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GA Kaygude
PG Student, Division of Soil Science and Agricultural Chemistry, College of Agriculture Pune, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

NB More
Associate Professor, AICRPDLA Zonal Agriculture Research Station, Solapur, Maharashtra India

SY Wankhede
Department of Agricultural Meteorology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

ST Shinde
Assistant Professor, Division of soil science and Agriculture Chemistry, College of Agriculture Kolhapur, India

GD Patil
Associate Professor, Division of soil science and Agriculture Chemistry, College of Agriculture Kolhapur India

Corresponding Author:
GA Kaygude
PG Student, Division of Soil Science and Agricultural Chemistry, College of Agriculture Pune, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

GIS-GPS based soil fertility maps of micronutrients of village Harnas of Bhor tehsil in Pune district

GA Kaygude, NB More, SY Wankhede, ST Shinde and GD Patil

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Abstract
Investigation on GPS based soil fertility maps of Harnas Village of Bhor Tehsil of Pune District was undertaken with 120 geo-referenced (GPS) surface soil samples (0-22.5 cm depth) during the year 2017-2018 at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune with the object to assess the soil chemical properties with available micro nutrients. The latitude and longitude of the sampling site were recorded with the handheld GPS instrument. It is observed that 97.5% soil samples belong to slightly acidic to acidic in reaction. However, the EC of soils ranged from 0.10 to 0.20 dSm^{-1} and soils are categorized as normal for emergence of seed. The organic carbon content of soil ranged from 0.21 to 0.71 per cent and categorized as low to high. The calcium carbonate content was medium to high and it ranged from 0.24 to 12.50 per cent. Soil pH was non-significant but positively correlated with DTPA extractable Zn but showed negatively significant correlation with Mn and Fe with the r values of -0.189*and -189* respectively, indicating that as soil pH decreases, the availability of Fe, Mn increases. Electrical conductivity had non significantly positive correlation with Cu. While, the organic carbon showed significantly positive correlation with extractable Fe (r = 0.239**) and non-significantly positive correlation with Mn, Zn and Cu. The $CaCO_3$ found negatively and significantly correlated with exchangeable Fe and Mn with the r value of -0.176*, -212** respectively. The spatial distribution maps of soil were developed with help of Arc GIS 10.2 software.

Keywords: Harnas, GIS, GPS, micronutrients, soil fertility maps

Introduction
Soils of Maharashtra state are categorized as poor in fertility and they vary widely in genetic, morphological, physical, chemical and biological characteristics. In recent years due to continuous and intensive multiple cropping and use of high yielding cultivars which may have higher nutrient demand for enhancing production of crop on marginal soils that contain low level of essential nutrients. Increase use of high analysis fertilizers with low amount of micronutrients. Decreased use of animal manure, compost and crop residues which affected the physical and biological properties of soil thereby creates element imbalances in soil. The soil fertility undergoes change due to different cropping pattern, manure and fertilizer applications. Geo reference soil technique (Anonymous, 2014) [1] and Global positioning system (GPS) has been used to identify actual geographic coordinates (latitude and longitude) for each observation. The weathering of different types of parent material has obviously resulted in soils showing appreciable variations in morphological, physical, chemical and biological characteristics. Thus the soil representing a continuum of diversified genetic processes and being one of the biggest natural heritages of mankind deserves greater consideration than merely as an inert medium for plant growth. Good cultivable lands are not only limited but differ also in their production potential. The soil variability within a village, district or state influences the use of soil for different purposes. Systematic study of morphology and taxonomy of soils provides information on nature and type of soil, their constraints, potential, capabilities and their suitability for various uses (Sehgal, 1996) [12]. Digital mapping is being used for preparation of soil fertility map of macronutrients and micronutrients. Geographical data in digital form is now widely available but its accessibility is still limited by the high cost involved. However, as time is passing out, the cost will

definitely come down with increased use of Global Positioning Systems (GPS) and satellite imagery (Singh *et al*., 2008). Global Positioning System (GPS) and Geographical Information System (GIS) are advanced tools for studying on site specific nutrient management which can be skilfully used for monitoring soil fertility variations and demand the systematic revision of macro as well as micronutrients status of soils to description of nutrient deficiency or sufficiency overtime. The geo-referenced nutrient status of soils in Village Harnas, Taluka Bhor, Dist- Pune would be useful for ensuring balanced fertilization to crops that demands the systematic study of macro as well as micronutrients status for assessment of nutrient status of soils to delineation of nutrient deficiency or sufficiency.

