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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

**RJ Patil**

PG Student,

Department of Soil Science and  
Agricultural Chemistry, Dr.  
PDKV Akola, Maharashtra,  
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 macronutrients of village Harnas of Bhore Tehsil in Pune District

**GA Kaygude, NB More and RJ Patil**DOI: <https://doi.org/10.22271/chemi.2020.v8.i2ac.9038>**Abstract**

Investigation on GPS based soil fertility maps of Harnas Village of Bhore 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 macro 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<sup>-1</sup> 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. The available nitrogen, phosphorus and potassium ranged 75.26 to 175.60 kg ha<sup>-1</sup> (mean 112.43 kg ha<sup>-1</sup>), 10.16 to 33.84 kg ha<sup>-1</sup> (mean 21.11 kg ha<sup>-1</sup>) and 117.24 to 285.70 kg ha<sup>-1</sup> (mean 212.97 kg ha<sup>-1</sup>), respectively. The available sulphur in soils ranged from 30.38 to 33.42 mg kg<sup>-1</sup> (mean 31.91 mg kg<sup>-1</sup>). The pH of the soil has negative and non-significant correlation with available K and S. however it has positive with significant correlation with P with 'r' value 0.164\*. EC of the soils showed negatively but non-significant correlation with available P and S. But positively non-significant correlation with available N and K. Organic carbon showed negatively non-significant correlation with available K. here as it has positively non-significant correlation with available N, P and S. The CaCO<sub>3</sub> was negatively and non-significantly correlated with available N, P and K. while it is positively and non-significantly correlated with available S. respectively. The spatial distribution maps of soil were developed with help of Arc GIS 10.2 software.

**Keywords:** Harnas, GIS, GPS, 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. Increased 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 there by 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) <sup>[1]</sup> and Global positioning system (GPS) has been used to identify actual geographic co-ordinates (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) <sup>[9]</sup>. 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) [10]. 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 demands 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 Bhore, 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 18° 09' to 18° 14' North latitude and 73° 02' to 73° 08' East longitudes. The geographical area of village is 312 hectare, elevated at 556 meters above ground level.

### Material and Methods

Harnas village of Bhore 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 macronutrients N, P, K and S. Base map of the Harnas village was digitized and geo referenced. Polygons were super imposed on the geo-referred map. Latitude, longitude and analysed data were entered into 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 belongs to slightly acidic to acidic in reaction indicating 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) [5].

### 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<sup>-1</sup> with the average of 0.13 dSm<sup>-1</sup>. 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) [8].

