International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 2202-2205

Received: 25-01-2018
Accepted: 28-02-2018

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Study GPS based soil fertility status of Tendukheda block of Narsinghpur district in central India

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Abstract
Study was undertaken to assess the soil nutrients status of Tendukheda Block of Narsinghpur District in Central India using GPS technique. In this study, spatial variability in properties that influence soil fertility such of eight villages of Tendukheda block was studied. Forty Eight (48nos.) soil samples were drawn from 0-20 cm depth. Six soil samples from each village selecting farmers randomly on the basis of land holding having low (<1 ha), medium (1-3 ha) and high (> 3 ha) farmer categories applying GPS, and only two soil samples were taken from each category. Soil samples were analyzed for different parameters *viz* pH, EC, O.C., available N, P, K, S and micronutrients like Zn, Cu, Fe and Mn. The soils of the area are characterized by neutral to alkaline in pH and medium to high in organic carbon content that was ranged from 0.51 to 0.96% with an average of 0.59 percent. The available NPK and S ranged low to medium (202-396 kg ha^{-1}), 9.26-23.44 kg ha^{-1}, 282-759 kg ha^{-1} and 5.45 to 14.41 mg kg^{-1} respectively. While micronutrients were reported from 0.19.to 0.69 mg kg^{-1} Zn, 1.24 to 2.5 mg kg^{-1} Cu, 4.00 to 6.13 mg kg^{-1} Fe and 7.70 to 11.75 mg kg^{-1} Mn. The nutrient index was with organic carbon, nitrogen and zinc while medium with phosphorus sulphur and Iron however, high N.I. was recorded with Cu and Mn content in the surface soil.

Keywords: Soil fertility, Tendukhed, Narsinghpur, GPS, central India

Introduction
Soil, land and water are essential resources for the sustained quality of human life and the foundation of agricultural development (Das *et al*., 2009) [6]. Efficient management of soil and water resources are emerging challenges for the scientists, planners, administrators and also farmers to ensure food, water and environmental security for the present and future generations (Das 1998 and Kanwar, 2000) [7, 12].
Any agricultural operations, soil is of the utmost importance as it is the cradle for all crops and plants. There are non re-renewable resources, formed at the rate of 1 inch. every 250–1200 years (John Madeley, 2002) [6]. This natural resource is finite in nature and also impossible for within time span of a human life (Mandal *et al*., 2009) [18]. The top soil having an average depth of about 15–30 cm on which the farming activities flourishes. It is facing serious problems due to human pressure. Hence, it is important to keep soil healthy and productive to continue our soil to function optimally to increase agriculture production with appropriate soil amendment and crop management practices (MacCarthy *et al*., 2013) [17]. In rural areas, the living standards of people mainly depend on agriculture, which is often determined by the fertility and productivity of soil. Soil fertility is a major constraints in countries like India (Gruhn *et al*., 2000) [9]. It comprises not only in supply of nutrient, but also indicates their nutrient supplying capability; moreover fertility of soil is subject to man’s control (Deshmukh, 2012) [8]. It may be maintained by scientific crop rotations, and the application of manure of fertilizers. Overuse of fertilizers can certainly lead to a waste of fertilizer resources and a serious environmental pollution (Clay, 2002) [4]. Hence, a comprehensive knowledge of soil fertility provides a better understanding in the current situation and for identifying soil nutrient distribution and trends (Dafonte *et al*., 2010) [5]. Earlier studies (Burrough and McDonnell, 1998; Li *et al*., 2003; Tan *et al*., 2005; Xu *et al*., 2013; Liu *et al*., 2014; Behera and Shukla, 2015) [2, 14, 27, 29, 16, 1] proved that geo-statistical analysis methods are most useful to obtain the knowledge of characteristics, distribution and variability of soil fertility in a timely and accurate manner for precision farming. For the purpose of improving soil management and quality cost/ control/benefit ratio by adapting new technologies like Geospatial Technology

(Iftikar *et al*., 2010; Markoski *et al*., 2015) [10, 19]. Therefore, study was undertaken to evaluate fertility status, for estimating soil as well as nutrient status for a site specific management approach in the farmers field of Tendukheda block of district Narsinghpur (M.P.) India.

