.49	23	33	44	Silty clay
7	Babulgaon	7.6-8.5	0.22-0.68	25	23	52	Clay
8	High way	7.9-8.7	0.20-0.58	19	26	55	Clay

Table 2. Available iron status of CRS soils

Sr. No.	Blocks	No. of samples analyzed	Available range (mg kg^{-1})	Mean (mg kg^{-1})
1	Mission School	21	0.12-7.85	5.31
2	Malkapur	27	0.38-8.96	5.77
3	Shivar	30	4.66-16.32	7.29
4	Western	22	3.75-14.64	6.38
5	Shivani	44	2.0-9.4	6.07
6	Gudadhi	32	2.40-8.30	4.78
7	Babulgaon	31	3.48-8.22	4.92
8	High way	15	3.84-8.99	5.93
	Total	222	0.12 –16.32	5.81

Table 3. Available iron status of CRS soils (DTPA extracts)

Sr. No.	Blocks	No. of samples analyzed	Low < 4.5 mg kg^{-1}	Medium 4.5 to 7.5 mg kg^{-1}	High > 7.5 mg kg^{-1}
1	Mission School	21	2 (10%)	18 (81%)	2 (9%)
2	Malkapur	27	3 (11%)	15 (59%)	9 (30%)
3	Shivar	30	0 (0%)	17 (57%)	13 (43%)
4	Western	22	1 (4%)	14 (64%)	7 (32%)
5	Shivani	44	2 (5%)	34 (77%)	8 (16%)
6	Gudadhi	32	15 (47%)	15 (47%)	2 (6%)
7	Babulgaon	31	19 (41%)	10 (32%)	2 (6%)
8	High way	15	3 (20%)	9 (60%)	3 (20%)
	Total	222	45 (20%)	132 (60%)	45 (20%)

Table 4. Available manganese status of Central Research Station soils

Sr. No.	Blocks	No. of samples analyzed	Available range (mg kg^{-1})	Mean (mg kg^{-1})
1	Mission School	21	0.72 - 7.05	4.61
2	Malkapur	27	1.64 - 4.67	3.79
3	Shivar	30	3.51 - 16.78	5.86
4	Western	22	1.79 - 16.17	4.59
5	Shivini	44	1.79 - 6.04	4.40
6	Gudadhi	32	0.32 - 9.43	3.33
7	Babulgaon	31	2.83 - 8.88	4.91
8	High way	15	2.95 - 8.33	5.74
	Total	222	0.32 – 16.17	4.65

Table 5. Available manganese status of central research station soils (DTPA Extractable)

Sr. No.	Blocks	No. of samples analyzed	Low < 2.0 mg kg^{-1}	Medium 2.0 to 4.0 mg kg^{-1}	High > 4.0 mg kg^{-1}
1	Mission School	21	2 (10%)	4 (19%)	15 (71%)
2	Malkapur	27	1 (4%)	12 (44)	14 (52%)
3	Shivar	30	0 (0%)	6 (20%)	24 (80%)
4	Western	22	2 (9%)	9 (41%)	11 (50%)
5	Shivini	44	4 (9%)	7 (16%)	33 (75%)
6	Gudadhi	32	8 (25%)	14 (44%)	10 (31%)
7	Babulgaon	31	0 (0%)	8 (29%)	23 (71%)
8	High way	15	0 (0%)	3 (20%)	12 (80%)
	Total	222	17 (7%)	63 (29%)	42 (64%)

Available iron status of CRS soils

The various forms of iron in soil are the immediately available, the available pool, available on decomposition and potential medium long term sources of available iron (Katyal and Deb, 1982). The plant usable fraction of soil iron can be determined by employing a suitable chemical extractant and its critical concentration in soil can be established by correlating with crop yield.