### Organic Carbon

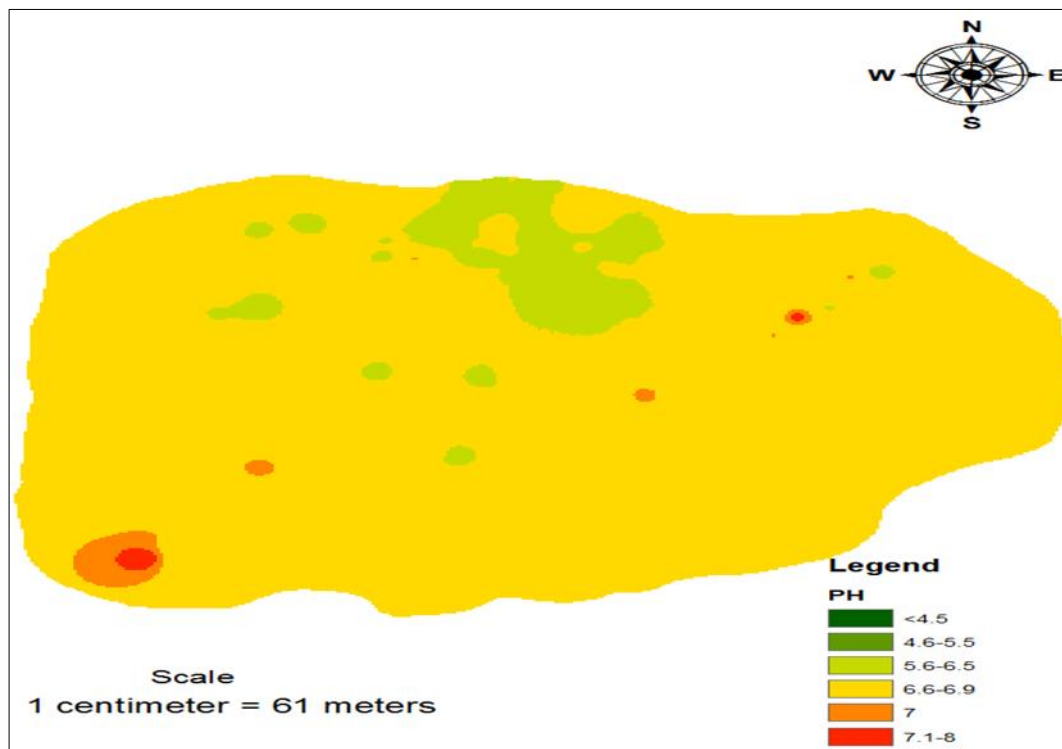
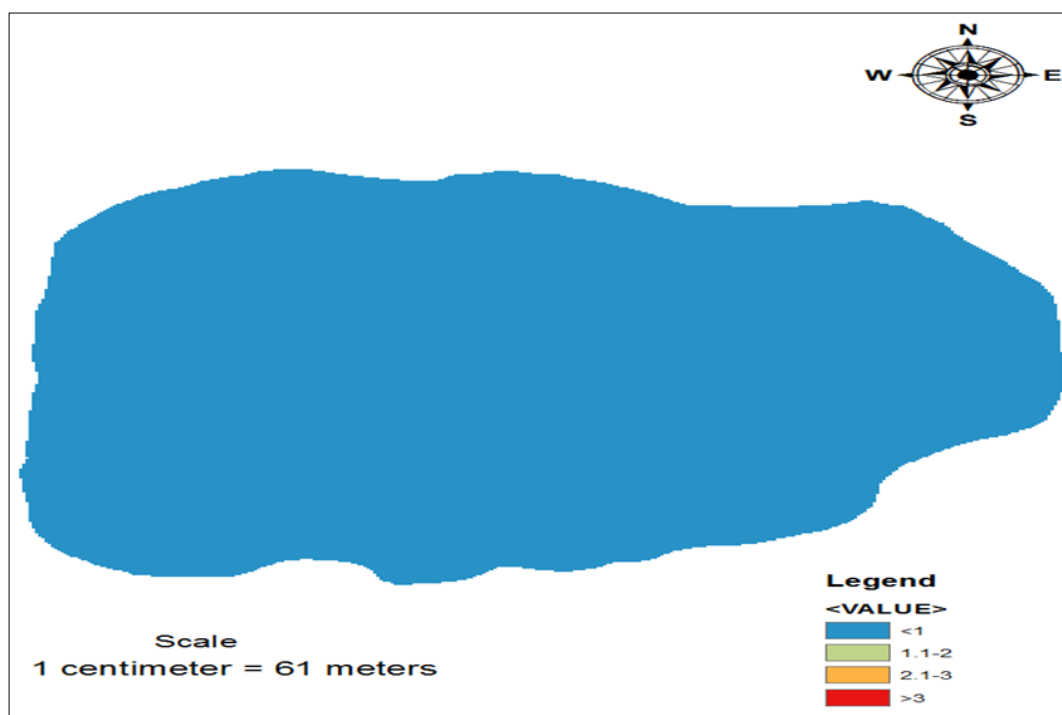
The data on organic carbon content in soils from village Harnas are presented in Table 1 and depicted on map (fig. 3) and that ranged from 0.21 to 0.71 per cent with a average of 0.44 per cent. The organic carbon content of soil samples were found low (38.33 per cent), moderate (52.5 per cent), moderately high (9.16 per cent). Similar result was also found by Meena, S. (2009) [6].

### 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 the 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<sub>3</sub> content. From this observation it is seen that majority (90.82 per cent) soil belongs to low to medium category with respect of 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) [2].