Materials and Methods

Tendukheda Taluka is one among the four Taluka of Narsinghpur District comes under Central Narmada Valley agro climatic zone where intensive cropping system prevails. Soybean-wheat and rice - wheat cropping systems are general practices in this region. Area lies between 23^0 04' to 23^0 10' north longitudes and 79^0 00' to 79^0 55'east latitude and has a semi arid sub-tropical monsoon type climate with hot summer (maximum day temperature 25ºC–43ºC) and mild winter (9ºC 25ºC). The total rainfall varies from 1000-1200 mm having relative mean humidity varied from 70- 80 percent. The areas have medium to deep black soils belonging to order *Vertisols* popularly known as "black cotton soil"of central India. Eight villages of Tendukheda block were selected by adopting stratified random sampling methodology. The farmer's of selected villages have been categorized on the basis of land holding.

The study was the part of ongoing project on GPS base soil fertility evaluation under AICRP on STCR. The list of the villages and other information were obtained from IISS, Bhopal. Eight percent (aprox.) villages were selected from each tehsil using simple random sampling without replacement (SRWOR). From each selected village, six farmers [two of each category *viz*. large (>3 ha), medium (1-3 ha) and small (<1 ha)] were selected for collecting further information. One field was selected from each selected farmers keeping in view that the selected fields falls in the same village. From each selected field six soil samples were collected and processed for nutrient estimation. The location of the mid field was recorded using GPS. All the collected soil samples were analyzed by the standard analytical methods for pH, EC, O.C., N, P, K, S, Zn, Cu, Fe and Mn. Soil pH was determined in a 1:2.5 soil water suspension by glass electrode using pH meter (Piper, 1967) [23] and conductivity by using conductivity meter (Piper, 1967) [23]. Organic carbon was determined by Walkley and Black (1934) rapid titration method. Soil available nitrogen was estimated using alkaline permanganate method (Subbaiah and Asija, 1956) [26]. Soil available phosphorus was estimated by ascorbic acid method (Olsen *et al*., 1954) [21] and available potassium was estimated using flame photometer (Kundsen *et al*., 1992). Micronutrient analysis of the soil samples were extracted with DTPA-$CaCl_2$ – TEA solution (Lindsay and Norvell, 1978) [15]. The available Zn, Cu, Fe and Mn content in the extract were determined with the help of Atomic Absorption Spectrophotometer. Summarization of soil test values for each element was done to get the average status in the revenue villages.

The test values for each element were pressed statistically NI (Parkar, 1951) [22] for interpretation.

Results and Discussion

Estimation of component in soil, determines the magnitude of the acidity and alkalinity which directly influences agriculture productivity. The pH value reflects the integrated effect of the acid base reactions taking place in the soil system (Mokolobate and Haynes, 2002) [20].

Soil analysis data of 8 villages of Tendukheda block indicated that the pH of the soils of individual village (Table 1) ranged from 7.43 to 8.30. Among all the eight villages the highest pH values were found associated with village Padam fallowed by Gangai, Mudapar and lowest value was recorded in Kunda village with a mean value of 7.89 were calculated. The soils of Kunda village had neutral soil pH 7.43, and rest was recorded to be almost slightly alkaline. The electrical conductivity and organic carbon of the soils (Table 1) varied from 0.12 to 0.26 dsm^{-1} and 0.42 to 0.82% with a mean value of 0.17 dsm^{-1} and 0.59% respectively. On the basis of the limits suggested by Muhr *et al.*,(1963) for judging salt problems of soils it was observed that, all samples of area were found suitable indicating no salt problem. The organic carbon content (Table 1 and Figure 1) was found to be low (<0.50%) in 33 percent and only 10 percent samples were high (>0.75%) while 22 percent soil samples were found in medium organic carbon range.

The range is considerably large which might be due to variation in soil properties viz., pH, organic matter content, texture and various soil management and agronomic practices. Fort six percent soil samples were found to be in low phosphorus (<10 P kg ha^{-1}) might be due to the presence of organic phosphorus forms and after decomposition of organic matter as humus is formed which forms complex with Al and Fe and that is a protective cover for P fixation with Al and Fe thus reduce phosphorus. Villages of Tendukeda block are given in table 1. The ranges of available potassium were found 282-602 kg ha^{-1} with mean value of 539 kg ha^{-1}. While highest values were recorded with Kunda (758 kg ha^{-1}) fallowed by Keshali (602 kg ha^{-1}) and Gangai (583 kg ha^{-1}). However, 8.3% soil samples of Tendukheda block found to be deficient. The values with regard to sulphur ranged from 6.8 to 13.7 kg ha^{-1}. The 62% soil samples were found to be deficient in tenndukheda block which were noticed lowest among all the major and micronutrient except zinc.