Experimental site

120 soil samples were collected from Harnas village located 56 km from Pune city, off Pune Bangalore highway at 180 09 to 180 14 North latitude and 730 82 to 730 88 East longitudes. The geographical area of village is 312 hectare, elevated at 556 meters above ground level.

Material and Methods:

Harnas village of Bhor tehsil of Pune district was selected for carrying out the study to prepare GPS and GIS based thematic soil fertility maps. Latitude (Lat) and Longitude (Long) were recorded by GPS instrument from soil sampling places. Soil samples were brought to the laboratory and air dried under shade avoiding contamination with foreign materials and then crushed with a wooden pestle. The sample collection screening through a 2mm sieve was done and the pebbles, stones and roots were rejected. About 0.5 to 1kg of air dried crushed soil sample was put in the plastic sample bottle, labelled and stacked on the open sample racks for analysis. The analysis of soil samples have been done by using standard methods i.e. pH (1:2.5), EC (1:2.5), organic carbon (Walkley and Black method), calcium carbonate (Wet oxidation Method) and available micronutrients Mn, Fe, Cu, Zn (DTPA extractable method). Base map of the Harnas village was digitized and georeferenced. Polygons were superimposed on the geo-referred map. Latitude, longitude and analysed data were entered into the attributed table and linked to Arc GIS 10.2 software for making thematic soil fertility maps.

Result and discussion

Soil reaction (pH)

The data with respect to the soil pH are reported in Table 1 and depicted on map (fig.1). The pH of the soils ranged from 5.84 to 7.12 with the average of 6.65. Among the 120 soil samples tested, 67.5 per cent soils were slightly acidic, 30.0 per cent soils were moderately acidic and 2.5 per cent soils were neutral. From the study it is observed that 97.5% soil samples belong to slightly acidic to acidic in reaction indicting that these soils are best suited for paddy crop and also suitable for most of cereal pulses, sugarcane and all type of fruit crops. Similar result was also found by Katariya, P. (2011) [7].

Electrical conductivity (EC)

The data related to electrical conductivity of soils from village Harnas are presented in Table 1 and is depicted on map (fig. 2). The EC of soil samples collected were ranged from 0.10 to 0.20 dSm-1 with the average of 0.13 dSm-1. The EC values indicated that all analyzed soil samples (85.33 per cent) are found normal in total soluble salt content and suitable for healthy plant growth and remaining (14.16 per cent) are poor for seed germination. Similar result was also found by Padole, V.R. and Mahajan S.B. (2003) [11].

Organic carbon

The data on organic carbon content in soils from village Harnas are presented in Table 1 and depicted on map (fig. 3) and that ranged from 0.21 to 0.71 per cent with an average of 0.44 per cent. The organic carbon content of soil samples were found low (38.33 per cent), moderate (52.5 per cent), moderately high (9.16 per cent). Similar result was also found by Meena, S. (2009) [90].

Calcium carbonate

The data on calcium carbonate status are presented in Table 1 and depicted on map (fig. 4). The calcium carbonate content in soils of village Harnas ranged from 0.24 to 12.50 per cent with an average of 4.94 per cent. Among the 120 soil samples collected, 7.5 per cent samples are very low, 44.16 per cent are low, 46.66 per cent samples were found as medium and 1.66 per cent samples are high in $CaCO_3$ content. From this observation it is seen that majority (90.82 per cent) soil belongs to the low to medium category with respect to calcium carbonate content; it is indicated that most of the soils suited for all type of crops. Similar result was also found by Durgude, A.G. (1999) [4].