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

Particulars	pH (1:2.5)	EC (dSm <sup>-1</sup> ) (1:2.5)	Organic Carbon (%)	CaCO <sub>3</sub> (%)
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 <sub>±</sub>	0.022	0.001	0.012	0.244

**Fig 1: Soil pH****Fig 2: Soil EC status**

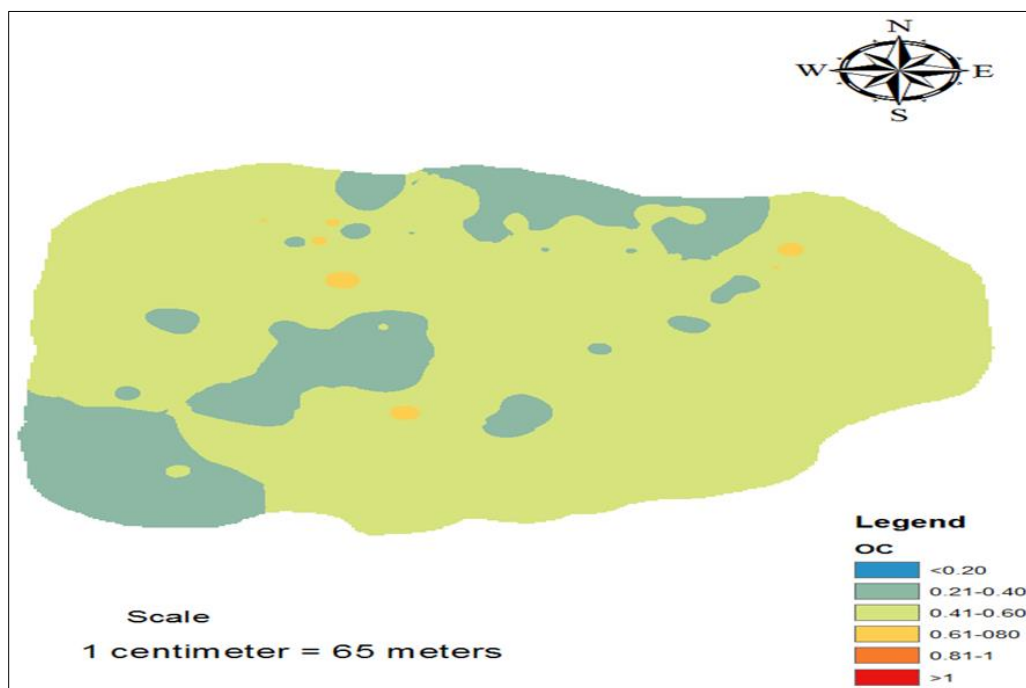


Fig 3: Soil organic carbon

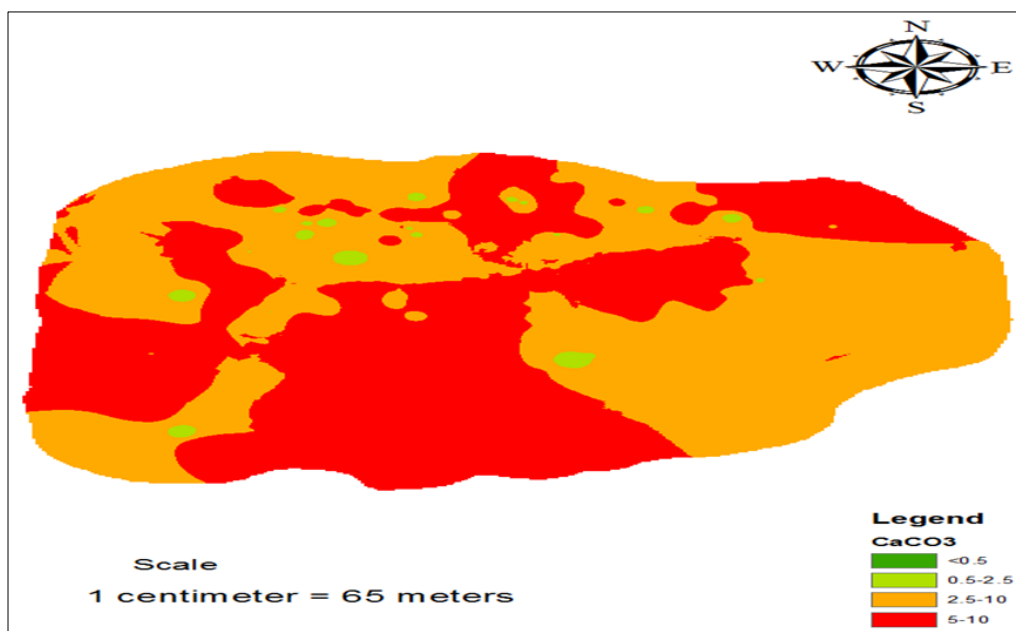


Fig 4: Soil Calcium carbonate

#### Available Nitrogen

The available nitrogen status of studied soils are presented in Table 2 and depicted on map (fig. 5). The available nitrogen in soils of village Harnas ranged from 75.26 to 175.6 kg ha<sup>-1</sup> with an average of 112.43 kg ha<sup>-1</sup>. Soil samples collected from Harnas village were categorized as very low (87.5 per cent) and low (12.5 per cent) categories in available nitrogen, that indicated the majority of soils are low in available nitrogen content. The available nitrogen were recorded by Katariya (2011)<sup>[5]</sup> in soils of the Water Management Project-Block A., Meena (2009)<sup>[6]</sup> in Central Research Farm, Central Campus, M.P.K.V, Rahuri.

#### Available Phosphorus

The data with respect to available phosphorus status are presented in Table 2 and depicted on map (fig. 6). The available phosphorus in soils of village Harnas was ranged

from 10.16 to 33.84 kg ha<sup>-1</sup> with an average of 21.11 kg ha<sup>-1</sup>. Among the 120 soil samples collected, 11.66 per cent in low, 36.66 per cent in moderate, 33.33 per cent in moderately in high, 18.33 per cent in high categories were observed.

#### Available Potassium

The data on available potassium status in soils are presented in Table 2 and depicted on map (fig. 7). The available potassium in soils of village Harnas was ranged from 117.24 to 285.70 kg ha<sup>-1</sup> with an average of 212.97 kg ha<sup>-1</sup>. Among the 120 soil samples collected, 6.66 per cent soils are low, 26.66 per cent samples are moderate, 50.83 per cent samples are moderate high, and 15.83 per cent samples are high categories. The similar result of available K were reported by Katariya (2011)<sup>[5]</sup> in soils of water management Project-Block A and Meena (2009)<sup>[6]</sup> in Central Research Farm, Central Campus, MPKV, Rahuri.