Table 1: Soil chemical properties of Tendukheda block

Village	Longitute	Latiitute	pH	EC (dsm^{-1})	O.C. %	Ava.N (kg ha^{-1})	Ava. P (kg ha^{-1})	Ava. K (kg ha^{-1})	Ava. S (mg kg^{-1})
Mudapar	N230 10 33.4"	E0 780 55' 52.3"	8.04	0.26	0.67	320.00	11.89	524.53	7.04
Badiya	N230 10 47.0"	E0 780 55' 58.9"	7.75	0.14	0.50	239.81	12.54	585.01	5.45
Kunda	N230 08 22.9"	E0 780 53' 30.1"	7.43	0.25	0.51	246.99	11.82	758.80	13.17
Nandiya	N230 08 35.2"	E0 780 00' 08.7"	7.81	0.12	0.51	244.71	22.59	412.72	10.99
Keshali	N230 04 06.1"	E0 780 59' 17.7"	7.74	0.15	0.42	202.71	9.26	601.81	14.41
Padam	N230 03 58.3"	E0 780 57' 24.0"	8.30	0.16	0.82	394.19	6.96	568.03	9.65
Mahua Kheda	N230 10 53.6"	E0 780 59' 44.6"	7.83	0.13	0.67	323.59	9.98	281.68	13.73
Gangai	N230 05 57.5"	E0 780 50' 43.5"	8.21	0.15	0.59	284.20	23.44	582.77	6.81
		Mean	7.89	0.17	0.59	282.03	13.56	539.42	10.16
		Range	7.43-8.30	0.12-0.26	0.42-0.82	202 –394	6.96-3.4	282-602	6.8-13.7
		Nutrient Index			1.88	1.75	1.65	2.73	1.42

Note: Six soil samples drawn from each village

The status of Zn, Cu, Fe and Mn ranged from 0.19 to 0.69, 1.24 to 2.56, 4.00 to 6.13and 5.95 to 10.89 mg kg^{-1} with the mean values of 0.42, 1.85, 5.27 and 9.18 mg kg^{-1} respectively. On the basis of critical limits suggested by Takkar and Mann (1975) for Zn, (<0.6 mg kg^{-1} for deficient, 0.6 to 1.2 mg kg^{-1} for marginal and > 1.2 mg kg^{-1} for sufficient). The 72% samples were found be low in available Zn similar sresults were reported by Chouhan *et al.*, (2012) [3]. Considering the critical limits (4.5 mg kg^{-1}) proposed by Lindsay and Norvell (1978) [15], only 31.3% soil samples were deficient in available Fe. All the soil samples were sufficient in available Cu and Mn considering 0.2 mg kg^{-1} for Cu and 1.0 mg kg^{-1} for Mn as critical limits suggested by Lindsay and Norvell (1978) [15]. Similar results were reported by Sharma *et al.*, (2003) [25].

Soil Nutrient Index

Soil test information can be compiled area-wise in the form of "Soil test summaries" which indicate the number of samples falling in the category of low, medium and high status of major and micronutrients. This information of NI or Parker Index (Parker, 1951) [22] can be used to develop soil fertility map of the area. Where Nl, Nm and Nh are the number of samples falling in the category of low, medium and high nutrient status and are given weightages of 1, 2 and 3 respectively. Considering the concept of "Soil Nutrient Index" the soil of study area were categorized in medium fertility status for nitrogen, phosphorus and potassium while low NI was recorded with sulphur (Table 1 and 2 and Fig. 3). The values worked out from nutrient index for Organic carbon, nitrogen, phosphorous potassium and sulphur were 1.88, 1.75, 1.65, 2.73 and 1.42 respectively, against the Nutrient Index values < 1.5 for low 1.5 to 2.5 for medium and > 2.5 for high fertility status Ravikumar and Somashekar, 2013 also reported similar results. Similarly data obtained for micronutrient were 1.29, 3.0, 1.83 and 3.0 with Zn, Cu, Fe and Mn respectively.

