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Mapping of DTPA extractable micronutrients and their relationship with soil properties in Pathardi Tehsil of Ahmednagar District. (M.S.)

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Abstract
A study was conducted to assess available micro nutrient status of soils of Pathardi Tehsil of Ahmednagar District by GIS technique. 199 soil samples (0-22.5 cm) drawn during 2014 from the 70 villages were analyzed for their fertility status and mapped by geographic information system (GIS) technique. The exact locations of soil samples were recorded with the help of GPS.
The results indicated that all samples were slightly alkaline to moderately alkaline in soil reaction (7.09-8.39), non-saline (0.11 -0.58 dS m^{-1}), low to moderately high in organic carbon (0.22-0.74 %) and Calcium Carbonates ranged from (5.75-13.0 %).
Regarding to micronutrients, the soils were sufficient in available Fe, Mn, Zn, Cu, B and Mo which ranged between (1.13- 5.96 mg kg^{-1}), (2.65- 3.96 mg kg^{-1}), (0.19- 0.74 mg kg^{-1}), (1.15- 7.72 mg kg^{-1}), (0.25-0.77 mg kg^{-1}) and (0.026-0.068 mg kg^{-1}) respectively, whereas Mn, Cu and Mo were sufficient and Fe, Zn and B were poorly deficient to sufficient in soil.
The pH of the soils recorded negative and non-significant correlation with available Mn and Mo. It was positive and non-significant correlation with available Fe, Zn and B. While negative and significant with available Cu. The EC showed positive and non-significant correlation with available Fe, Zn, B and Mo While negative and significant correlation with available Mn. Organic carbon showed negative and non-significant correlation with available Mn and positive and non-significant correlation with available Fe, Zn and Mo. While B showed negative and significant correlation with organic carbon. $CaCO_3$ was negative and non-significantly correlated with available Mn, Zn, Mo and positively correlated with available Cu and B.

Keywords: Geographic information system, Global positioning system, Nutrient mapping, Micronutrients.

Introduction
Soil is a vital natural resource and should be used judiciously according to its potential to meet the increasing demands of ever growing population. To ensure optimum agricultural production, it is imperative to know best fact about our soils and their management to achieve sustainable production. The quality of soil needs to be looked into because presently the natural resources are being over exploited. Soils of Maharashtra state are categorized as poor in fertility and vary widely in genetic, morphological, physical, chemical and biological characteristics (Challa *et al*, 1995) [4]. The deficiencies started appearing in different areas due to introduction of intensive production systems after green revolution period. It is due to net removal rates of micronutrients by crops being higher under intensive productivity regimes (Kanwar, 2004) [7]. The situation was further increased by discontinuous and diversified use of organic manures and chemical fertilizers.
The incidence of micronutrient deficiencies in crops has increased markedly in recent years which might be due to the continuous and intensive multiple cropping and use of high yielding cultivars which may have higher nutrient demand, enhanced production of crops on marginal soils that contain low levels of essential nutrients, increased use of high analysis fertilizers with low amount of micronutrient contamination, decreased use of organic fertilizers *viz*; animal manures, composts and crop residues, use of soils that are inherently low in micronutrient reserves and involvement of natural and anthropogenic factors that limit adequate plant nutrient availability and create element imbalances.
The recent technologies like GIS and Global Positioning System (GPS) thus have much to

offer for preparing soil fertility maps. Soil chemical and physical properties vary within a single field. Spatial tools like Global Positioning System (GPS) and Geographic Information System (GIS) for storing and analyzing spatial data can help us to make better decisions in agriculture particularly land development, environmental protection and restoration. In precision agriculture, farmer's uses GPS and GIS as yield monitors and variable rate technology to apply appropriate quantities of input in different parts of field. Farmers can use GPS to locate the nutrient deficiencies and can manage the accurate distribution of fertilizer chemicals. GPS can provide suitable location on the earth with a unique address (its precise location). A GIS is basically a descriptive database of the earth or a specific part of the earth. GPS-GIS are advanced tool for studying on site specific nutrient management which can be efficiently use for monitoring soil fertilization in Patrhardi Tehsil of Ahmednagar district (M.S.) and would be useful for ensuring balanced fertilization to crops.

Material and Methods

Study area

Pathardi Tehsil is located in between 19°1719316 North latitude and 75°1790062 East longitude. The total geographical area of Patrhardi Tehsil is 1214.10 ha. The elevation in between 504-676 Meter above mean sea level. The "Pathardi-Tehsil, is situated about 52 km away from Ahmednagar city, towards north-east. The locations of soil sampling on the basis of GPS- GIS are depicted in the location map. (fig 1).