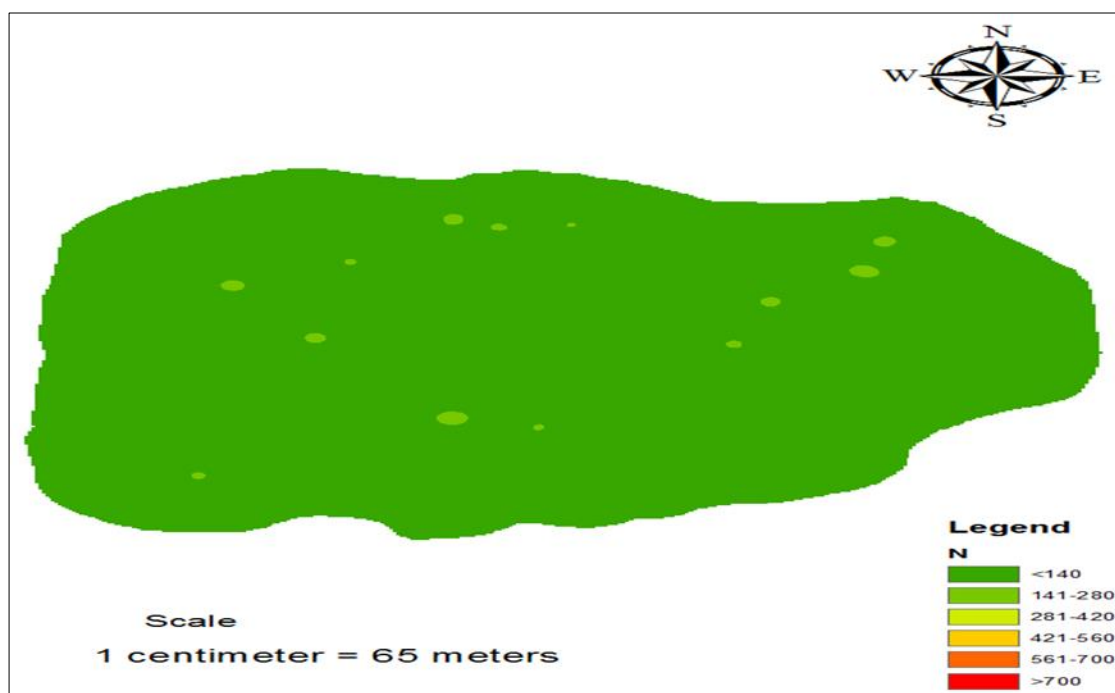
### Available Sulphur

The data on available sulphur are presented in Table 2 and depicted on map (fig. 8). The available sulphur in soils of village Harnas ranges from 30.38 to 33.42 mg kg<sup>-1</sup> with an average of 31.91 mg kg<sup>-1</sup>. In general, the available sulphur

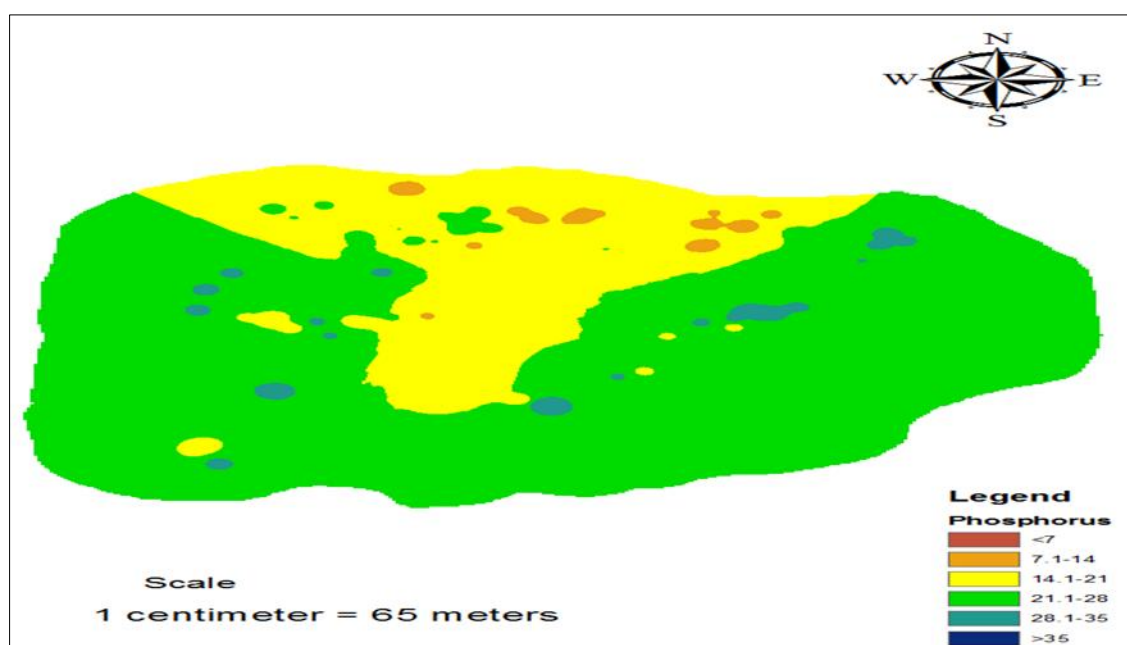
status in soils of village Harnas were 100 per cent soil samples in sufficient status which might be due to content of sufficient amount of sulphate anions in irrigation water or native Similar result was also found by Kanwar (1976)<sup>[12]</sup>.

