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Assessment of spatial variability of soil fertility status in KVK farm of Pahanda in Durg district, Chhattisgarh using Gis-Gps

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Abstract
The precise nutrient management is one of the most important and integral part of the modern-day agriculture. For this to happen we have to know the spatial variability of soil fertility. In this study, all soil physico-chemical properties (pH, EC, OC), Available macronutrients (N, P, K, S) and Available micronutrients (B, Fe, Mn, Cu, Zn) status with their spatial variability in KVK farm of Pahanda was quantified and based on their result soil fertility maps were prepared for respective nutrients using Arc-GIS software. Total 52 soil samples from soil surface (0-15 cm) collected from the study area and analyzed for these parameters. Soil reaction of the study area varied from neutral to saline range with EC below<1.0 dS/m for all collected samples. Soil OC content was low to medium, Soil N and P in low, Soil K medium to high fertility category and S status found to be ranging between 11.20 to 39.60 kg/ha. Also, Fe, Cu and Mn status found in medium to high range but Zn status found deficient in about 83% samples. Hot water extractable B content in 36.54% samples found in low and rest in medium fertility range. These observed spatial variability used in further fertilizer recommendation and input management based on requirement of crop plants.

Keywords: Soil fertility, soil fertility map, nutrient management

Introduction
Soil fertility is the property by virtue of which soil provide all essential nutrients to crop plant in optimum quantity. So, details study regarding soil fertility is essential for better crop production and management. A detailed investigation of chemical, physical and biological properties of soil will provide us a greater insight into these soil dynamics. It will throw a better understanding of soil fertility and problem lies in it for successful crop production.

Currently the intensive crop production using HYV and hybrid varieties completely exhaust the soil nutrient pool. Again, to meet the plant nutrient requirement farmer add only urea, DAP and potash in the most area of our country neglecting micronutrient fertilization making this an imbalance input management system. So, for better, precise and balance fertilizer management in farm spatial fertility evaluation is very important in it.

Indian agriculture in recent years progressed dramatically owing to modernization, mechanization and use of advance technologies. Using these advance technologies like GIS, GPS and remote sensing we can evaluate the spatial variability of soil fertility for precise nutrient management in a large area easily and effectively in very less time. Geographical Information System (GIS) is the tool of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and displaying of spatially referenced data for solving complex planning and management problems (Bernhardsen, 1999). It aids to manipulation of different variable data useful for handling multiple data of diverse origin. As soil fertility evaluation is a basic requirement for the sustainable & effective planning of particular area and its importance became manifold if it is for the planning of a K.V.K. Farm as it decides the farmers' decision for the adoption of different crop varieties and modern techniques or machinery based on the crop performance in KVK farm field.

Material and Methods

Study area

The study was carried out at KVK farm of Pahanda in Durg district. It is situated in mid-eastern part of Chhattisgarh state and comes under Chhattisgarh plains agro climatic zone. It situated at the latitude 21.11˚N to 21.12˚Nand longitude 81.31˚E to 81.32˚Ewith altitude 311 meter above sea level. The general climatic condition of Durg is sub-humid to semi-arid as it located near the tropics of cancer. The soil of the study area is dominantly black soil locally called as *Kanhar* and it comes under the order of *Vertisols*.

Sample collection and analysis

Total 52 soil samples from surface layer (0-15cm) were collected from the study area of about 52 acres. One samples each from all plots in the farm and through random technique from the rest of barren field area. GPS coordinate of all sampling sites recorded using a hand held GPS device.

The collected soil samples were air dried after grinding with wooden pestle and mortar, then sieved through 2-mm sieve, labelled and stored. The samples were analyzed for 12 chemical parameters *viz*. pH by pH meter, electrical conductivity (EC) by solu-bridge method (Jackson 1973), organic carbon (OC) by method of Walkley and Black (1934), available nitrogen (N) using method described by Subbiah and Asija (1956), phosphorus (P) using method of Olsen *et al*. (1954), available potassium (K) by method of Hanway and Heidal, (1952) [5], available sulphur (S) by method of Williams and Steinbergs (1959), available zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) using DTPA extractant method proposed by Lindsay and Norvell (1978) [9] and available boron (B) using hot water extractant method described by Berger and Troug (1944).

The analytical results of each soil sample was categorized as low, medium and high categories for OC and macronutrients and as deficient, moderate and sufficient for micronutrient based on standard rating values.