Table 2: Soil Micronutrient properties of Tendukheda block

Village	Longitute	Latiitute	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})
Mudapar	N23^0 10' 33.4"	E0 78^0 55' 52.3"	0.30	1.89	5.48	8.60
Badiya	N23^0 10' 47.0"	E0 78^0 55' 58.9"	0.35	1.47	5.95	7.70
Kunda	N23^0 08 ' 22.9"	E0 78^0 53' 30.1"	0.38	2.56	5.15	9.56
Nandiya	N23^0 08' 35.2"	E0 78^0 00' 08.7"	0.43	1.96	6.13	10.37
Keshali	N23^0 04' 06.1"	E0 78^0 59' 17.7"	0.19	2.07	5.91	5.95
Padam	N23^0 03' 58.3"	E0 78^0 57' 24.0"	0.56	1.24	4.87	8.65
Mahua Kheda	N23^0 10' 53.6"	E0 78^0 59' 44.6"	0.51	1.62	4.64	11.75
Gangai	N23^0 05' 57.5"	E0 78^0 50' 43.5"	0.69	2.00	4.00	10.89
		Mean	0.42	1.85	5.27	9.18
		Range	0.19-0.69	1.24-2.56	4.00-6.13	5.95-10.89
		N.I.	1.29	3.00	1.83	3.00

Note: Six soil samples drawn from each village

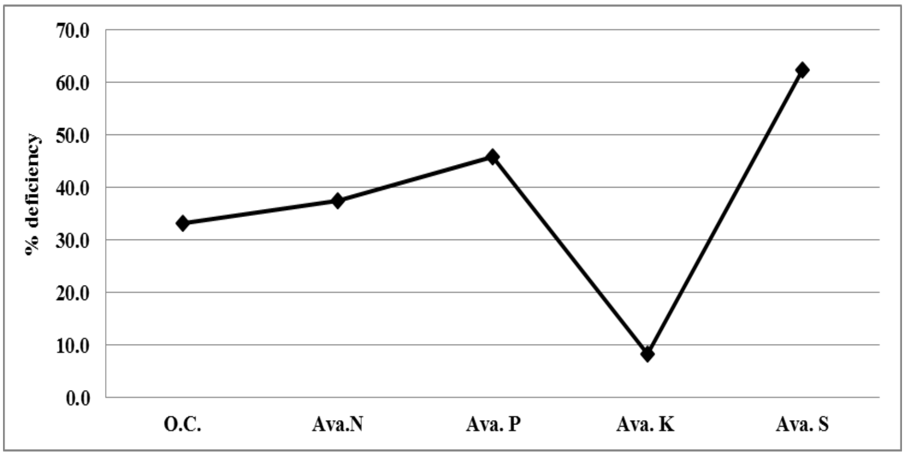

Fig 1: Variability in soil macro and secondary properties of Tendukheda block

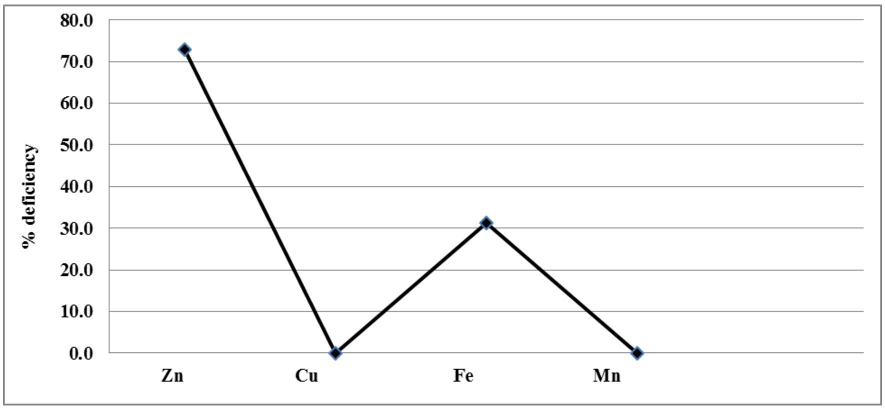

Fig 2: Variability in soil micro nutrient properties of Tendukheda block

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