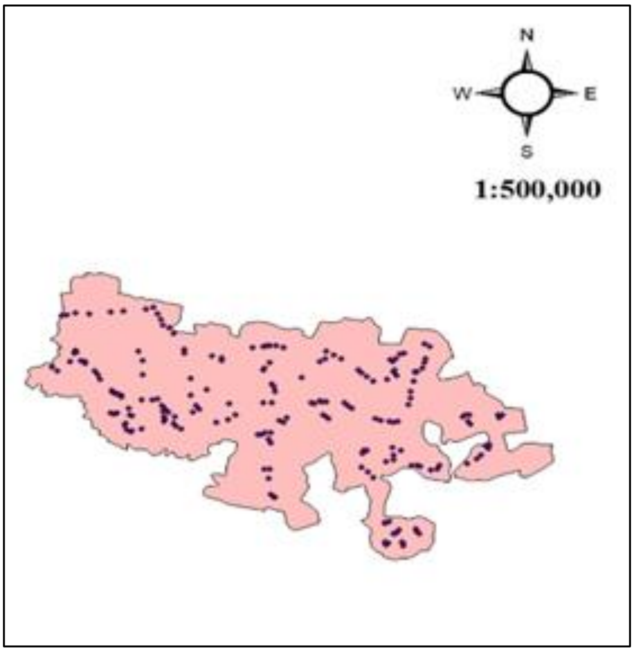

Fig 1: Base Map of Pathardi Tehsil

Methodology

Soil sample collection and analysis

A geo-referenced surface (0-22.5 cm depth) soil samples were collected from 119 sites of 70 villages. Three soil samples of soil order shallow, medium and deep (Entisols, Inceptisols and Vertisols) from each village following the standard procedures of soil sample collection with stainless steel auger to avoid iron contamination. The exact sample location was recorded using a GPS.

Soil samples were analyzed for chemical characteristics by following standard analytical techniques. Soil reaction was determined in 1:2.5 suspension using standard pH meter by potentiometry (Jackson, 1973) [6]. The electrical conductivity was determined by 1:2.5 suspension using EC meter by Conductometry (Jackson, 1973) [6]. Soil organic carbon was estimated using the wet oxidation method (Nelson and Sommer, 1982) [13] and $CaCO_3$ is determined by Acid neutralization metod by Alison and Moodie (1965) [2].

DTPA-extractable micronutrients Fe, Mn, Zn and Cu were extracted from the soil samples by 0.005M DTPA at pH 7.3 according to Lindsay and Norvell (1978) [9] and the concentration of the micronutrients was estimated by atomic absorption spectrophotometer (AAS). While, B determined by Azomethine-H method (Bingham, 1973) [3] Mo estimated by AB-DTPA method given by (Soltanpour and Schwab, 1977) [21].

Generation of maps

The delineation of the area for different nutrient levels of soils and their extent of area were calculated and mapping was carried out by using Arc-GIS 9, version 9.3 software.

Statistical analysis

The soil chemical properties data were statistically analyzed by using standard statistical methods given by Panse and Sukhatme (1985) [16].

Result and Discussion

Chemical characteristics of soil

The pH of the soils ranged from 7.09 to 8.39. Among the soil samples tested, were slightly alkaline (57.79 per cent) to moderately alkaline (42.21 per cent) in reaction. The similar results was recorded by Nalawade (2013) [12] in soils of Savlivihir Farm of Kopergaon Tehsil, Dist-Ahmednagar. The Moderately alkaline reaction might be due to deep to medium black soils being under irrigation since long have shifted to alkaline condition. The EC of various soil samples were ranged from 0.11 to 0.58 dSm^{-1}. The EC indicated that all the soils were normal in salt content (100 per cent) and suitable for healthy plant growth. The similar results were reviewed by Padole and Mahajan (2003) [15] in swell-shrink soils of Vidarbha region. The organic carbon content in soils are ranged from 0.22 to 0.74 per cent with the mean of 0.45 per cent the similar results were reported by Yeresheemi *et al.* (1997) [26] in salt affected soils of Krishna Command of Karnataka. The calcium carbonate content in soils were ranged from 5.75 to 13.0 per cent with an average of 9.23 per cent. The calcareousness is common in soils of arid and semi-arid climate particularly in Vertisols (Black soils) due to precipitation of carbonates and bicarbonates due to acidity. The similar trend of $CaCO_3$ in Block C Central Campus M.P.K.V., Rahuri was reported by Durgude (1999) [5].