Nutrient index values and fertility rating

Nutrient index value (NIV) was calculated from the number or proportion of samples under low, medium and high available nutrient status (Ramamoorthy and Bajaj 1969) [13]. i.e:

$$\text{NIV} = \frac{1 \times \text{PL} + 2 \times \text{PM} + 3 \times \text{PH}}{100}$$

Where, NIV = nutrient index value;

PL, PM, and PH are the percentage of soil samples falling in the category of low, medium and high nutrient status and given weightage of one, two and three respectively.

The index values are rated into various fertility categories *viz*., low (<1.67), medium (1.67-2.33) and high (>2.33) for OC and available N, P and K.

For available S and micronutrients, the ratings are very low (<1.33), low (1.33-1.66), marginal (1.66-2.00), adequate (2.00-2.33), high (2.33-2.66) and very high (>2.66). Based on this value farm categorized into various fertility class.

Generation of fertility maps

Database on soil available nutrient was generated in Microsoft Excel based on test result. Using these database and GPS location of sample sites soil fertility maps were prepared at Geo-Informatics laboratory of IGKV, Raipur using Arcgis 10.3.1 software.

Result and Discussion

Soil reaction

soil reaction of the study varied from 6.79 to 7.81 in a very narrow range with mean value of 7.36 and out of all 52 samples 63.46% were found within neutral, and rest 36.54% fall under saline reaction category (Fig: 1). It might be due to vertisols dominant soil and semi-arid climate of the region (Balakrishna *et al.* 2017) [1].

Electrical conductivity

The electrical conductivity of the soil water suspension ranges from 0.15 to 0.33 dS/m in soil of study area with a mean value of 0.24 dS/m. All the collected soil samples fall under normal E.C. (<1.0 dS/m) category (Fig: 2). It indicated that there is no soil limitation for crop production from soluble salt concentration in soil.