The available iron content varies from 0.12 to 16.32 mg kg^{-1} with a mean of 5.81 mg kg^{-1} (Table 2) regards iron status of central research station soils, 20% soil samples are low, 60% samples medium and 20%, soil samples are high in available iron out of 222 soil samples (Table 2 and Fig 1). The iron deficiency was observed except Shivar soil 10 per cent in mission school, 11 per cent Malkapur, 4 per cent in western, 5 per cent in Shivani, 47% in Gudadhi, 61 per cent in Babulgaon and 20 per cent in High way Block soil.

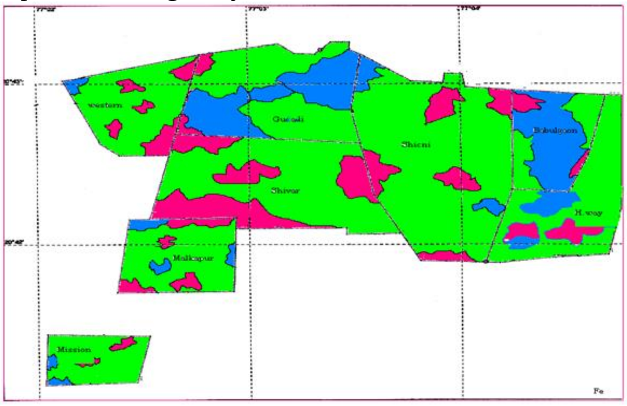

Fig 1. Iron Status Of Central Research Station Soils, Akola

In spite of high total iron in soils, its availability to the crops is a major problem in many soils. Usually crops take up iron as Fe^{+2} and in available soils Fe^{+2} oxidizes to the unavailable Fe^{+3} form. Soil with pH 7 is the major factor which governs the solubility and an increase in pH decreases solubility of divalent and trivalent cation by 100 – 1000 folds respectively.

Fine texture soil retained major part of applied iron in unavailable form because of surface adsorption and only small fraction was made available (Table 1 and 2).

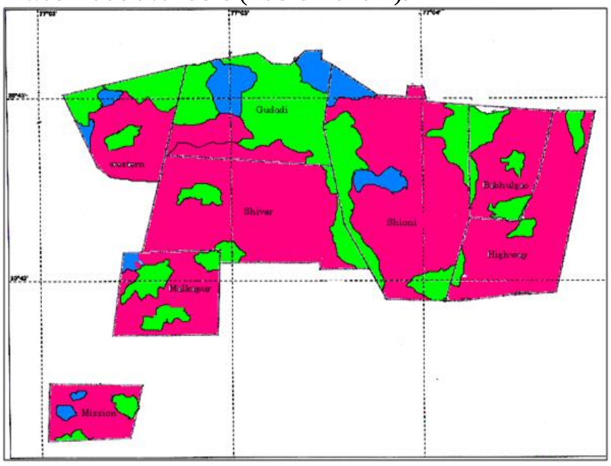

Fig 2 . Manganese status of central research station soils, akola

Available Manganese status of CRS soils

Available Mn constitutes 1-15% of the total soil Mn, the size of which with climatic conditions, soil type and extraction method used.

The behaviour of Mn in soils depends largely on pH and redox potential. All factors which influence oxidation reduction influence Mn solubility and its availability to plants. These include pH, $CaCO_3$, organic matter, microbial activity and soil moisture. A rise in pH, increases oxidation of Mn, whether the process is chemical or biological and thus at high pH, Mn availability to plants is reduced. The reverse is true in acid soils. The soluble Mn^{+2} decreases 100 fold for each unit increase in pH which also enhances the formation of Mn – Soil organic matter complexes which also render Mn less available (Page 1962)Available Mn was extracted by DTPA from 222 soil samples collected from central research station farm and the content varied between 0.32 to 16.17 mg kg^{-1} with the mean of 4.65 mg kg^{-1} (Table 4) Based on critical limits, availability of Mn would be rated as marginal to adequate in soils of Central Research Station. Out of total samples 7 per cent soil samples are in low, 29 per cent in medium and 64 per cent soil samples in high range in available Mn. (Table 5 and Fig. 2) Thus, at present a positive response to Mn application is unlikely due to its adequacy in majority of soils.

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