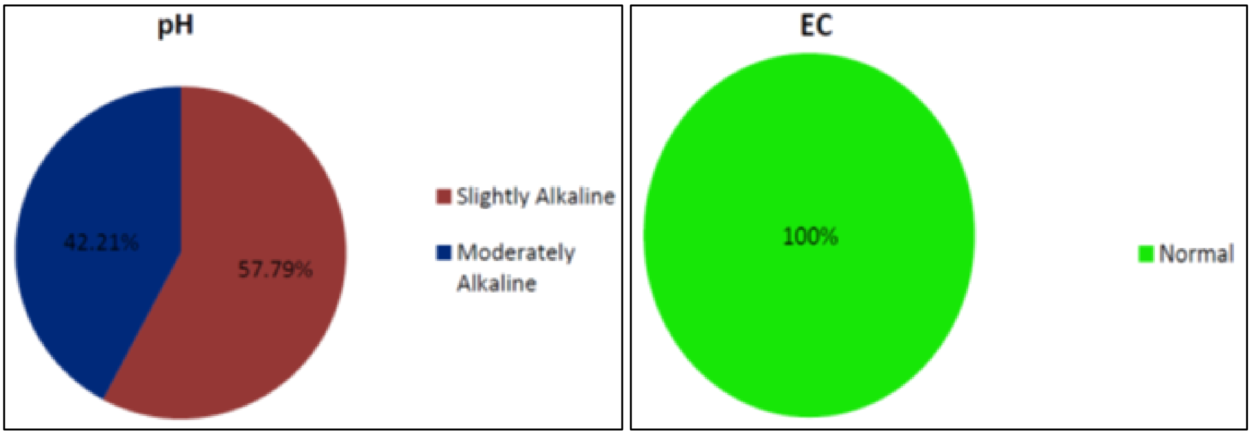

Fig 2: Soil pH and EC status of Pathardi Tehsil

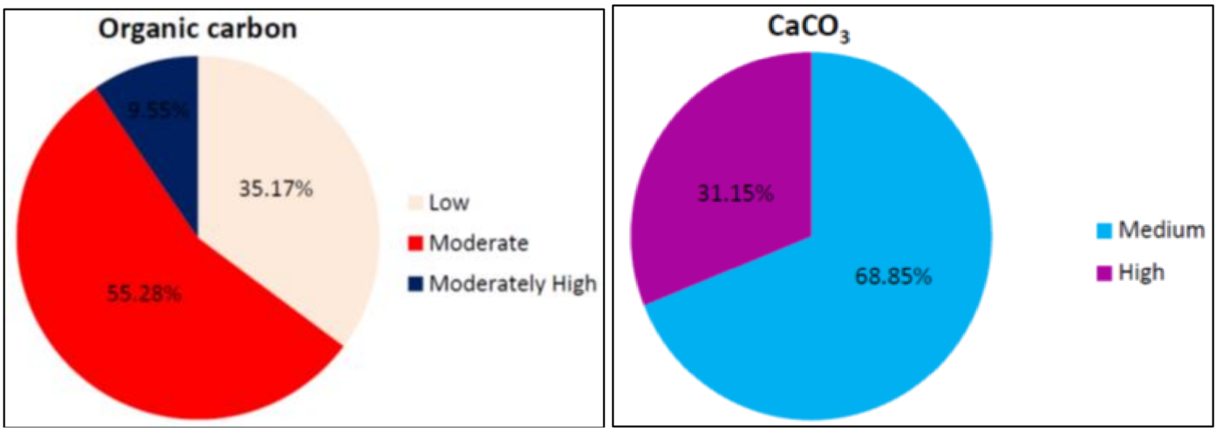

Fig 3: Soil Organic Carbon and $CaCO_3$ status of Pathardi Tehsil

Available micronutrients status and influence of soil chemical characteristics

Iron.

The available iron in soils were ranged from 1.13 to 5.96 mg kg^{-1} (Table 1 and fig.4) with an average of 3.94 mg kg^{-1}. Out of all the soil samples collected 69.35 per cent were deficient and 30.65 per cent sufficient in available iron, as the critical limit of available iron is 4.5 mg kg^{-1} (Takkar *et al*., 1989) [22]. The similar trend of Fe was noted by Meena (2009) [11] in Central Research Farm M.P.K.V., Rahuri and by Nipunge *et al*. (1996) [14] for different Inceptisols of Maharashtra. It showed negative and significant relation with pH (r = -0.484**) and poor negative correlation with EC, OC and $CaCO_3$. The similar result was observed by Singh *et al*. (1990) [19]. (Table 2.)