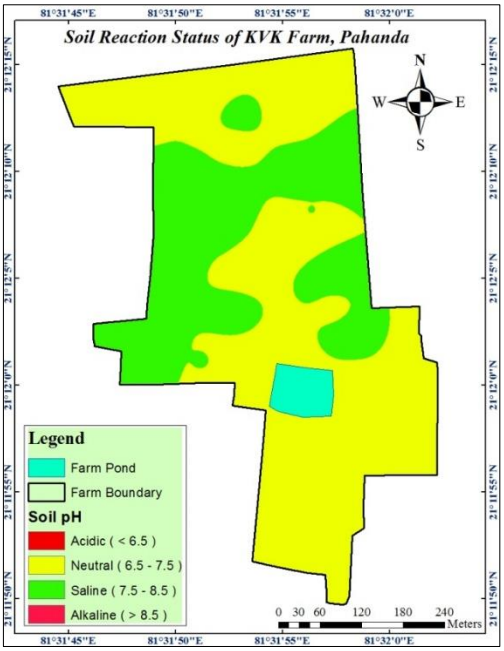

Fig 1: Soil Reaction

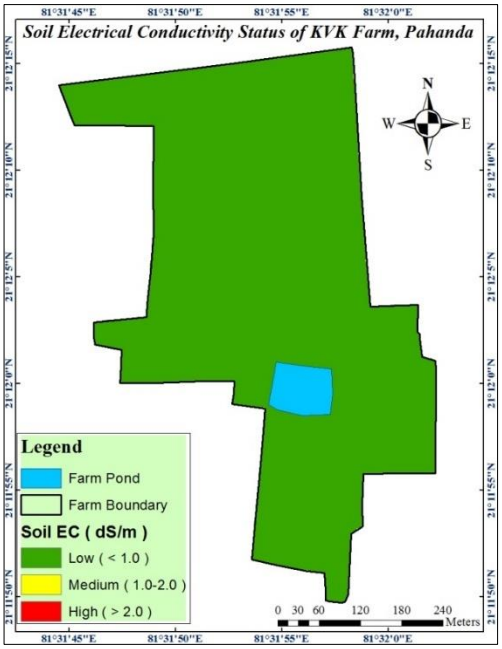

Fig 2: Electrical Conductivity

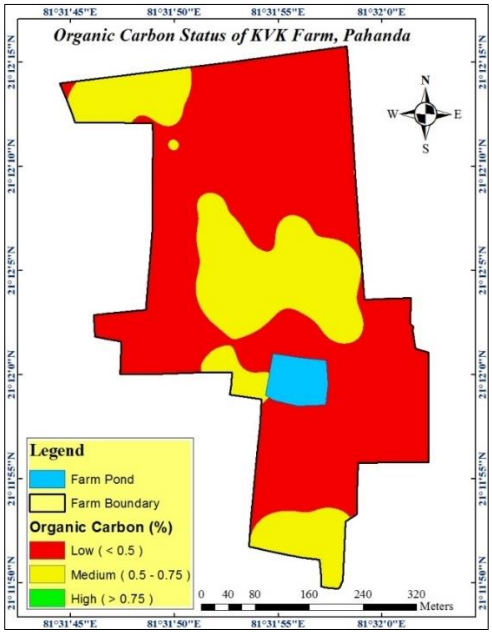

Fig 3: Organic Carbon

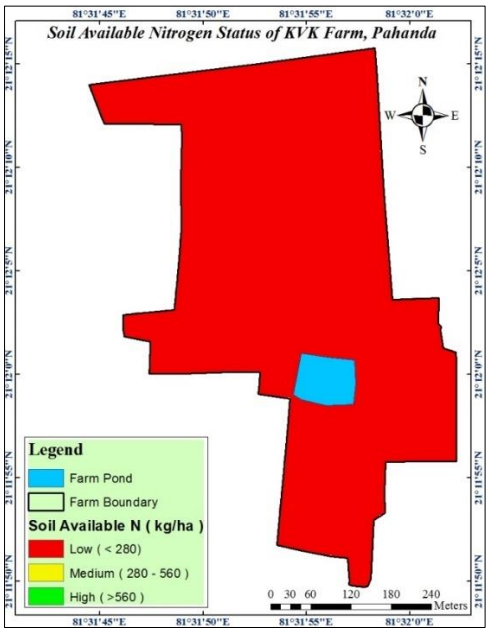

Fig 4: Available Nitrogen

Organic carbon

Organic Carbon content in study area ranges from 0.27 to 0.71% with a mean value of 0.48%. From all collected soil samples 67.31% samples fall under low and rest 32.69% under medium fertility category (Fig: 3). It may be ascribed due to the fact that soils have very low carbon pool and high C decomposition due to warm climate (Jatav *et al*. 2012).

Available nitrogen

Available N content in soil of study area ranges from 87.81 to 200.70 kg/ha with mean value of 133.40 kg/ha. Also all collected samples fall under low fertility category (Fig: 4). It may be ascribed to the poor organic carbon pool of soil (Jatav *et al.* 2012)

Available phosphorus

Available P content in KVK farm of Pahanda found to be varied from 2.69 to 11.65 kg/ha with average content of 6.44 kg/ha with 100% collected soil samples representing low fertility status (Fig: 5). It might be due to poor C pool and fixation by montmorillonitic clay of the soil in the region (Singh *et al.* 2017).

Available potassium

Soil available K status ranges from 283.47-538.72 kg/ha with mean value of 376.53 kg/ha. Among all the collected soil samples 36.54% samples were in medium and rest 63.46% samples were in high fertility categories (Fig: 6) indicating there is no K deficient area within study area.