Table 1: Status of some chemical properties in soils of village Harnas

Particulars	pH (1:2.5)	EC (dSm^{-1}) (1:2.5)	Organic carbon (%)	$CaCO_3$ (%)
Average	6.65	0.13	0.44	4.94
Range	5.84-7.12	0.10-0.20	0.21-0.71	0.24-12.50
Category	Moderately acidic (30%)	Normal (100%)	Low (38.33%)	Very low (7.5%)
	Slightly acidic (67.5%)		Moderate (52.5%)	Low (44.16%)
	Neutral (2.5%)		Moderately high (9.16%)	Medium (46.66%)
				High (1.66%)
SE±	0.022	0.001	0.012	0.244

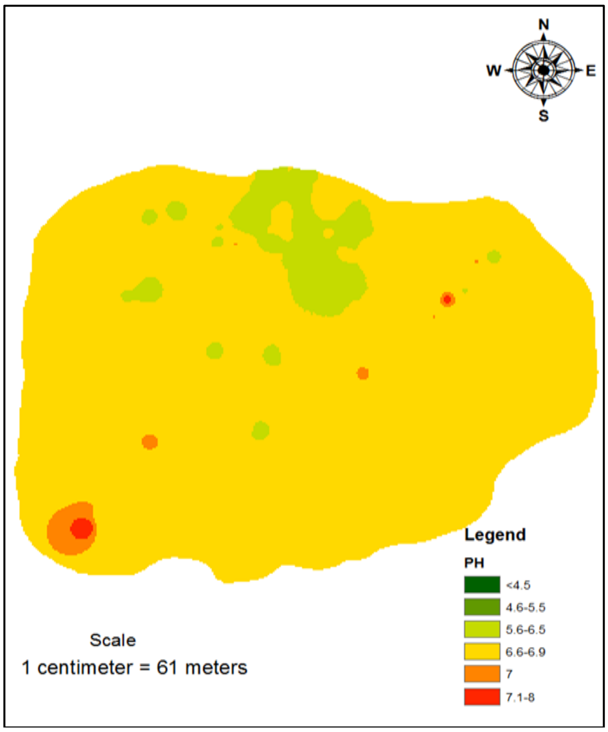

Fig 1: Soil pH

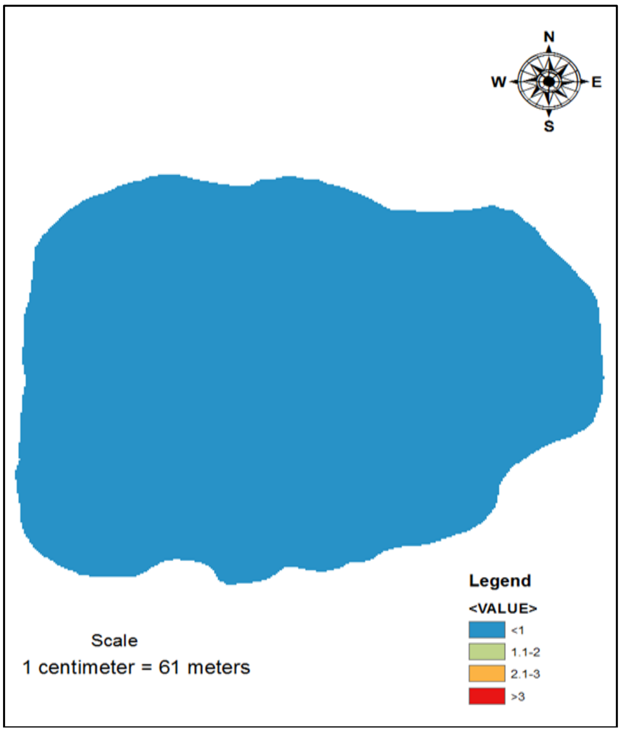

Fig 2: Soil EC status

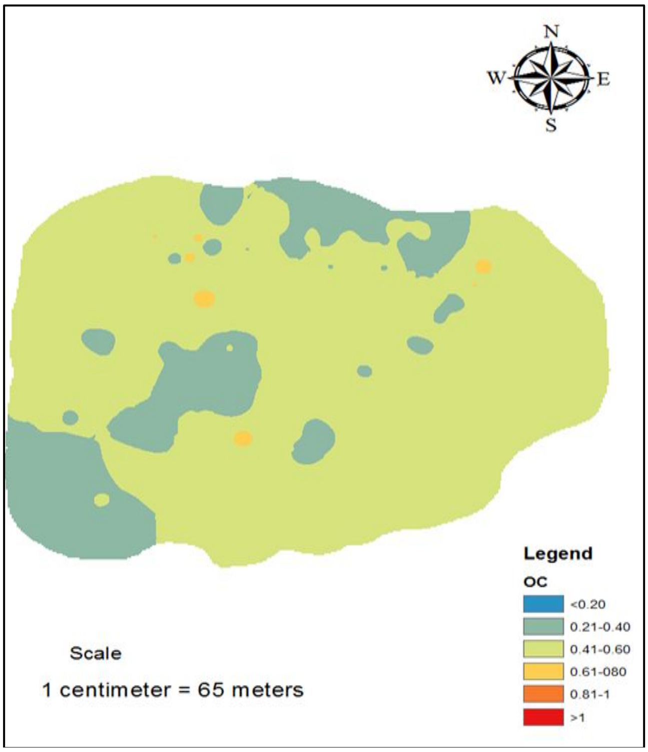

Fig 3: Soil organic carbon

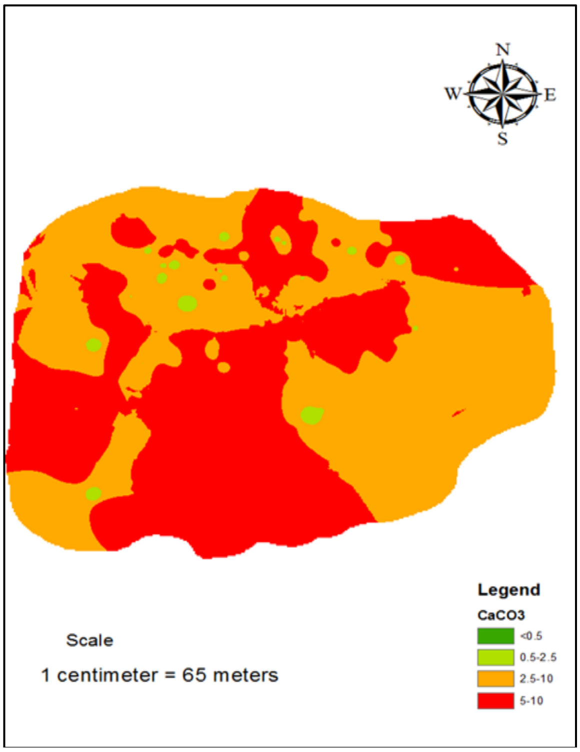

Fig 4: Soil Calcium carbonates

Available micronutrients

Available iron

The DTPA extractable iron values of soils in village Harnas are presented in Table 2 and depicted on map (fig. 5). The available iron content in soils ranged from 2.62 to 9.71 mg kg-1 with an average of 5.99 mg kg-1.Available Fe content in soils 85.83 per cent which is sufficient. Similar result was also found by Dhage *et al*. (2002) [3].

Available manganese

The available Mn status of present study soils are presented in Table 2 and depicted on map (fig. 6). The available manganese in soils of village Harnas was ranged from 0.68 to 5.74 mg kg-1 with an average of 3.00 mg kg-1. Among the 120 soil samples collected in village Harnas (79.16 per cent) were sufficient and (20.83 per cent) deficient in available manganese on the basis of the critical limit of available manganese is 2 mg kg-1. The similar observations have been reported by Meena (2009) [9] in soils of Central Research Farm, Central Campus, M.P.K.V

Available zinc

The data on available zinc status of soils are presented in Table 2 and depicted on map (fig. 7). The available zinc in soils of village Harnas was ranged from 0.74 to 2.34 mg kg-1 with an average of 1.33 mg kg-1.Out of 120 soil samples collected, 100 per cent soil sample were sufficient in available zinc, as the critical limit of available zinc is 0.6 mg kg-1. Similar result was also found by Waghmare *et al*. (2007) [15].