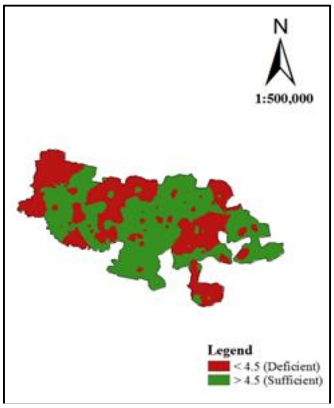

Fig 4: Soil available Iron (mg kg^{-1}) status of Pathardi Tehsil

Manganese

The available manganese in soils were ranged from 2.65 to 3.96 mg kg^{-1} (Table 1 and fig. 5) with an average of 3.33 mg kg^{-1}. All the soil samples collected were sufficient in available manganese, as the critical limit of available manganese is 2 mg kg^{-1}. The sufficiency of available Mn might be due to high organic matter content and optimum soil moisture content. The similar observations have been reported by Meena (2009) [11] in Central Research Farm, Central Campus, M.P.K.V., Rahuri and Shinde (2007) [18] in soils of Udgir and Deoni Tehsil of Latur District. It had significant and negative relation with EC (r = -0.150*) and non-significantly negative with $CaCO_3$ while, positive with pH and OC. (Table 2.)

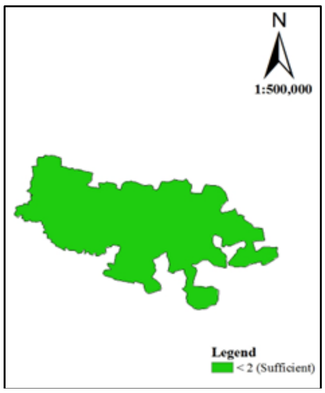

Fig 5: Soil available Manganese (mg kg^{-1}) status of Pathardi Tehsil

Zinc

The available zinc in soils were ranged from 0.19 to 0.74 mg kg^{-1} (Table 1 and fig.6) with an average of 0.41 mg kg^{-1}. Out of all the soil samples collected 87.44 per cent were deficient and 12.56 per cent sufficient in available zinc, as the critical limit of available zinc is 0.6 mg kg^{-1}. (The deficiency in available zinc might be due to low organic matter content in soil, which acts as natural chelating agent and washout of the upper soil surface. Kharche *et al.* (2001) [8] recorded the similar trends of DTPA, Zn status in soils of Nashik District Maharashtra and Waghmare *et al.* (2007) [25] in soils of Ausa Tehsil of Latur District. It showed negative and significant relation with pH (r = -0.355**) and non-significant negative correlation with OC and positive with EC and $CaCO_3$. (Table 2.)

Copper

The available copper in soils were ranged from 1.15 to 7.72 mg kg^{-1} (Table 1 and fig.7) with average of 3.25 mg kg^{-1}. All the soil samples collected were sufficient in available copper, as the critical limit of available copper is 0.2 mg kg^{-1}. The sufficiency of available copper might be due to the high organic matter content and optimum soil moisture in soil. Similar results were reported by Shinde (2007) [18] in soils of Udgir and Deoni Tehsil of Latur and Agrawal and Singh (2001) [1] in soils of Varanasi division of Eastern U.P. It had negative and significant relation with pH (r =-0.184**) while, non-significantly negative correlation with OC and positive with EC and $CaCO_3$. The similar result was observed by Singh *et al*. (1990) [19]. (Table 2.)