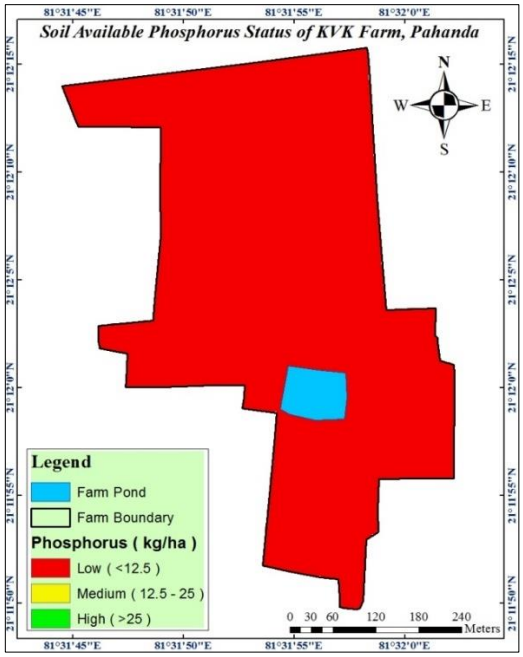

Fig 5: Available Phosphorus

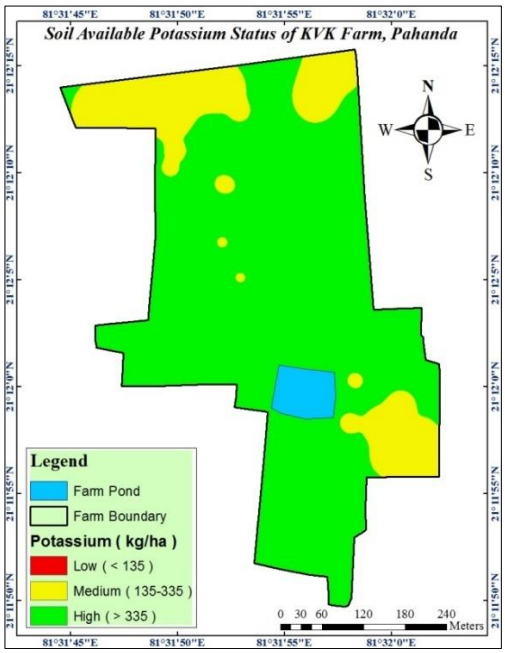

Fig 6: Available Potassium

Available Sulphur

Available S status was found to be ranging between 11.20 to 39.60 kg/ha with a mean content of 27.27 kg/ha. Also it was found that among all collected samples 28.85% in low, 51.92% in medium and 19.23% samples in high fertility category (Fig: 7).

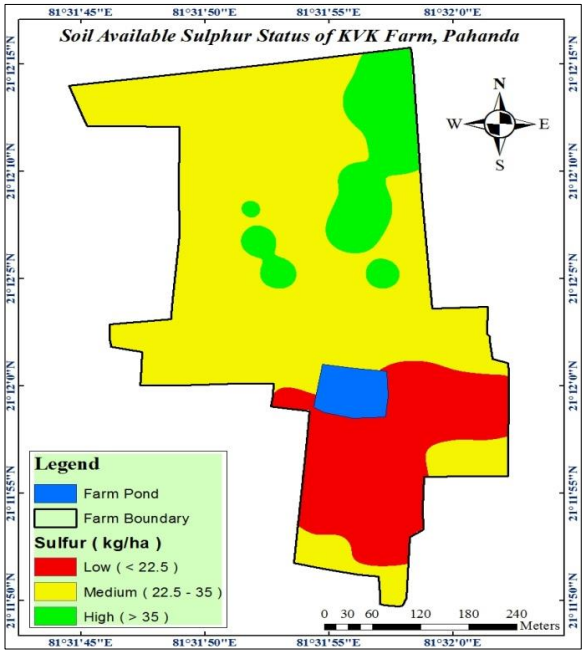

Fig 7: Available Sulphur

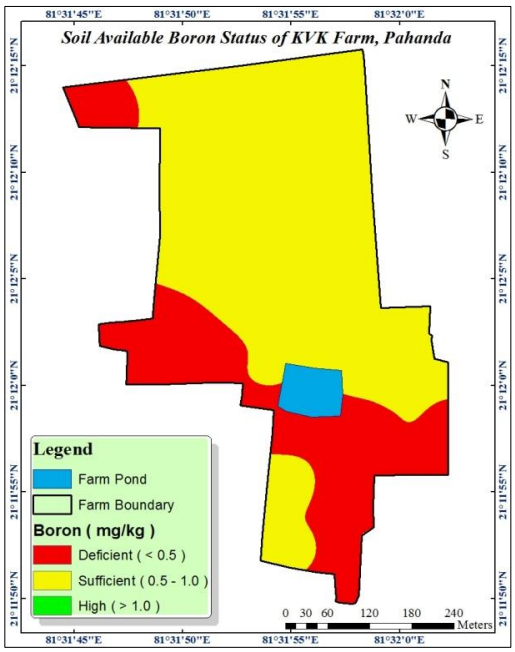

Fig 8: Available Boron

Available boron

Hot water extractable B content in the study area found to be ranges from 0.10 to 1.00 mg/kg with a mean value of 0.54 mg/kg soil. Also, among the total samples collected 36.54% samples found in lower and rest 63.46% in medium fertility status (Fig: 8).

DTPA extractable micronutrients

Available Fe content in the study area found to be ranging from 7.40 to 17.02 mg/kg with mean value of 9.52 mg/kg. Of all collected samples 42.31% samples were found in medium and 57.69% in high fertility category (Fig: 9).