Available copper

The values of available copper are reported in Table 2 and depicted on map (fig. 8). The available copper in soils of village Harnas ranged from 0.95 to 3.97 mg kg-1 with average value of 2.56 mg kg-1. All the 120 soil samples collected from village Harnas were 100 per cent sufficient in available copper, as the critical limit of available copper is 0.2 mg kg-1. Similar result was also found by Katyal, J.C. and Randhawa, N.S. (1983) [8].

Table 2: Status of DTPA micronutrients in soils of village Harnas

Particular	Available micronutrients (mg kg^{-1})			
	Fe	Mn	Zn	Cu
Average	5.99	3.00	1.33	2.56
Range	2.62-9.71	0.68-5.74	0.74-2.35	0.95-3.97
Category	Sufficient (85.83%)	Sufficient (79.16%)	Sufficient (100%)	Sufficient (100%)
	Deficient (14.16%)	Deficient (20.83%)		
SE $\pm$	0.125	0.102	0.029	0.0571

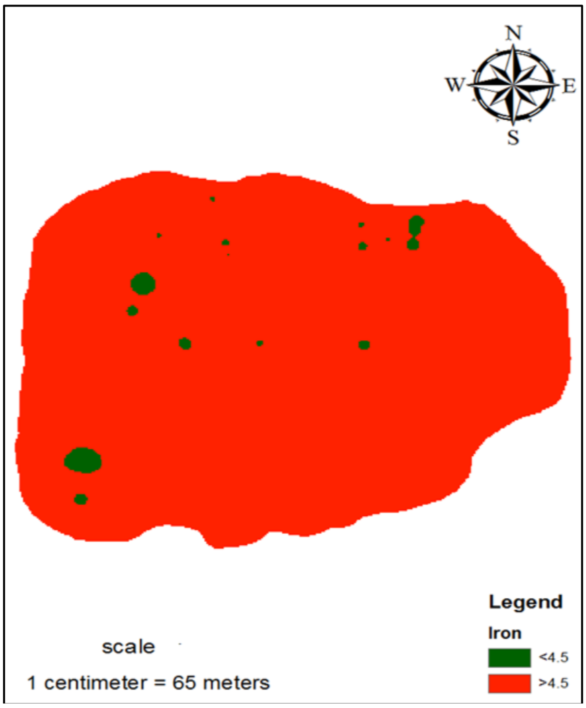

Fig 5: Available iron status in soil

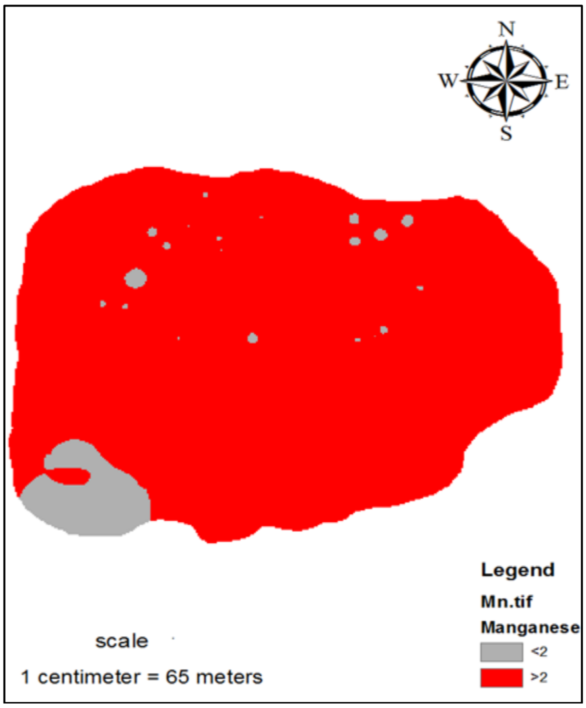

Fig 6: Available manganese status in soil

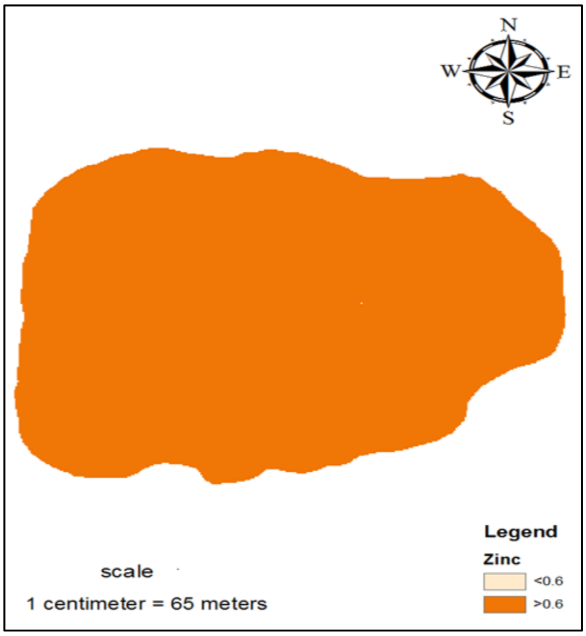

Fig 7: Available zinc status in soil

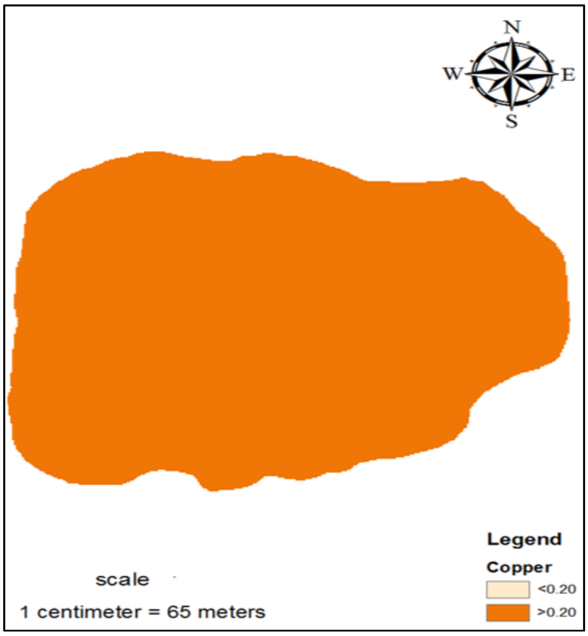

Fig 8: Available copper status in soil

Correlation of Available Nutrients with Chemical Properties of Soils.

The pH of the soils of village Harnas has negative and non-significant correlation with available Cu. however it has positive non-significant correlation with available exchangeable Zn (0.042). It showed negatively significant correlation with available Mn, Fe with the r values of -0.189*, and -189* respectively, indicating that as soil pH decreases, the availability of Fe and Mn increases. Similar