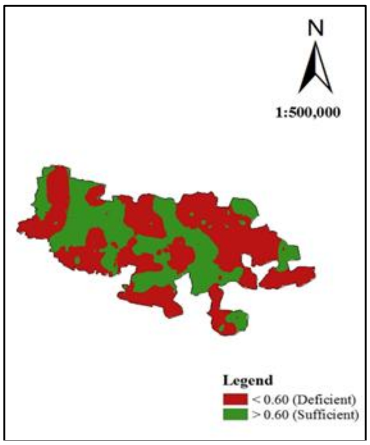

Fig 6: Soil available Zinc (mg kg^{-1}) status of Patrhardi Tehsil

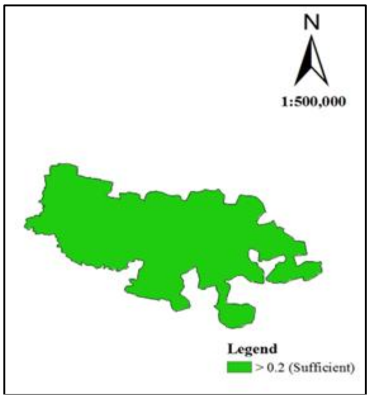

Fig 7: Soil available Copper (mg kg^{-1}) status of Patrhardi Tehsil

Boron

The available boron in soils were ranged from 0.25 to 0.77 mg kg^{-1}(Table 1 and fig. 8) with an average of 0.49 mg kg^{-1}. Out of all the soil samples collected 56.28 per cent soil samples were deficient and 43.72 per cent were sufficient in available boron, as the critical limit of available boron is 0.5 mg kg^{-1}. The deficiency of boron in soils might be due to higher content of $CaCO_3$ and alkaline pH of soil. Sharma and Katyal (2006) [17] reported that hot water soluble B (HWSB) in surface soils ranged from 0.07 to 3.62 mg kg^{-1}. Tandon (1995) [23] reported status of available boron of Indian soils and found that available boron in Indian soils ranged between traces to 8 mg kg^{-1}. It had negative and significant relation with pH (r =-0.349**) while, non-significantly negative correlation with EC and positive with OC and $CaCO_3$. (Table 2.)

Table 1: Soil available micronutrients status of Patrhardi Tehsil

Particular	Available micronutrients (mg kg^{-1})					
	Fe	**Mn**	**Zn**	**Cu**	**B**	**Mo**
Mean	3.94	3.33	0.41	3.25	0.49	0.047
Range	1.13 - 5.96	2.65 - 3.96	0.19 - 0.74	1.15 - 7.72	0.25 - 0.77	0.026 - 0.068
Critical limit	4.5	2.0	0.6	0.2	0.5	0.05
Sufficient	(30.65)	(100)	(12.56)	(100)	(43.72)	(38.19)
Deficient	(69.35)	(0.00)	(87.44)	(0.00)	(56.28)	(61.81)
SE±	0.064	0.022	0.010	0.105	0.008	0.001

(Total number of soil samples analyzed-199, Figures in parenthesis expressing per cent value)

Molybdenum

The available molybdenum in soils were ranged from 0.026 to 0.068 mg kg^{-1} (Table 1 and fig. 9) with an average of 0.047 (mg kg^{-1}). Out of all the soil samples collected 61.81 per cent were deficient and 38.19 per cent were sufficient in available molybdenum, as the critical limit of available molybdenum was 0.05 mg kg^{-1}. It had non-significant positive relation with pH and $CaCO_3$ and negative with EC and OC.

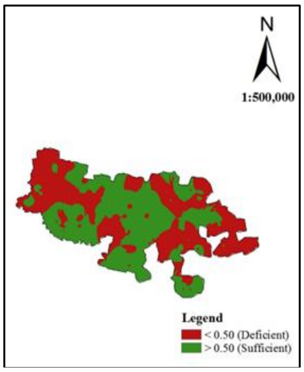

Fig 8: Soil available Boron (mg kg^{-1}) status of Patrhardi Tehsil

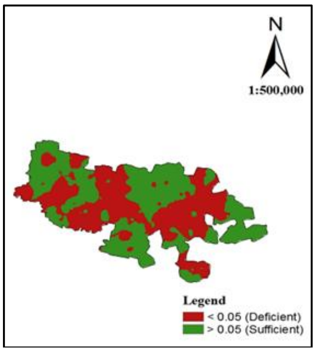

Fig 9: Soil available Molybdenum (mg kg^{-1}) status of Patrhardi Tehsil

Table 2: Correlation of soil properties with available nutrients

Available nutrients \ Chemical Properties	pH	EC	OC	$CaCO_3$
Fe	0.033	0.112	0.125	0.195**
Mn	-0.014	-0.165*	-0.118	-0.052
Zn	0.084	0.057	0.039	-0.003
Cu	0.198**	0.162*	0.155*	0.025
B	0.119	0.117	-0.153*	0.063
Mo	-0.091	0.070	0.012	-0.130

(* Significant at 5% level, ** Significant at 1% level)

Conclusion

From the study, it can be concluded that, soils of Patrhardi Tehsil area for micronutrients, 40.89 per cent samples were deficient and 59.11 per cent were sufficient in available iron. Total 36.89 per cent soil samples were deficient and 63.11 per cent sufficient in available zinc. For available boron, 28.44 per cent of soils shows deficiency and 71.56 per cent samples were sufficient. The soils of Patrhardi Tehsil were sufficient in available Mn, Cu and Mo.

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