Available Mn content in all soil samples were in medium to sufficient category with its content found to be within 5.02 to 12.55 mg/kg with a mean value of 8.14 mg/kg of soil (Fig: 10) in the study area.

Available Cu content in study area found to be ranges from 0.25 to 2.22 mg/kg with a mean value of 0.78 mg/kg. Also, it was found that 11.54% samples were in medium and rest 88.46% in high fertility category (Fig: 11).

Available Zn content in study area found to be ranges from 0.10 to1.16 mg/kg with a mean value of 0.46 mg/kg. Also, it was found that 82.69% samples were in deficient and 17.31% samples in medium fertility category (Fig: 12).

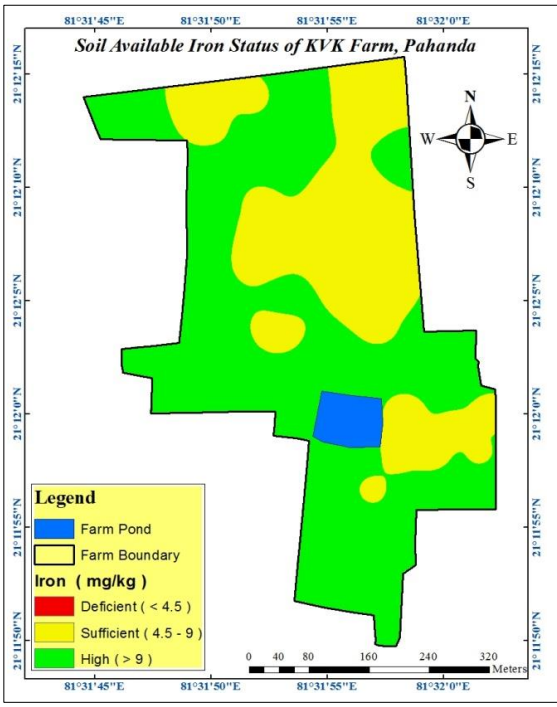

Fig 9: Available Iron

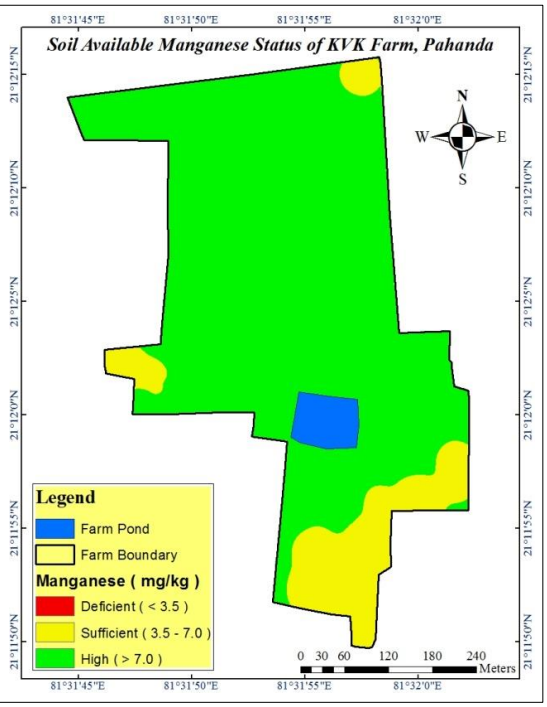

Fig 10: Available Manganese

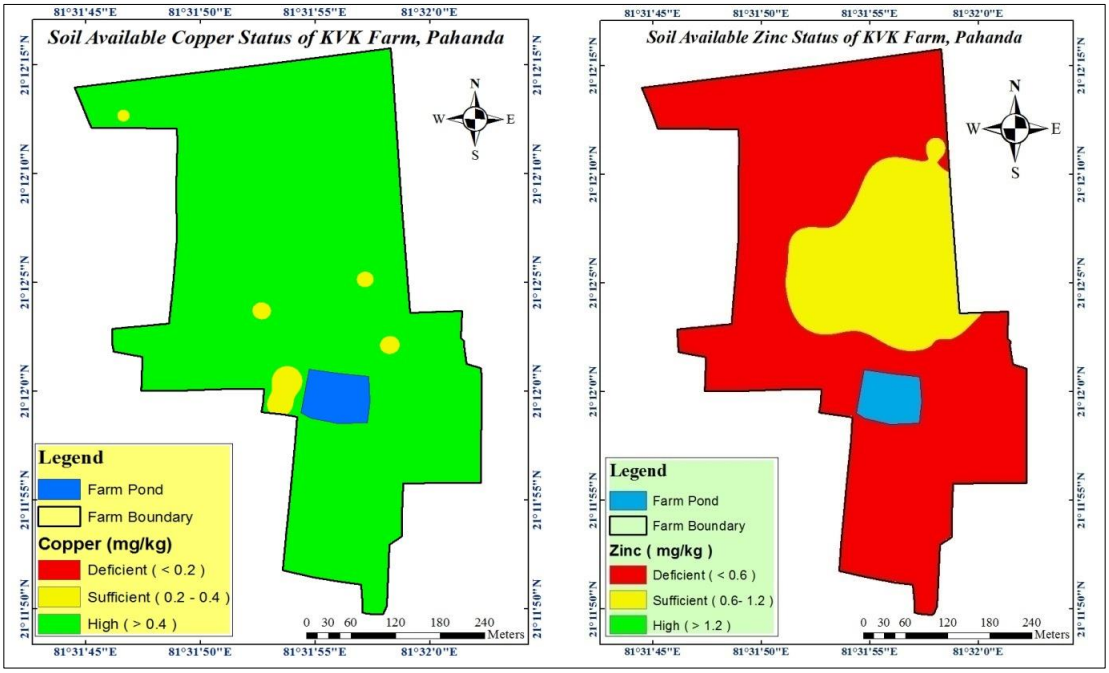

Fig 11: Available Copper

Fig 12: Available Zinc

Nutrient management & fertilizer recommendation

Based on the result obtained from this study and fertility maps prepared based on it better nutrient management practices taken up to avoid imbalance fertilizer application and improve crop production.

As KVK farm is an extensive area where a lot of crop plants are cultivated based on their nutrient requirement proper input should be provided. For crop plants, in the deficient, sufficient and high fertility area of a particular nutrient 25% more than recommended, exact recommended and 25% less than recommended dose of fertilizer respectively should be provided. But for fruit and plantation crop nutrient uptake should be correlated with soil nutrient and accordingly nutrient should be applied to soil of the area.