result was also found by Jadhav *et al*. (1978) [6]. The EC of the village Harnas showed a negative but non-significant correlation with available Fe, Mn, and Zn. But positively non-significant correlation with available Cu. It also indicates that soil EC decreases with increasing the availability of Fe, Mn and Zn. Similar result was also found by Chavan *et al*. (1980) [2].

Organic carbon showed positively non-significant correlation with available Mn, Zn and Cu. It showed positively significant correlation with Fe. Similar result was also found by Indulkar *et al*. (2007) [5]. The CaCO3 was negatively and non-significantly correlated with available Zn, and Cu. and it was negatively and significantly correlated with exchangeable Fe and Mn with the r value of -0.176*, -212**. Similar result was also found by Nipunage *et al*. (1996) [10].

Table 3: Correlation values of available nutrient with soil chemical

Particulars	Soil chemical properties			
	pH	EC	Organic carbon	$CaCO_3$
Fe	-0.189*	-0.138	0.239**	-0.176*
Mn	-0.189*	-0.116	0.015	-0.212**
Zn	0.042	-0.115	0.137	-0.085
Cu	-0.060	0.117	0.048	-0.117

* Significant at 5% level: 0.150

**Significant at 1% level: 0.210

Conclusion

It is concluded that the soils of Harnas village were slightly acidic in reaction, The EC of soils are categorized as normal for emergence of seed, low to medium in organic carbon and calcium carbonate content was medium to high. Sufficient in DTPA-Extractable copper, zinc are sufficient and deficient in DTPA-Extractable iron (14.16%) and manganese (20.83%).

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