**Table 2:** Status of available macronutrients (N, P, K, S) in soils of village Harnas

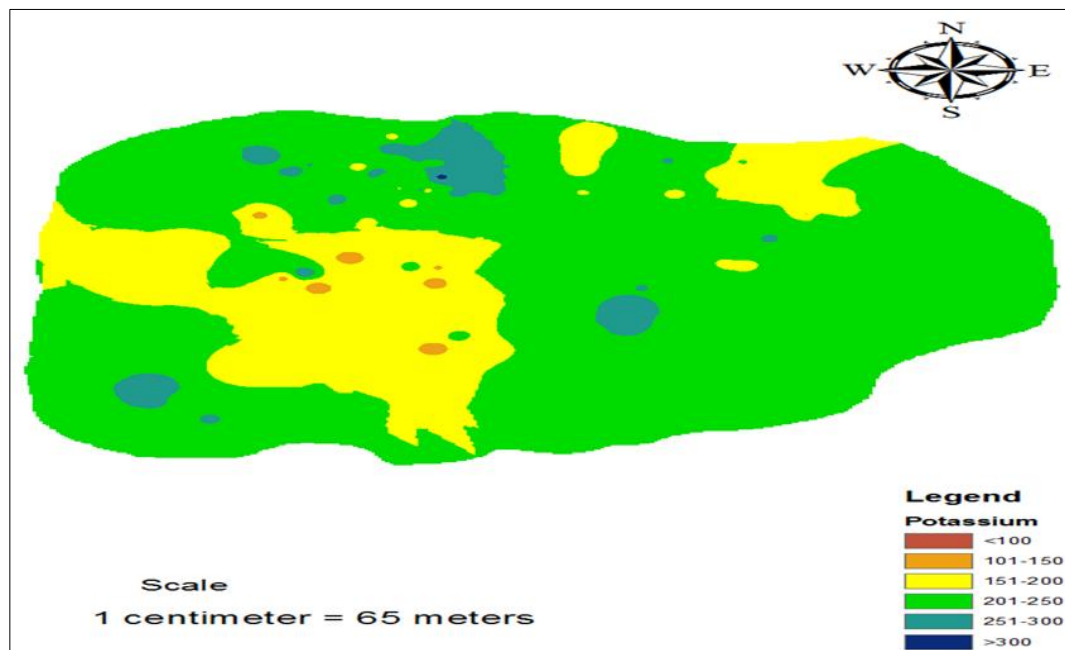
Particulars	Available Nutrients(kg ha <sup>-1</sup> )			
	N	P	K	S (mg kg <sup>-1</sup> )
Average	112.43	21.11	212.97	31.91
Range	75.26-175.6	10.16-33.84	117.24-285.70	30.38-33.42
Category	Very low (87.5%)	Low (11.66%)	Low (6.66%)	Sufficient (100%)
	Low (12.5%)	Moderate (36.66%)	Moderate (26.66%)	
		Mod. High (33.33%)	Mod. High (50.83%)	
		High (18.33%)	High (15.83%)	
SE±	2.171	0.538	3.353	0.068



**Fig 5:** Available nitrogen status in soil



**Fig 6:** Available phosphorus status in soil



**Fig 7:** Available potassium status in soil



**Fig 8:** Available sulphur status in soil

#### Correlation of Available Nutrients with Chemical Properties of Soils

The correlation of available nitrogen, phosphorus potassium and sulphur with soil pH, EC, calcium carbonate and organic carbon content in soil are studied and the correlation coefficients between soil chemical properties and available nutrients are reported in Table 3.

The pH of the soils of village Harnas has negative and non-significant correlation with available K and S. however it has positive with significant correlation with P with 'r' value 0.164.\* It showed negatively significant correlation with available N. indicating that as soil pH decreases, the availability of Nitrogen increases. The similar results were noted by Jadhav *et al.* (1978)<sup>[4]</sup>.

The EC of the village Harnas showed negatively but non-significant correlation with available P and S. But positively non-significant correlation with available N and K. It also indicates that soil EC decrease with increasing the availability of P and S. The similar results were noted by Sakal *et al.* (1988)<sup>[11]</sup>.

Organic carbon showed negatively non-significant correlation with available K. here as it has positively non-significant correlation with available N, P and S. The similar results were noted by Indulkar *et al.* (2007)<sup>[3]</sup>.

The  $\text{CaCO}_3$  was negatively and non-significantly correlated with available N, P and K. while it is positively and non-significantly correlated with available S. Similar type of observations were also reported by Nipunge *et al.* (1996)<sup>[7]</sup>.



**Table 3:** Correlation values of available nutrient with soil chemical properties

Particulars	Soil chemical properties			
	pH	EC	Organic carbon	CaCO <sub>3</sub>
N	-1.092**	0.048	0.132	-0.086
P	0.164*	-0.030	0.134	-0.059
K	-0.068	0.114	-0.010	-0.064
S	-0.058	-0.074	0.012	0.008

\* 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.very low in available nitrogen, moderately high in available phosphorous, moderately high in available potassium, sufficient in available sulphur.

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