Table 1: Soil Fertility Status of KVK Farm, Pahanda, Durg

S. No.	Soil Characteristics	Range	Average	Standard Deviation	% Samples Category			NIV	Fertility Rating
					Low	Medium	High		
1	pH	6.79-7.81	7.36	0.27	-	-	-	-	-
2	EC (dS/m)	0.15-0.33	0.24	0.03	-	-	-	-	-
3	OC (%)	0.27-0.71	0.46	0.11	67.31	32.69	0.00	1.33	Low
4	N (kg/ha)	87.81-200.70	133.40	29.08	100.00	0.00	0.00	1.00	Low
5	P (kg/ha)	2.69-11.65	6.44	2.69	100.00	0.00	0.00	1.00	Low
6	K (kg/ha)	283.47-538.72	376.53	70.03	0.00	36.54	63.46	2.63	High
7	S (kg/ha)	11.20-39.60	27.27	7.89	28.85	51.92	19.23	1.90	Marginal
8	Fe (ppm)	7.40-17.02	9.52	2.01	0.00	42.31	57.69	2.58	High
9	Cu(ppm)	0.25-2.22	0.78	0.40	0.00	11.54	88.46	2.88	Very High
10	Mn (ppm)	5.02-12.55	8.14	1.89	0.00	25.00	75.00	2.75	Very High
11	Zn (ppm)	0.10-1.16	0.46	0.23	82.69	17.31	0.00	1.17	Very Low
12	B (ppm)	0.10-1.00	0.54	0.22	36.54	63.46	0.00	1.63	Very Low

Conclusions

From the above intensive study of the KVK farm in Pahanda, Durg of Chhattisgarh it can be concluded that the soil of area found to be in neutral reaction range with conductivity less than 1 dS/m implied that soil suitable for cultivation of the most of crop plants without major problem.

Soil found to be low to medium in organic C and completely deficient in available N and P. But soil K found to be in medium to high status. Fe, Mn and Cu status of study area found to be in medium to high but Zn and B in deficient condition. Also, the fertility maps prepared were very helpful in spatial fertility management in the farm area.

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